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On the Design of a European Unemployment Insurance System*

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Abstract

We study the welfare effects of both existing and counter-factual European unemployment insurance policies using a rich multi-country dynamic general equilibrium model with labour market frictions. The model successfully replicates several salient features of European labor markets, in particular the cross-country differences in the flows between employment, unemployment and inactivity. We find that mechanisms like the recently introduced European 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 benefits, yield sizable welfare gains, contradicting the conventional classical view that costs of business cycles are small. Furthermore, we find that a harmonized benefit system that features a one-time payment of around three quarters of income upon separation is welfare improving in all Eurozone countries relative to the status quo.

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1 Introduction

The 2008 - 2012 financial and sovereign euro debt crises affected European labour markets asymmetrically both in terms of duration and severity of unemployment. In particular, stressed countries - such as Greece, Portugal and Spain - experienced high levels of unemployment, making it very difficult, if not impossible, to provide adequate insurance for the unemployed without violating the low-deficit (Fiscal Compact) commitments. This raised interest in proposals for a Europe-wide – or, more specifically, Euro-Area-wide – unemployment insurance scheme (EUIS). Following these proposals, in 2020, the European Comission has 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 EUR 100bn in the form of loans from the EU to affected Member States to address the recessionary increases in expenditures on the unemployed.

A common EUIS could be beneficial even without large aggregate shocks, 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. A prerequisite for any type of harmonization is the existence of a set of unemployment benefit policies that are acceptable for all member countries. However, implementing a European unemployment insurance may not be politically feasible. European countries differ in their unemployment rates not only because they are, at a given point in time, in different phases of the business cycle, but also because they have structurally different labour market institutions. As a consequence, long-term averages of unemployment rates vary substantially across Europe. The differences in labour market institutions may imply very different optimal benefit schemes, making it potentially difficult to agree on one common system.

In this paper we quantify both the welfare gains of an EUIS as a risk sharing mechanism (like SURE) against large country level shocks and the feasibility of a harmonised EUIS that can be a starting point of a common European system taking advantage of the above-mentioned potential gains. We do this in a multi-country dynamic general equilibrium model, in which unemployment insurance affects 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). These decisions in turn have aggregate consequences: on the aggregate stocks of employed,

unemployed and inactive; and on national budgets, in particular on taxes needed to finance unemployment insurance expenditures. In order to capture well the key aspects that determine the desirability of these two proposals, we develop and calibrate our model such that it can replicate well the labor flows and wealth distributions of the member countries of the Eurozone.

Our main quantitative results provide a positive prospective on both of these aspects of an EUIS. First, insurance against large aggregate shocks provide significant consumption smoothing benefits (through tax smoothing) for all member countries at a relatively low cost. Second, despite the large underlying differences across European labor markets (resulting in large unemployment differentials), member countries can agree on a common policy that improves welfare in all countries. The common policy, in most countries, increases the generosity of the UI system and provides better incentives to search with a frontloaded payment scheme.

In Section 2, we present the model we use 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 for 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 linear taxes on labor income.

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 labor market flows; (iii) the (current) country-specific unemployment insurance policies 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, our 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.

We see our multi-country model and its flexible parameterization, allowing for country-specific features of labour markets, 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 us to consider general equilibrium effects of these institutional reforms as well.

Our model and its calibration provide the framework for our policy experiments, the ultimate goal and other contribution of this paper. First of all, in Section 4, we hit our economies with a large shock that creates a significant rise in unemployment and a drop in TFP. Then we compare the aggregate path of our economies both under financial autarky and with the help of the EUIS modeled as a fund (like SURE) that allows smoothing the increased need for tax revenue. We use financial autarky as a benchmark as large crisis often makes borrowing very costly (due to rising spreads) especially for Southern and Eastern members of the Eurozone. As opposed to autarky, the EUIS allows to smooth the taxes that finance the rising unemployment benefit claims. The participation in the program is financed through country-specific 'experience-rated' contribution rates that make the EUIS dynamically budget neutral. These contribution rates clearly reflect the labor markets conditions in these countries. In countries, where the labor market is less resilient to aggregate shocks 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 labor 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).

Then, in Section 5, we assess whether, given the considerable heterogeneity in labour market institutions we document, European governments 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 first 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. Second, and more important 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 heterogenous and reflect the differences in labor market institutions. The welfare gains across countries are sizeable, up to one percent in consumption equivalent variation, and they do 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.

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)[1] 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).[2] 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,

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

[2] 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.

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.[3] 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. On the one hand, 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.

On the other hand, Claveres and Clemens (2017) and Moyen et al. (2019) study unemployment insurance and international risk-sharing in a two-regions DSGE model with frictional labour markets and calibrate their model to the core and the periphery of the Eurozone.[4] In both papers, a supranational agency runs an unemployment insurance scheme that triggers transfers to recessionary countries but has zero transfers in expectation. Such a scheme allows recessionary countries to maintain unemployment benefits and simultaneously reduce taxes, thus dampening recessionary effects similarly as in our experiment assessing the potential insurance gains of an 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

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

[4]Within the same DSGE 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.

participating in an 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 an 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 an 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 on (constrained) optimal national and EUIS design 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 our 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 the same replacement ratio.

2 Model

Our model economy consists of a union of I countries. We assume that the population in each country $i \in \{1, ..., I\}$ 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. 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. Each country is modeled 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, in the model, given labour income taxes and unemployment benefits, agents with

an opportunity to work are able to choose whether or not they work and agents currently not employed are able to choose whether or not to actively search for a job.

Timing and Preferences. Time $t \in \{0, 1, 2, ...\}$ 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:

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

Agents derive utility from consumption c_t and disutility from employment w_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. $w_t \in \{0, 1\}$. 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 $z \in Z = \{\bar{z}_1, \bar{z}_2, ..., \bar{z}_{n_z}\}$. 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

$$\log(z') = \rho \log(z) + \epsilon_e, \qquad \text{where } \epsilon_e \sim N(0, \sigma_z^2)$$

while during non-employment

$$\log(z') = \rho \log(z) + \epsilon_n, \qquad \text{where } \epsilon_n \sim N(\mu_z^n, \sigma_z^2),$$

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 labor 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.[5] Consequently, there is no complete overlap between

[5]Note that while the government cannot distinguish the inactive from the unemployed, official unemploy-

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 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. In this way we capture the heterogeneity in labour market institutions across the Eurozone.

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 agents 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.[6] 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 $x \in \{e, n^e, n^n\}$, which are 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 virtually zero liquid wealth. Finally,

ment 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.

[6] 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).

eligible non-employed agents receive unemployment benefits of

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

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 should be a good enough proxy for previous labour earnings. Furthermore, to avoid counter-factual dis-saving behavior, unemployment benefits can never be lower than means tested social income.

We now define the decision problem of agents in different labor market states recursively. To ease notation, we drop the time t dependency and country specific dependency i.

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

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

The continuation value depends on the future realization of labour market and productivity shocks and on savings 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

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

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 and hence 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

$$N_n(a,z) = \max_{a',c,s}\Big\{u(c) - \gamma(s) + \beta\mathbb{E}_{z'}\Big[\lambda(s)\tilde{V}(a',z') + (1-\lambda(s))N_n(a',z')\Big]\Big\}$$
$$\text{s.t.} \qquad c + a' = \mathbb{I}_{\{a<\underline{a}\}}t_r + (1+r)a.$$

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, respectively, the job acceptance decision for eligible and non-eligible agents,

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

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.[7]

Government. The government taxes labor 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

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

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 can actively search to reduce the risk of long unemployment spells. Unemployment insurance can provide insurance against job loss and job finding risk. However, this insurance is not without (moral hazard) 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

[7] We deviate from this assumption only in section 4.

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 $Z = \{\bar{z}_1, \bar{z}_2, ..., \bar{z}_{n_z}\}$ 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:

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

(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 $t + 1$.

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* $i \in \{1, 2, ..., I\}$ *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.*

3 Calibration

We calibrate the model to quarterly data assuming that the union of $I = 16$ Eurozone countries is in a stationary general equilibrium.[8] 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. In particular, 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. Further, we assume that idiosyncratic productivity follows the same Markov process, for which we use a discretised 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 $(\bar{b}^i, \mu^i, \tau^i, t_r^i)$.[9]

In total our model has $6+16\times10 = 166$ parameters. We interpret the three sets of parameters as a hierarchical structure in the degree to which policy can influence them. The policy

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

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

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 1: Parameters

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.[10] 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.

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

3.1 Calibration strategy

We now describe in detail how the model is calibrated. First, 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.[11]

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

Table 2: Common parameters

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% each 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%.[12]

The country specific parameters are summarized in Table 3. The policy parameters are set using data counterparts. Specifically, the tax rate τ^i corresponds to the social security contribution rate in country i.[13] 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

[11] 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.

[12] 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.

[13] 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 $G = 0$.

expected duration of unemployment benefits eligibility in the model. We therefore set $1/\mu^i$ to the duration of eligibility according to the law in country i. As described above, we model the eligibility process in this way because it allows for a simpler representation and a reduction in the dimensionality of the state space. For the unemployment benefit replacement rates, we set $\bar{b}^i$ to the data equivalents in Esser et al. (2013). 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.

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

Table 3: Country specific parameters.

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.[14] Dubois and Ludwinek (2015) report high non-take-up rates (19.9%-80%) of guaranteed 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.

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

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,[15] 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. 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. Figure 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.

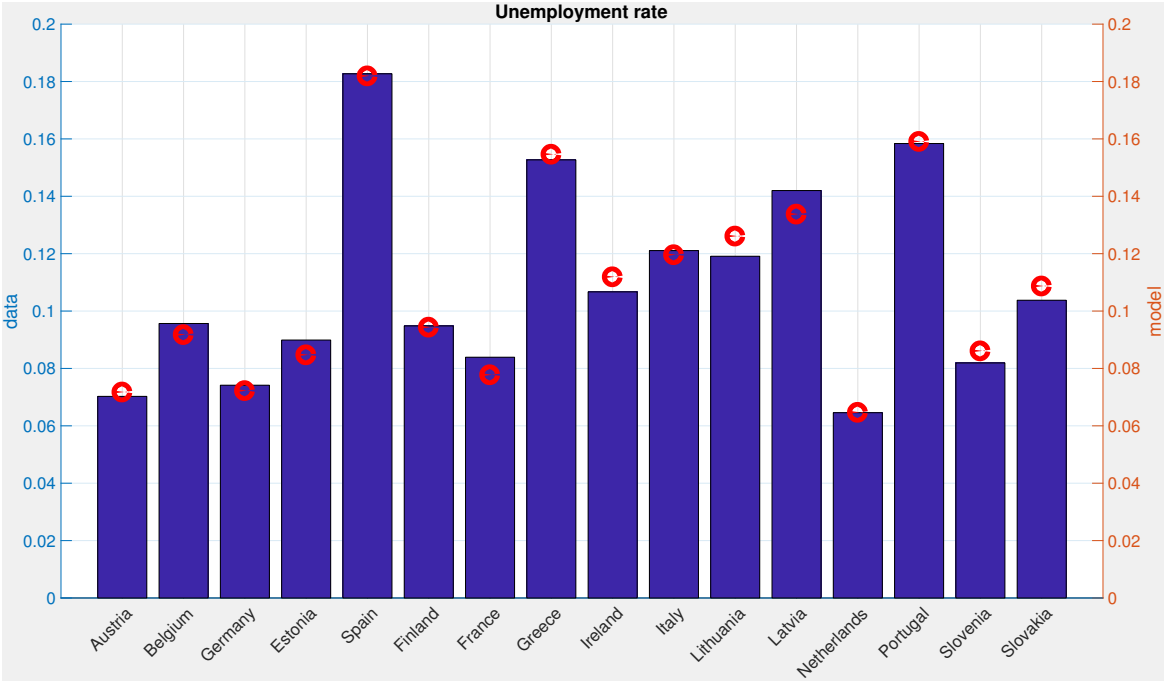

Figure 1: Unemployment rates

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.

[15]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.

Regarding the flows across labour market states, we only target the flows into employment. The remaining six flows are summarized in Figure 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.

Figure 2: Untargeted labour market flows

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 inactivitiy. 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 is this flow 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.

Also the flows from inactivity to unemployment as well as the persistence of inactivity are well matched in most countries. In all countries but Finland is the persistence in inactivity at 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. In particular, 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 Figure 3 shows the wealth shares of the five quintiles of the wealth distribution for the studied countries according to Eurostat data (data from 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.

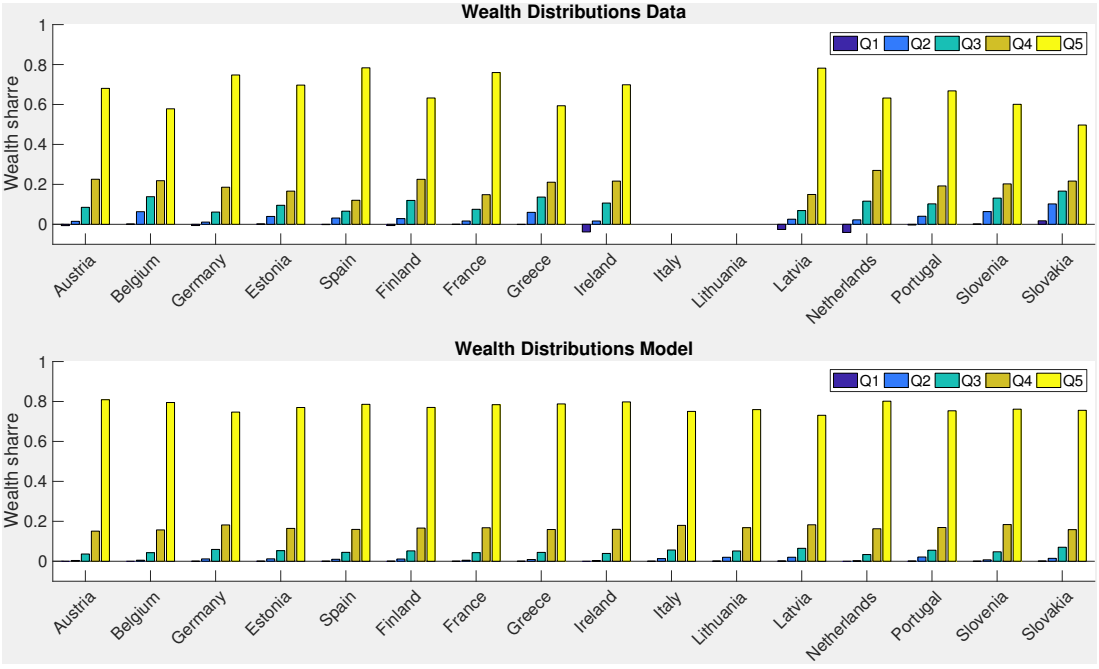

Figure 3: Wealth distributions

In the model, wealth inequality 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 even 50-50 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.[16] 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

A contribution of our calibration exercise is that it provides a parsimonious diagnosis of the diversity of European labour market institutions. We visualize this in Figures 4 to 6. Figure

[16]Home ownership rates are high also 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.

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 21 percent while λ_u^i ranges between 10 percent and 26 percent. These parameters provide a reduced form description of institutions related to job creation and job search effectiveness. High arrival rates indicate dynamic labor 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 no efficiency gains from making agents actively search.

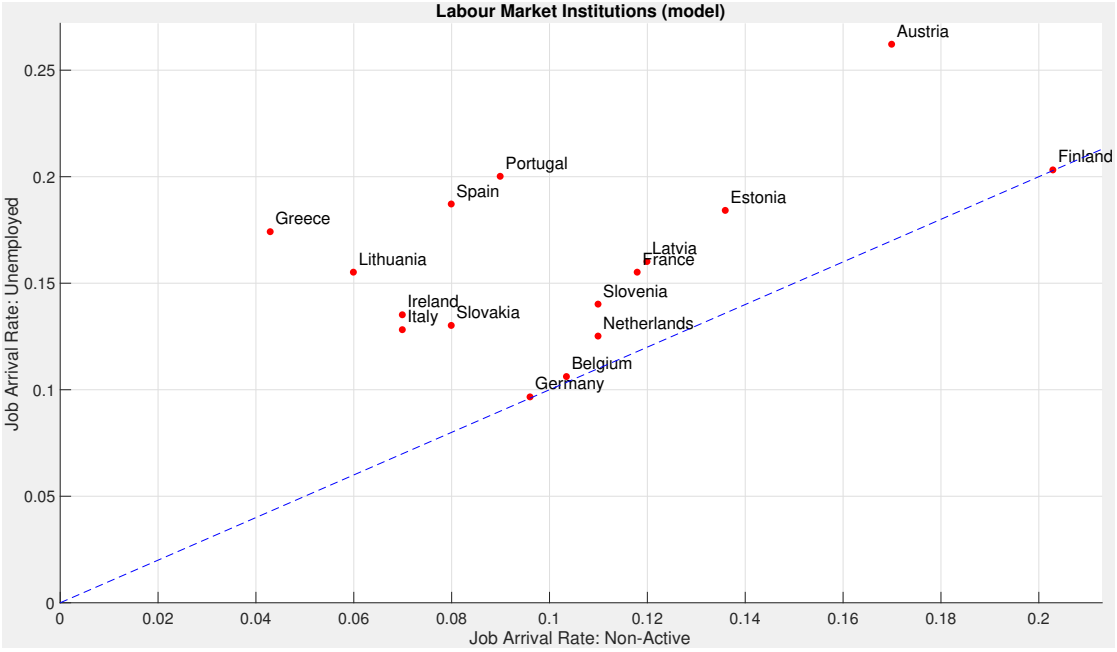

Figure 4: Job Arrival Rates.

Figure 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.[17] 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 characterised 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

[17]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.

job destruction rate is largely due to the high prevalence of temporary labor contracts with very low firing costs in Spain.

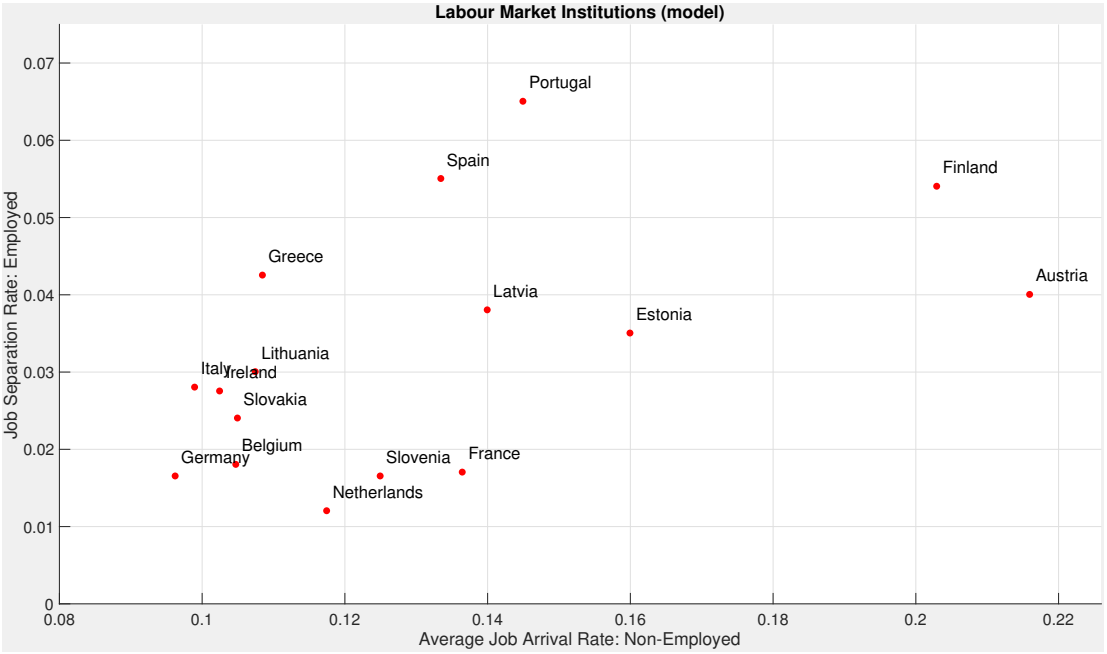

Figure 5: Labour Market Rigidity.

Finally, Figure 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.[18] 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 replacement rates (Finland, Portugal, France and Spain). Given that the parameters representing the effectiveness of labor 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 welfare criterion.

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

[18]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.

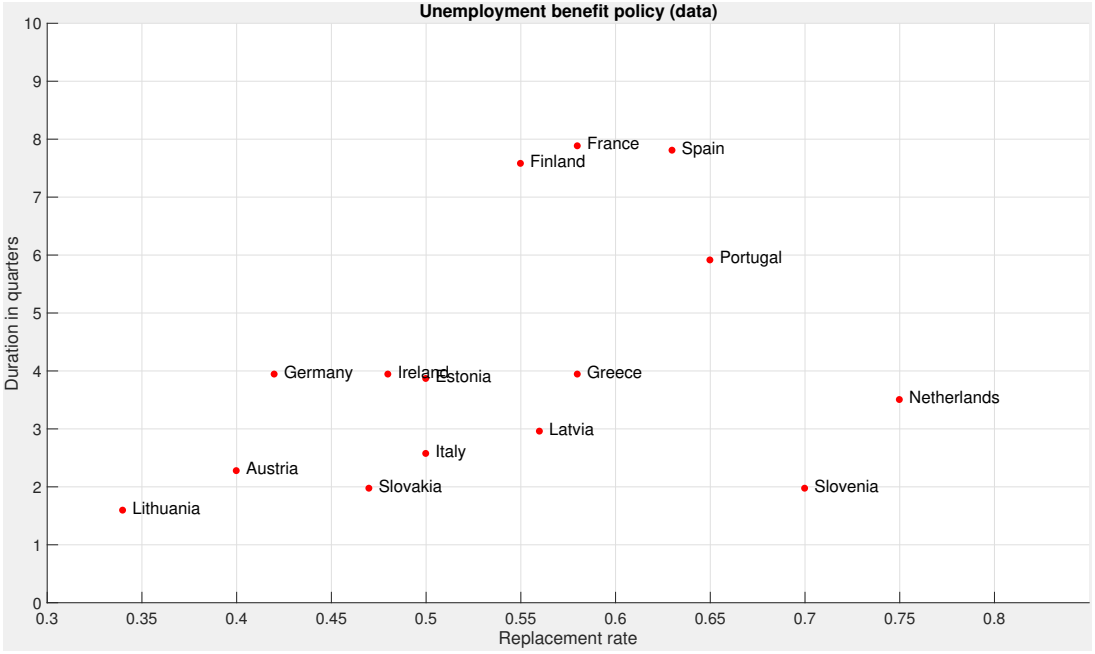

Figure 6: National Unemployment Benefit Systems.

4 European Unemployment Insurance as Automatic Stabilizer

One of the main arguments for a European Unemployment Insurance System (EUIS) is its potential capacity to insure participating countries against fluctuations in unemployment expenditures. In particular, during severe economic recessions this would relief national governments' stressed budgets. With this rationale in mind in 2020 the European Comission has 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 EUR 100bn in the form of loans from the EU to affected Memeber States to address the recessionary increases in expenditures on the unemployed. As of the time of writing, more than EUR 75bn have been disbursed, thereof EUR 18.0bn and EUR 26.7bn to heavily affected Spain and Italy, respectively. These amounts are substantial, corresponding to around 1.4% of both countries' GDP in 2020. In this section we quantitatively assess the desirability of having such mechanism in place. We design the EUIS in a way that closely mimics the SURE instrument. While our experiment is designed to closely mimic the SURE instrument, its insights carry over to broader cross-country risk sharing mechanisms.

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 a completely 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.[19]

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).[20] In particular, a deep recession will be modelmodeleded 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 modeled endogenously.

We consider two cases: financial autarky and insurance through the EUIS. In financial autarky, along the transition the tax rate needs to adjust to balance the national government budget constraint period by period.[21] This should capture the fact that in deep recessions national governments often have very little borrowing capacity. In the case of the EUIS, we assume that countries only need to balance their budgets inter-temporally. Through borrowing from a European fund, national governments are able to inter-temporally smooth their expenditures on unemployment benefits. In particular, in that case the tax rate increases by a constant and permanent amount such that in net present value terms each country's net position to the fund is zero. Hence, as with the SURE instrument, countries are required to repay their withdrawals. 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 such that the intertemporal budget constraint clears only in expectation, rather than actually.[22]

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

[20] 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.

[21] 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.

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

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 optimisation problems. We calculate the difference in aggregate social welfare of going through the recession with the EUIS in place versus the same negative shock in autarky.

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,

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

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

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

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

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

holds.

We consider a deep recession with TFP dropping by 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 $\rho_A = \rho_\sigma = \rho_{\lambda_u} = \rho_{\lambda_n} = 0.75$. Figure 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.

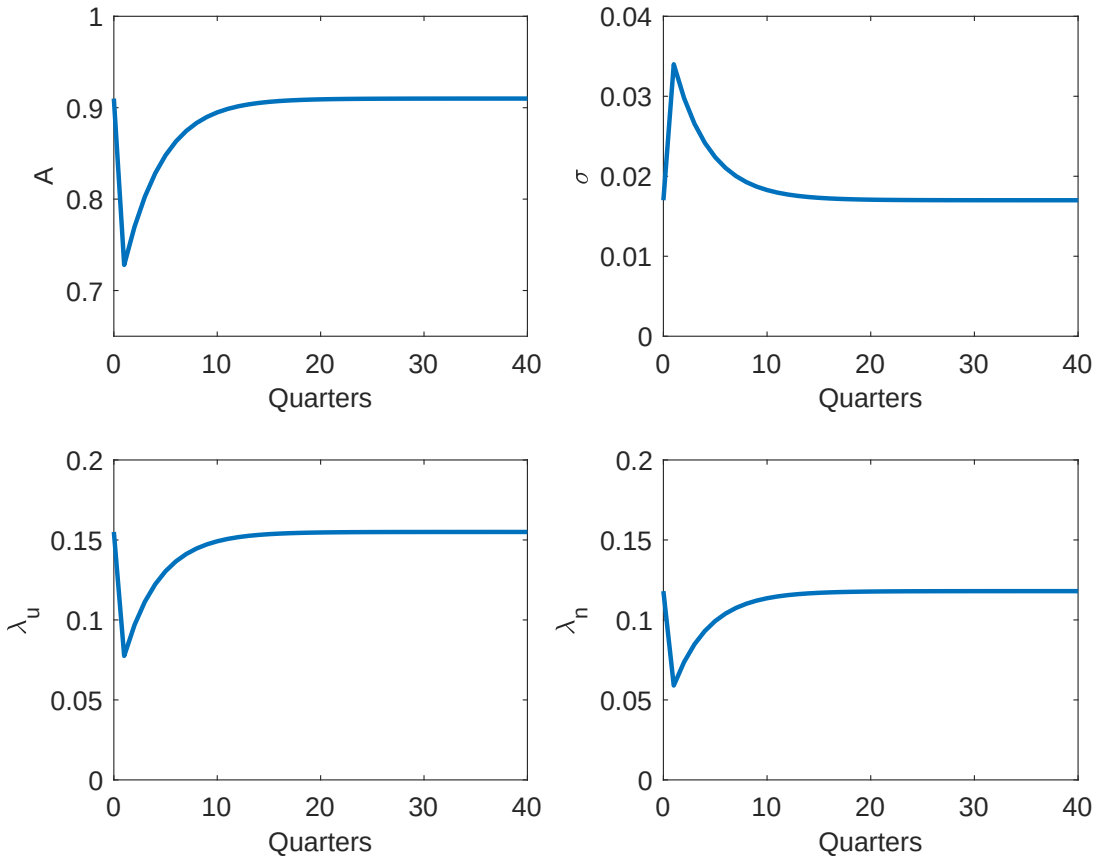

Figure 7: Shock process in France.

The shock induces changes in labour markets, which are depicted in Figures 8 and 9. Figure 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 agents not in employment, which is the mirror image of the employment rate. These agents are either unemployed, that is actively searching for a job, 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 mechanically prevent more agents from finding new jobs. However, to a substantial degree they result from endogenous decisions of agents. The two right panels of Figure 9 decompose the share

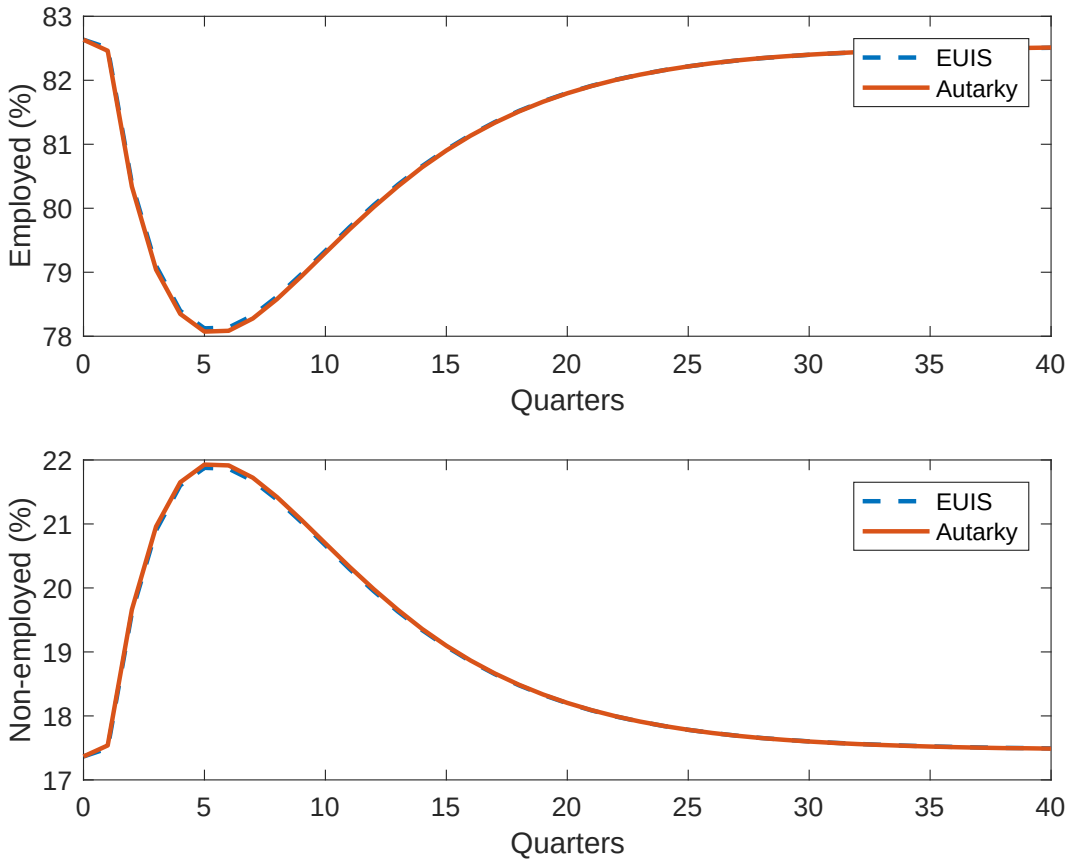

Figure 8: Employment and Non-Employment in France.

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 not separated agents decide to quit working because of the reduction in wages.

The two left panels of Figure 9 decompose the share of non-employed agents 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. Hence, 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 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%.

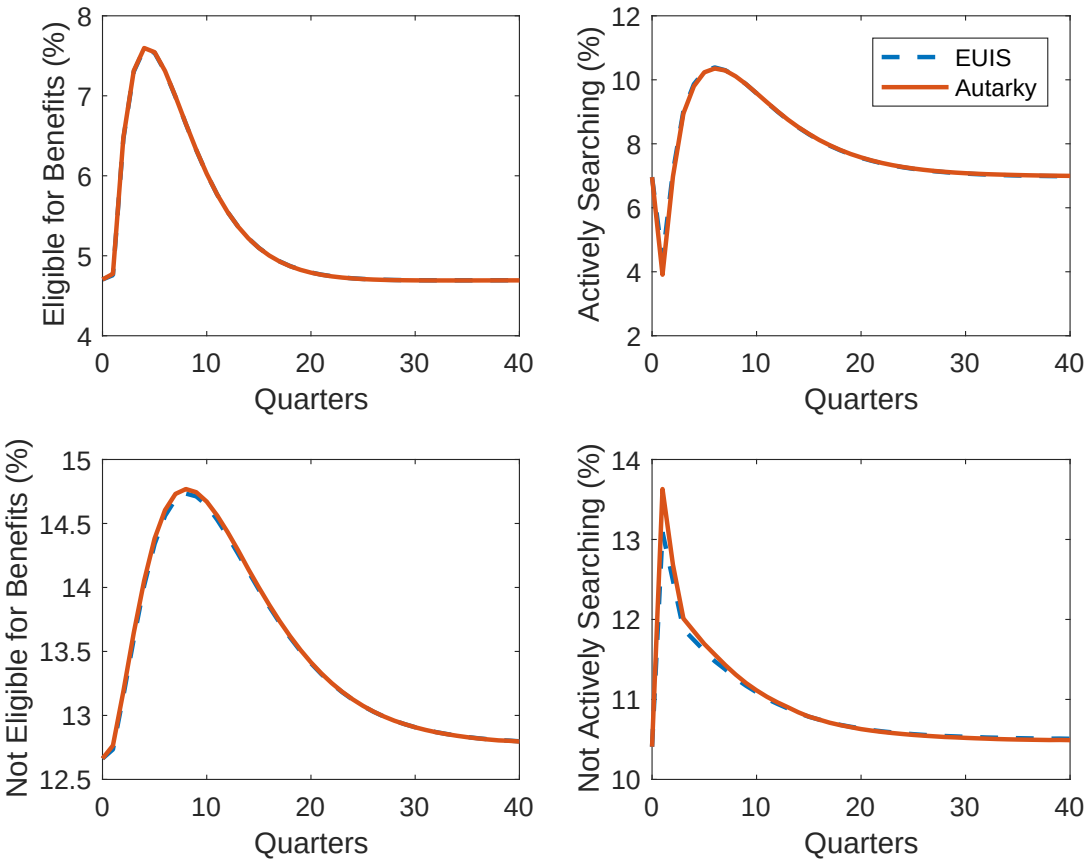

Figure 9: Decomposition of Non-Employment in France.

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 Figure 10 depicts the evolution of the tax rate in France for the case of financial autarky, 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.[23]

By contrast, the dashed line shows the rise in the tax rate when the country is able to

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

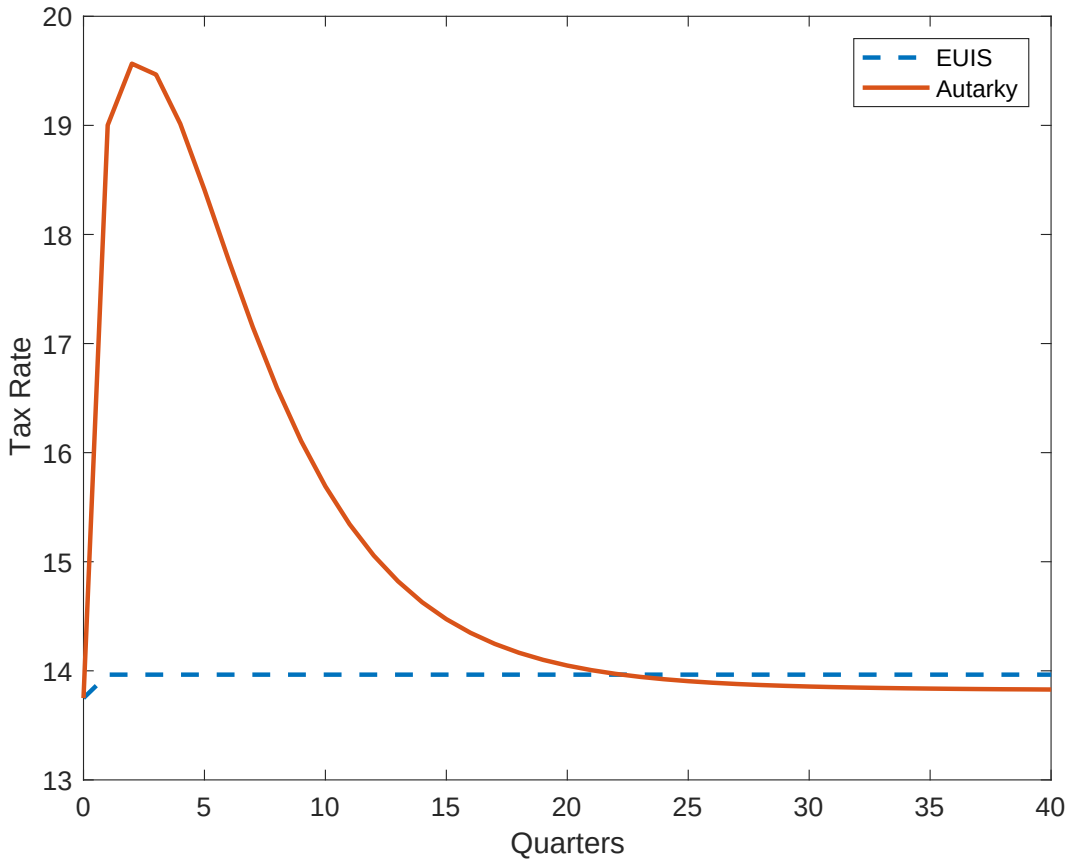

Figure 10: Taxes in France.

borrow from the EU fund, e.g. the SURE instrument, and is allowed to pay back these withdrawals gradually over time. Specifically, 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 behavior, in a way that dampens the recessionary impact of the initial shock. Most apparently, in the lower right panel of Figure 9 we observe that the initial increase in inactivity is around half a percentage point less in the case of the EUIS than under autarky. 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, behavioral responses to the tax changes are an order of magnitude smaller than those induced by stochastic shock as in most of the other Figures above the solid line almost overlaps with the dashed line.

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 an 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.[24] Figure 11 depicts the contour lines of these welfare gains.

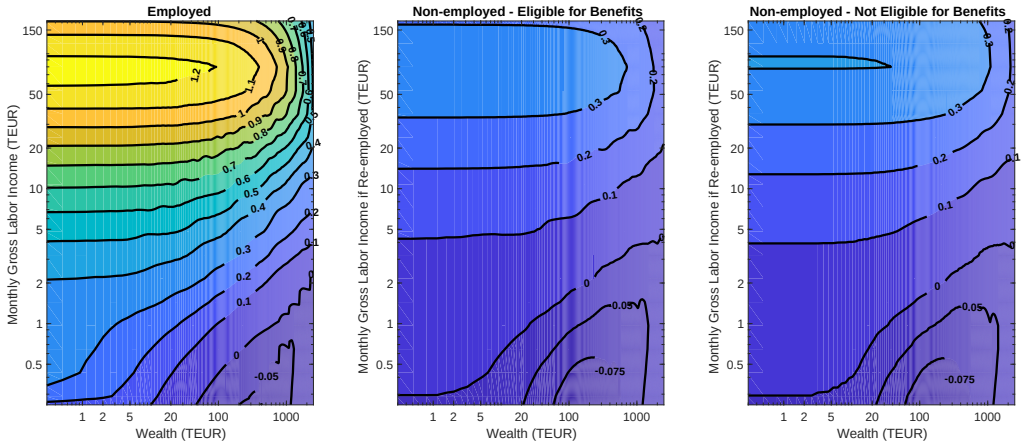

Figure 11: Welfare Gains (% CEV) in France.

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 labor 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 labor income rather than assets. The gains tend to increase in labor income since the tax savings increase in wages.

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

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

is the monthly gross labor income, which they would get, if they would be re-employed immediately, that is 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 labor 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 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 means we define the aggregate welfare gain as the average over all individual gains

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

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

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

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 $\Delta^{FR}_e = 0.27$. The average gain for non-employed individuals, who are eligible for unemployment benefits, is $\Delta^{FR}_{n^e} = 0.02$, while the non-employed agents, who already lost eligibility, experience a small loss of $\Delta^{FR}_{n^n} = -0.04$ on average.

Another dimension to assess the viability of an 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 French people would be in favor. 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 favor 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 Figure 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.

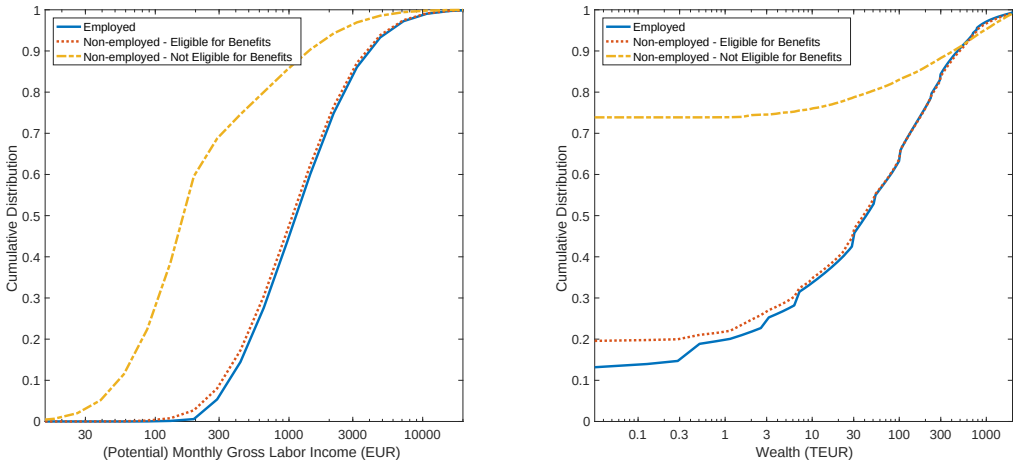

Figure 12: Composition of agents in France.

The left panel of Figure 12 shows the cumulative distribution functions for productivity conditional on employment and eligibility status. As before, for better interpretability we convert productivity into gross monthly labor 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 Figure 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 agents among the non-eligible non-employed, which is driven by a wealth effect. In particular, some agents with high incomes in the past have accumulated a high 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 this very 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 each and 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

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

Table 4: Welfare Gains from the EUIS (Share of Agents in Support)

in favor of the EUIS. There is quite some 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 favor, while in Germany and Ireland their support is just under 50%. However, on the aggregate, 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 labor 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 labor 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.

On the "No-Borrowing" Assumption

An important assumption we make is that countries 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 Eurozone as a whole has a much greater borrowing capacity than individual governments.

However, higher borrowing costs usually reflect a higher probability of default. One could hence argue that giving countries the opportunity to borrow at cheap rates is in fact a cross-country transfer, since effectively the Eurozone as a whole is taking on the borrowing countries' default risk, without being adequately compensated for it. In this context it is important to keep in mind that a large supranational organization like the EU or the Eurozone is not a regular investor. In particular, it has substantial power to influence the countries' repayment probabilities.

5 Harmonization

In the previous section, we studied a European unemployment insurance system which provides relief to national government budgets in crisis situations. There, are however, proposals for an even more integrated European system that harmonizes unemployment insurance across all member states. Such 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 labor across European countries. It may strengthen social/political cohesion across Europe. Again, the explicit modeling of these reasons is beyond the scope of this paper. Instead, in the following we

ask a simpler question: Would a fully harmonized system across Europe would be politically feasible (i.e. be acceptable by all member states compared to their current system), given the documented heterogeneity in European labor market institutions. A positive answer would give a very strong indication that a common system put in place to capture the above (unmodeled) benefits have 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 labor 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.

Specifically, 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 social income l 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.[25] Figure 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

[25]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.

there were no behavioral responses of agents in terms of search, job acceptance, and quitting behavior. In the case of Spain (and most other countries) these behavioral responses are not that large.

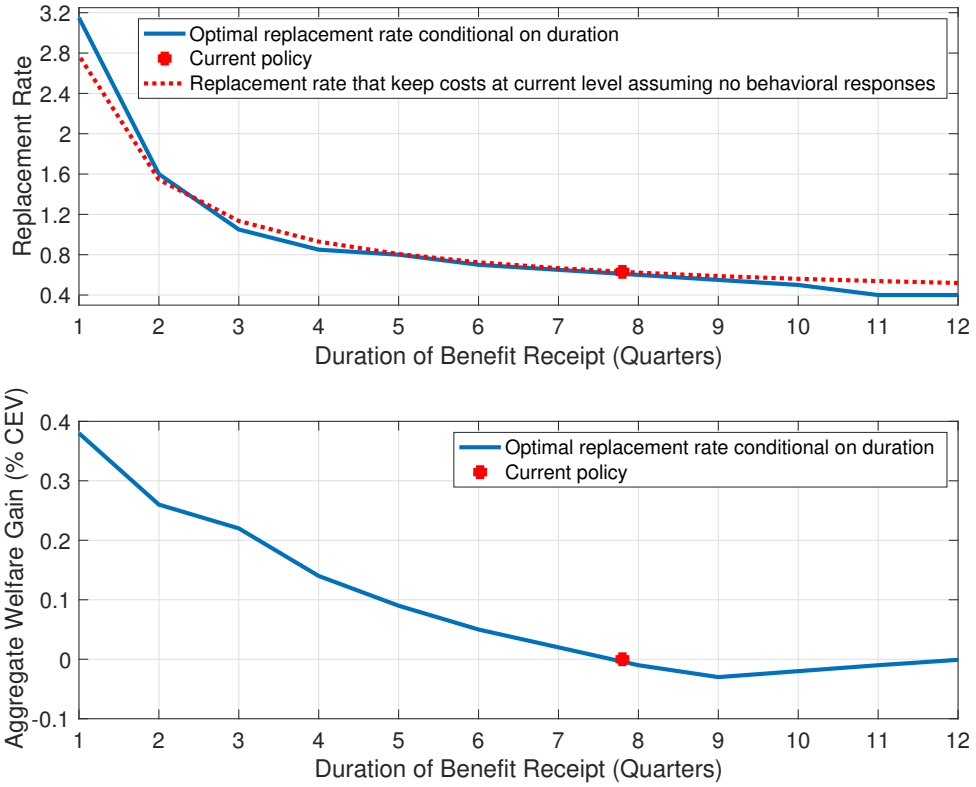

Figure 13: National Optimum in Spain.

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 that the optimal replacement rate $\bar{b}(\mu)$ is chosen, is U-shaped. Specifically, for durations between 8 and 12 quarters the welfare gain is slightly negative, while it is again 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.

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 then 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, with which the amount of received benefits is independent of the duration of non-employment, provides better incentives to search for a job and to accept offers. At the same, time 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 labor market institutions in the respective countries, and (ii) the level of means tested social income, which any agent without wealth is entitled to. When the latter is sufficiently high, a one time payment at the beginning of the spell is optimal, because the social transfer is a close substitute to constant UI and therefore provides enough insurance against long-term unemployment. At the same time, 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 behavior 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 (searching) 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.[26]

In sum, whenever the social costs of agents' search and job acceptance behavior are very different from the private ones, e.g. when $\lambda_u >> \lambda_n$ and $\gamma >> 0$, or when $z >> 0$, a one time payment at the beginning of the spell is optimal. By contrast, in some countries like Germany where the moral hazard problem of search is not such a big issue, since $\lambda_u \approx \lambda_n$ 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 only payed 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 behavior in duration, and (ii) the overall generosity of the system is currently not optimal, that is that unlike in Spain, fixing the current duration, the replacement rate should be much higher (Germany, Finland), or lower (Belgium).

5.2 An Agreeable Harmonized Benefit Scheme

Figure 14 summarizes the results for all countries. It shows the average welfare gains in percent of consumption equivalent variation of 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 in a very drastic and abrupt way. In particular,

[26] 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, 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.

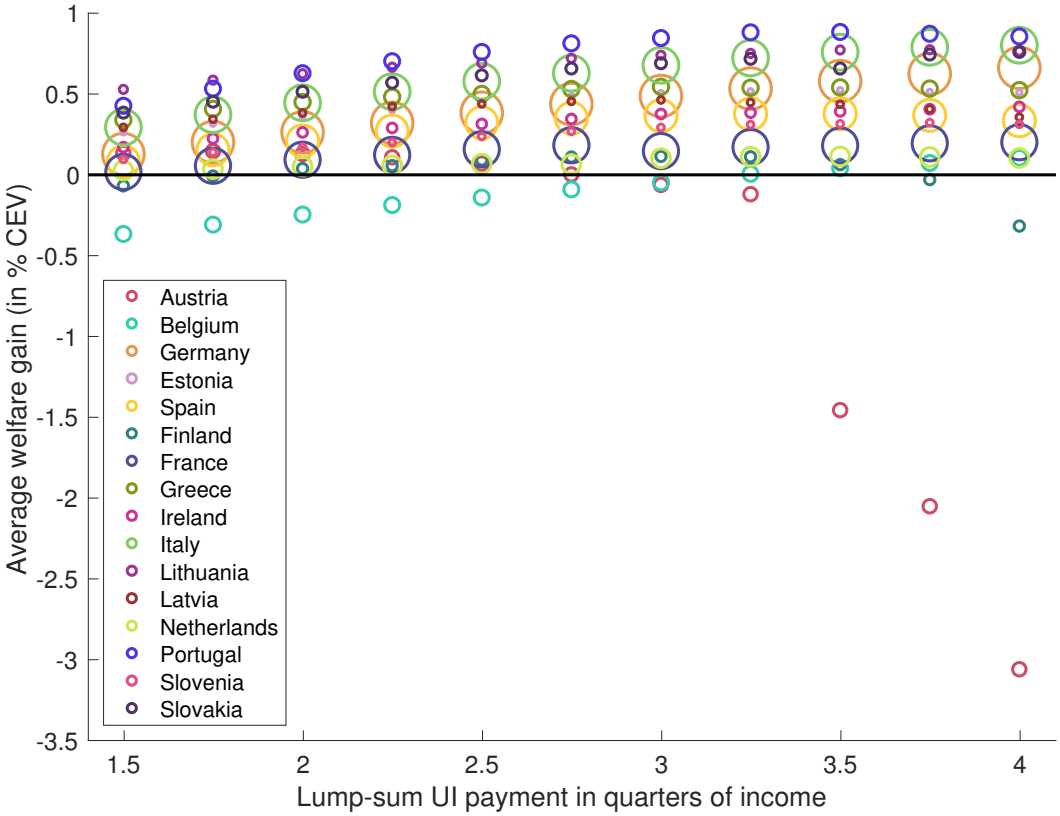

Figure 14: Harmonized System.

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 labor markets (see Figure 5), in which a substantial share of agents gets separated, re-matched and separated 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.[27] Similar qualification periods are part of the existing unemployment schemes in

[27]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

many countries.

As mentioned before, the lump-sum payment has the disadvantage that some agents, who quickly find jobs, are "overpaid" by the government, which is socially costly. However, it has the advantage that the agents immediately have a higher incentive to search and accept job offers. The effects of frontloading 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 behavioral 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.

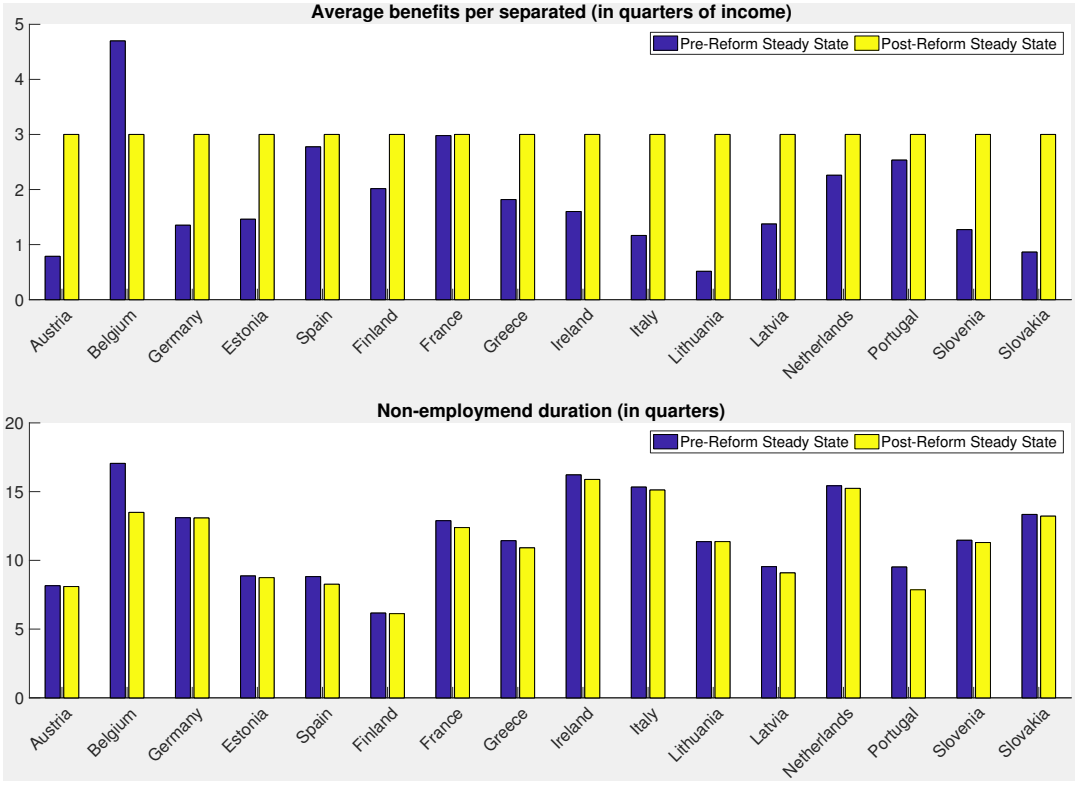

Figure 15: Generosity of benefits and duration of unemployment

The upper panel of Figure 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

the number of quarters $\{1, 2, ..., 7, 8\}$ 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.

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 benefits encourages search effort and job acceptances. Specifically, 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.[28]

The positive effect of front-loading UI on search and acceptance behavior 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. Especially, 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 less decummulation of human capital and therefore a more productive labor force. Furthermore, in all countries but Austria, Finland and Lithuania is the wage change smaller than the productivity change. The reason is that now more jobs, that is also more lower paying jobs, are accepted. As also discussed in Lindner

[28]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.

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

Table 5: Long run changes post reform

and Reizer (2020) the overall effect on wages is hence 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 a 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. In particular, if one takes into account that a more gradual introduction, where initially non-employed are subject to the old system, would reduce the initial costs on the employed and hence increase welfare further. Finally, 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).[29]

[29]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.

Open vs. Closed Capital Markets

In our computations above we fixed the interest rate, that is we effectively assumed that 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, in which the interest rate adjusts 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 an increase of total European capital supply (savings) of 0.25% and an increase of total European capital demand of 0.95%. This implies that the excess demand for capital is only 0.7% of the initial capital stock. When instead treating 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. For more details, see Appendix A.2.

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 whole Eurozone, successfully replicates several salient features of European labor 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 realistic framework finds significant benefits from such an instrument. Appropriately replicating the wealth distributions, in particular the fact that a substantial share of the population owns basically zero wealth, is crucial for this finding. Our analysis thus provides strong support for this actually implemented European policy.

We then consider an even more integrated counter-factual European unemployment in-

surance system that involves the harmonization of unemployment benefit policies. We find that despite the large heterogeneity in European labor 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.

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,[30] maintaining country specific actuarially fair accounts. Then if, as we 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 will become a central element of EU social protection policy.

In this paper, we assume that the national 'labour market institutions' do not change with the introduction of an EUIS, but the resulting tax differences across countries, reflecting their structural labour market differences, in terms of job creation and destruction, provide clear incentives for labour market reforms. Addressing these questions would require to endogenize some of the parameters representing these institutions. We leave this interesting task for future research.

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A Robustness Exercises

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.

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 6: Welfare Gains from the EUIS (Share of Agents in Support)

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 singly country but Austria do 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, also the gains for the non-eligible non-employed, that is all agents who are non-employed for longer than one quarter, also slightly decline, 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 the initially employed. By contrast, initially non-employed, or newly separated agents, are better of in financial autarky because they don't 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 autarky. Only in Belgium is the gain to the employed 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 labor market, in which a substantial share of agents gets separated, re-matched and again separated within a short period of time (Figure 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 Figure 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 as there are capital flows in and out of the Eurozone, it is a large enough player to potentially affect world interest rates. We hence performed several robustness checks with respect to the assumption that the interest rate is fixed. As it turned out, even the other 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 demonstrate why.

Specifically, 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 change substantially in all countries. Nevertheless, the responses in capital supply and demand are very small. Assuming a constant interest rate, any change in effective labor supply is absorbed one for one by an equal change in the demand for capital, that is the capital-labor 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.

Looked 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

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

Table 7: Long run changes in supply and demand of capital

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 response have any substantial effect.