Incentive-Compatible Unemployment Reinsurance for the Euro Area*

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Abstract

We model a reinsurance mechanism for the national unemployment insurance programs of euro area member states. The proposed risk-sharing scheme is designed to smooth country-level unemployment risk and expenditures around each country's median level, so that participation and contributions remain incentive-compatible at all times and there are no redistributionary transfers across countries. We show that, relative to the status quo, such scheme would have provided nearly perfect insurance of the euro area member states' unemployment expenditures risk in the aftermath of the 2009 sovereign debt crisis if allowed to borrow up to 2 percent of the euro area GDP. Limiting, or not allowing borrowing by the scheme would have still provided significant smoothing of surpluses and deficits in the national unemployment insurance programs over the period 2000–2019.

Keywords: unemployment insurance, risk sharing, reinsurance, euro area, fiscal policy, mechanism design, limited commitment
JEL codes: E62, J65, F32

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1 Introduction

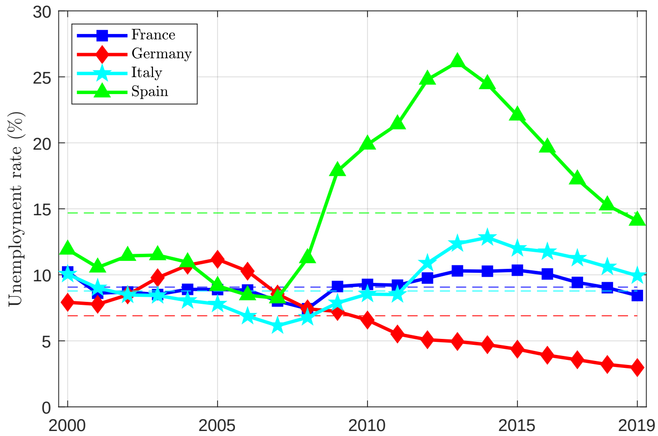
The 2009-2014 euro area sovereign debt crisis has demonstrated that national economies may be subject to pro-cyclical financial constraints (Bénassy-Quéré et al. (2018)). Countries at the euro area periphery had to scale down their social safety nets and implement austerity measures under pressure from creditors. These pro-cyclical fiscal policies could have been avoided if member states had not been subject to rising spreads on their sovereign debt.

There have been numerous proposals to increase cross-country risk sharing in the euro area (EA) in the form of a common reinsurance mechanism for national unemployment insurance programs (see the reviews in Dolls (2019), Beblavy and Lenaerts (2017) and our survey in Section 2). Using historical data, several authors have shown that relatively small contributions to such reinsurance scheme could fund transfers to member countries subject to large adverse macroeconomic shocks. However, most of these proposals are based on strictly statistical or ad hoc rules.

We complement and extend this literature by proposing a euro area unemployment reinsurance scheme (thereafter EA-URS) derived from mechanism-design first principles. Specifically, we develop, solve, and simulate using historical data, a model in which countries participate in a common reinsurance platform. The EA-URS is optimally designed so that member countries co-insure one another, both within and across time periods, in terms of their own *relative* variations in unemployment over time. A country contributes (pays an insurance premium) into a common fund when its unemployment rate is low, defined relative to the country's median unemployment rate, and receives a payout (indemnity) from the fund when its unemployment rate is relatively high. The contribution and payout amounts are optimally determined as the solution of a dynamic mechanism-design problem. Net redistributionary transfers or subsidies from countries with persistently low unemployment to countries with persistently high unemployment are not part of the scheme by design. Each country's net expected contributions or payouts with respect to the scheme are nil over a long time horizon by construction.

The EA-URS is based on the presence of idiosyncratic (cyclical or other) fluctuations in country-level unemployment, that we document, and on the ability of euro area countries to borrow jointly through the reinsurance platform at equal or better conditions compared to having to issue their own debt in downturns. Figure 1 plots the unemployment rates of the four largest euro area countries – France, Germany, Italy and Spain. The Figure demonstrates that country-level unemployment fluctuations are significant but imperfectly correlated. For example, only in one of the twenty years plotted (2010) the unemployment rate was above the median in all four countries. In all other years since 2000 at least one of the countries had an unemployment rate below its median value for the 2000-2019 period.

Figure 1: Unemployment rates in the euro area 'big four'



Notes: the figure plots the unemployment rate (in percent) in the four largest euro area economies over 2000-2019. The horizontal dashed lines show each country's median unemployment rate over the period.

Our main contribution is the design of a reinsurance scheme which is incentive-compatible and robust to *limited commitment*. This means that the optimal insurance contributions and payouts are such that, given the countries' intertemporal smoothing preferences, no country has an incentive to leave the platform at any time and in any unemployment state. To give a concrete example, even if a member country goes through several consecutive years of low unemployment, the country would still prefer to continue to contribute to the reinsurance platform because, in expectation, it would benefit from receiving payouts from the platform in future years when its unemployment rate is high relative to its median value. Second, by suitably normalizing the countries' unemployment rates and unemployment insurance revenues, we explicitly address and avoid possible concerns about persistent one-way redistributionary transfers, focusing instead on smoothing idiosyncratic fluctuations around each country's median economic conditions.

We simulate the proposed EA-URS for 17 euro area countries using data on their unemployment rates and unemployment insurance revenues from 2000 to 2019. We show that the countries' national unemployment insurance programs could have shared risk with one another nearly perfectly if the EA reinsurance scheme is able to borrow up to EUR 203 billion (less than 2 percent of the euro area GDP) in 2017. Not allowing borrowing by the scheme still achieves nearly perfect unemployment risk smoothing in the periods 2000-2010 and 2017-2019, however, without the ability to borrow, the EA-URS' risk-sharing ability is diminished between 2010 and 2016, the sovereign debt crisis period, when most EA countries experienced above-median unemployment rates at the same time.

2 European Unemployment Benefits Scheme (EUBS)

The debate on creating a centralized unemployment insurance scheme for the euro area is not new and has been an important building block in the wider discussion about fiscal macroeconomic stabilization instruments for the area. The great financial crisis reinforced the case for stronger fiscal capacity to complete the architecture of the Economic and Monetary Union (EMU), see Burriel et al. (2020). Many authors have raised concerns that the policies and institutions supporting the currency union remain incomplete and leave the euro area vulnerable to future shocks, for example see Bénassy-Quéré et al. (2018), Berger et al., (2019), Pasmeni (2015) or Allard et al., (2013). Moreover, several features of the euro area economy imply that it would benefit from a more centralized fiscal policy: reduced internal labour mobility, sticky prices and wages (see Chortareas (2013)), and the limited integration of member states' financial markets. However, there is also caution against moving toward a full fiscal union, if that would lead to persistent one-way transfers across member states.

While the existing European Stability Mechanism (ESM) plays a significant role in providing loans to member states, risk-sharing mechanisms operating either through financial markets or fiscal instruments remain limited. The policy discussion has thus focused on other fiscal tools which could act as automatic stabilizers while at the same time limiting the risk of permanent transfers across member states. Drawing inspiration from the United States' experience with state 'rainy day funds' (RDFs)[1], Lenarčič and Korhonen (2018) explore the idea of establishing a fiscal stabilization mechanism for the euro area, aiming to avoid permanent fiscal transfers and minimize moral hazard. The design incorporates upfront eligibility criteria and restricts payouts to instances of severe economic shocks. The authors show that their model can achieve stabilization effects similar to a transfer-based fund.

Other researchers have also explored the feasibility of a euro area wide unemployment insurance scheme and the way such scheme could be designed to mitigate the impact of country-level idiosyncratic shocks. The evaluation and operational feasibility of a *European Unemployment Benefits Scheme (EUBS)* was initiated by the European Parliament and the European Commission's Directorate-General for Employment, Social Affairs and Inclusion in 2015 (Contract VC/2015/0006). The final report, Beblavy and Lenaerts (2017), provides a broad synthesis of the need for a EUBS and the ways in which it could be put into practice. The report discusses the key functions, features, and policy choices involved and outlines the challenges and political obstacles the scheme may face, focus-

[1]In the USA, rainy day funds (RDFs) are state-level financial reserves designed to address economic downturns or unexpected fiscal challenges. These funds allow states to accumulate savings during periods of economic growth, providing a financial buffer for times of revenue shortfalls or unforeseen expenses. RDFs vary in design and operation across the states but share the common goal of enhancing fiscal resilience during uncertain economic conditions.

ing extensively on legal operational barriers and how the EUBS could be implemented without requiring a treaty change. One of the report's contributions is the identification of legal bases on which to set up the 18 proposed EUBS variants.[2] However, like most of the works we review here, the schemes proposed in the report are not explicitly grounded in economic theory, in particular regarding the incentive compatibility of the countries' contributions and participation in the scheme.

More generally, the literature on the topic can be divided in two broadly-defined themes which we review below: (i) assessing the potential benefits of a EUBS in terms of macroeconomic stabilization, and (ii) describing the mechanics of a EUBS, that is, the framework and rules governing contributions, payouts and the way the scheme is financed.

Benefits of a EUBS

A fairly broad consensus exists on the need for the euro area to enhance its fiscal capacity to deal with asymmetric shocks. Chortareas (2013) discusses the optimal design of fiscal policy rules in monetary unions and analyses the rationale for imposing such rules on member states. In this context, a EUBS can contribute to the management of fiscal policy and help stabilize country-specific business cycle fluctuations. The EUBS would provide a proper automatic stabilizer to deal with idiosyncrasies within the euro area in situations in which monetary policy cannot cope with shocks that affect member states asymmetrically, see Andor (2016). Andor (2016) also argues for linking EMU reforms to the European Union's social policy agenda and for valuing risk-sharing in Europe from both a political and an economic perspective.

Claveres and Strasky (2018) also argue that a euro area centralized fiscal capacity in the form of a European unemployment reinsurance scheme can result in potentially high stabilization effects. Their results show that small contributions by the member states (around 0.2% of GDP) would go a long way toward effective risk sharing via transfers to national unemployment insurance funds when in deficit. An additional benefit would be to stabilize the euro area business cycle. Overall, the authors show that the introduction of a euro area unemployment benefits reinsurance scheme would have provided additional macroeconomic stabilization during the financial crisis of 2009-2013, both at the euro area level and at the member state level.

On the capacity of a EUBS scheme to stabilize output around the business cycle, Gros (2016) argues that assessing the potential benefits is hard because of the multiple ways in which a EUBS could be implemented, each having different implications for the potential stabilization impact. In fact, depending on the design, the impact could range from

[2] The 18 variants proposed in the report have different combinations of features (e.g., trigger, pay-in, caps, etc.), see Beblavy and Lenaerts (2017) for details on each variant.

negligible to significant, as we discuss below. Similarly, Dolls (2019) finds that an unemployment reinsurance scheme would have cushioned, on average, 12% of income losses through inter-regional smoothing, and 8% through intertemporal smoothing, consistent with the presence of large asymmetries in labor market shocks within the euro area.

In addition to the empirical analysis on the topic, a few authors have proposed theoretical models to explore the benefits of a EUBS. For example, Abraham et al. (2023) study the welfare and incentive effects of unemployment insurance policies at the individual worker level using a comprehensive multi-country dynamic general equilibrium model and find that a payroll tax funded common pool scheme designed to mitigate excessive costs for unemployment benefits in case of a severe crisis can yield sizable welfare gains. While we reach similar overall conclusion, our paper differs by focusing the analysis on the country level and explicitly modeling the scheme members' incentives to contribute and participate.

While a consensus appears to exist about the potential benefits of a EUBS, successful implementation will depend on how such scheme is designed. Importantly, to ensure its viability, the scheme needs to be incentive-compatible and politically feasible. Specifically, member countries must have an incentive to maintain their required contributions and participation at all times and the scheme should not involve permanent or one-way redistributionary transfers. The next section discusses the existing literature on proposed EUBS design features.

Designing a EUBS

There is an extensive literature on the design of a potential European Unemployment Benefit scheme for the euro area. In a European Commission report, Beblavy and Lenaerts (2017) provide a comprehensive assessment of the EUBS feasibility and value added and describe specifics and policy choices associated with its possible design. Below we summarize the key EUBS features outlined in the report.

- *Trigger*: This feature refers to the exact conditions that cause a country to be asked to make a contribution (pay an insurance premium) or to receive a payout (insurance indemnity). There are different ways in which EUBS triggers can be defined. Brandolini et al. (2014) consider different possible triggers: one in which the unemployment scheme is always active, one in which the EUBS is active only for the countries experiencing a decrease in the output gap greater or equal than a certain threshold[3], and one which is only active for countries experiencing a decline

[3] A decrease greater or equal to half standard deviation of the output gap calculated across all considered countries.

in employment greater than or equal to a threshold[4]. Alternatively, Dolls (2019) proposes a scheme triggered by an increase of 2% of the difference between the unemployment rate and the NAWRU (non-accelerating wage rate of unemployment). Both Claveres and Strasky (2018) and Arnold et al. (2018) propose an automatic trigger based on deviations of the unemployment rate from its average.

- *Pay-in*: This feature refers to how contributions to the common scheme insurance fund are defined. Most authors model contributions to the scheme as a percentage of the country's GDP, e.g., Beblavy and Maselli (2014) and Dolls (2019). The contributions can be either fixed or variable, depending on the context. For instance, Beblavy and Lenaerts (2017) suggest a fixed contribution until the fund accumulates 0.5% of the EU GDP, then contributions are stopped. If the fund balance falls below the 0.5% threshold contributions are restarted. Others have suggested taxes on employers and employees in a similar way to how national unemployment insurance funds operate, e.g., Dullien (2014).

- *Experience rating*: This feature aims to ensure that the reinsurance scheme does not lead to permanent transfers across countries. It limits member state contributions based on a moving average of past contributions over several years. The experience rating acts as a slow-moving memory mechanism accounting for labor market trends. Most papers apply some variant of experience rating to limit net redistributive transfers across countries, e.g., see Claveres and Strasky (2018).

- *Cap*: This feature complements the experience rating by imposing an exogenous cap on yearly contributions, usually defined as a percentage of GDP. Beblavy and Lenaerts (2017) propose different cap variants and range. Naturally, the higher is the cap the larger are the cross-country risk-sharing benefits, however, larger redistributive effects arise. Many authors (including the present paper) apply a long-term cap of zero, meaning that over a sufficiently long time horizon each country needs to be in balance with the scheme. It is argued that caps are necessary to make participation in the reinsurance fund incentive-compatible and reduce moral hazard; for example, Beblavy and Lenaerts (2017) suggest that moral hazard can be addressed by the use of caps and experience rating.

The four EUBS design features discussed above pertain to the scheme's feasibility, both in terms of budget balance and effective provision of unemployment risk insurance to the member states, and also, more closely related to this paper, in terms of the incentives of the member states to contribute and participate. The incentive compatibility of the schemes discussed in the literature is, however, based on exogenous 'rules

[4]A fall in employment greater than or equal to 20 per cent of the standard deviation of the changes in employment levels calculated across countries.

of thumb' with respect to the countries' willingness to contribute and benefit from reinsurance. The idea is that, with sufficiently small contributions and sufficiently large payouts/indemnities during recessions when unemployment peaks, member states would be willing to participate, but the exact size of contributions and payouts is determined in an ad hoc way.

Our contribution is to elaborate and quantitatively assess a euro area reinsurance scheme in which the demand for insurance, the optimal contributions and payouts, and the incentive compatibility constraints, are all founded on and derived from an explicit mechanism-design theoretic economic model. The notions corresponding to experience rating, triggers, pay-in rate, and caps are hence endogenously determined by our model's solution key elements: promised utility, serving the function of experience rating, and the optimal state- and history-contingent transfers, combining the functions of trigger, pay-in, and cap.

3 Model

We consider a multi-period setting in which a group of countries face economic shocks affecting their unemployment rates and unemployment insurance (UI) expenditures that the countries would like to smooth out. We compare and quantitatively evaluate two main settings: (i) each country smoothing unemployment risk and UI expenses on its own via current UI revenues and savings and (ii) a mutual reinsurance platform in which all countries participate voluntarily.

Suppose that, in each period t, each country faces an economic shock process with discrete state s_i, $i = 1...I$, where s_i occurs with probability $P(s_i)$ common to all countries. The economic state realizations can vary over time for each country and can be correlated ex-post across the countries. The country's unemployment in state s_i is $n(s_i)$, normalized relative to the country's median unemployment rate (see Section 4.1 for details). Let c_i denote UI expenditure ('consumption') per normalized unemployed in state s_i and let q_i denote the UI revenue ('income') per normalized unemployed in state s_i.

3.1 Saving only

In the saving only setting each country manages its unemployment insurance on its own and can save in a riskless asset at gross interest rate R but cannot borrow. The country maximizes the present discounted value of a concave function, U of expenditure per unemployed, c_i. This can be interpreted as smoothing consumption per unemployed over time and across economic states. Denote by d the current-period savings per unemployed. The country's optimization problem can be written recursively as a dynamic programming problem with current savings d, as the state variable, and consumption c_i and next-period savings d_i', as the choice variables:

$$V(d) = \max_{\{d_i', c_i\}} \sum_i P(s_i) \left(U(c_i) + \beta V(d_i') \right) \tag{1}$$

$$\text{s.t.} \quad c_i + d_i' = Rd + q_i \quad \text{for all i} \tag{2}$$

where we restrict d and d_i' to be ≥ 0 in all states s_i, precluding borrowing. Alternatively, a borrowing limit $\bar{d}$, with $\bar{d} < 0$, can be imposed (see Section 5).[5] The variables c_i, d and d_i' are per unemployed in the current period. We keep track of the evolution of the number of unemployed $n(s_i)$ and total country savings when simulating the model, see Section 4.2. Initial savings d_0 can be set to zero or taken from the data.

3.2 Risk-sharing reinsurance scheme

We next consider a common risk-sharing scheme/platform for unemployment reinsurance across countries, with voluntary participation. Specifically, we use the mechanism-design framework of *limited commitment*, e.g., Thomas and Worrall (1988) or Karaivanov and Townsend (2014). In each period, each participating country must have incentive to remain in the scheme and not renege on any due contributions. The country's outside option is the saving only setting described above.

We model this setting as the solution to a mechanism design problem in which a risk-neutral insurance platform can transfer funds across the participating countries' national UI programs and can save and borrow funds over time at gross rate R, subject to participation and commitment constraints. This problem can be written recursively as:

$$\Pi(w) = \max_{\{w', c_i, \tau_i\}} \sum_i P(s_i) \left(-\tau_i + R^{-1} \Pi(w_i') \right) \tag{3}$$

$$\text{s.t. } c_i = q_i + \tau_i \text{ for all } i \tag{4}$$

$$U(c_i) + \beta w_i' \geq U(q_i) + \beta V^o \text{ for all } i \tag{LC}$$

$$\sum_i P(s_i) \left(U(c_i) + \beta w_i' \right) = w \tag{5}$$

where V^o is the country's outside option (set equal to the saving-only present value $V(0)$ in the simulations). The promised utility state variable w summarizes the history of unemployment shocks experienced by the country. Such history-dependence is optimal when full insurance is infeasible. The risk-sharing platform uses cross-country transfers, τ_i to smooth the expenditure per unemployed, $c_i = q_i + \tau_i$. The function $\Pi(w)$ captures the present-value deficit (if negative) or surplus (if positive) of the platform when facing

[5] It is also possible to assume different rates for saving vs. borrowing ($R^s < R^b$), which changes the budget constraint to $c_i + d_i' = q_i + R^s \max\{0, d\} + R^b \min\{0, d\}$.

a country with promised utility state w.

Constraint (LC) is the key 'limited commitment' constraint, which ensures that the country has no incentive to renege on the arrangement and switch to saving only. Constraint (5) is the promise-keeping constraint, reflecting the reinsurance platform's commitment to deliver present discounted value w to the country.

4 Data and simulations

We use unemployment rate data for 17 euro area countries in the period 2000 to 2019. The data were sourced from the IMF International Financial Statistics database for all countries except Germany and France for which the data are from the OECD Main Economic Indicators. We also construct UI revenue data series for each country as the product of the percentage of gross salary income withheld by the government for unemployment insurance, the average gross salary income (from Eurostat), and the total number of employed persons (from the OECD's Main Economic Indicators).

4.1 Data normalization

For each country we normalize the observed unemployment rates over the period by dividing each observed value by the country's median unemployment rate. The reason for the normalization is that we want to abstract from structural differences in unemployment across the countries and instead focus on smoothing deviations from the median unemployment level only and avoid redistribution triggered by structural differences.[6] We similarly normalize the UI revenue data series for each country by dividing each observation by the country's median UI revenue over the period. This addresses the large differences in country size or GDP per capita in the data. This double normalization of the data, explained in detail below, puts the countries on 'equal footing', as agents facing a common standardized income distribution as assumed in our theoretical model, and allows us to use the Karaivanov and Townsend (2014) approach to solve for the optimal consumption expenditure and insurance transfers (contributions/premia or payouts/indemnities) and quantify the gains from improved risk sharing.

Specifically, we first take the unemployment rates for each country j and year t from the data and normalize each observation by the country's median unemployment rate over the twenty year period 2000 to 2019. We define the *normalized unemployment rate*

[6] In our simulations we chose each country's median unemployment rate for the period 2000–2019 as the 'anchor rate' used to normalize the distribution of income per unemployed in the model, but other anchor rates can be easily explored too.

$\bar{u}_{jt}$ for country j in year t as

$$\bar{u}_{jt} = \frac{u_{jt}}{u_j^{median}} \tag{6}$$

where u_{jt} is the actual unemployment rate for country j and year t in the data and u_j^{median} is the median unemployment rate in country j for the sample period 2000–2019.

We then discretize the distribution of normalized unemployment rates $\{\bar{u}_{jt}\}$ on the 9-point grid $\{n(s_i)\}$, $i = 1...9$, where the grid points $n(s_i)$ are set equal to the first to ninth deciles of the $\{\bar{u}_{jt}\}$ data, pooled over all countries j and years t in our sample.[7]. By construction, state s_5 corresponds to the median unemployment rate in each country during the 2000–2019 period (e.g., 5.2% for Austria; 9.1% for France, etc.) and $n(s_5) = 1$. State s_1 corresponds to the lowest normalized unemployment level in the model, $n(s_1)$, and state s_9 corresponds to the highest unemployment, $n(s_9)$, each relative to the country's median unemployment rate. See Table A1 for the correspondence between the $\{n(s_i)\}$ grid in the model (normalized unemployment rate deciles) and the actual unemployment rates in the data, for each country.

For each country-year pair (j, t), the discretized unemployment distribution $\{n(s_i)\}$ maps $\bar{u}_{jt}$ to the nearest grid point $n(s_i)$. We use this mapping to define

$$\Gamma(j, t) = s_i \tag{7}$$

as the unemployment state s_i, $i \in \{1, .., 9\}$ in which country j is in year t. We also compute the implied discrete probability distribution for the states $\{s_i\}$ by setting the probability (frequency) $P(s_i)$, for $i = 1, ..., 9$, equal to the fraction of all observations $\bar{u}_{jt}$ for which the nearest grid point is $n(s_i)$, that is, for which $\Gamma(j, t) = s_i$.[8]

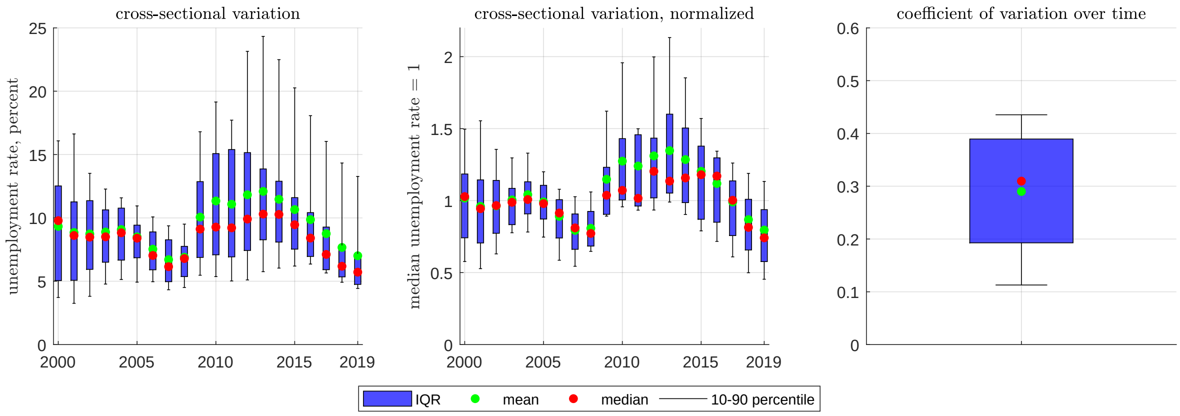
The unemployment rates normalization allows countries to have different structural unemployment levels and ensures that the reinsurance platform does not make redistributionary transfers based on such structural differences. Instead, optimal insurance transfers (contributions or payouts) are only based on the country's *relative*, e.g., business-cycle state of unemployment, that is, on how large the country's current unemployment rate is relative to the country's median unemployment rate.

Figure 2 plots the cross-sectional variation (left and centre panel) and the time variation (right panel) in the unemployment rates of the 17 euro area countries in our data. We see that there exists a large variation across the countries' unemployment rates in each year, ranging from one half to twice the median rate over the period 2000–2019 (the

[7]We use a histogram function to map each normalized unemployment rate $\bar{u}_{jt}, \forall j, t$ in the data (see equation (6)) to the nearest grid point $n(s_i)$ for some $i = 1, ..., 9$. This procedure yields the normalized unemployment grid $\{n(s_i)\}_{i=1}^{9} = \{0.67, 0.77, 0.88, 0.96, 1, 1.06, 1.14, 1.28, 1.50\}$

[8]For our data we obtain $\{P(s_i)\}_{i=1}^{9} = \{0.147, 0.112, 0.091, 0.091, 0.112, 0.097, 0.100, 0.103, 0.147\}$.

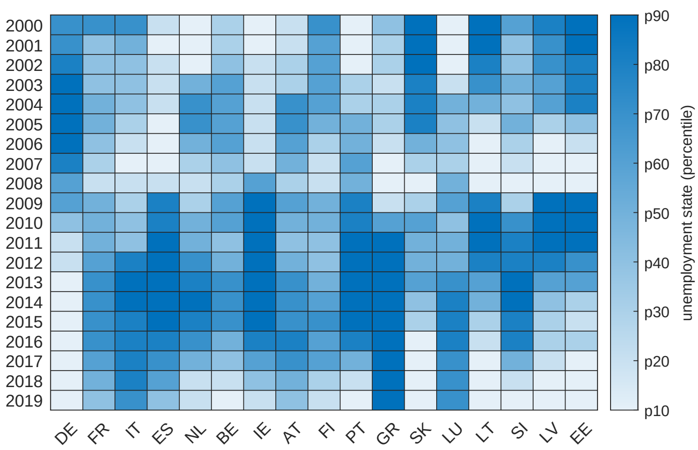
Figure 2: Unemployment rates variation



Notes: the left-hand panel plots the cross-sectional distribution (inter-quartile range IQR, mean, median, 10th and 90th percentile) of the unemployment rates in the 17 euro area countries in our data. The centre panel plots the cross-sectional distribution of normalized unemployment rates, defined as the actual rate divided by the country's median unemployment rate for the period 2000–2019. The right-hand panel plots the distribution of the countries' coefficients of variation of unemployment over time (2000–2019).

median rate is normalized to 1 in the centre panel). While there is partial co-movement (e.g., an overall increase in unemployment in the period 2008 to 2012 followed by a decrease), the correlation between the different countries' relative unemployment states is imperfect, as shown on Figure 3, which leaves scope for potentially large gains from sharing unemployment risk and smoothing UI expenditures across countries and over time, as we quantify and illustrate below.[9]

Figure 3: Unemployment relative to the country median



Notes: the figure displays the normalized unemployment state s_i, defined in equation (7), for each country (in the columns) and each year (in the rows). The median unemployment level for each country is denoted by p50 and corresponds to state s_5. Darker colour means higher unemployment relative to the country median. See Table A1 for the mapping between unemployment states and unemployment rates for each country.

[9] A perfectly positive correlation between the countries' unemployment states would result in all cells in each row of Figure 3 to have the same colour.

To account for differences in country size or economic development in the data, we construct *normalized UI revenue*, $\overline{r}_{jt}$ for country j and year t, defined as the actual UI revenue r_{jt} in bln Euros in the data divided by the median revenue, r_j^{median} for country j computed over the years 2000 to 2019,

$$\overline{r}_{jt} = \frac{r_{jt}}{r_j^{median}} \tag{8}$$

The UI revenue for each country j and year t in the model is thus expressed in common normalized units, as a fraction or multiple of the country's median UI revenue.

Using the unemployment rate and revenue normalizations described above, we define the 'income' grid values, q_i in the model (common for all countries) corresponding to the normalized UI revenue per normalized unemployed in each state s_i as

$$q_i = \frac{\kappa(s_i) median\{\overline{r}_{jt}\}}{n(s_i)} \text{ for all } i \tag{9}$$

where $median\{\overline{r}_{jt}\}$ is the median of normalized UI revenues computed over all country-time observations jt and equals 1 using equation (8). Higher unemployment, $n(s_i)$ implies lower UI revenue per unemployed q_i, that is, less resources to finance UI expenditure.[10] The coefficients $\kappa(s_i)$ allow normalized total UI revenue, $n(s_i)q_i$ in the model to vary with the unemployment state s_i, relative to its median value of 1 (for example, when there is high unemployment, total UI tax revenue can be lower).[11] That is, we do not assume constant national UI revenue across economic states.

The unemployment and UI revenue normalizations imply that we can convert model units (consumption, transfers, savings) into euros by multiplying the model quantities (measured in normalized resources per normalized unemployed) by the normalized unemployment level $n(s_i)$ in the respective state s_i and by the median UI revenue, for each respective country. For example, suppose that in the risk-sharing model solution the optimal transfer per normalized unemployed in state s_i is $\tau_i = 0.05$ (that is, since $\tau_i > 0$, a payout is due from the reinsurance scheme to the country) and suppose normalized unemployment in that state is $n(s_i) = 1.14$ (the 70th percentile, see Table A1). Then, the total payout the country would receive from the platform equals $n(s_i) \times \tau_i = 0.057$ model units, which in turn converts to $n(s_i) \times \tau_i \times r_j^{median}$ bln euros. To pick a specific country, for Austria $r_j^{median} = 8.68$ bln and hence the payout in this example would be $0.057 \times 8.68 = 0.49$ bln, to be distributed among the 5.9% unemployed from the country population.[12]

[10] For our data we obtain: $\{q_i(s_i)\}_{i=1}^9 = \{1.65, 1.31, 1.15, 1.04, 1, 0.95, 0.89, 0.78, 0.63\}$.

[11] We construct $\kappa(s_i)$ using the median of the countries' normalized UI revenues expressed in constant CPI-adjusted units for each state s_i; for our data we obtain $\{\kappa(s_i)\}_{i=1}^9 = \{1.10, 1.02, 1.01, 0.99, 1, 1.00, 1.02, 1.00, 0.94\}$.

[12] See Tables A1 and A2 which show the mapping between normalized (used in the model) and actual

4.2 Model simulation

We assume strictly concave utility of the CRRA form, $U(c) = \frac{c^{1-\sigma}}{1-\sigma}$, with the baseline simulations performed using log utility ($\sigma \to 1$). We calibrate the gross interest rate R used to compute the models to $R = 1.0156$, which equals 1 plus the average interest rate in the data for the period, 1.56%.[13] We set the discount factor to $\beta = 1/R$. The simulations assume that all countries face the same discrete distribution for the normalized unemployment rate (the nine unemployment levels relative to the country median rate $n(s_i)$ with corresponding probabilities $P(s_i)$ for each $i = 1...9$), which the countries and the reinsurance scheme know and use to solve the dynamic mechanism design problem in Section 3.2.

We set initial savings, d_0 to zero in the saving only model. In the risk-sharing (limited commitment) model we set the initial state, w_0 equal to the value that yields zero ex-ante expected present-value profits for the reinsurance platform, i.e. such that $\Pi(w_0) = 0$. For any given period, the value $n(s_i)\Pi(w)$ is the current balance of the platform with a country with history of unemployment summarized by w. This balance may be a surplus or a deficit, however the chosen initialization ensures that on average, over the long run, the platform breaks even with respect to each country and therefore with respect to all member countries overall.

To simulate the saving only model we also need to track the evolution of total savings over time, since the model variables and budget constraint (q_i, c_i, d, d'_i) are defined per current normalized unemployed, the magnitude of which, $n(s_i)$, varies over time. Specifically, if current total savings for the country are D model units and the current normalized unemployment is $n(s_i)$, we set the value of the state d in the saving only model (current savings per unemployed) to $d = \frac{D}{n(s_i)}$. Given d and the economy state realization s_i, the model solution determines the next-period savings per unemployed, d'_i. We then compute the total savings D' for the country carried into the next period as $D' = n(s_i)d'_i$, and use the value D' and next-period's normalized unemployment to compute the new savings-per-unemployed state, and so on.

We solve each of the two models numerically, feeding the actual unemployment and revenue series from the data (normalized as explained above) for each country. The model solution determines the optimal path for savings and consumption expenditure in the saving only model and the optimal insurance transfers (positive or negative), consumption, and promised utility in the risk-sharing model, for each year 2000 to 2019. We then convert back the model units into euros (see Tables A1 and A2 in Appendix A) and add up the resulting monetary values, for example, to compute the yearly total

unemployment rates and between median revenue (the normalized resource unit in the model) and bln euros for each country.

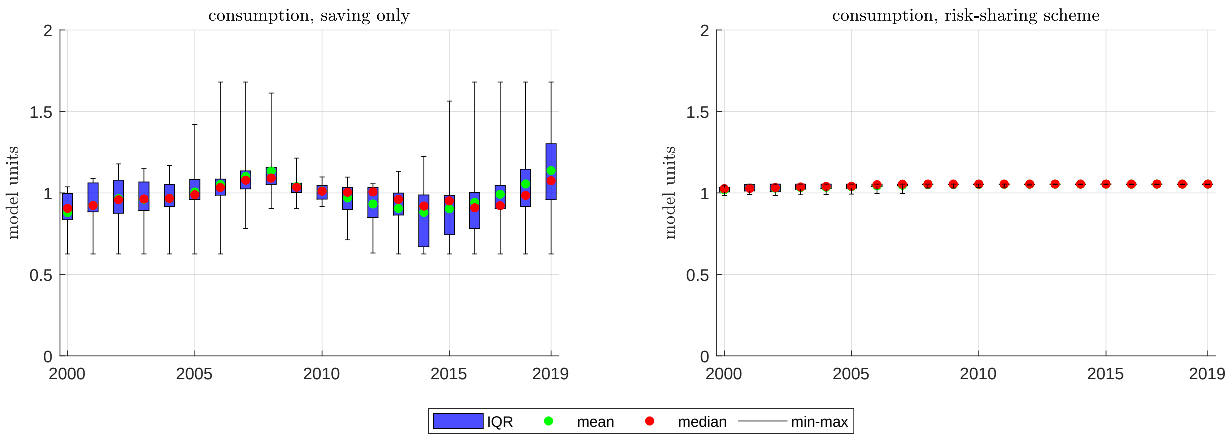
[13] We calculated this average using data on the euro short-term repo interest rate from 2000 to 2019 sourced from the European Central Bank.

insurance payment flows (contributions or payouts) and the cumulative balance (surplus or deficit) for the risk-sharing platform in any year (see the next section for details). The simulation results allow us to quantify how much consumption smoothing results from having access to the risk-sharing platform compared to in the saving-only baseline where each country self-insures on its own.

5 Results

We use the model solution, together with the countries' (normalized) unemployment and revenue data for the period 2000 to 2019, to compute the gains from insuring unemployment-related risk across the euro area countries. Specifically, we compare the consumption (UI expenditure) smoothing in each country in the saving only setting, in which each country can only smooth expenditures by accumulating or running down savings on its own, versus in the risk-sharing setting, in which all countries pool the risk and co-insure each other by contributing (paying an insurance premium) into a common fund when their unemployment is low relative to the country's median unemployment rate, or receiving a payout (indemnity) from the fund when their unemployment is high relative to the median.

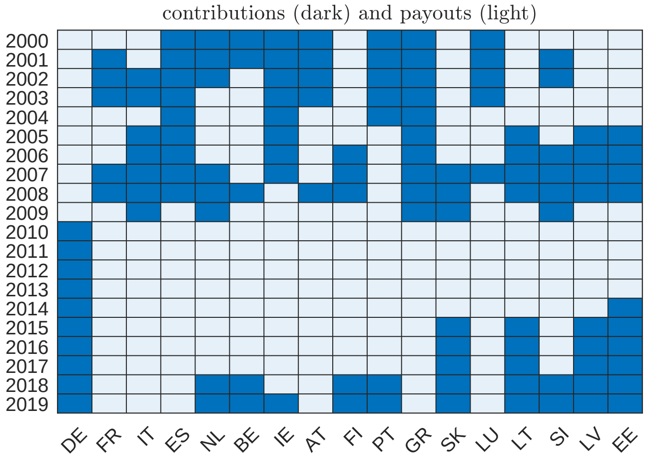
Figure 4: Gains from risk-sharing – consumption smoothing



Notes: the figure plots the cross-sectional distribution of consumption (UI expenditure per unemployed) in model units. Model units are measured in normalized resources per normalized unemployed (see Section 4.1). The left-hand panel plots the inter-quartile range (IQR), the mean, the median, and the minimum and maximum normalized consumption in the saving-only setting. The right-hand panel plots the consumption cross-sectional distribution for the risk-sharing scheme.

In Figure 4 we plot the simulated consumption (UI expenditure per unemployed) in model units for the saving only setting (the left panel) and in the risk-sharing scheme with limited commitment and voluntary participation (the right panel). The Figure shows that, for the same parameters, the insurance scheme smooths the consumption (UI expenditure) per unemployed nearly perfectly. In contrast, in the saving only setting there remains sizable unsmoothed variation in normalized consumption, both across the countries and over time.

Figure 5: Risk-sharing contributions and payouts



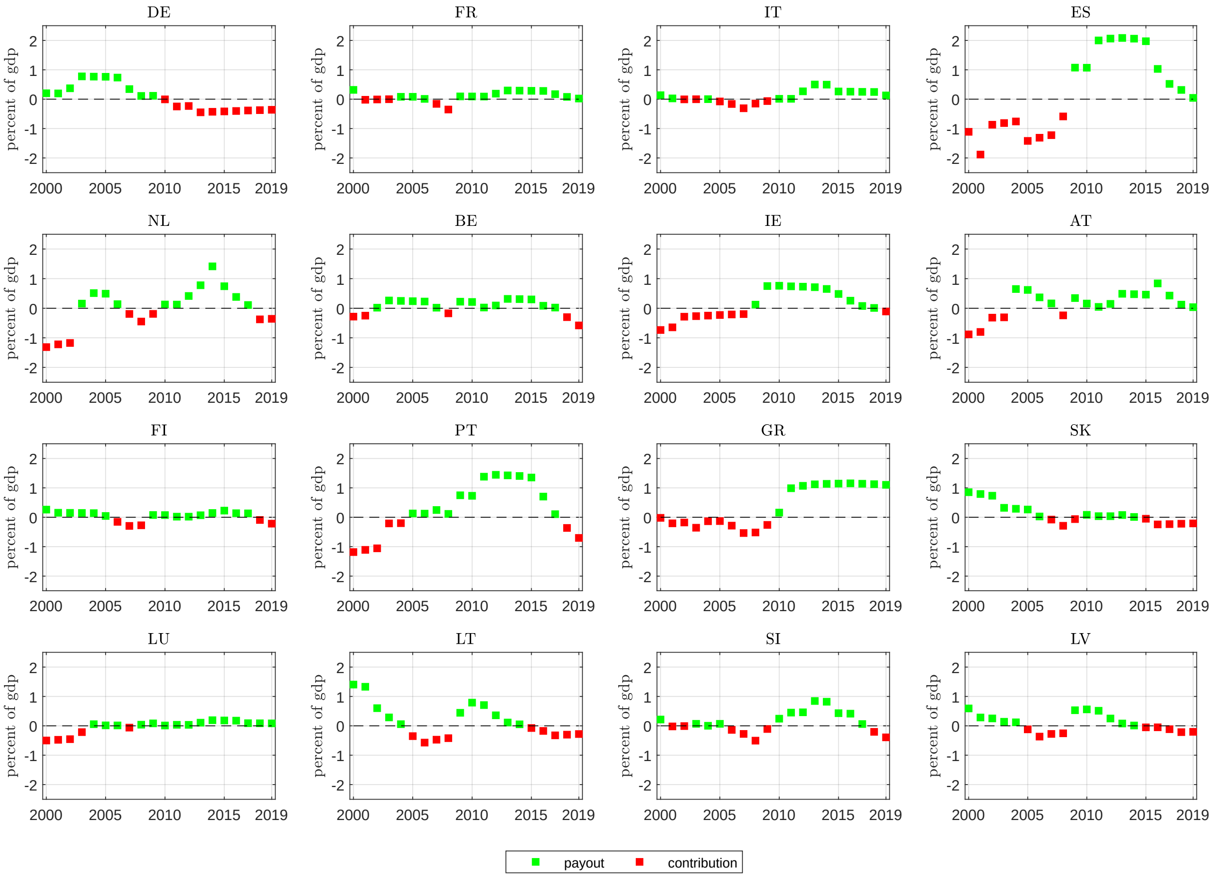
Notes: each column corresponds to a country, each row corresponds to a year. Dark color means that the country is a net contributor to the risk-sharing scheme (pays an insurance premium) in a given year. Light color means that the country is a net recipient (receives an insurance payout/indemnity).

In Figure 5 we illustrate how the gains from consumption smoothing are achieved in the reinsurance scheme, by reporting whether and when a country is asked to contribute (pay an insurance premium) or receives a payout (indemnity), for each year, as implied by the optimal risk-sharing solution. The Figure shows that before 2008 and after 2017 there is an approximate balance in the number of countries with positive (low unemployment) and negative (high unemployment) states. However, in the period 2009-2017 the majority of countries, with the notable exception of Germany, optimally draw from the scheme, as they simultaneously experience high unemployment. The main takeaway is that in most years the unemployment shocks are sufficiently uncorrelated across the countries which, together with the risk-sharing scheme's ability to save or borrow, enables the large gains from sharing the risks and smoothing consumption depicted on Figure 4.

Figure 5 clearly illustrates the scope for reinsurance but does not quantify the magnitude of the risk-sharing transfers (contributions or payouts). In Figure 6 we do that by first converting the model units into monetary units (bln Euro) and then displaying the implied optimal transfers to or from the platform as percent of GDP for each country. For most countries (except Spain, Portugal, Lithuania, and the Netherlands for a small number of years), the implied transfers (payouts in green and contributions in red) are within 1% of GDP.

On Figure 7 we assess how the optimal risk-sharing transfers in the reinsurance scheme add up across all countries in terms of the total payouts received, total contributions paid

Figure 6: Risk-sharing transfers as share of GDP

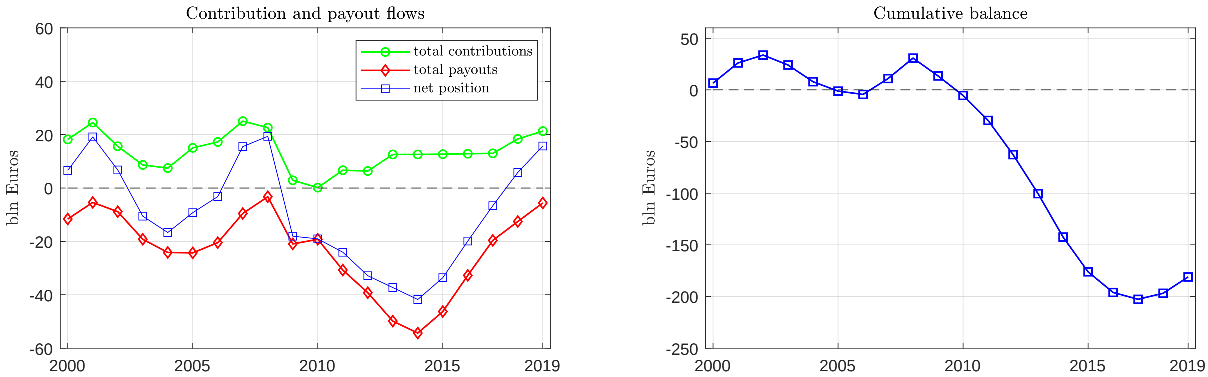


Note: each panel displays the optimal country contribution (in red) or payout (in green) as share of GDP in the risk-sharing scheme over the period 2000–2019.

in, and the net balance of the reinsurance fund for each year from 2000 to 2019.[14] The left-hand panel plots total contributions, total payouts, and the difference between the two ("net position"), for each year. We see that the platform inflows and outflows are approximately balanced or in net surplus in 2000 to 2002, 2006 to 2008, and 2018 to 2019. In contrast, yearly deficits are incurred in the periods 2003 to 2005 and 2009 to 2017, with a maximum deficit of €42 bln registered in 2014. The reason for the deficits is that in those years more countries, or larger countries, are receiving payouts compared to those making contributions (see Figure 5). The platform's net cashflow position steadily improves after 2014 and reaches a surplus of 16 bln euro in 2019, the last year in our data. Cumulatively, see the right-hand panel of Figure 7, the yearly net flows imply that the reinsurance fund is balanced or in surplus from 2000 to 2009, however, because of the common high-unemployment shocks affecting most euro area countries starting in 2009, the scheme's cumulative balance goes into deficit (debt), reaching a maximum of €203 bln in 2017. The deficit is then gradually reduced.

[14]To compute the cumulative balance in the right-hand panel we use the ECB euro short-term interest rates for 2000–2019, see Table B1.

Figure 7: Risk-sharing scheme - annual flows and cumulative balance



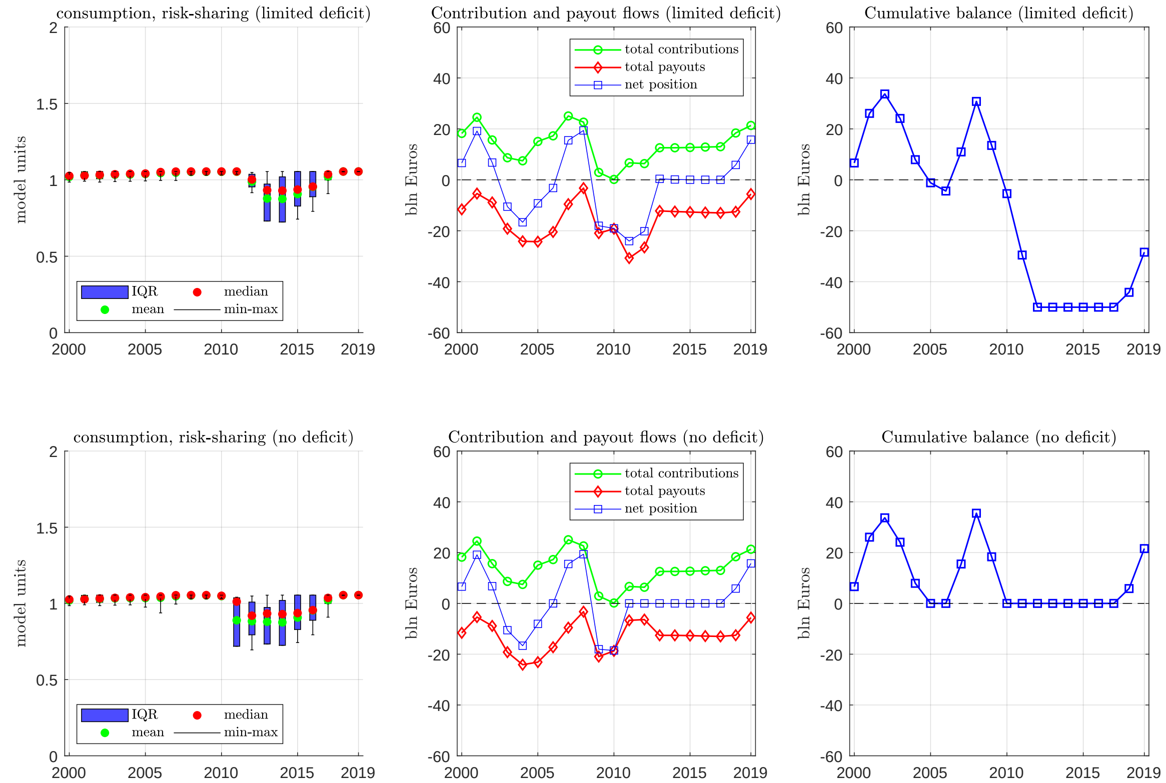
Notes: the left-hand panel plots the total annual fund flows into and out of the risk-sharing scheme and the resulting annual net surplus or deficit over the period 2000–2019. The right-hand panel plots the cumulative balance (total savings or debt) of the risk-sharing scheme in each year.

The simulation numerical results depend on the parameters used to compute the model solution: the interest rate (1.56%, calibrated from ECB data as average for 2000–2019), the discount factor (1\1.0156), and the assumed CRRA risk-aversion value (log utility). A higher interest rate (making borrowing for the scheme more costly) or lower risk aversion each would lead to slightly less smoothing of unemployment shocks but significantly smaller yearly and cumulative deficits – see Figure A3 computed using CRRA risk-aversion parameter 0.5 where the cumulative deficit in 2017 reaches only €122 bln.

In Appendix Figure A4 we also simulate and compare the extent of consumption smoothing in the saving-only setting vs. a setting in which countries can also borrow individually at the same interest rate. Clearly, allowing borrowing yields better smoothing of UI expenditure per unemployed compared to in the saving-only regime, however, the residual variation in consumption is still much larger compared to that in the risk-sharing scheme (compare with Figure 4). The reason is that individual country saving and borrowing is an imperfect substitute for insurance via pooling idiosyncratic risk. A country may suffer a sequence of negative shocks and reach the borrowing limit (see section 3.1) reducing its ability to smooth expenditures. In addition, debt is assumed to be non-contingent, thus a county which borrowed in an earlier period is required to repay, no matter what its current economic state is. The maximum total borrowed amount by all 17 countries reaches slightly above €86 bln in 2015, which is lower that in the reinsurance scheme with no borrowing limit (compare with Figure 7).

In the period 2009-2014 most euro area countries suffered from high unemployment at the same time, which (optimally) leads to yearly deficits and debt accumulation for the reinsurance scheme as a whole, as shown in Figure 7. If negative balances are, however, politically (e.g., Germany finding itself on one side of the ledger) or economically infeasible, we also analyze scenarios in which we impose an exogenous limit on the cumulative deficit/debt that the reinsurance scheme can incur. The results are shown on Figure 8 for

Figure 8: Risk-sharing scheme with limited or no deficit



Notes: the left-hand panels plot the cross-sectional distribution of consumption (UI expenditure per unemployed) in model units. The center panels plot the annual flows in and out of the risk-sharing scheme, as well as the net position. The right-hand panels display the cumulative balance of the risk-sharing scheme over the studied period. The top row of panels shows the simulation results when the risk-sharing scheme is subject to a borrowing/deficit limit of 50 bln EUR. The bottom row shows the results for the case in which the scheme is not permitted to run a deficit (no borrowing).

a cumulative deficit ceiling equal to either €50bln (in the top panels) or when no deficit is allowed and only surpluses can be accumulated (in the bottom panels).[15]

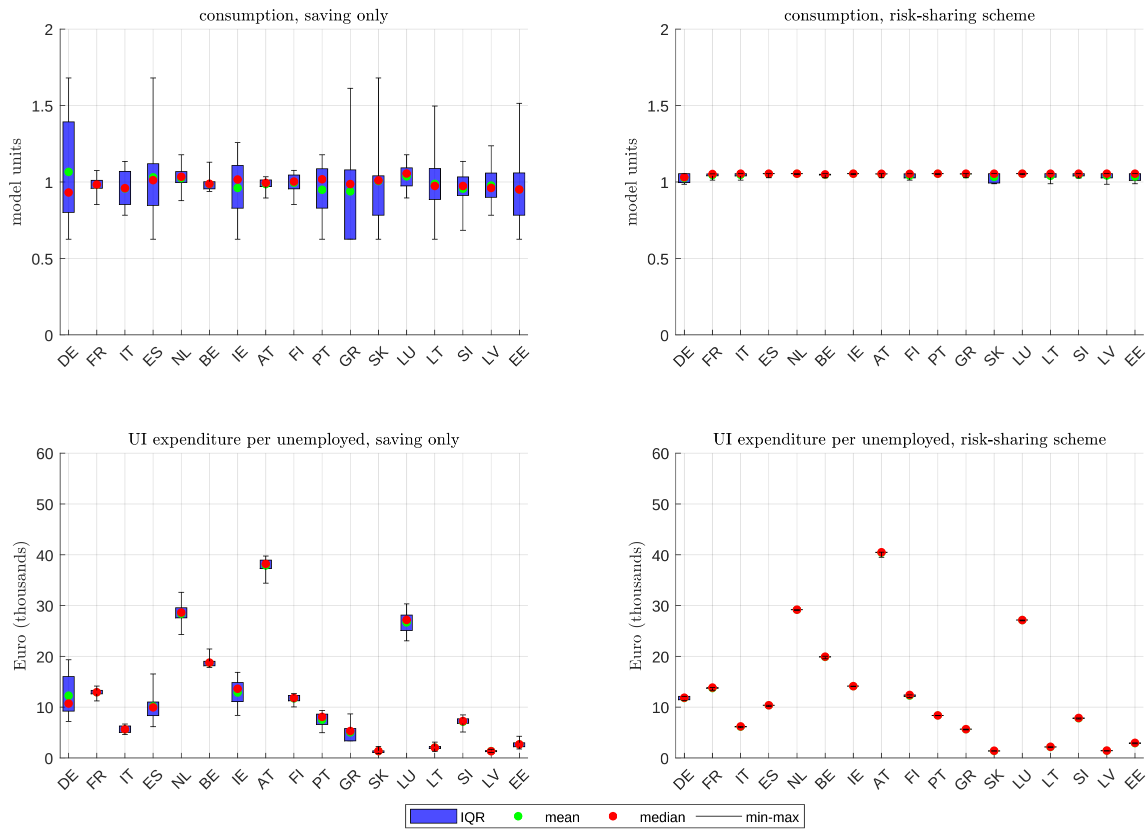
The left-hand panels of Figure 8 show that imposing a deficit limit on the reinsurance scheme reduces its ability to smooth consumption (UI expenditure per unemployed) in the years for which the limit binds, specifically 2012–2017 for the 50 bln deficit limit scenario and 2005–2006 (a very small distortion) and 2011–2017 for the "no deficit" scenario. The imperfect smoothing of unemployment risk in the years when the deficit limit is binding resembles that in the saving only setting, when a country exhausts its savings after a sequence of negative shocks. Conversely, in the years when the deficit limit does not bind, consumption is almost perfectly smoothed unlike in the saving only setting - compare Figure 8 with Figure 4, left-hand panel or see Figure A5 in which we display head-to-head the smoothing in all four analyzed scenarios (saving only and optimal risk-sharing with unlimited deficit, limited deficit, and no deficit). We show the insurance

[15]To compute these results, we use the model solution with unlimited deficit, however, if in some year the total due payouts are such that the cumulative deficit limit is exceeded, we reduce all payouts proportionally to match the limit.

transfers for the scenario without deficit in Figure A6.

Finally, in Figure 9 we plot time variation of UI expenditure per unemployed in the saving only vs. in the risk-sharing scheme by country, both in model units (in the top panels) and in euros (in the bottom panels). The figure illustrates the nearly perfect smoothing over time achieved in the reinsurance scheme. The bottom-row panels clearly demonstrate how our proposed scheme only smooths UI expenditures around each country's own median level of unemployment and resources, as opposed to redistributing across countries with systematically different levels or unemployment or UI revenues.

Figure 9: Consumption (UI expenditure per unemployed) smoothing by country



Notes: the top panels display the distribution of consumption over 2000–2019 for each country in model units (normalized resources per normalized unemployed) for the saving-only setting (left-hand panel) and for the risk-sharing scheme (right-hand panel). The bottom panels show the same results expressed in monetary units (euros). We convert into euros by multiplying the model-unit values by the 2000–2019 median UI revenue (in bln EUR) per median unemployment (in mln) for each respective country.

6 Comparison with earlier proposals

We provide a brief discussion and comparison of our proposed euro area unemployment risk reinsurance scheme based on mechanism design foundations, with the reinsurance scheme proposed in Dolls (2019). We take the Dolls scheme as a representative of the 'rules of thumb' EUBS schemes discussed in Section 2, based on exogenously defined trigger conditions and contribution and payout rates.

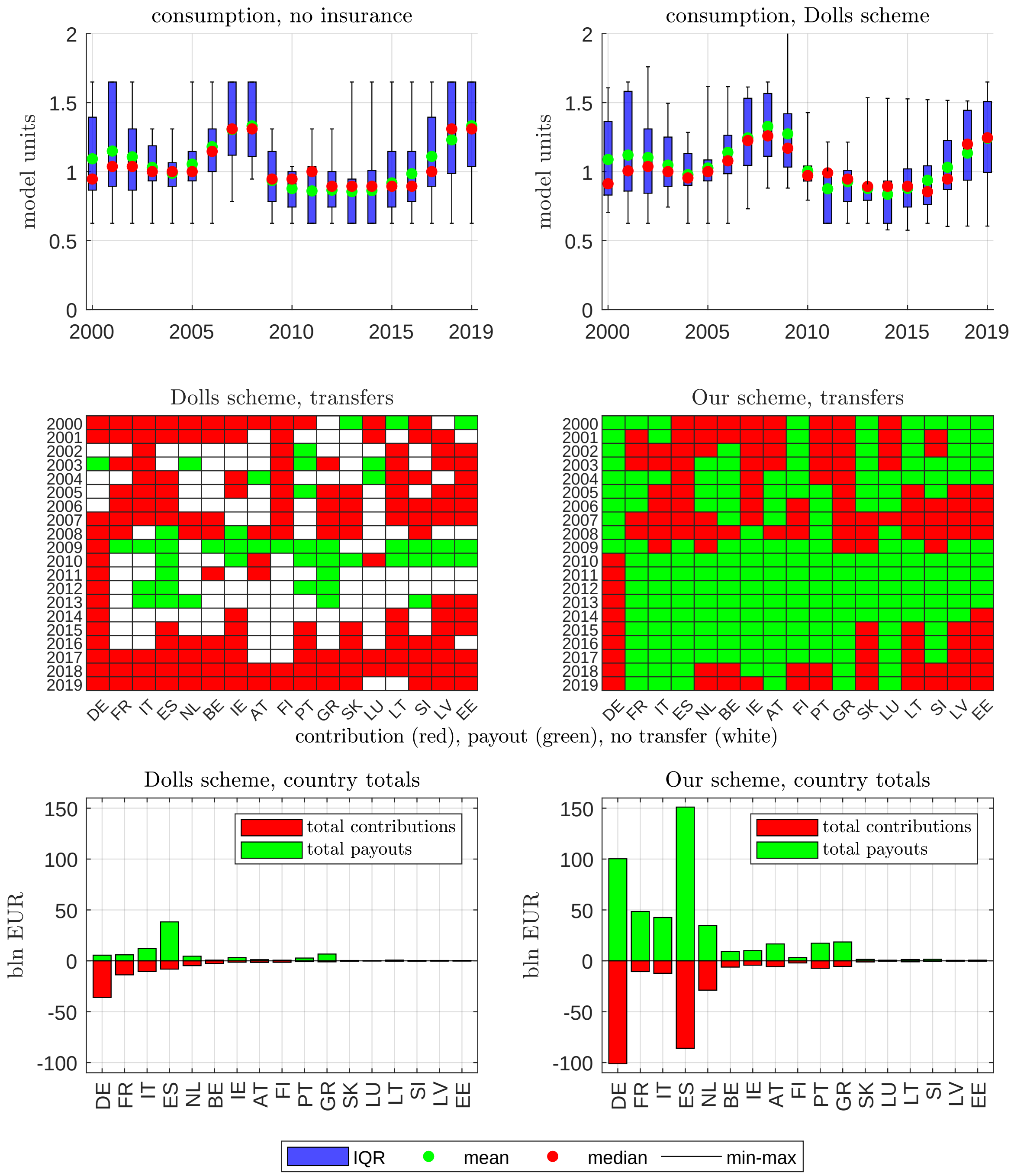
A contribution obligation in the Dolls (2019) scheme is triggered when two conditions hold simultaneously for the current unemployment rate, $u_{j,t}$ of country j in year t: (c1) there is a year-on-year decrease (no matter how small) in the unemployment rate, i.e., $u_{j,t} < u_{j,t-1}$ and (c2) the current unemployment rate is below the country's 7-year moving average. A payout obligation is triggered when: (p1) the year-on-year increase in the unemployment rate exceeds 1 percentage point and (p2) the current unemployment rate is above the 7-year moving average. If the payout trigger for country j and year t is activated, then the payout amount, $P_{j,t}$ is determined by the increase in the number of unemployed relative to the previous year and current gross wages.[16] The contribution rate is determined as a fraction of the country's total gross wages, so that all triggered payout amounts are fully covered over the period of analysis (2000–2019 here) and the scheme is in balance ex-post.

On Figure 10 we simulate the Dolls (2019) scheme for our data and compare it with our proposed reinsurance scheme. The top panels of Figure 10 illustrate the smoothing of consumption (normalized UI expenditure per normalized unemployed) in the Dolls' scheme. Consumption is expressed in model units, so that we can compare with our results in Section 5, and equals $c_i^{dolls} = q_i + \tau_i^{dolls}, \forall i$, where τ_i^{dolls} is the Dolls scheme payout or contribution converted into model units, and q_i is normalized UI revenue per normalized unemployed as defined in Section 3. We contrast the consumption smoothing in the Dolls scheme (the top right panel) with the scenario of no smoothing (top left panel), that is, when consumption equals income in all states and times ($c_i = q_i, \forall i$). We see that the Dolls scheme reduces the variation in consumption (UI expenditure per unemployed) across the euro area countries and dampens the 2009–2010 sharp drop in income per unemployed. However, because of its relatively strict payout conditions and ex-post balanced budget requirement, the consumption smoothing in the Dolls scheme is lower than in our proposed scheme (including, for most years, when no deficit is permitted) – compare with Figure 4 and Figure 8.

The centre panels display the pattern of contributions and payouts by country and year in the Dolls (2019) scheme versus in our scheme. We observe that payouts in the Dolls (2019) scheme are less frequent, which is because the payout trigger condition requires a continuing year-on-year *increase* in unemployment of at least 1 percentage point, compared to in our scheme where payouts are optimally triggered when unemployment remains high (even if decreasing year-on-year) relative to the country's median level. Because of how the payout trigger is defined, the Dolls scheme also features years in which

[16] The payout formula is: $P_{j,t} = 0.7 \times \Delta Unemployed_{j,t} \times 0.5 \times GrossWages_{j,t}$, based on the additional resources needed to cover the unemployment benefits. The calculation assumes a 50% wage replacement rate and a 70% coverage rate, indicating that, on average, 70% of the newly unemployed individuals are eligible for benefits which replace 50% of their annual gross salary.

Figure 10: Comparison with Dolls (2019)



Notes: The top panels display the smoothing of normalized consumption in the Dolls' scheme (top-right panel), compared to no smoothing (top-left panel), expressed in model units (normalized revenue per normalized unemployed). The centre panels show the years for each country in which contributions (in red) or payouts (in green) are made in the Dolls (2019) scheme (left) vs. our reinsurance scheme (right). The bottom panels compare the total contributions and total payouts by country (added over 2000–2019) in the Dolls scheme vs. in our proposed scheme.

a country is neither a contributor, nor receives a payout (marked in white on the figure).

In the bottom-row panels of Figure 10 we display and compare the total contributions and payouts by country in the Dolls scheme vs. in our scheme. We see that the implied transfers in the Dolls (2019) scheme are smaller in magnitude than in our EA-URS scheme. While Spain (ES) is the main net recipient over the analyzed period in both schemes, in our scheme this is financed primarily through borrowing (see Figure 7), while in Dolls (2019) Germany is the largest net contributor, as the scheme is required to be balanced ex-post.

We also ran a simulation of the EA-URS in which we calibrated the scheme's maximum debt limit to 21.5bln euro, so that the scheme is balanced ex-post (it has zero cumulative deficit in 2019), as assumed in the Dolls (2019) scheme. In this simulation, displayed on Figure A7, Spain receives lower total payouts overall (about 75bln, as compared to 150bln in the unconstrained scheme), with reductions in the years for which the scheme's debt limit binds. Naturally, as in Figure 8, the degree of consumption smoothing in our scheme is reduced in the period 2011–2016, when the debt limit binds, but it remains almost perfect for the rest of years in our data period.

There are two main takeaways from these comparisons. First, requiring the scheme to be balanced over a relatively short or arbitrarily chosen period reduces its ability to smooth UI expenditures. Instead, allowing the scheme to borrow in years when many countries have high unemployment is optimal, while each country (and hence the scheme as a whole) achieves balance over a sufficiently long time horizon. Second, better consumption smoothing is obtained if the contribution and payout triggers are defined relative to an anchor rate (in our scheme, the country median unemployment rate), without requiring year-on-year increases or decreases in unemployment.

7 Conclusions

The euro area sovereign crisis brought back the debate on establishing additional fiscal instruments for the euro area. A centralized European unemployment benefits scheme has been one of the solutions proposed to strengthen the fiscal automatic stabilizers of the European Monetary Union. Existing plans to set up a euro area unemployment reinsurance mechanism aim at exploiting the observed asymmetries in the cyclical fluctuations of unemployment rates within the euro area member countries. However, most studies do not include explicit derivation of the preferences or incentives of participants and are based on rules of thumb and ad hoc exogenous thresholds defining the terms of the cross-country insurance mechanism. A major shortcoming of these approaches is that they do not articulate whether member states would have an incentive to join and remain in such scheme over a long horizon.

Borrowing from previous work on mechanism design, digital safety nets and dynamic financial constraints by Karaivanov and Townsend (2014) and Karaivanov et al. (2023), we design an incentive-compatible reinsurance scheme for euro area member states' unemployment risk (EA-URS). Our simulations using data for 17 euro area countries for the period 2000-2019 show that a euro area wide platform could have provided nearly perfect risk-sharing of unemployment risk if allowed to borrow up to 2% of the euro area GDP. We also show that in *normal times*, (the years before 2008 and after 2017), there is an approximate balance in the number of countries which pay in a contribution (those where the unemployment rate is below the country median) and the countries which receive an indemnity (where the unemployment rate is above the country median), implying that unemployment shocks in the euro area are sufficiently uncorrelated. Conversely, in a period of synchronised downturns such as between 2009 and 2016, most countries would optimally draw from the scheme.

Importantly, the EA-URS we propose is robust to limited commitment concerns, so that in no scenario a member country would gain from leaving the scheme or renege on a due contribution. We focus on limited commitment as the main friction and obstacle to risk sharing, since we believe that other potential obstacles based on hidden information are less relevant in the institutional euro area setting. Future work could, however, extend our mechanism design framework by adding and modeling other frictions, e.g., moral hazard.

Our findings underscore that an inventive-compatible unemployment reinsurance for the euro area is not only feasible, but it would contribute to minimise the fluctuations in euro area members' domestic unemployment expenditures. Since unemployment and economic activity are counter-cyclical, the EA-URS we propose would benefit the member states, which could possibly allocate resources to alternative fiscal policies during an economic downturn rather than to cover for increased unemployment benefit expenses.

References

Abraham, A., de Sousa, J. B., Marimon, R., and Mayr, L.: On the design of a European Unemployment Insurance System, European Economic Review, 156, https://doi.org/10.1016/j.euroecorev.2023.104469, 2023.

Allard et al.,: Toward a Fiscal Union for the Euro Area, https://www.imf.org/external/pubs/ft/sdn/2013/sdn1309.pdf, 2013.

Andor, L.: Towards shared unemployment insurance in the euro area, IZA Journal of European Labor Studies, 5, https://doi.org/10.1186/s40174-016-0060-7, 2016.

Arnold, N., Barkbu, B., Ture, H. E., Wang, H., and Yao, J.: A Central Fiscal Stabilization Capacity for the Euro Area, Tech. Rep. 2018/003, IMF, https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2018/03/22/A-Central-Fiscal-Stabilization-Capacity-for-the-Euro-Area-45741, 2018.

Beblavy, M. and Maselli, I.: Designing a European Unemployment Insurance Scheme, Intereconomics, 49, 184–203, https://doi.org/10.1007/s10272-014-0500-4, 2014.

Beblavy and Lenaerts: Feasibility and Added Value of a European Unemployment Benefits Scheme, https://www.ceps.eu/wp-content/uploads/2017/02/EUBS%20final.pdf, 2017.

Bénassy-Quéré, A., Brunnermeier, M., Enderlein, H., Farhi, E., Fuest, C., Gourinchas, P.-O., Martin, P., Pisani-Ferry, J., Rey, H., Schnabel, I., et al.: Reconciling risk sharing with market discipline: A constructive approach to euro area reform, 2018.

Berger et al.,: Revisiting the Economic Case for Fiscal Union in the Euro Area, IMF Economic Review, 2019.

Brandolini, A., Carta, F., and D'Amuri, F.: A feasible unemployment-based shock absorber for the Euro Area, Questioni di Economia e Finanza (Occasional Papers) 254, Bank of Italy, Economic Research and International Relations Area, https://ideas.repec.org/p/bdi/opques/qef_254_14.html, 2014.

Burriel et al.: A fiscal capacity for the euro area: lessons from existing fiscal-federal systems, ECB Occasional Paper Series, 2020.

Chortareas, G.: Fiscal Policy Rules in Monetary Unions, Journal of Post Keynesian Economics, 36, 85–103, http://www.jstor.org/stable/43671391, 2013.

Claveres, G. and Strasky, J.: Stabilising the Euro Area through unemployment benefits re-insurance scheme, https://doi.org/10.1787/6ab5edd0-en, 2018.

Dolls, M.: An Unemployment Re-Insurance Scheme for the Eurozone? Stabilizing and Redistributive Effects, EconPol Policy Reports 10, ifo Institute - Leibniz Institute for Economic Research at the University of Munich, 2019.

Dullien, S.: A European Unemployment Benefit Scheme, Verlag Bertelsmann Stiftung, Gütersloh, 2014.

Gros, D.: The Stabilisation Properties of a European Unemployment Benefit Scheme, CEPS Papers 11826, Centre for European Policy Studies, 2016.

Karaivanov, Mojon, Pereira da Silva, and Townsend: Digital Safety Nets - A Roadmap, BIS Papers 139, 2023.

Karaivanov, A. and Townsend, R.: Dynamic Financial Constraints: Distinguishing Mechanism Design from Exogenously Incomplete Regimes, Econometrica, 82(3), 887–959, 2014.

Lenarčič, A. and Korhonen, K.: A case for a European rainy day fund, ESM discussion paper, 2018.

Pasmeni: The Economic Rationale of an EMU Fiscal Capacity, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3216390, 2015.

Thomas, J. and Worrall, T.: Self-enforcing wage contracts, Review of Economic Studies, 55(4), 541–554, 1988.

Appendix A

Table A1: Normalized and actual unemployment rates by country

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Normalized rate, $\mathbf{n}(\mathbf{s_i})$	**0.67**	**0.77**	**0.88**	**0.96**	**1**	**1.06**	**1.14**	**1.28**	**1.50**
Country \ percentile	p10	p20	p30	p40	p50	p60	p70	p80	p90
Austria, AT	3.5	4.0	4.6	5.0	5.2	5.5	5.9	6.7	7.8
Belgium, BE	5.2	6.0	6.8	7.4	7.7	8.2	8.8	9.9	11.6
Estonia, EE	5.5	6.4	7.2	7.9	8.2	8.7	9.4	10.5	12.3
Finland, FI	5.7	6.5	7.4	8.1	8.5	8.9	9.6	10.8	12.7
France, FR	6.1	7.0	8.0	8.7	9.1	9.6	10.3	11.6	13.6
Germany, DE	4.6	5.3	6.1	6.6	6.9	7.3	7.8	8.8	10.3
Greece, GR	8.1	9.3	10.6	11.6	12.1	12.8	13.7	15.4	18.1
Ireland, IE	4.2	4.8	5.5	6.0	6.3	6.6	7.1	8.0	9.4
Italy, IT	5.9	6.8	7.7	8.4	8.8	9.3	10.0	11.2	13.1
Latvia, LV	7.5	8.7	9.9	10.8	11.2	11.9	12.8	14.4	16.8
Lithuania, LT	7.2	8.3	9.5	10.3	10.8	11.4	12.3	13.8	16.2
Luxembourg, LU	3.3	3.8	4.3	4.7	4.9	5.2	5.6	6.3	7.4
Netherlands, NL	4.0	4.6	5.2	5.7	6.0	6.3	6.8	7.6	9.0
Portugal, PT	6.2	7.2	8.1	8.9	9.3	9.8	10.5	11.8	13.9
Slovenia, SI	4.4	5.1	5.8	6.3	6.6	6.9	7.5	8.4	9.8
Slovakia, SK	9.1	10.5	11.9	12.9	13.5	14.3	15.4	17.3	20.3
Spain, ES	9.8	11.3	12.9	14.0	14.7	15.5	16.7	18.7	22.0

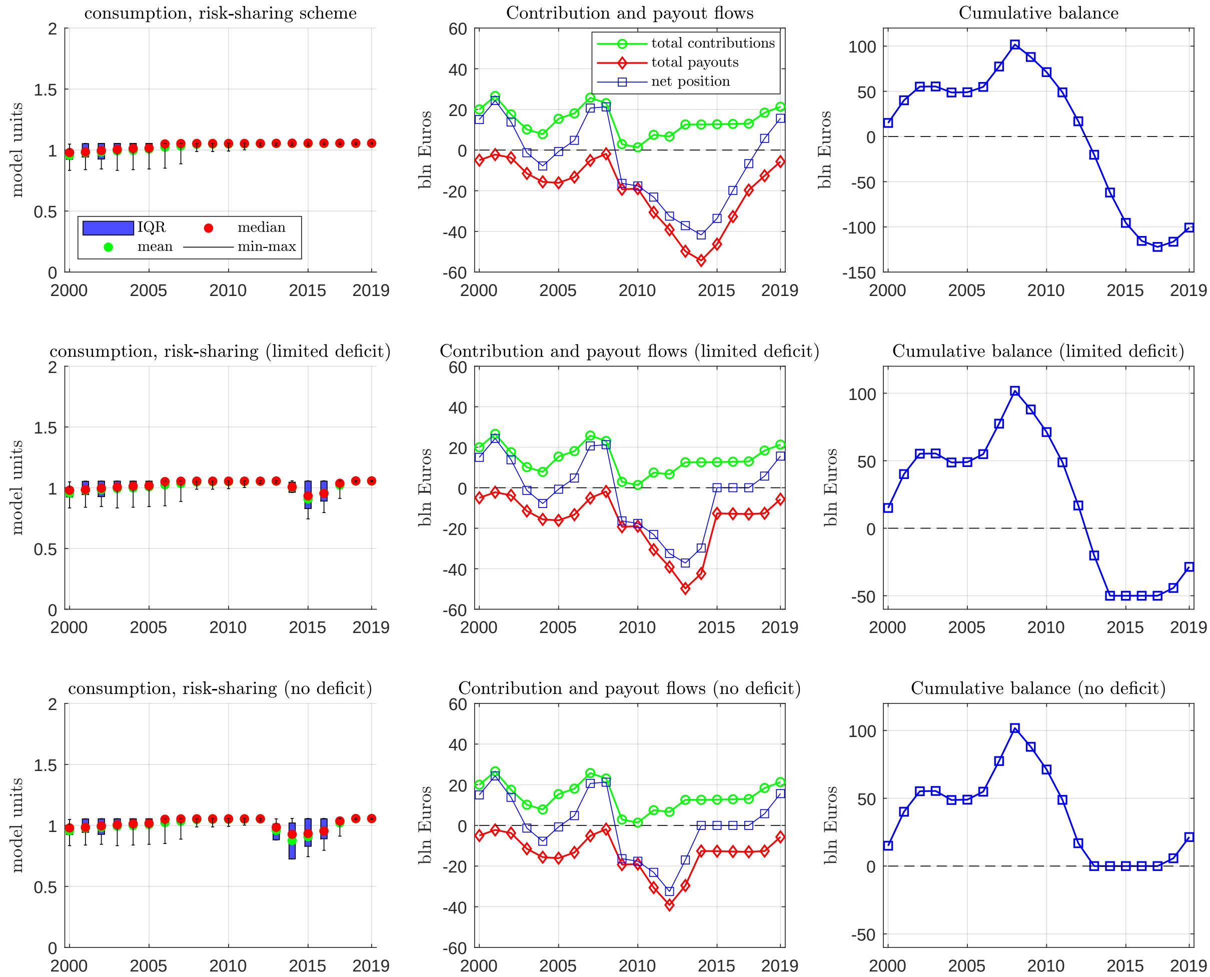
Notes: the table displays the normalized unemployment rates (the top row) used in the model simulations and their mapping to actual unemployment rates (in percent) for each country. The normalized unemployment rate for each country is defined as the actual unemployment rate divided by the country's median unemployment rate for the period 2000-2019, see Section 4.1 for details. The median (p50 percentile) unemployment rate for each country, corresponding to normalized rate of 1, is shown in column (5). The numbers in columns (2)–(4) and (6)–(9) are obtained by multiplying the corresponding normalized rate in row 1 by the median unemployment rate for each country from column (5).

Table A2: Unemployment insurance (UI) revenue and tax rate

Country	**median revenue** bln EUR (1)	**tax rate** percent (2)
Austria, AT	8.68	6.00
Belgium, BE	6.99	4.03
Estonia, EE	0.16	2.40
Finland, FI	2.64	3.00
France, FR	34.78	4.05
Germany, DE	31.60	2.40
Greece, GR	3.14	4.52
Ireland, IE[1]	1.98	2.40
Italy, IT	12.52	2.00
Latvia, LV	0.16	1.84
Lithuania, LT[2]	0.34	2.40
Luxembourg, LU[1]	0.28	2.40
Netherlands, NL	14.79	4.19
Portugal, PT	3.78	5.00
Slovenia, SI[2]	0.48	2.40
Slovakia, SK	0.50	2.00
Spain, ES	33.09	7.05

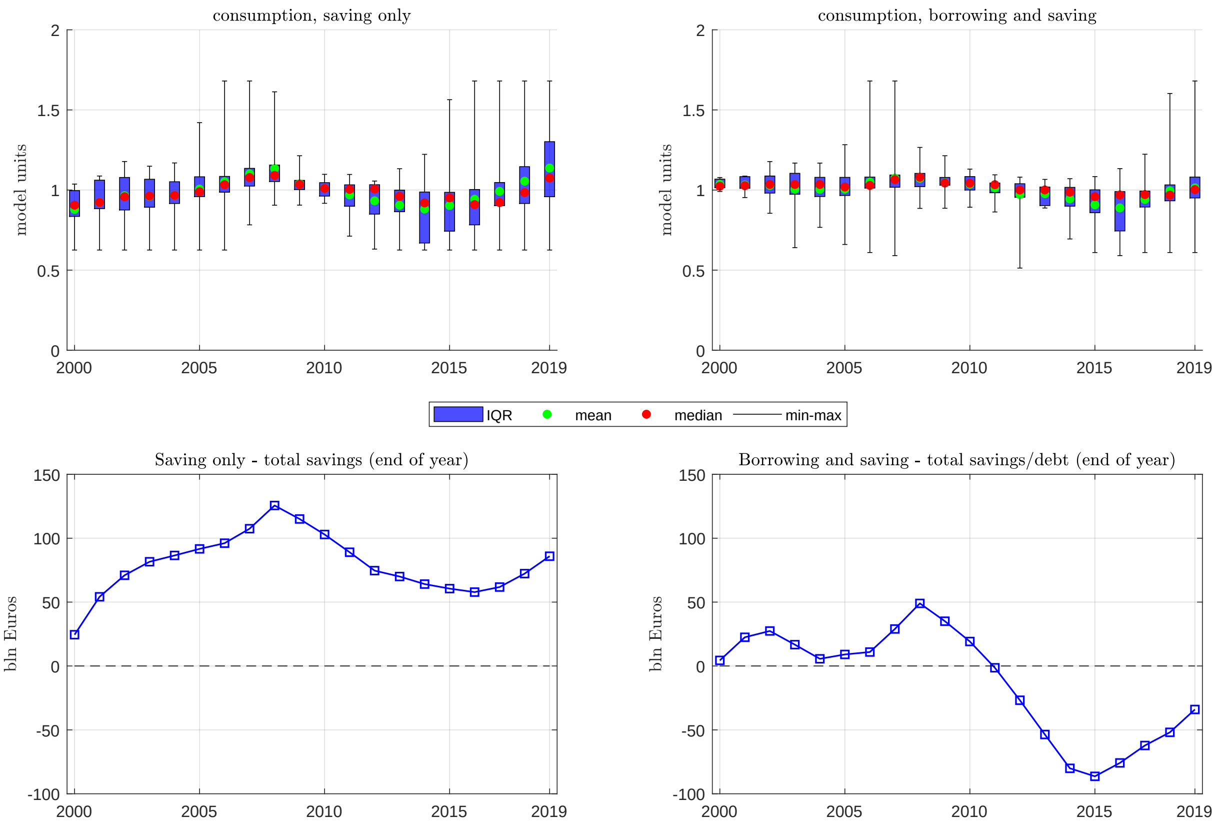
Notes: column (1) displays the median unemployment insurance (UI) revenue for each country over the period 2000–2019, used to compute normalized resource units in the model simulation. The UI revenue is calculated as the product of three data variables: (A) the percent of average gross wages withdrawn as contribution to unemployment insurance, (B) the average gross annual wage, and (C) the total number of employed. Column (2) displays the national UI contribution/tax rate, (A) used to calculate UI revenue. See Table B1 for all data sources and definitions.
[1]Absent an official UI tax rate, we use the sample median (2.4%). [2]Assuming that the official UI-specific tax rate (0.16% for LT and 0.21% for SI) is insufficient and is supplemented from other budget sources, we use the sample median rate as proxy for the actual UI contribution rate.

Figure A3: Risk-sharing scheme, consumption, flows and cumulative balance (lower risk aversion, CRRA parameter 0.5)



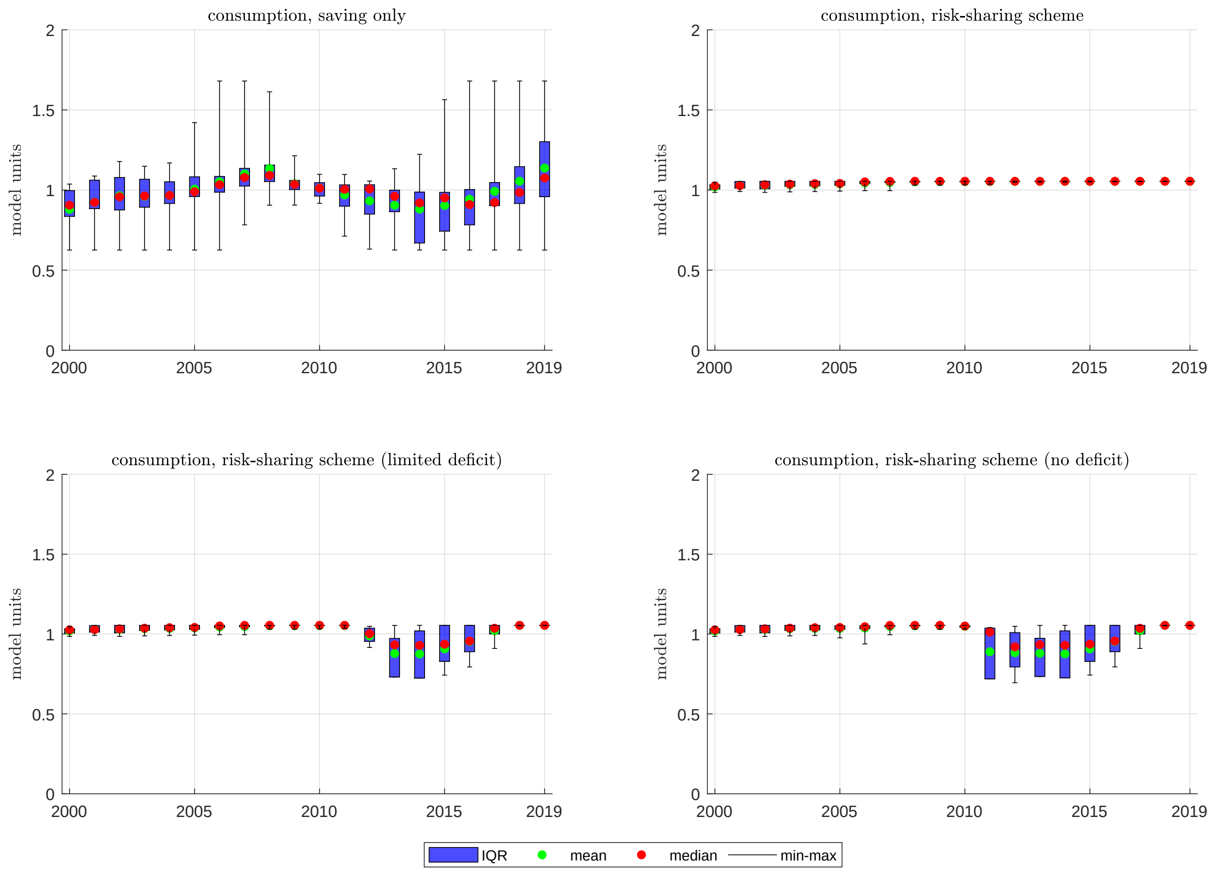
Notes: The figure displays simulation results for CRRA risk aversion parameter 0.5. The top row of panels shows the results when the risk-sharing scheme is not subject to a borrowing limit; the center row shows the results when the risk-sharing can run a limited deficit up to 50 bln EUR, and the bottom row shows the results for the case when the scheme is not permitted to run a deficit. The left-hand panels plot the cross-sectional distribution of model consumption (UI expenditure per unemployed). The center panels plot the annual flows into and out of the risk-sharing scheme and the scheme's net position (surplus or deficit) by year. The right-hand panels show the cumulative balance of the risk-sharing reinsurance scheme over the period 2000-2019.

Figure A4: Saving only vs. Borrowing and saving



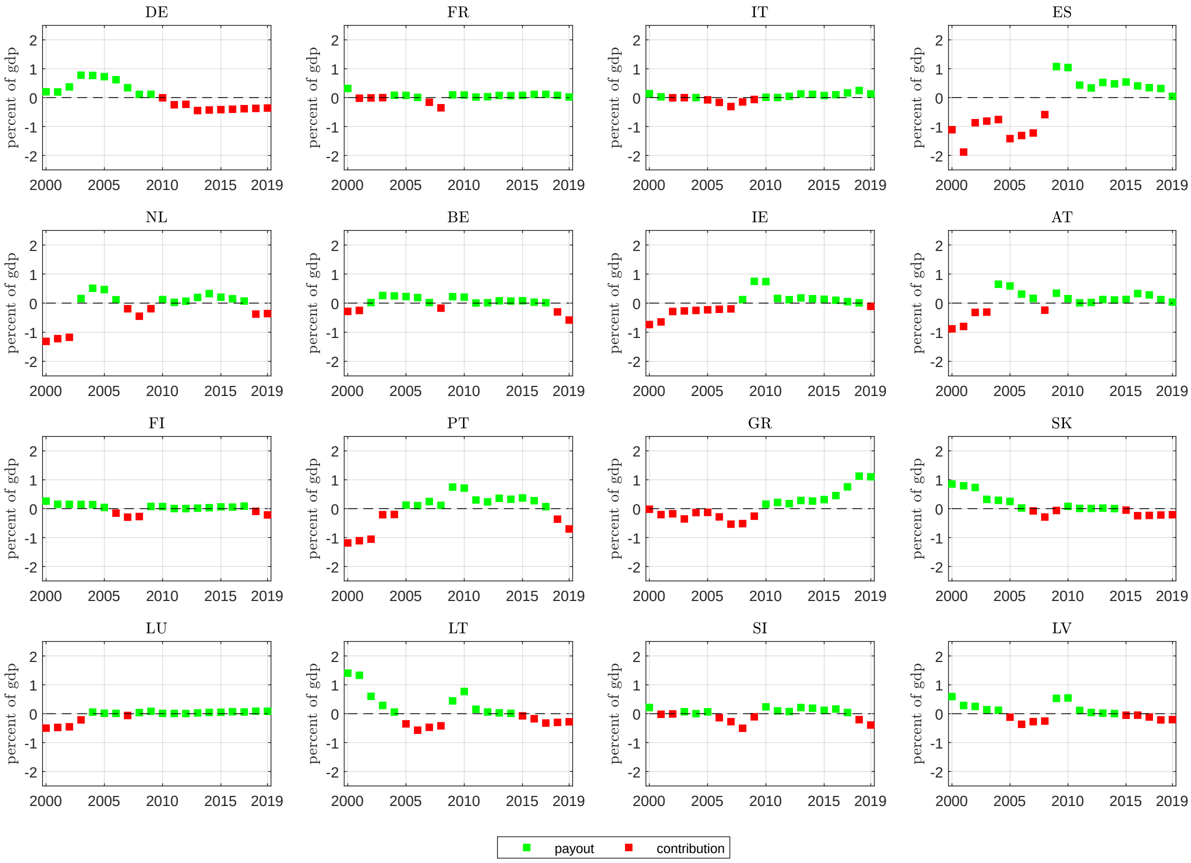
Notes: the top row of panels compares the cross-country distribution of consumption (UI expenditure per unemployed) in model units in the saving only setting (left-hand panel) and in the borrowing and saving setting (right-hand panel) for each year from 2000 to 2019. The bottom row compares the annual net balance (total savings or debt aggregated over all countries) in bln euros in the saving-only setting (left-hand panel) and in the borrowing and saving setting (right-hand panel).

Figure A5: Consumption smoothing – comparison



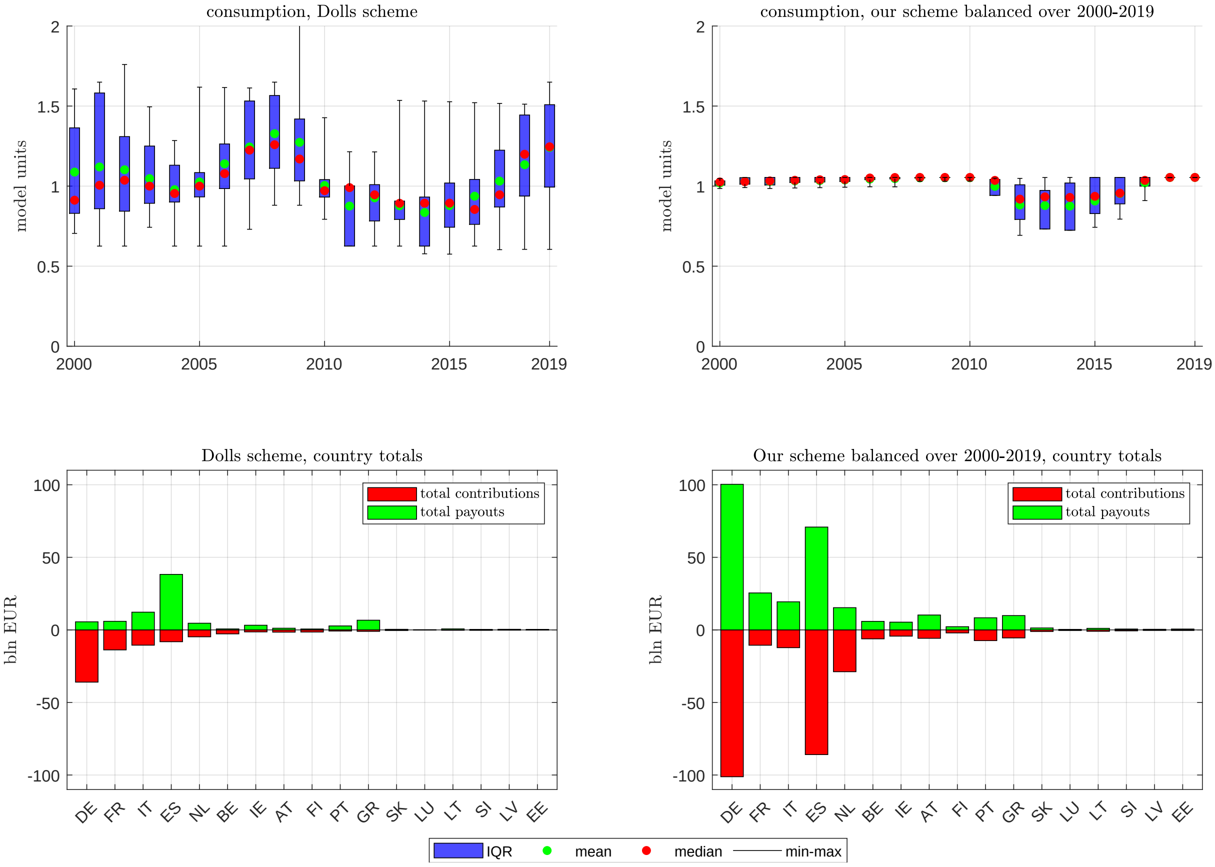
Notes: each panel shows the cross-sectional distribution of consumption (UI expenditure per unemployed) in model units for a different setting: saving only (top left), risk-sharing scheme with unlimited borrowing capacity (top right), risk-sharing scheme with maximum 50 bln EUR limited deficit (bottom left), and risk-sharing scheme with no permitted deficit (bottom right).

Figure A6: Risk-sharing transfers as fraction of GDP (zero deficit scenario)



Note: each panel shows the size (expressed as share of GDP) of the reinsurance contribution/premium to the scheme (in red) or the reinsurance payout/indemnity from the scheme (in green) for each country in the risk-sharing scheme under zero permitted deficit.

Figure A7: Comparison with Dolls (2019), balanced over 2000–2019



Appendix B

Table B1: Data Sources and Definitions

Data variable	Definition	Source	Link
Unemployment (mln people)	Unemployment comprises all persons of working age who were: a) without work during the reference period, i.e. were not in paid employment or self-employment; b) currently available for work, i.e. were available for paid employment or self-employment during the reference period; and c) seeking work, i.e. had taken specific steps in a specified recent period to seek paid employment or self-employment.	IMF, *International Financial Statistics*	unempl_IMF
Unemployment rate (percent)	The unemployment rate is calculated by expressing the number of unemployed persons as a percentage of the total number of persons in the labour force.	IMF, *International Financial Statistics*	unemp_rate_IMF
Employment (mln people)	Employment comprises all persons of working age who during a specified short period, such as one week or one day, were in the following categories: a) paid employment; or b) self-employment (whether at work or with an enterprise but not at work).	IMF, *International Financial Statistics*	employment_IMF
Average gross wages (EUR)	Average annual wages per full-time and full-year equivalent employee.	OECD	wages_OECD
Unemployment insurance revenues (bln EUR)	Calculated as the product of three data variables: (i) the percentage of average gross wages contributed to unemployment insurance, (ii) average gross annual wages, and (iii) total number of employed (employment).	authors' calculations	
GDP (bln EUR)	National accounts, expenditure, gross domestic product, nominal and seasonally adjusted.	IMF, *International Financial Statistics*	nGDP_IMF
Interest rate (percent)	Euro short-term Main Refinancing Operations (MRO) rate for 2000–2019.	European Central Bank (ECB)	ECB_rate
UI tax rate (percent)	Contribution to unemployment insurance by employers and employees.	OECD	OECD_TaxRate