One Scheme Fits All

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One scheme fits all: A central fiscal capacity for the EMU targeting eurozone, national and regional shocks☆

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ABSTRACT

This paper proposes a central fiscal capacity for the euro area that generates transfers in response to eurozone, country, and region-specific shocks. The main novelty of this fiscal capacity is that it allows a joint response to these three types of shocks within a single scheme. Based on NUTS3 regional data over the last two decades and regional fiscal multiplier estimates, our analysis shows that – with a limited risk of moral hazard – substantial stabilisation could have been achieved in response to the eurozone and regional shocks, while country-specific shocks were on average weaker and therefore needed less stabilisation.

1. Introduction

Three major crises in the European Economic and Monetary Union (EMU) over less than fifteen years, *i.e.*, the global financial crisis (GFC), the European sovereign debt crisis and the Covid-19 pandemic, have shown that the common currency area is ill-equipped to handle such large shocks. A fourth crisis, the Ukraine–Russian war, has unfolded, and it would be wishful thinking to assume that this will be the last one. This deficiency in the design of the currency union has, of course, been recognised and given rise to several proposals for the reform of the EMU architecture, often including the introduction of a Eurozone central fiscal capacity (CFC), which would allow strengthening risk-sharing via public channels.

Even during a severe common crisis, there is substantial variation in how individual countries, and the regions within a country, fare. For example, the Covid-19 pandemic had a disproportionately negative effect on Southern Europe and, within this area, on

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regions relying strongly on contact-intensive sectors, such as tourism. Unlike the United States with its federal tax and transfer system, the eurozone has no central mechanism to attenuate the regional differences in the reaction to shocks. The main contribution of this paper is to propose a CFC in which transfers from and to a common fund respond to Eurozone-wide, country-specific, and idiosyncratic shocks hitting regional output.

Regional stabilisation, as foreseen by our CFC, but largely neglected so far in policy practice and analysis, serves as a useful complement to the euro area monetary and national fiscal policies, which address shocks that are common across regions. These common policies will suit a wider range of individual regions when the latter feature better-aligned business cycles.

Local business cycles would be better stabilised in the presence of a common CFC which would target different shocks influencing regional GDP, rather than the overall GDP per region. This is because transfers from and to regions can be fine-tuned to the different levels of persistence of the individual shocks: a higher shock persistence would lead to higher output variance and therefore would require stronger stabilisation. In other words, a scheme that would target the overall level of regional output (and aggregate persistence) would necessarily be less efficient, in terms of smoothing output volatility, than a scheme that targets the individual shocks underlying regional output (and their persistence). In addition, depending on which shock level (*i.e.*, euro area-wide, country- or region-specific) is predominant in influencing regional output, different types of CFC can be designed. For example, if regional GDP is mainly driven by euro area-wide shocks, the CFC will need to be equipped with a sizeable borrowing capacity, because the shock will hit contemporaneously most regions. If the regional level prevails, the opposite is the case, because transfers will generally cancel out within each year, hence the CFC will not need to borrow from the financial markets. If country factors are predominant, European policymakers could condition the transfers on specific structural reforms that could reinforce business cycle convergence across the regions.

We identify the three different shock layers by means of a multilevel Bayesian factor model approach, which – to the best of our knowledge – has never been applied in the context of the literature on EMU reform. This approach has several advantages. In particular, it allows to handle a large cross-section of data in a parsimonious way. Indeed, we apply this methodology on a very rich dataset of regional output growth from the ARDECO database of the European Commission.

The three different levels of the proposed CFC are to some extent reminiscent of already existing arrangements. The first level, which targets eurozone-wide shocks, has a similar nature to the recently established EU's Recovery and Resilience Facility (RRF), which was adopted in response to the Covid-19 pandemic.[1] The RRF, however, is temporary and more focused on financing investment. The second level, aimed at cushioning national shocks, may have some resemblance to the ESM/IMF official loans that were activated for the countries hit most severely during the European sovereign debt crisis. Finally, the third level, intended to dampen the effects of region-specific shocks, is novel. Its closest analogue in existing arrangements is the EU Solidarity Fund (ESF), which was "set up to respond to major natural disasters and express European solidarity to disaster-stricken regions within Europe".[2]

Regional shocks can come from different sources. In addition to natural disasters hitting a specific region, one can think of sectoral shocks, as the business cycle of a region is often linked to its sectoral specialisation. Therefore, a region will be affected by shocks in the industrial sector to which it has a relatively high exposure (*e.g.*, the automotive sector for Piedmont in Italy, the fishery sector for Galicia in Spain, etc.). Further, regional output may be also affected by global non-eurozone shocks. This could explain, for example, developments in some regions which are very exposed to the US or Chinese economy (*e.g.*, the regions of Amsterdam and Dublin, due to the fact that many multinational corporations have their headquarters there).

Based on 928 NUTS3 eurozone regions from 1999 until 2021, thus including the bulk of Covid-19 crisis, our analysis puts forward three main contributions. First, we find that business cycles at the regional level diverge substantially across euro area countries. Some countries (*e.g.*, Germany) are dominated by the euro area business cycle, others by the national business cycle (*e.g.*, Spain, Greece), while in yet other countries the region-specific shocks have the most prominent role (*e.g.*, the Netherlands, Ireland). Second, we show that – based on our own estimates of the regional fiscal multipliers – our "multilevel" CFC can produce substantial stabilisation at an aggregate borrowing capacity in the order of magnitude of the EU's RRF. The overall borrowing need of our CFC is de facto limited in every year, which is mainly the result of gross transfer flows partially cancelling out, because the region-specific shocks are uncorrelated within and across countries. Third, stabilisation is mainly achieved in response to the eurozone and regional shocks, while country-specific shocks were weaker and therefore needed less stabilisation.

Our stabilisation analysis builds on a theoretical framework in which a European social planner minimises a weighted sum of the variances of regional GDP growth around region-specific trends and is subject to a political cost of deploying a transfer scheme, which could be interpreted as arising from difficulties in finding a political agreement around the scheme, from outright euro-scepticism or from fear on the side of some Member States of becoming a net payer into the system. After estimating the euro area, country and regional factors driving regional GDP growth, and the region-specific government spending multipliers, we solve for the planner's optimal policy response parameters to the estimated factors. Given these optimal values, and the estimated decomposition of regional GDP around its trend, the actual transfers automatically follow. The *only* element that needs to be calibrated is the borrowing limit of the transfer scheme in a particular year. This will affect the overall size of the scheme (for the reference year and all other years).

[1] The RRF entered into force on 19 February 2021. It was launched to finance reforms and investments in EU Member States from the start of the Covid-19 pandemic in February 2020 until 31 December 2026. It made available €723.8 billion in total, of which €385.8 billion in loans and €338 billion in grants to EU countries.

[2] See https://ec.uropa.eu/regional_policy/en/funding/solidarity-fund/. While many countries have fiscal-equalisation or revenue-sharing schemes for sub-national entities, the difference with the regional stabilisation component in our proposal will be that the latter is steered from the supranational level.

In particular, the borrowing limit can be interpreted as the sum of *net* transfers for the three layers. We choose a borrowing limit roughly comparable to a fraction of the EU's RRF launched in 2020, since that scheme was approved by EU countries. Hence, it proved politically acceptable.

A common criticism on the idea of a CFC is that it may lead to moral hazard.[3] We believe that no transfer scheme can be fully free from moral hazard effects. However, our proposed scheme should be relatively insulated from them, for several reasons. First, policies of individual regions exert a negligible influence on the common factors driving the European and national business cycles. Second, our scheme prevents not only ex-ante redistribution (*i.e.*, it does not redistribute in expected terms), but also ex-post redistribution over longer periods, because the transfers are based on deviations from mean growth at the level of each single region. As a result, the scheme tends to avoid long-lasting transfers into one direction. Indeed, since positive and negative deviations of regional growth from mean growth essentially cancel out, we observe that (over time) accumulated net transfers to each region are close to zero at the end of our sample.

All in all, while our analysis focuses on the euro area, the findings of this paper could potentially also inform policymakers on the construction of centralised fiscal capacities in other federations, such as the US, and in emerging economies, such as China or Brasil.

The rest of the paper is organised as follows. Section 2 discusses some existing proposals for a CFC for the euro area, Section 3 presents the data, Section 4 lays out the dynamic factor model used to decompose regional GDP growth, and Section 5 describes the optimisation problem and our transfer scheme proposal. Section 6 shows the results of the transfer schemes, Section 7 its stabilising properties and Section 8 collects some robustness exercises. Then, Section 9 turns to the real-time implementation of the scheme. Finally, Section 10 concludes.

2. Proposals for a fiscal capacity for the EMU

Several proposals for a CFC have been made in policy circles. Some go back to before the euro came into existence, for example Marjolin (1975) and Padoa-Schioppa (1987). At the time, however, it was quite generally believed that macroeconomic stabilisation would be achieved through market mechanisms alone and that EMU by itself would lead to more business cycle synchronisation within the euro-area (EA) (Allard et al., 2013). After the EMU took off, however, it became clear that these mechanisms were imperfect and that the currency union was not complete, thus giving rise to different proposals on its completion. This lack of completeness is aggravated by the fact that cross-border private risk-sharing remains limited.[4] The "Four Presidents' Report" of Van Rompuy et al. (2012) envisages the gradual creation of a CFC, while the "Five Presidents' Report" of Juncker et al. (2015) discusses a euro-area stabilisation function that rules out permanent transfers through the convergence of economic structures beforehand, so as to encourage governments to follow sound fiscal policies. In its reflection paper, the European Commission (2017) sketches options for a euro-area macroeconomic stabilisation function, such as a scheme to protect investment during downturns and an unemployment reinsurance scheme. The case for a CFC was also recently made in contributions by officials of the IMF (see Berger et al., 2019, and Arnold et al., 2018), the European Fiscal Board (2018),[5] and the European Commission.[6] Although the RRF is a response to the Covid-19 crisis, it is temporary and mainly aimed at structural reforms and investment, in particular in climate transition and digitalisation, implying there is still a need for a CFC aimed at economic stabilisation.[7]

Other proposals have been put forward by academic researchers and policy experts.[8] Most focus on some form of unemployment reinsurance, for example Beblavý et al. (2015), Dolls et al. (2017), Beblavý and Lenaerts (2017), Carnot et al. (2017) and Abraham et al. (2023).[9] Beetsma et al. (2021) propose a scheme in which a country whose exports are hit by a shock gets compensated to the extent that the decline in exports is driven by a decline in world trade in the relevant sectors in which the country is active. Bénassy-Quéré et al. (2018) instead suggest that pre-qualified countries would be allowed to borrow from the ESM. However, various

[3] Moral hazard issues associated with a CFC are discussed in several contributions, for example Koester and Sondermann (2018), Burriel et al. (2020) and Beetsma et al. (2021). Wyplosz (2020) takes the position that emergencies, such as those arising from the Covid-19 pandemic, dominate moral hazard issues.

[4] This is shown in early work, *e.g.*, by Sorensen and Yosha (1998) and confirmed in more recent work by, *e.g.*, the European Central Bank (2018). Cimadomo et al. (2020) demonstrate some improvement in cross-border consumption risk sharing in the eurozone due to IMF/ESM official assistance programmes, but also owing to increased cross-border financial assets holdings (see, also, Milano (2017)). Farhi and Werning (2017) show that, due to private agents failing to internalise the beneficial macroeconomic stabilisation effects of their investment decisions, some degree of public risk-sharing remains desirable even in the presence of complete markets. Hettig and Mueller (2018) point to another interesting externality that could be taken care of by a CFC. Within a New-Keynesian currency-union model, they show that, with monetary policy constrained by the effective lower bound, absence of fiscal coordination induces governments to unduly hold back public spending for fear of a terms-of-trade appreciation, which would undermine demand for domestic products when there is economic slack.

[5] De Haan and Kosterink (2018) identify the circumstances under which a CFC may be most effective.

[6] In an intervention at an ECB conference on 2 December 2021, the EU Commissioner for Economy, Paolo Gentiloni, claimed that the EU should have resources to help stabilise economies in a crisis, especially after the EU's post-pandemic recovery fund ends in 2026. See: https://www.ecb.europa.eu/pub/conferences/html/20211202_5th_fiscal_policy_conference.en.html.

[7] In her Press Conference of 10th March 2022, ECB President Christine Lagarde claimed that: "*We have a long-standing record of arguing for some fiscal facility at the European-wide level in order to respond to shocks. We are clearly facing a major shock [...] we do believe that [such capacity] can be extremely helpful particularly in order to move Europe to a more integrated basis.* See https://www.ecb.europa.eu/press/pressconf/2022/html/ecb.is220310~1bc8c1b1ca.en.html

[8] For an overview, see Favaque and Huart (2017), while De Grauwe (2018) provides a conceptual discussion. Buti and Messori (2021) make the case that in the current EMU architecture a CFC is necessary to alleviate the stabilising burden on monetary policy and for fiscal policy to adhere to the fiscal rules.

[9] The popular support for such a scheme will typically depend on its design (*e.g.*, Burgoon et al., 2020 and Beetsma et al., 2022). Beetsma et al. (2022) show that this support can be substantial, even among populations in countries with a reputation of scepticism towards these types of schemes.

other contributions are critical about the need for a CFC and ask whether it will do more harm than good (see, *e.g.*, Feld and Osterloh, 2013, and Feld, 2018).

Closer to this paper is Enderlein et al. (2013), in which transfers would flow to and from a fund depending on a country's relative cyclical position, and Furceri and Zdzienicka (2015), where transfers are based on country-specific GDP shocks. However, none of the above contributions explore stabilisation at the regional level, nor engineer a fiscal capacity in which transfers are calibrated according to the different (euro area, national or regional) origins of the shocks, which is instead the focus of this paper.[10]

3. Data

We use eurozone NUTS3 regional statistics from the ARDECO database of the European Commission. This database includes annual statistics on demography, labour market, capital formation and regional gross domestic product (GDP). Data is provided at constant prices with base year 2015. We collect regional GDP for the 949 NUTS3 eurozone regions from 1999 until 2021.[11] After removing the so-called "extraregions", which are non-geographical economic territories (*e.g.* airspace, territorial waters, embassies, consulates, military bases, etc.), and which are included in the NUTS classification as these territories are subject to the Treaty establishing the European Community,[12] we are left with 939 NUTS3 regions (Table 1). We further exclude Cyprus, Malta and Luxembourg from our analysis as these countries consist of only one or two regions, which prevents us from disentangling country-specific and regional shocks.[13] Moreover, we omit seven overseas territories from our analysis due to their geographical distance from the eurozone.[14] Hence, we retain 928 eurozone regions for our empirical analysis.

There is considerable variation in the number of regions in each country and in the size of the regions, both within and across countries. Hence, in the following we use regional real GDP in per capita terms, which for conciseness we simply refer to as "regional GDP". Table 1 shows that regional GDP differs quite considerably over regions and countries. To avoid that our proposed transfer scheme responds to structural differences, we use demeaned growth rates in the empirical analysis. In particular, we compute the deviation of regional GDP growth from its historical average. We then use the ensuing demeaned series for the estimation of factors and the implementation of our CFC.

Fig. 1 shows the distribution of regional GDP growth for the 16 eurozone countries in our sample. Average values are depicted in blue. Although for many countries some common business cycle among its regions can be observed (visible through country-wide shifts in the frequency distribution of regional growth rates), there exists substantial heterogeneity in regional growth rates around the country averages. Differences in regional growth rates within a country appear to have been larger during the GFC of 2009 than during the Covid crisis year of 2020. A potential explanation is the strong commonality of the Covid shock, which hit all parts of a country, while the GFC may have been relatively harsher on regions with a concentration in the financial industry. This observation suggests that a transfer scheme should be flexible enough to cushion different types of shocks. Not surprisingly, from a purely statistical point of view, countries with a larger number of regions tend to have more dispersion in regional growth rates.

4. Regional variance decomposition: the dynamic factor model

In this section we first decompose demeaned regional growth using a multilevel dynamic factor model which allows for eurozone-, national-, and region-specific shocks. Our model is based on that of Kose et al. (2003) but is more general in that we allow for a richer factor structure. We define $y_{r,t}$ as the demeaned GDP growth of region r, belonging to country c_r, in year t.[15] We assume $r \in \mathcal{R}$, the lexicographic region set, with $|\mathcal{R}|$ the number of regions and $c_r \in \mathcal{C}, \forall r$, the lexicographic country set, with $|\mathcal{C}|$ the number of countries.

We then model $y_{r,t}$ with a 3-level dynamic factor model.[16] Regional growth rates, and their co-movements, are explained by latent unobserved factors: one or more euro-area common factors, $F_t^{EA,l}$, one or more country-specific factors, $F_t^{c,l}$, and an idiosyncratic regional factor, $F_t^{r,l}$, with $l \in \{1, 2, \dots, K_k\}$, where K_k is the number of factors in level $k \in \{EA, \mathcal{C}, \mathcal{R}\}$. We use the term "factor level" as each level could contain multiple factors. Region r's exposure to each of the factors is determined by the loadings $\lambda_r^{EA,l}$ and $\lambda_r^{c,l}$, $\forall r$, where $\lambda_r^{k,l}$ denotes the loading of the lth factor in level k, $F_t^{k,l}$, for region r.[17]

[10] Canova and Pappa (2021) employ the ARDECO database to estimate the multipliers associated with the RRF. Based on the same dataset, Hauptmeier et al. (2020) explore how monetary policy impacts on sub-national inequality in the EU. An important commonality with our paper is the role of instruments designed at the central level of the EU or the euro area for the functioning of the regional economies.

[11] The vintage of the ARDECO database used in the analysis is dated May 5, 2021, and was downloaded on June 21, 2021.

[12] See Regions in the European Union, Nomenclature of territorial units for statistics NUTS 2010/EU-27, Annex 1 (12), pp. 138–139. https://ec.europa.eu/eurostat/documents/3859598/5916917/KS-RA-11-011-EN.PDF

[13] In the robustness section, we also consider the case in which all 19 euro area countries are included, as well as a number of other robustness exercises. Results are virtually unchanged (see B.1.5). However, for sake of simplicity in the exposition, we exclude these three small countries from the baseline estimations.

[14] For France, the overseas territories are Guadeloupe, Martinique, French Guiana, La Réunion and Mayotte. For Portugal, these territories are the Azores and Madeira.

[15] Growth rates are demeaned over the time dimension. As transfers will be based on demeaned growth rates, they should not be affected by structural differences in growth rates. Instead of demeaning, one could include an intercept in our regression model below.

[16] Del Negro (2002) also adopts a three-layer dynamic factor model to disentangle output and consumption movements in the US in response to national, regional and state-specific business cycle shocks. For related approaches using factor models for business cycle analysis, see also Giannone et al. (2008), Doz et al. (2011) and D'Agostino et al. (2016).

[17] Note that we normalise $\lambda_r^{r,l} = 1, \forall r, l$.

Table 1
NUTS3 regional summary statistics.

Country	# Regions	Population ($\times 10^3$)		Reg. GDP ($\times 10^3$)	
		Mean	Std. Dev.	Mean	Std. Dev.
AT	35	240.9	282.1	34.4	8.8
BE	44	247.6	235.9	28.6	9.6
CY	1	802.6		22.6	
DE	401	204.7	232.3	32.5	14.4
EE	5	268.6	183.4	11.6	5.4
EL	52	209.3	223.8	15.6	4.7
ES	59	762.2	1065.2	21.6	4.4
FI	19	282.1	325.5	34.8	6.3
FR	101	638.6	489.5	27.8	10.6
IE	8	556.2	309.7	42.8	20.7
IT	110	536.5	585.1	26.0	7.1
LT	10	311.9	235.2	9.0	3.0
LU	1	522.2		89.5	
LV	6	352.8	169.1	9.0	4.6
MT	2	216.6	261.1	15.8	5.5
NL	40	416.2	319.6	34.8	9.3
PT	25	416.3	584.8	15.1	3.4
SI	12	169.8	135.9	16.2	4.0
SK	8	675.9	89.7	13.0	7.4
Total	939	333,446.1			

Notes:
(i) NUTS3 regional statistics from the ARDECO database of the European Commission, vintage 5 May 2021. Figures are calculated over the sample period 1999–2021.
(ii) The table displays country averages (across regions within a country) and standard deviations, calculated over regions within a country, and averaged over time.
(iii) AT = Austria, BE = Belgium, CY = Cyprus, DE = Germany, EE = Estonia, EL = Greece, ES = Spain, FI = Finland, FR = France, IE = Ireland, IT = Italy, LT = Lithuania, LU = Luxembourg, LV = Latvia, MT = Malta, NL = the Netherlands, PT = Portugal, SI = Slovenia, and SK = Slovakia.

Hence, we can write:

$$y_{r,t} = \sum_{l=1}^{K_{EA}} \lambda_r^{EA,l} F_t^{EA,l} + \sum_{l=1}^{K_{c_r}} \lambda_r^{c_r,l} F_t^{c_r,l} + F_t^r \tag{1}$$

By construction, regional output $y_{r,t}$ is not exposed to region-specific factors of any other regions in the euro area. However, the output of different regions can be correlated through the euro-area factors and, in some cases, through country-specific factors. Indeed, a given country-specific factor may simultaneously drive output in other countries, but not all countries (otherwise such a factor would be a euro area factor).[18] Within a country, regional GDPs can only be correlated through the euro-area factors and the domestic country-specific factors. Further, all factor *levels* are assumed to be orthogonal (*i.e.*, $F_t^{EA,l} \perp F_t^{c_r,k}$, $F_t^{c_r,l} \perp F_t^r$, $F_t^{EA,l} \perp F_t^r$, for all l, k and r), and the factors within each level for a given country are assumed to be orthogonal.[19]

The factors are assumed to follow an AR(1)-process[20]:

$$\begin{aligned} &F_t^{k,l} = \theta_{k,l} F_{t-1}^{k,l} + \upsilon_{k,l,t} \\ &\upsilon_{k,l,t} \sim \mathcal{N}\left(0, \sigma_{k,l}^2\right) \\ &\quad \forall k \in \{EA, C, \mathcal{R}\}, l \in \left\{1, 2, \dots, K_k\right\} \end{aligned} \tag{2}$$

Collecting all factors and their loadings, Eq. (1) can be simplified as:

$$\boldsymbol{y}_t = \boldsymbol{\Lambda}^{EA} \boldsymbol{F}_t^{EA'} + \boldsymbol{\Lambda}^{C} \boldsymbol{F}_t^{C'} + \boldsymbol{F}_t^{R'} \tag{3}$$

where $\boldsymbol{y}_t$ is a vector which contains the stacked observations of each region and country at time t, and $\boldsymbol{\Lambda}^{EA}$, of size $|\mathcal{R}|$ by K_{EA}, is a matrix that stacks the euro area factor level loadings of all regions.[21] The country layer loading matrix $\boldsymbol{\Lambda}^C$ is block-diagonal and thus sparse with each row including the country-specific loading of that region at the correct position and zeros elsewhere indicating that the region in question is not exposed to country-specific factors of other countries. It similarly stacks all regions and countries

[18] For example, because some (but not all) countries may be particularly affected by Brexit, this would imply a common country-specific factor across a subset of euro area countries. Hence, their country-specific factors would exhibit some correlation not picked up by the aggregate euro area factor(s).
[19] See Appendix C for an empirical test of such orthogonality.
[20] Given the above discussion, we do not restrict to zero the correlations of the innovations associated with the country factor, $\upsilon_{k,l,t}$, with $k \in C$, across different countries. However, any correlation across *all* countries $k \in C$ is excluded as this would already have been picked up in one or more euro area factors.
[21] See also Appendix A.1.

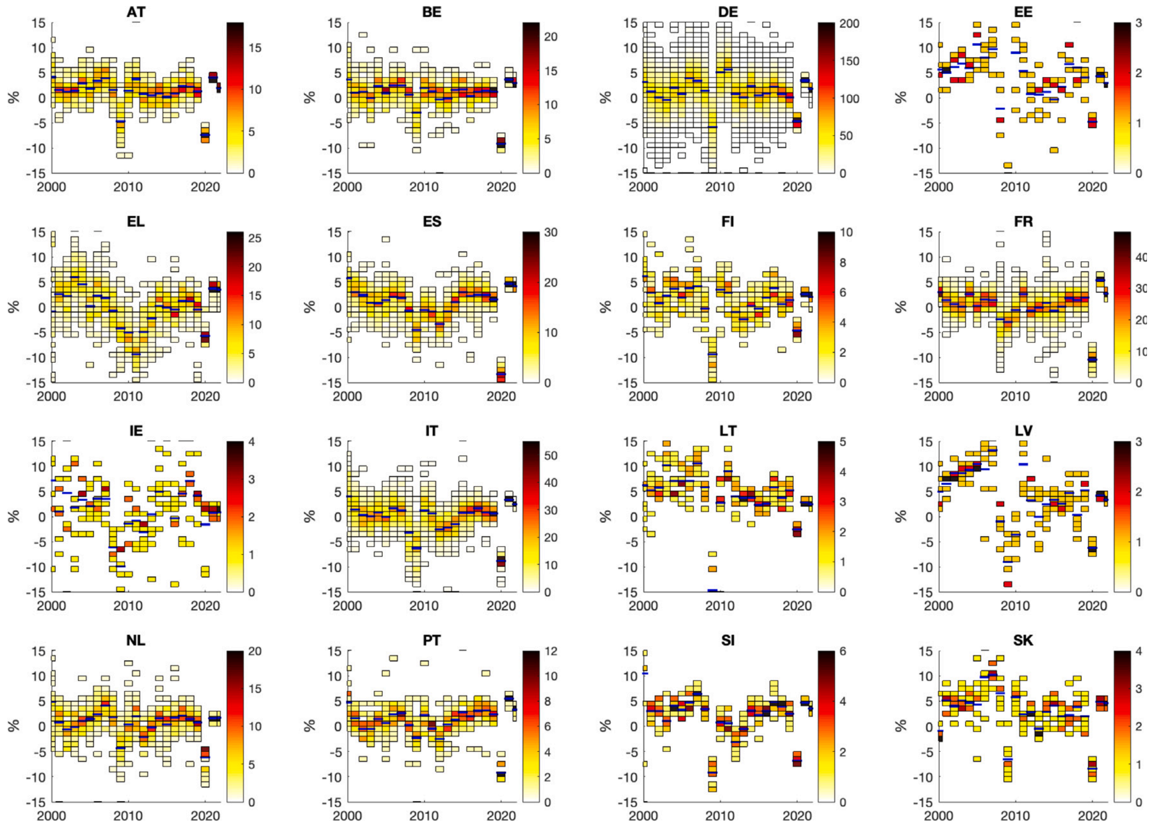


Fig. 1. Distribution of regional real per-capita GDP growth rates by year. Average values in every year are in blue. Sample: 1999–2021. Source: European Commission's ARDECO dataset.

over the row dimension and is of size $|\mathcal{R}|$ by $\sum_{c\in C} K_c$.[22] The vector $\boldsymbol{F}_t^C$ has capital C superscript, which represents the country layer. It collects the country-specific factors of all countries, hence it has size $\sum_{c\in C} K_c$. Further, $\boldsymbol{F}_t^R$ concatenates the regional factors F_t^r of all regions, hence has size $|\mathcal{R}|$. Finally, we denote by $\lambda_r^i \equiv \mathbf{row}_r\left(\boldsymbol{\Lambda}^i\right)$, for $i \in \{EA, C, R\}$, where $\mathbf{row}_r(\boldsymbol{\Lambda})$ is the row operator that extracts row r out of some matrix $\boldsymbol{\Lambda}$.[23]

Differently from Kose et al. (2003), who assume that the global, regional and national business cycles can be explained by one factor each, our model allows for multiple factors in the euro-area and country levels.

4.1. Identification, normalisation, and variance decomposition

The scale, sign and loading of the factors are not uniquely determined. Taking the negative of a factor and multiplying its loading by minus one yields a statistically identical decomposition. The same is the case if we rescale a factor and rescale its loading by the reciprocal number. Moreover, if a factor level consists of multiple factors, all permutations of the factor ordering within the level yield identical decompositions.

Therefore, as is common in the literature, we adopt identifying assumptions. In particular, for every factor level we restrict the loadings of the first regions (exposed to those factors) to be positive: for the euro area factor level we restrict the first region in the first country to be positively exposed, for the country factor levels we restrict the first region in every country to be positively exposed. To exclude non-uniqueness through symmetry, we restrict the first number (equal to the number of factors in the factor level) of rows of the loadings matrix to be lower triangular, such that the first region is only exposed to the first factor, the second to the first and second factors, etc. That is, for the euro area factor the first region in the first country is only exposed to the first euro area factor, while the second is affected by the first and second factors, etc., and likewise for the country levels. The exact restrictions can be found in Appendix A.2.

[22] Formally, the regional layer loading matrix $\boldsymbol{\Lambda}^R$ is an identity matrix of size $|\mathcal{R}|$.

[23] Hence, $\lambda_r^R = e_r$, the unit vector, with element 1 at position r and zeros elsewhere.

The scale of the factors is pinned down by setting $\sigma^2_{k,l}$ equal to a constant. In the following we assume that $\sigma^2_{k,l} \equiv 1$, $k \in \{EA, C\}$, $l \in \{1, 2, \ldots, K_k\}$. Note that we do not restrict the variances of the region-specific shocks. The variance of each observation is then given by:

$$\mathbb{V}\mathrm{ar}\left[y_{r,t}\right] = \sum_{l=1}^{K_{EA}} \frac{\left(\lambda_r^{EA,l}\right)^2}{1-\left(\theta_{EA,l}\right)^2} + \sum_{l=1}^{K_{c_r}} \frac{\left(\lambda_r^{c_r,l}\right)^2}{1-\left(\theta_{c_r,l}\right)^2} + \frac{\sigma_r^2}{1-\theta_r^2} \tag{4}$$

The proportion of the variance explained by each factor level is obtained by dividing every term in (4) by $\mathbb{V}\mathrm{ar}\left[y_{r,t}\right]$. In case the data is standardised such that $\mathbb{V}\mathrm{ar}\left[y_{r,t}\right] = 1$, $\forall r, t$, the explained variance by each factor level equals the corresponding term in the expression above.

4.2. Estimation conditional on a given factor structure

The estimation procedure follows the Bayesian approach by Otrok and Whiteman (1998), and Kose et al. (2003).[24] The priors are conjugate and stated in Appendix A.3.1. The posteriors are given in Appendix A.3.2.

In the estimation procedure, we adapt the algorithm proposed by Jackson et al. (2015), which is in turn based on Kose et al. (2003), in two ways. First, to satisfy the sign restrictions, the authors sample the λ_r-vectors (in our case consisting of λ_r^{EA} and λ_r^{c}) from a multivariate normal distribution until the vector satisfies the constraints. If the true factor loadings are small, which is typically the case with standardised data, there exists a (high) probability that a factor loading draw obeys the constraints even though the factor draw itself might be mirror-imaged. Then, if in the next draw the mean of λ_r is negative, the algorithm will mirror the factor draw so as to obtain the correct decomposition. Subsequently, taking the average over the draws, both the factor and loading estimates converge to zero. Instead, we opt to sample each entry of the λ_r-vector individually, which is possible since the factors are orthogonal. If a specific entry has to satisfy a sign restriction, we replace the normal distribution by its truncated (by zero from below) counterpart.

Second, for a dataset with a small time dimension, the algorithm might fail in drawing factors that are completely orthogonal. As a result, the variance decomposition can be biased. As a solution, after every factor draw in each factor level, we orthogonalise the draw with respect to previously sampled factors *in that level*.[25] For instance, the second eurozone factor is orthogonalised to the first eurozone factor by deploying the annihilator matrix. More specifically, the orthogonalised second eurozone factor is given by $F^{EA,2,orth} = (I - F^{EA,1}(F^{EA,1'}F^{EA,1})^{-1}F^{EA,1'})F^{EA,2}$, where $F^{EA,2}$ is the original factor draw. Similarly, for each country's factor level, factors are projected to the matrix space that is orthogonal to the previously sampled factors in that level and the complete eurozone factor level. If the factors are in fact already orthogonal, their matrix spaces do not intersect and, hence, the annihilator matrix equals the identity matrix making the transformation inoperative. However, if the matrix spaces overlap, the previously sampled factors contain common information that should only be contained in these previously sampled factors. In that case, the transformation eliminates the intersection of the matrix spaces.

We estimate a range of potential models, which vary in the numbers of factors per level. We allow the eurozone and country factor levels to consist of zero to three potential factors. We then rank the models according to their average Bayesian Information Criterion (BIC).

5. The transfer scheme

As outlined in the Five Presidents Report (Juncker et al., 2015), a central fiscal capacity should be a business cycle stabilisation tool and not target structural differences in income. Our proposal complies with this basic principle as it targets divergences from the individual regions' average growth paths. In this section we present our transfer scheme aimed at minimising a weighted average of regional GDP variances subject to the political cost of deploying a transfer scheme.

5.1. The European policymaker's decision

The decision to implement a specific transfer scheme is a trade-off between its benefits in terms of macroeconomic stabilisation and its potential costs in terms of political support and financial resources. One can think of this political decision-making process as an optimisation problem at the central European level where the goal is to reduce regional growth variation (relative to the region-specific historical average) against acceptable costs. The "optimal" scheme can be seen as absorbing all regional output volatility, once the macroeconomic effects of the transfers – captured by the region-specific fiscal multiplier g_r – are factored in.

We model the transfers as a set of policy rules $\tau\left(\lambda_r^i, \boldsymbol{F}_t^i, \gamma^i\right)$, which are functions of the factors and their loadings, where the parameter γ^i regulates the size of the counter-cyclical response to the factors driving the regional business cycles, for $i \in \{EA, C, R\}$. We assume the policymaker responds in a similar fashion to shocks irrespective of the region or country, hence here γ^i runs over the three layers EA, C and R, and not the different countries and regions in these layers. We also consider a cost associated with the transfers, *i.e.*, $f(\gamma^{EA}, \gamma^C, \gamma^R, \kappa)$, where κ is an exogenous parameter controlling the size of the cost or the "political orientation"

[24] Due to the large number of parameters a Bayesian approach is much faster than its frequentist counterpart.

[25] This still allows country factors to be correlated for a subset of the countries in our sample, as explained above.

of the policymaker. For $\kappa > 0$, this penalty function may capture the political cost of an (ex-ante) agreement on the transfer scheme. The political cost may be driven by outright euro-scepticism or by a fear of some Member States of becoming a net payer into the system, whether that is true or not. For $\kappa < 0$, one can think of the case of a European policymaker who is particularly eager to run redistributive policies (in which case κ can therefore be interpreted as an incentive). Formally, for a given value of κ, the European social planner chooses the optimal level of the response parameters $(\gamma^{EA,*}, \gamma^{C,*}, \gamma^{R,*})$ minimising the following loss function:

$$(\gamma^{EA,*}, \gamma^{C,*}, \gamma^{R,*}) = \text{argmin } L(\gamma^{EA}, \gamma^{C}, \gamma^{R}|\kappa) \tag{5}$$

where

$$\begin{aligned} L\left(\gamma^{EA}, \gamma^{C}, \gamma^{R}|\kappa\right) = &\sum_{r\in\mathcal{R}} w_r \mathbb{V}\text{ar}\left(y_{r,t} + g_r \tau_{r,t}\right) \\ &+ f(\gamma^{EA}, \gamma^{C}, \gamma^{R}, \kappa) \end{aligned} \tag{6}$$

and where w_r is the region's share of the total euro area population. The variances in (6) are calculated over output growth resulting from the original "raw" output growth process (expressed relative to $GDP_{r,t-1}$), so not including any transfers, plus the (estimated) regional spending multiplier, *i.e.*, g_r, multiplied by the total transfer from the different levels of the scheme in percent of regional GDP for year $t-1$, *i.e.*, $\tau_{r,t} = T_{r,t}/GDP_{r,t-1}$, where $T_{r,t}$ is the total regional transfer in euro terms.

Notice that, being based on the variance of regional growth in deviation of average growth, the loss function in (6) penalises equally fluctuations in either direction of average growth. By minimising fluctuations in growth rates from their trends this loss function differs from the most common welfare loss approximations of micro-founded utility in the literature on optimal monetary and fiscal policy in dynamic stochastic general equilibrium models (see, *e.g.*, Beetsma and Jensen, 2005; Schmidt, 2013), where the objective of the policymaker is to minimise the gap between one or more endogenous variables and their efficient equilibrium values. Deviations from the efficient equilibrium in either direction cause a utility loss from an inefficient use of resources. Indeed, in practice, policymakers not only try to limit overcapacity but also to reduce overheating. We prefer a loss function that targets deviations of growth rates from trend rather than output gaps, because the latter are hard to measure in real time. Moreover, it is politically more difficult to base transfers on output gaps, because they cannot be directly observed and channelling transfers to countries experiencing a boom but even faster-growing potential output would be politically hard to justify.

5.2. The optimal γ^i and total transfer scheme

In the following, we assume a linear transfer function for each layer $i \in \{EA, C, R\}$ and a quadratic penalty function. The total transfer for a region r will be given by the sum of the transfers associated with each of the three layers. More specifically:

$$\begin{aligned} \tau\left(\lambda_r^i, \boldsymbol{F}_t^i, \gamma^i\right) =& \gamma^i \lambda_r^i \boldsymbol{F}_t^{i'} \\ f\left(\gamma^{EA}, \gamma^{C}, \gamma^{R}, \kappa\right) =& \kappa\left((\gamma^{EA})^2 + (\gamma^{C})^2 + (\gamma^{R})^2\right) \end{aligned} \tag{7}$$

We would expect only simple transfer schemes to be politically feasible because complicated schemes are difficult to communicate and to understand by policymakers and the broader public, while they could also easily run into discussions about the correct transfer levels once shocks have materialised. Hence, we confine ourselves to linear transfer schemes.

A higher value of κ penalises more ex-post redistribution after the shocks have materialised, as the response parameters to the shocks enter the formulation of the loss function in (7) in a quadratic way. Hence, stronger fears of ex-post redistribution would be reflected in a higher κ.

The optimal policy parameter of the transfer scheme is given in the following proposition:

Proposition 1 (*Optimal Response Parameters*)**.** *Given a linear transfer function $\tau(\cdot)$, a quadratic penalty function $f(\cdot,\cdot,\cdot)$, and a penalty level κ, the optimal response parameters at CFC level $i \in \{EA, C, R\}$ are given by:*

$$\gamma^{i,*} = -\frac{\sum_{r\in\mathcal{R}} w_r g_r v_r^i}{2\left(\sum_{r\in\mathcal{R}} w_r g_r^2 v_r^i + \kappa\right)} \tag{8}$$

where v_r^i is the fraction of regional output variance explained by level i. The v_r^i are given in Eq. (4). For example, if $i = EA$, $v_r^{EA} = \mathbb{V}ar\left[\lambda_r^{EA}\boldsymbol{F}_t^{EA'}\right] = \sum_{l=1}^{K_{EA}}\left(\lambda_r^{EA,l}\right)^2/\left(1-\theta_{EA,l}^2\right)$.

Proof. See Appendix A.4. □

Hence, the European policymaker sets $\gamma^{i,*}$ by weighing the relative importance of every region (w_r), the effectiveness of the transfer, captured by the regional multiplier g_r, and the explained variance of that specific layer (v_r^i). Fig. 2 depicts $\gamma^{i,*}$, for different values of θ_i, as a function of the political cost κ and the regional fiscal multiplier g_r. It shows that an increase in the persistence of shocks θ^i raises their variance and, hence, increases the optimal size of the transfers (in absolute value) which are needed to stabilise output. Because persistence generally differs across the shock levels, the optimal response parameters will also be different

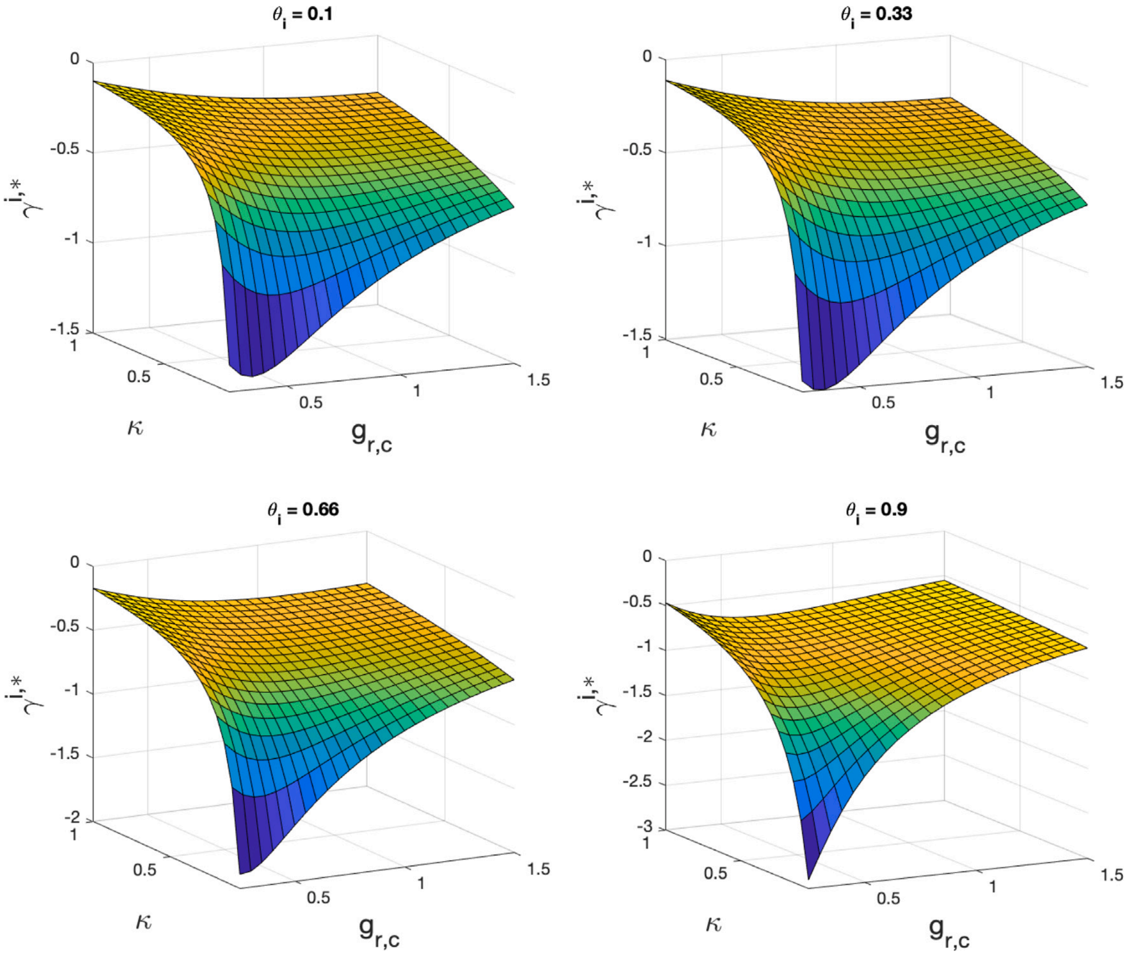


Fig. 2. Optimal gamma per layer, $\gamma^{i,*}$, as function of political cost κ and fiscal multiplier g_r.

across the shock levels.[26] Moreover, the optimal size of the transfer is a non-linear function of the penalty cost κ and the regional multiplier g_r. In particular, the larger the multiplier, the smaller will be the transfers needed to stabilise output, because the money received or donated through the scheme will be more "effectively" used.

Overall, the total scheme for region r and time t will be equal to the sum of the transfers generated by the three layers, where the response parameters for each layer are optimised as described above. This results in a transfer function akin to a fiscal policy rule, where transfers depend on the shocks hitting the three layers[27]:

$$\tau_{r,t} = \sum_{i \in \{EA,C,R\}} \tau\left(\lambda_r^i, \boldsymbol{F}_t^i, \gamma^{i,*}\right) = \gamma^{EA,*} \lambda_r^{EA} \boldsymbol{F}_t^{EA'} + \gamma^{C,*} \lambda_r^{C} \boldsymbol{F}_t^{C'} + \gamma^{R,*} \boldsymbol{F}_t^{R'} \tag{9}$$

In "normal times", the scheme does not need much external financing because positive and negative shocks at the regional level will largely cancel out (within and across countries).[28] The same holds for country-specific shocks. The only instance in which the scheme might need non-negligible external financing is when all countries are hit simultaneously by an aggregate and large area-wide shock (*e.g.*, the GFC and the more recent Covid-19 crisis).[29] The borrowing limit would be set by European policymakers according to political considerations. In the empirical illustration laid out in Sections 6 and 7, we assume the overall borrowing

[26] More formally, in any micro-founded model, the factors at the different levels constitute the state of the economy. The optimal rule generally responds with different coefficients to the different elements in the state vector.

[27] In the reaction function (9), the parameters γ are used to counteract the "shocks" (or factors), occurring at time t, therefore contemporaneously. In real-time, GDP at t will be available in terms of a forecast only, therefore policymakers may prefer to use either the forecast for t or values of the factors at time $t-1$.

[28] Note that, according to (9), two regions characterised by the same deviation from their trend GDP growth will receive a different total transfer only if the "optimal response parameters" $\gamma' s$ for the three layers will be different. It might be politically difficult to justify differences in transfers resulting from identical growth deviations. However, full transparency of the method applied and the fact that cumulative transfers tend to zero should make this easier to justify.

[29] The scheme may (partly) finance the adverse shock with funding from prior payments into the scheme due to an above-trend growth path.

limit to be a fraction of the RRF, launched in 2020, which should be therefore politically acceptable. In case a larger shock hits the euro area in the future, policymakers may decide to stick to the original limit, thus leaving a large part of the shock unsmoothed (Appendix A.5 solves for the optimum in this case), or to increase the borrowing limit. This will of course depend on political considerations at the time of the next crisis.[30]

5.3. Operationalising the scheme: calibration of κ

To operationalise the scheme, we still need to identify the size of the parameter κ. As this parameter captures a political cost, it can be viewed as imposing a limit on the intensity of the policymaker's response to shocks. Since one cannot estimate this parameter from the data, we calibrate the scheme such that the aggregate transfers in terms of euros match a funding limit S in a given year t. Given the latter, the value of κ follows automatically. As the aggregate regional transfer $\tau_{r,t}$ is a fraction of GDP in $t-1$, the transfers in euros are given by:

$$T_{r,t} = \tau_{r,t} GDP_{r,t-1} \tag{10}$$

Because the factor estimation is based on a decomposition of detrended growth, the dampening effect of the transfer is a fraction of the growth between periods $t-1$ and t. Hence, to arrive at a euro amount of the transfer, this fraction needs to be multiplied by regional GDP of period $t-1$.

Next, κ^* is the solution to the equation:

$$\left\{ \kappa^* \middle| \sum_{r\in\mathcal{R}} \sum_{i\in\{EA,C,R\}} \tau\left(\lambda_r^i, F_t^i, \gamma^{i,*}\right) GDP_{r,t-1} = \sum_{r\in\mathcal{R}} \tau_{r,t} GDP_{r,t-1} = S \right\} \tag{11}$$

On the far left-hand side the inner summation sums for region r across the levels of the CFC, while the outer summation sums across the regions, resulting in the amount of resources needed by the CFC as a whole. The middle part is simply the far left-hand side in compact notation. The solution κ^* is used, alongside the estimated factor decomposition, to calculate $\gamma^{i,*}, i \in \{EA, C, R\}$, by using Eq. (8) and the transfers at each time point using Eq. (7).

To sum up, the implementation of the proposed fiscal capacity follows these steps:

1. We solve analytically the minimisation problem of the European social planner, which will result in the optimal response coefficients γ (Eq. (8)), and the policy response function (Eq. (9));
2. The optimal response coefficients depend on the "political cost" parameter κ, which needs to be calibrated. We do so by using the borrowing limit of the scheme, S, in euro billions, in a reference year (this will affect also the envelope of the scheme in other years). In our empirical application, we choose a borrowing limit roughly comparable to a fraction of the EU's RRF launched in 2020. While not generally true for all transfer and penalty function specifications, the parameter S maps one-to-one to the parameter κ (Eq. (11)) under (7).
3. Once the factor decomposition of regional GDP growth is estimated (disentangling regional growth in a euro area, country, and regional factor, as from Eq. (1)), we use the policy function (9) to derive the total transfers which are attributed to each region r.

More euro-scepticism or fear of some Member States to become net payers into the scheme would be reflected in a higher value of κ, which would imply a lower value of S and a scaling down of all transfer flows by the same proportion.[31]

5.4. Transfer scheme properties

Our linear CFC in (7) features some desirable properties, some of which have also been highlighted in the Five Presidents Report (2015).

First, the scheme is on average *counter-cyclical*, which is ensured by the fact that $\gamma^{i,*}$, for $i \in \{EA, C, R\}$, is predominantly negative (see Fig. 2). Hence, the transfer scheme generally dampens the effect of the shocks on growth: in response to a negative GDP growth shock (as reflected in the euro area, country and regional factors), the transfers generated according to (8) will be positive (and vice versa for positive GDP shocks). An exception to this is when the regional multiplier is negative. In this case, Eq. (8) becomes positive and the scheme will be pro-cyclical. However, as shown in Section 6.2 below, the case of negative regional multipliers is very rare.

Second, this scheme avoids permanent transfers. Since our scheme targets deviations from average growth, transfers are not aimed at reducing structural income differences. The expected transfer to each region is zero, hence there is no ex-ante redistribution, as formally stated in the following proposition:

[30] While beyond the scope of the current paper, it would be interesting in future research to investigate schemes that set separate aggregate borrowing capacities for the different (area-wide, country-specific and regional) levels of such schemes. Such a more complicated arrangement could be deployed to limit aggregate cross-border transfer flows, while simultaneously it could respond forcefully to euro area shocks.

[31] The scheme can generate a large amount of redistribution also in the presence of a high κ (and low S). This is because the regional transfers may largely cancel out (by construction). However – ceteris paribus (*i.e.*, in the presence of a given distribution of regional shocks) – a higher S will generate more transfers (mainly to offset euro area-wide shocks), therefore more redistribution across countries, and this has to be politically acceptable.

Proposition 2 (*Ex-ante Neutrality*). *Assume that the transfer functions are sum-separable in their arguments and odd, i.e.* $\tau^i(x) = -\tau^i(-x)$, *which holds for the case of the linear transfer function in (7). For every region r, the expected transfer in each CFC level* $i \in \{EA, C, R\}$ *at every time point t equals zero, i.e.* $\mathbb{E}\left[\tau^i\left(\lambda_r^i, \boldsymbol{F}_t^i, \gamma^i\right)\right] = 0$. *Hence, for any end period* $T > 1$, *the expected cumulative transfers over time are also zero, i.e.* $\mathbb{E}\left[\sum_{t=1}^{T} \tau^i\left(\lambda_r^i, \boldsymbol{F}_t^i, \gamma^i\right)\right] = 0$.

Proof. See Appendix A.4. □

Of course, when the scheme is started at some arbitrary moment, there will be some redistribution in expected terms, unless all the regions are exactly at their average growth rate and all the factors, including the region-specific shock component, are zero. Otherwise, there will be one or more regions making net payments into the CFC and others obtaining net benefits from the CFC at the starting moment. In expected terms, the former group loses and the latter group wins. These expected gains and losses will shrink towards zero when the scheme is in place over a sufficiently long period of time.

Third, the scheme should lead to only limited concerns about *moral hazard*, as the factors influencing the transfers are difficult to manipulate by the regional governments. Regions are exposed to the latent eurozone and national business cycles, but are in most cases individually too small to influence these. Regional exposure to these cycles, determined by the loadings, is calculated over a long time-window, implying that there can also be little incentive to "strategically manipulate" the degree of exposure itself. Further, regions obviously cannot adapt their preceding growth path, or deviations therefrom, to benefit from higher current-period transfers. The part of the transfer triggered by the regional shock component is potentially vulnerable to strategic manipulation. However, it is hard to conceive of regional governments on purpose generating recessions in order to receive higher transfers.

What is conceivable, though, is that both national and regional governments have an incentive to forego politically costly structural reforms that raise sluggish trend growth, especially when it is difficult to estimate the trend going forward, so that it is difficult to disentangle to what extent weak performance is attributable to low trend growth versus an adverse business cycle development. Moral hazard of this type can be mitigated with conditionality constraints on the receipt of transfer payments. Of course, it is unlikely that conditionality can completely erase any moral hazard concerns, as in any other transfer scheme.

Fourth, the idiosyncratic regional shocks F_t^r are uncorrelated across regions and countries, making it unlikely that the aggregate transfer volume associated with these shocks to or from an individual country is large at any moment. Because the transfers are based on deviations from average growth, positive transfers to a region in specific years (in response to negative shocks to that region) will be compensated over time by negative transfers in response to positive shocks to the same region. This is a particularly desirable property, as the regional level is most vulnerable to moral hazard.

5.5. Theoretical stabilisation properties

In this subsection we explore the contribution of each individual level of our CFC to regional GDP growth stabilisation, based on the theoretical framework presented above. We define the stabilisation effect as the percentage reduction in the variance of the original raw regional growth process, once the transfers generated by the scheme are added to the original series. Formally, the stabilisation effect of each level $i \in \{EA, C, R\}$ is defined as:

$$s_r^i = \frac{\mathbb{V}\mathrm{ar}\left[y_{r,t} + g_r \tau\left(\lambda_r^i, \boldsymbol{F}_t^i, \gamma^i\right)\right]}{\mathbb{V}\mathrm{ar}\left[y_{r,t}\right]} - 1 \tag{12}$$

Proposition 3. *Given the linear transfer function* $\tau(\cdot)$ *in (7), a quadratic penalty function* $f(\cdot,\cdot,\cdot)$, *and a penalty level* κ, *the optimal stabilisation effect of level* $i \in \{EA, C, R\}$ *equals:*

$$s_r^{i,*} = \left(\left(g_r \gamma^{i,*}\right)^2 + 2 g_r \gamma^{i,*}\right) v_r^i \tag{13}$$

where $\gamma^{i,*}$ *is given by (8).*

Proof. See Appendix A.4. □

The stabilising effect of our scheme at level i is a function of the fiscal multiplier g_r, the level-specific smoothing parameter $\gamma^{i,*}$, and the level-specific explained variance, v_r^i. Further, note that the stabilising effect is a bi-variate convex function in g_r and $\gamma^{i,*}$. Therefore, the marginal stabilising effect decreases for larger g_r and/or $\gamma^{i,*}$ up to the point where $g_r \gamma^{i,*} = 1$, at which the stabilisation at this level is maximised.

6. Results

6.1. Eurozone, national and regional business cycles

Before we estimate our factor model, we normalise the regional GDP growth rates, *i.e.*, by subtracting the regional mean and dividing by the standard deviation for each region. The results from the estimation are then transformed back such that they display the regional heteroskedasticity. Estimates are based on 5000 posterior draws with a burn-in of 2000, and a thinning factor of 5, so as to end up with 1000 posterior draws. The model selection algorithm indicates as the optimal model one in which each level always consists of one factor, except in the case of the country-specific level for France which indicates two factors. However, the simplest model with each level always containing only one factor performs very similarly, with a BIC score difference of around 2%.[32]

6.1.1. Decomposition of regional GDP growth: national averages

Fig. 3 depicts, for each country, the average GDP growth rate over the regions in that country (grey area) and its decomposition into the EA factor (solid line), the country factor (dashed line) and the region-specific factor (dotted line). A few facts are worth highlighting. First, the eurozone factor primarily extracts the common components of the GFC in 2009 and the Covid-19 pandemic in 2020. The factor has a very strong role in explaining regional real GDP growth in Austria, Germany, Slovenia, among others. Second, in some other countries, the eurozone factor plays a smaller role. This is, for example, the case of Greece. For this country, the country factor is by far the most important driver of regional output. This can be explained by the fact that Greece was particularly exposed to the euro area sovereign debt crisis, which affected only a subset of countries. Indeed, on top of Greece, the country-specific factor is also prominent in Spain, Latvia and Portugal, which were also affected by the sovereign debt crisis of 2010–2012.[33] Finally, the *average* contribution of the region-specific shocks to the total is close to zero for most countries. This is the result of the orthogonality of the regional shocks, which largely cancel out at the country level.

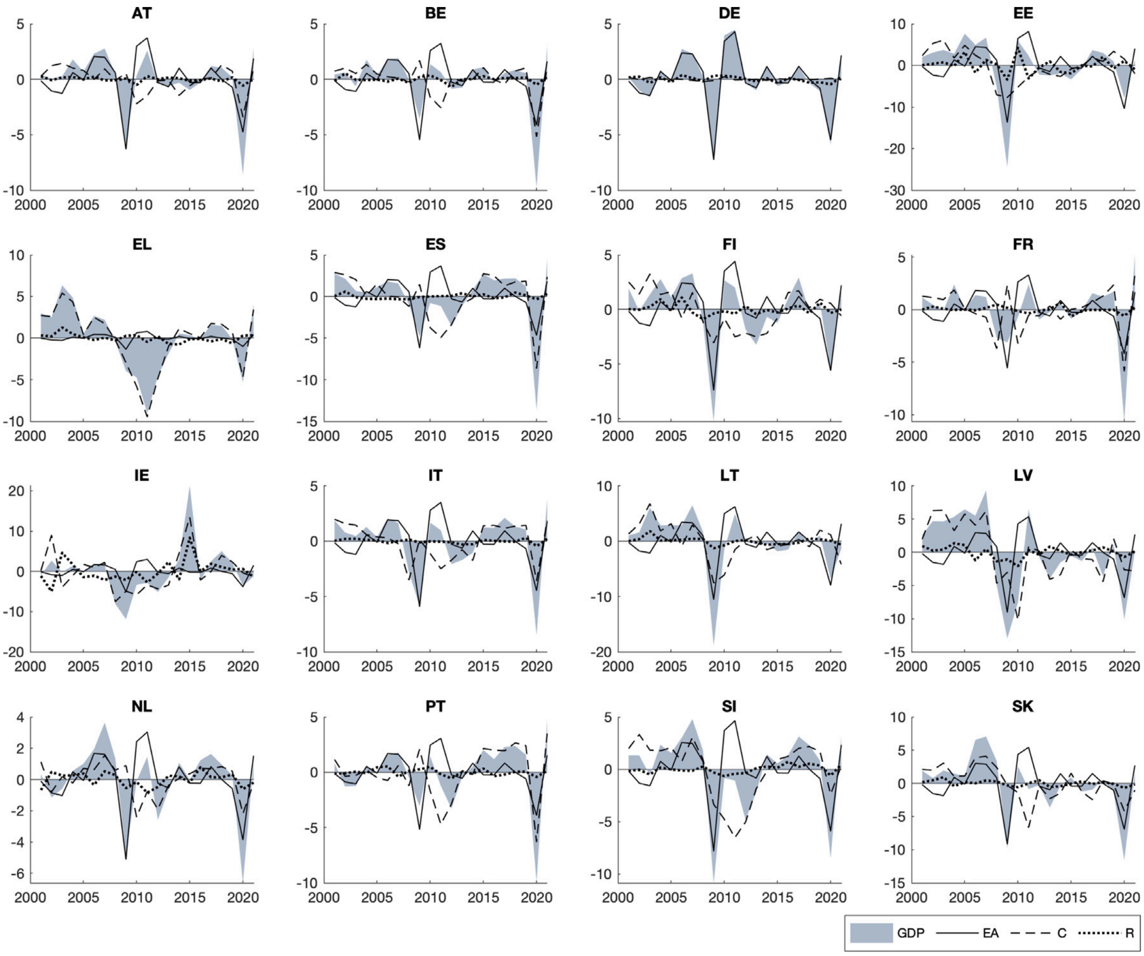


Fig. 3. Regional GDP growth decomposed into euro area, country, and region-specific factors, averaged over regions within each country.

Figures 21, 22 and 23 in Appendix C depict the correlation between the euro area and country factors, the country and regional factors, and the regional factors themselves, respectively. Due to our orthogonalisation step in the Gibbs sampler the various correlations are clearly centred around zero.

32 See robustness Section 8 for the case in which two country factors are included for France.

33 Irish growth in 2015 is an outlier. This is explained by the fact that in that year a change in tax legislation led to an international relocation towards Ireland of output produced by intellectual property, see https://www.oecd.org/sdd/na/Irish-GDP-up-in-2015-OECD.pdf. We re-estimated the model where we proportionally scale back the growth rates of the Irish regions such that the 2015 Irish average GDP growth rate equals 6.4%, which is its 2015 net national income growth. Since 2015 is the base year, no further transformation is needed to obtain real numbers. The results are virtually identical.

Table 2
Share of regional GDP growth variance explained by the euro area, the country, and the regional factors (percentages).

Country	*EA*	*C*	*R*
AT	50.71	18.00	31.29
BE	41.85	26.28	31.87
DE	51.11	3.52	45.37
EE	42.55	28.26	29.18
EL	3.71	62.46	33.83
ES	29.66	51.23	19.11
FI	44.67	18.46	36.87
FR	32.59	38.15	29.26
IE	12.34	33.72	53.94
IT	38.25	27.28	34.48
LT	46.52	37.20	16.27
LV	26.03	47.16	26.81
NL	37.45	23.53	39.02
PT	28.96	43.24	27.80
SI	48.59	38.84	12.57
SK	43.47	29.81	26.72
EA	41.23	21.75	37.01

Note: Entries are country averages of regional growth variance explained by each level, in percentages.
AT = Austria, BE = Belgium, CY = Cyprus, DE = Germany, EE = Estonia, EL = Greece, ES = Spain, FI = Finland, FR = France, IE = Ireland, IT = Italy, LT = Lithuania, LU = Luxembourg, LV = Latvia, MT = Malta, NL = the Netherlands, PT = Portugal, SI = Slovenia, and SK = Slovakia.

Table 2 reports the share of regional GDP growth variance (averaged over the regions in each country) explained by the euro area, country and regional factors. The main takeaways from Fig. 3 are confirmed: core euro area countries turn out to be more affected by the euro area factor, while more "peripheral" countries are more affected by the country and regional factors.

6.1.2. GDP growth decomposed at the regional level

The variance decomposition in Table 2 only provides an aggregate perspective at the country level, but does not provide the same information at the level of the individual regions. Therefore, Fig. 4 depicts a heat map of the percentage explained variance by each level for all NUTS3 regions. The eurozone factor explains most of the variance of most regions in the Western part of Germany, a number of regions in Austria, Northern Italy, the Netherlands, Belgium, and some regions in the Eastern part of France. Interestingly, the eurozone factor also plays a large role in some of the Baltic regions. According to the model and the data, these regions would thus form what is generally considered as the core of the euro area economy (the Benelux, France, Germany, Austria, Northern Italy). The second level, the country factor, explains most of the total variance of the Greek and Spanish regions, and a number of regions in the Western part of France. The country factor also seems to be prominent in parts of Ireland (Dublin and Cork), Rome and adjacent regions in the middle of Italy, Lithuania and Latvia. The regional factor is important in some parts of the eurozone periphery. This is the case for most of Ireland and some regions of Greece, the South of Italy and Portugal. Interestingly, also most of Eastern Germany and the North-East of the Netherlands fall into this group. This may not be surprising. These areas are less embedded in the EU internal market.

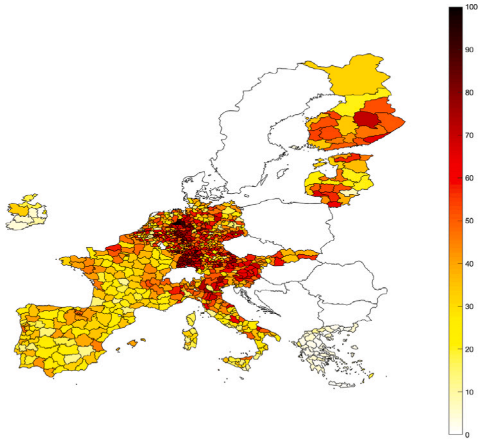
It is interesting to zoom in further on Germany and Italy. Fig. 5 shows more clearly the regional differences in the relative roles of the eurozone and the regional factors for these two countries. Indeed, the Western parts of Germany and Northern Italy clearly belong to the core of the eurozone economy, while Eastern Germany and the South of Italy are more driven by the regional factors.

6.2. The transfer scheme

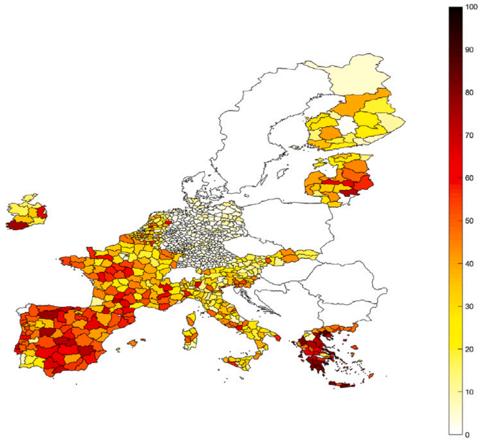
6.2.1. Estimation of regional fiscal multipliers

The stabilisation properties of the transfer scheme depend on the regional spending multipliers, which capture the output effect of the transfers to a given region (as reflected in Eq. (9)). Therefore, before simulating the transfers that would have been generated by the scheme in the past two decades, we need to come up with an estimate of these regional multipliers.[34] We proceed in two ways. First, we estimate the multipliers by regressing each region's annual GDP on regional public spending, similar to Brueckner

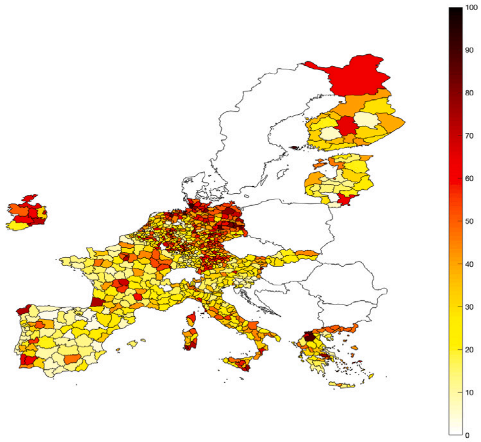
[34] See Caldara and Kamps (2017) for a discussion on the estimation of fiscal multipliers and Castelnuovo and Lim (2018) for a survey.



(a) Eurozone factor.



(b) Country factor.



(c) Region-specific factor.

Fig. 4. Share of regional output variance explained by each factor level.

et al. (2023). Following their work, we proxy regional public spending by NUTS3 non-market gross value-added (GVA).[35] However, whereas Brueckner et al. (2023) use pooled regressions to aggregate fiscal multipliers at the country level, we estimate multipliers

[35] Non-market GVA data at the NUTS3 level can be found in the ARDECO database.

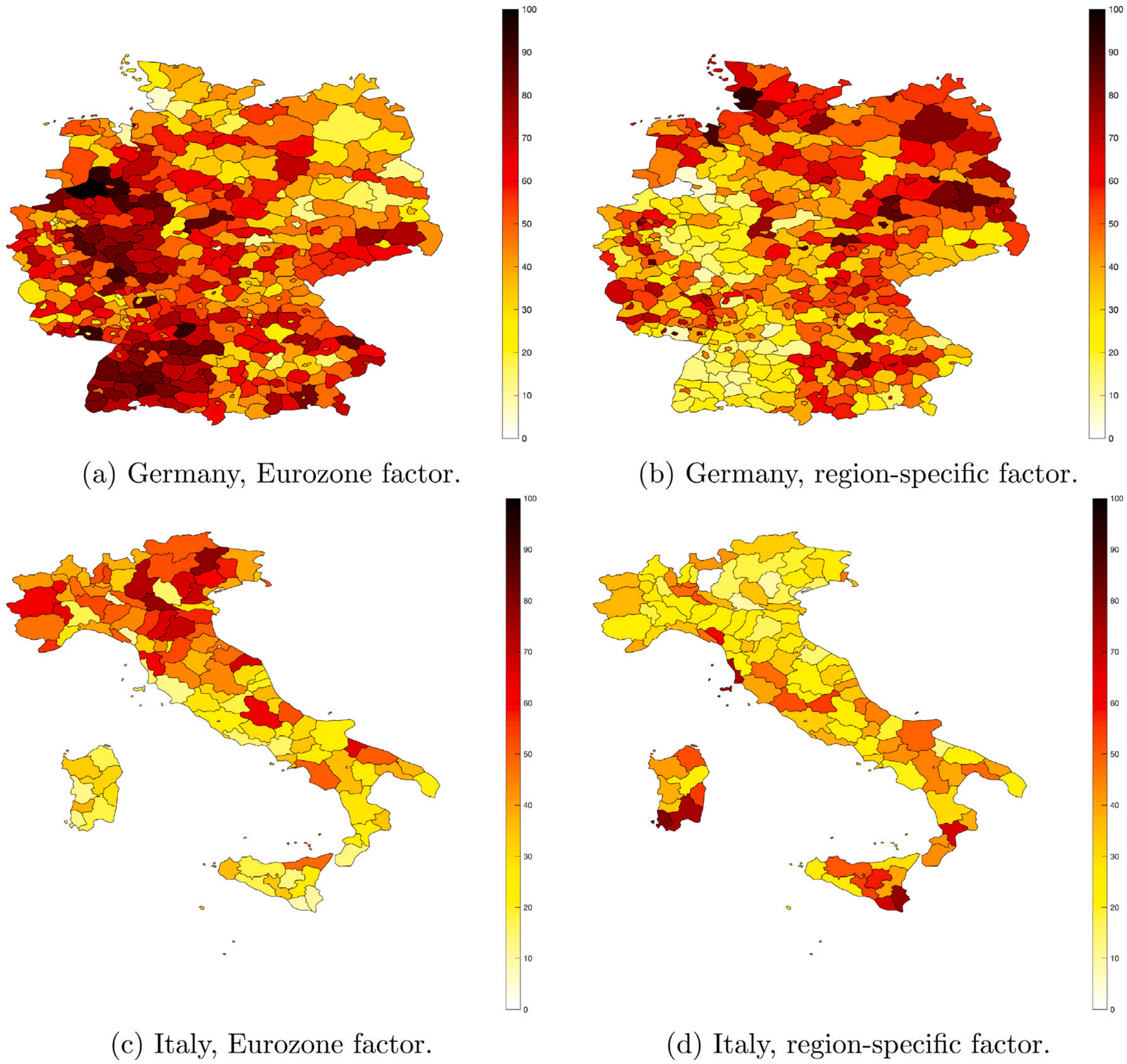


Fig. 5. Variance explained by the euro area and region-specific factors in Germany and Italy.

that are region-specific. Because we focus on the latter rather than spending multipliers at the national level, potential concerns about feedback from regional GDP to regional public spending should be minor as the room for discretionary public spending is usually smaller at the regional than at the national level. Regional tax bases are generally relatively small and regional governments are often subject to budgetary restrictions imposed by the national government. Yet, such feedback cannot be completely excluded. As a robustness exercise, we therefore also calculate regional public spending multipliers as the contemporaneous response from a bi-variate vector auto-regression (VAR) model, following an identification approach akin to Blanchard and Perotti (2002), where the Cholesky ordering implies that public spending does not respond to GDP in the same period. We estimate such a VAR model for each region in the sample. Both the univariate and the VAR estimation are based on a sample that runs from 1980 until 2021. Alternatively, one could run a panel model, which would allow to exploit a larger sample size, and come up with an average regional multiplier. The latter would be broadly around the mean of the region-specific estimates. Yet, we prefer to adopt a region-specific approach as this allows to obtain more granular estimates of the impact of transfer schemes.

Table 3 reports the average, over the regions in a given country, of the regional government spending multiplier as estimated with these two methods. Estimates based on the univariate method are somewhat higher, on average 0.8, than those resulting from the VAR model, which are on average 0.6. The average estimates are similar with what was found in related research. In particular, in her survey paper, Ramey (2019) shows that most estimates of government spending multipliers in the literature are in the range between 0.6 and 1. These estimates are also in line with those shown in other papers using EU regional data (*e.g.*, Duque Gabriel et al., 2020; Brueckner et al., 2023).

Table 3
Regional government spending multipliers (averaged across regions in a country).

	Univariate	VAR-model
AT	1.22	0.65
BE	1.07	0.51
DE	0.86	0.69
EE	1.05	0.12
EL	0.61	0.52
ES	0.77	0.42
FI	1.08	0.91
FR	0.64	0.43
IE	0.71	0.37
IT	0.43	0.37
LT	1.44	0.22
LV	1.02	0.33
NL	0.60	0.21
PT	0.98	0.77
SI	1.24	0.66
SK	1.24	0.20
EA	0.80	0.56

Notes. The table shows the average estimates (across NUTS3 regions in a given country) of the government spending multiplier. The estimates in the first column are from a univariate regression, including regional GDP as dependent variable, and government spending (as proxied by regional non-market gross value-added (GVA)) as independent variable. The estimates in the second column are from simple bi-variate structural VAR models at the regional level, including G and Y, where government spending is ordered first in the Choleski ordering.
Sample: 1980–2021.

We plot the distribution of all multipliers, as estimated with the two methods, in Fig. 6. It emerges that the mass of such multipliers is quite concentrated around the mean values, the two distributions appear to be rather symmetric, and the occurrence of negative values (leading to a pro-cyclical transfer scheme) is very rare in both cases. Multipliers range between 0.4 and 1.4 when considering the univariate model and between 0.1 and 0.8 in the other model. In the rest of the paper, we use as baseline the average estimate from the univariate model, although results are robust to the use of the second set of multipliers.

6.2.2. *Derivation of the optimal response parameters* $\gamma^{i,*}$

The next step consists of deriving the optimal response parameters, for each layer i, *i.e.*, $\gamma^{i,*}$. First, we need to calibrate the 'political cost' parameter κ^*. Then, using the estimates from the dynamic factor decomposition and the regional multiplier estimates, we can derive $\gamma^{i,*}$, where we use Eq. (11).

We calibrate κ such that the scheme generates an overall level of transfers, in 2020, of an order of magnitude comparable to that of the EU's RRF, which was approved to counteract the economic crisis that followed the Covid-19 pandemic. As such, the total envelope of the transfer scheme should be politically acceptable.

Table 4 reports – for different borrowing limits S (in billions of €) – the implied values $\hat{\kappa}^*$ and $\hat{\gamma}^{i,*}$, as well as the decomposition of S into the aggregate (over the regions) transfer associated with each of the three layers of the scheme. Indeed, it could be the case that the positive and negative transfers associated with a level, *e.g.* the regional level, cancel out. In this case, the table will show a zero value, which however does not mean that there were no transfers generated by that level. We present the results for different sizes S since it is not ex-ante evident how the total amount of €723.8 billion of euros represented by the EU's RRF was to be distributed over its six-year duration. Table 4 highlights that about half of the total envelope would be allocated to offset common euro area shocks, about 40% to offset national shocks, and the remainder to offset regional shocks (the absolute values of the regional transfers would, of course, be much higher).[36]

6.2.3. *Transfers estimation*

Our analysis is based on the 2021 data vintage of ARDECO, which includes data from 1999 until 2021 for each NUTS3 region. The transfers presented below are generated by our linear scheme, assuming that $S = 270$ in 2020, which amounts to roughly a third of the size of the EU's RRF.

[36] Appendix A.6 and Figure 14 show the implied values of κ^* and $\gamma^{i,*}$ as a function of the aggregate transfer size S.

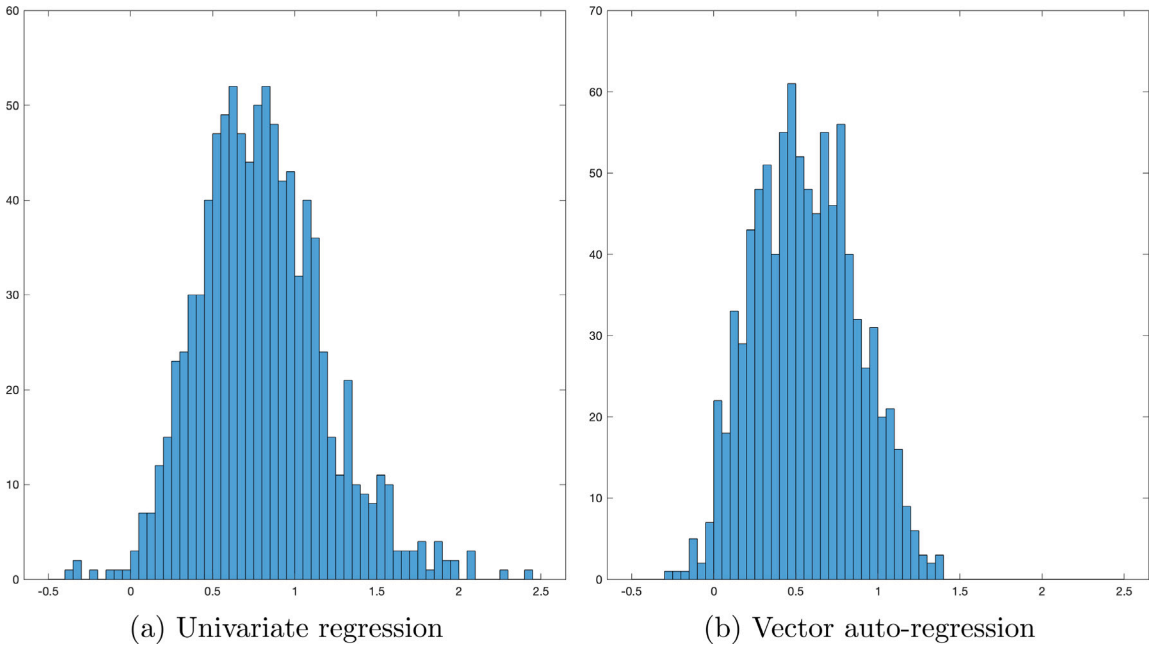


Fig. 6. Distribution of regional public spending multipliers based on a univariate model including Y and G (chart a) and based on a bi-variate VAR model where – following Blanchard and Perotti (2002) – public spending does not respond to GDP in the same period (chart b).

Table 4
Borrowing limit of the scheme and split over the three layers EA, C, R.

S in €billion	135	270	500
$T^{EA,*}$	80.74	154.46	263.40
$T^{C,*}$	42.42	90.81	187.82
$T^{R,*}$	11.84	24.73	48.78
$\hat{\gamma}^{EA,*}$	−.1569	−.3002	−.5119
$\hat{\gamma}^{C,*}$	−.1214	−.2598	−.5373
$\hat{\gamma}^{R,*}$	−.1260	−.2632	−.5192
$\hat{\kappa}^{*}$	.7064	.2226	.0034

Note: S is the fund size in billions of €, $\hat{\gamma}^{i,*}$ are the optimal response parameters for the three layers of the scheme, and $\hat{\kappa}^{*}$ is the political cost parameter. These parameters are the solutions to Eqs. (8) and (11). $T^{i,*}$ represent the monetary value associated with each layer of the scheme, in *net terms,* and are calculated with equation (10). Values for these indicators are in €billions. The sum of the three $T^{i,*}$, with $i \in \{EA, C, R\}$, is equal to the total envelope of the scheme, S, as reported in the first row of the table.

Fig. 7 depicts, for each year in the sample, the transfers generated by each level of our scheme as well as the total (or net) transfer received or paid by each country (shaded area), which is the aggregate over its regions of the total transfer received or paid by each region (as calculated in Eq. (9)). Each country would have received a positive transfer to cushion euro area wide large shocks (solid line), in particular those associated with the GFC and the Covid-19 pandemic, for which the euro area level of the scheme is on average about 2% of GDP. Transfers prompted by the country-specific factors (dashed line) predominantly flow to countries that were hit by the eurozone sovereign debt crisis. These transfers are especially visible for countries that received ESM official loans, *i.e.*, Greece, Ireland and, to a lesser extent, Spain. Not surprisingly, the aggregate transfers at the country level associated with the region-specific shocks (dotted line) are smaller (as reflected also in Table 4) as these shocks are orthogonal to each other and to any other factors. However, this does not mean that this transfer level is ineffective in stabilising the region-specific shocks. Indeed, Table 2 shows that region-specific shocks explain around 37% of the variation of regional GDP growth.

Fig. 8 shows the distribution of the regional transfers for Germany and Italy by sample year. The colours indicate the frequency mass of the different amounts of transfers at each level, with black indicating the highest frequency. This figure shows a contrast

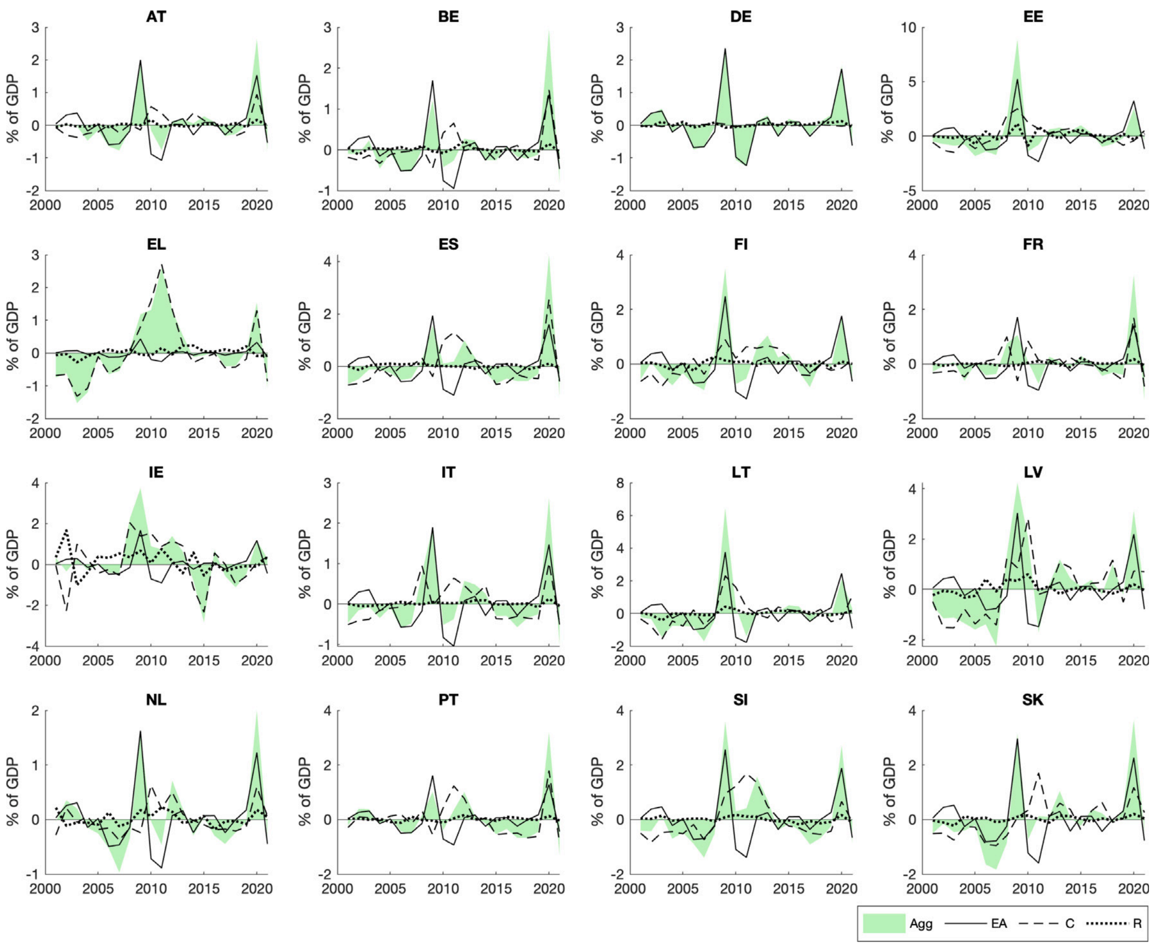
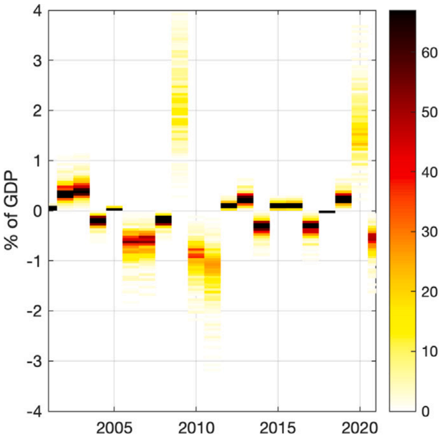


Fig. 7. Country transfers by (euro area, country and regional) level and aggregate transfer per country, in percent of country GDP.

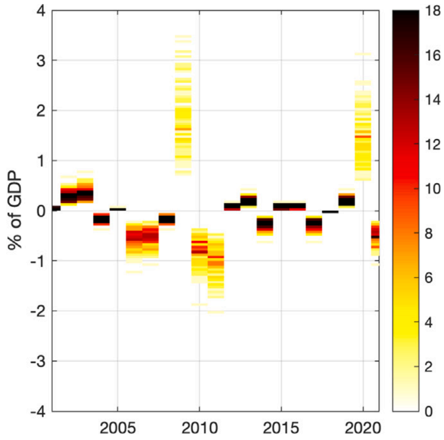
between the transfer flows in response to the euro area and country factors, which are of a comparable order of magnitude, and the transfer flows in response to the region-specific shocks. Although the transfers associated with the latter are close to zero on average, in virtually all the years the regional dispersion of the transfers at this level is larger than the regional dispersion of the transfers associated with the euro area and country factors. The ‘‘netting’’ effect of the transfers associated with the region-specific shocks is an attractive feature of our CFC, as it reduces the need for the CFC to borrow on the capital market. Extensive use of the capital market might be politically sensitive, as the resources obtained in this way are used for ex-post cross-border redistribution.

Panel (a) of Fig. 9 depicts the transfers to the eurozone regions in percent of GDP, averaged over the whole eurozone, while Panel (b) shows those transfers in euros. Because the system does not need to be balanced on an annual basis, we observe that there is a substantial positive net transfer in the years 2009 and 2020, the years when, respectively, the GFC and the Covid-19 pandemic struck hardest. This positive net transfer in 2009 is ‘‘financed’’ by a negative net transfer in the relatively good years preceding the GFC and the two years after 2009 when economies were rebounding and GDP growth rates were higher than normal. The 2020 net positive flow is in part compensated by net outflows during the years in the run-up to Covid-19 and in 2021 when economies are rebounding. The net outflow exceeds 100 billion euros or one percent of euro area GDP in only these two years. In these years, the scheme would need to borrow on the financial market, unless preceding years were good enough to allow the scheme to ‘‘save for rainy days’’.

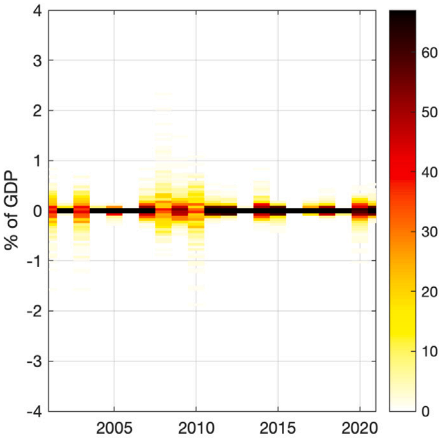
Fig. 10 depicts, by country, the transfers aggregated over the country’s regions, cumulated over the years since the start of the sample period. The figure also depicts the cumulative transfers by level of the transfer scheme. The figure shows that the cumulative transfers converge to roughly zero at the end of the sample period for most countries. This confirms the findings discussed above: typically, in the run-up to the GFC regions make net payments to the CFC, while substantial positive transfers are received by the regions during the GFC. Countries that experienced a double dip recession during the sovereign debt crisis tend to receive net transfers during this period. A pattern of negative cumulated transfers, indicating that the scheme is collecting funds from members states due to the relatively good state of the economy in those years, arises in the years preceding the Covid-19 pandemic.



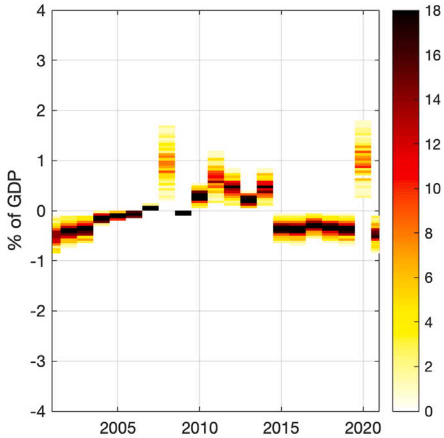
(a) Germany, Eurozone factor.



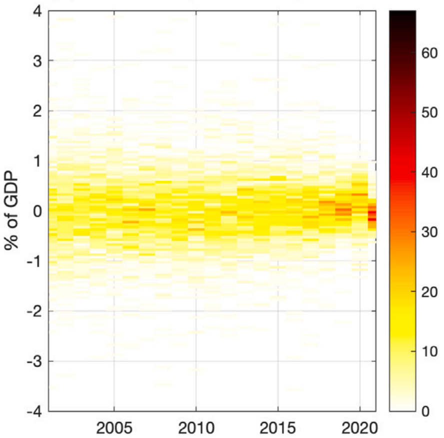
(b) Italy, Eurozone factor.



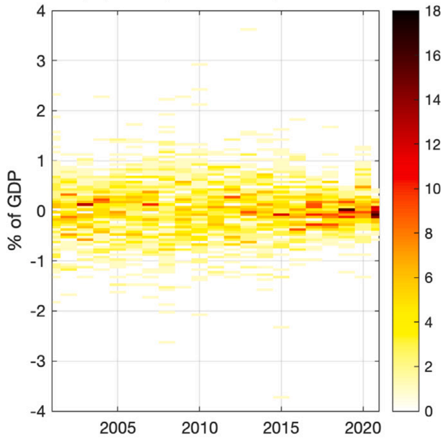
(c) Germany, country factor.



(d) Italy, country factor.



(e) Germany, regional factor.



(f) Italy, regional factor.

Fig. 8. Regional distribution of transfers for Germany and Italy, in percent of regional GDP.

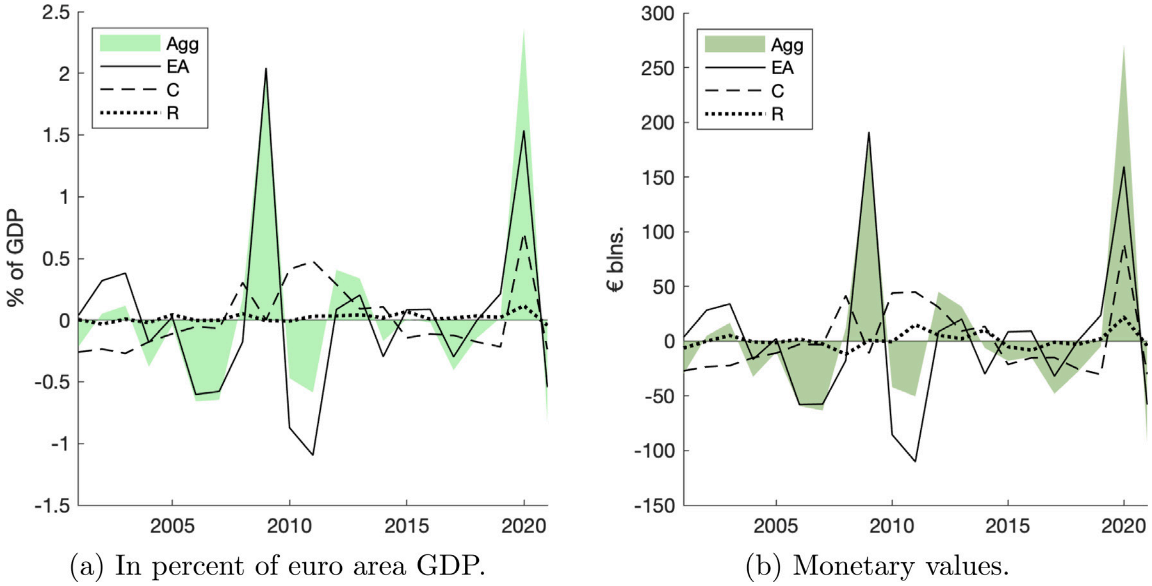


Fig. 9. Annual net transfers, euro area aggregates.

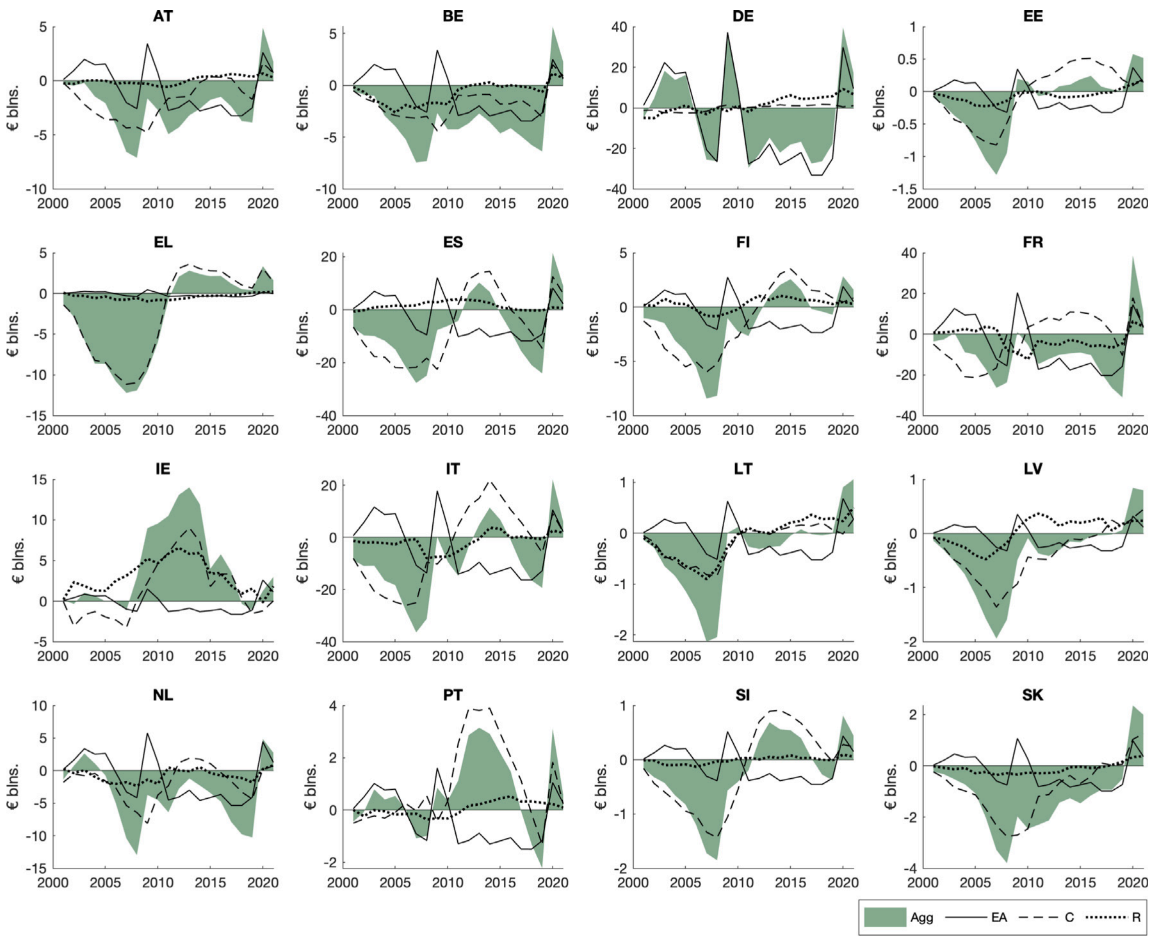


Fig. 10. Cumulative net transfers per country, monetary values.

Table 5
Stabilisation effect (in percent) for each level of the CFC and for different values of S.

S :	125			270			500		
Level	EA	C	R	EA	C	R	EA	C	R
$\hat{y}^{i,*}$	−.16	−.12	−.13	−.30	−.26	−.26	−.51	−.54	−.52
$T^{i,*}$	80.74	42.42	11.84	154.46	90.81	24.73	263.40	187.82	48.78
AT	−16.91	−5.05	−9	−28.87	−9.75	−16.83	−40.45	−15.72	−25.94
BE	−12.48	−6.9	−7.49	−21.64	−13.4	−14.3	−31.24	−22.08	−23.2
DE	−12.8	−0.73	−9.09	−22.53	−1.45	−17.6	−33.5	−2.53	−29.61
EE	−13.28	−6.91	−6.58	−23.26	−13.48	−12.71	−34.23	−22.47	−21.29
EL	−0.68	−8.69	−5.15	−1.22	−17.65	−10.17	−1.91	−32.52	−17.92
ES	−6.65	−9.07	−3.56	−11.9	−18.24	−6.97	−18.22	−32.85	−12.03
FI	−13.78	−4.11	−9.54	−23.98	−8.01	−18.08	−34.91	−13.26	−28.88
FR	−6.24	−5.61	−4.54	−11.21	−11.35	−8.92	−17.27	−20.75	−15.55
IE	−2.55	−5.69	−9.07	−4.61	−11.44	−17.9	−7.16	−20.64	−31.47
IT	−4.84	−2.65	−3.74	−8.87	−5.43	−7.43	−14.13	−10.25	−13.26
LT	−18.73	−10.35	−6.78	−31.4	−19.59	−12.53	−42.38	−29.9	−18.69
LV	−7.91	−10.79	−6.35	−13.88	−21.36	−12.27	−20.55	−36.99	−20.57
NL	−6.76	−3.53	−5.04	−12.08	−7.07	−9.8	−18.45	−12.62	−16.65
PT	−8.07	−9.35	−6.74	−14.14	−18.55	−12.9	−20.85	−32.28	−21.14
SI	−16.96	−10.18	−4.3	−29.15	−19.71	−8.15	−41.38	−32.12	−13.01
SK	−15.24	−8.06	−7.74	−26.04	−15.67	−14.5	−36.56	−25.84	−22.52
EA	−9.91	−3.73	−6.98	−17.45	−7.43	−13.52	−25.92	−13.12	−22.74

Note: the table reports, for different total fund sizes S and the regional multipliers g_r estimated with the univariate regression, the stabilising effect of the CFC. Specifically, the table reports the percentage reduction in the average regional variance of output, once the transfers calibrated according to S for each layer are factored in.

7. Stabilising effects in the 1999–2021 sample

In this subsection we explore the contribution of each individual level of our CFC to the stabilisation of regional GDP growth. More specifically, for each level of our optimal scheme we calculate the empirical counterpart of expression (12).

Table 5 reports, for different values of S and for each level of our scheme, the empirical stabilising effect in percent of the variance of regional growth (averaged over all its regions) for each country, as well as for the entire eurozone. We calculate the stabilising effect using the regional multipliers estimated in Section 6.2, as the percentage decrease in the variance of the growth rate when the transfers are added to the raw output data, factoring in the multiplier effects. In the extreme case in which the scheme would be fully stabilising output, Table 5 would report −100 for all countries.

Of course, this exercise is potentially subject to the Lucas critique, as the transfer scheme was not in place at the time the regional output was generated. The introduction of the scheme may affect the behaviour of agents who internalise its presence in their choices. How this impacts the stabilising effect is difficult to predict. Here we can in any case only provide a broad assessment of the stabilising power of our scheme. Indeed, despite the fact that our multiplier estimates are broadly in line with the related literature (see, *e.g.*, Ramey, 2019), it is not possible to precisely determine the size of the multipliers to be applied in our assessment. One reason is that, among other factors, the overall multiplier depends on the composition of public spending. In addition, the Lucas critique would apply to the stabilising effects of the transfers, not to the calculation of the transfers themselves. In practice, the latter would be based on current-year or past-year regional GDP growth, before topping up regional GDP with the transfers themselves. A scheme that would re-calculate the transfers after inputting them to GDP is unfeasible, it has never been proposed in the literature, and it is also not proposed here. For example, the transfers under the EU's RRF were calculated in 2021 on the basis of GDP losses suffered during the pandemic, in particular in 2020. Finally, the critique is quantitatively most relevant to the extent that the transfers are large and alter agents' perceptions about the data-generating process of GDP. The exercise here is based on transfer volumes that are small relative to the size of GDP — large transfers would be politically unfeasible.

The table shows that, for a scheme of 'average' size (*i.e.*, 270 billion in 2020), transfers associated with the euro area factors would stabilise around 17% of output variability, on average across countries. The transfers associated with country-specific factors stabilise roughly 7% of output variability, while the transfers associated with regional factors stabilise about 14%.[37] Clearly, for countries with a higher share of regional variance explained by the euro area factor (*e.g.* Germany), the transfers associated with that layer will have a more powerful stabilising role. For countries with a higher share of regional variance explained by the country-specific factor (*e.g.*, Greece) or regional factors (*e.g.*, Finland), the stabilising power will be stronger for those layers. Indeed, the smaller role of the second layer of the transfer scheme is due to the fact that the country-specific shocks explain on average less of the regional growth variation than do the euro area and region-specific shocks.

Due to the netting behaviour, as can also be seen from Figs. 7–10, the aggregate transfer flows associated with the region-specific shocks are close to zero, although on average this level of the CFC is almost as effective as that dealing with euro area shocks. By

[37] The robustness results for g_r estimated using the contemporaneous response from the bi-variate VAR are qualitatively similar and can be found in Appendix B.2.

helping to align regional business cycles, the regional level of the CFC also strengthens the euro area and national policy transmission mechanisms, and as such it should be considered a useful complement to the euro area central monetary policy and national fiscal policies, which address common components of the shocks hitting the regions. These common policies will suit a wider range of regions when the business cycles of the latter are better aligned through the operation of the CFC.

8. Robustness

We run a number of robustness exercises on the estimation of the factor model and the transfer scheme.

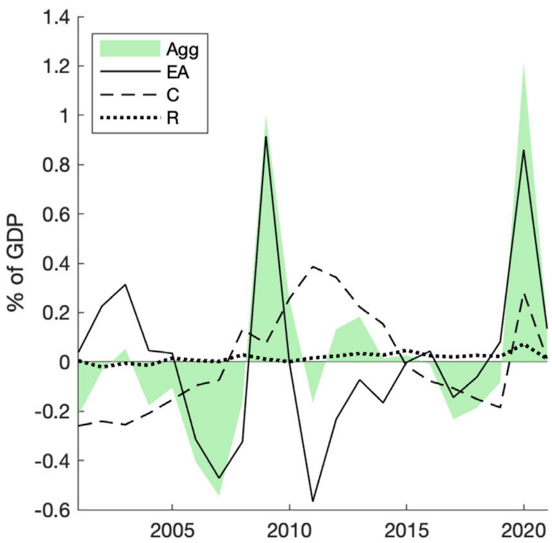
8.1. Estimation of the factor model

Since the transfer scheme depends on the factor decomposition (see Eq. (9)), it is important to test if this decomposition is robust over different specifications. We investigate the robustness of the decomposition in a number of ways.

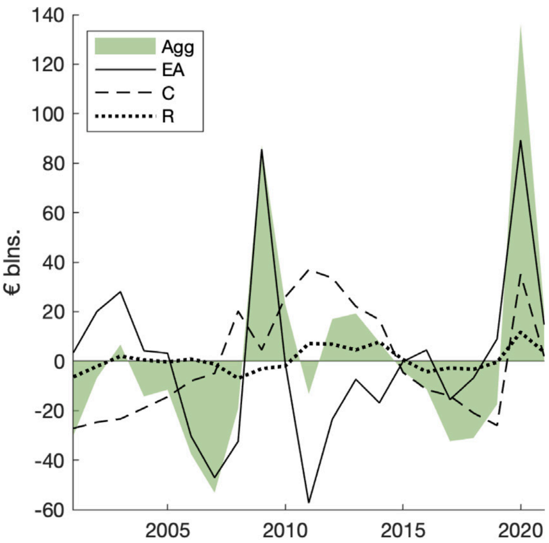
First, we assess whether the results are affected by the fact that some countries feature in proportion to their size a relatively large number NUTS3 regions. We do this by replacing the NUTS3 regions by the NUTS2 regions for Germany, Italy, France, Greece, and Spain. The factor decomposition based on this (more aggregated) dataset is shown in Figure B.1.1 in the Appendix. Second, the BIC scores suggest more than one country-specific factor for France, which may be explained by the fact that the degree of variation in growth is relatively large for this country. While the effect on the BIC scores is only small, we nevertheless explore a variant with two factors in the French country-specific level (see Figure B.1.2 in the Appendix). Third, because the sizes of the regions in our sample vary, we also consider a variant in which we weigh the size of each region's per-capita real GDP growth rate $y_{r,t}$ by its share of the EA population, $POP_{r,t}/\sum_r POP_{r,t}$. We do not standardise the data in this case as this would largely undo the transformation. Results are reported in Figure B.1.3 in the Appendix. Fourth, we also consider a variant based on real GDP weights (Figure B.1.4 in the Appendix). Finally, we include Cyprus, Malta and Luxembourg in our analysis. From our baseline estimations, we excluded these countries because they consist of one or two regions. As a robustness check, we now include these countries in our empirical model. This implies that we drop the country factor and include only the EA and regional factors. The results are reported in Figure B.1.5 in the Appendix. In all these cases, the factor decomposition is close to that in the baseline (results available upon request).

8.2. Smoothed transfers

The deeply negative shocks of the GFC and Covid-19 were followed by periods of above-average growth, leading on average to negative transfers (*i.e.* contributions to the scheme). Our CFC requires regions to make net payments during periods of growth above historical trends, even when this growth is merely the result of the elimination of a large overcapacity created by a crisis and the economy has not yet returned to its potential. In practice, however, this could be a sub-optimal timing of net payments, given that countries could need several years to fully recover from a recession. In addition, governments would likely prefer more stable money flows rather than volatile ones, for easier planning and better absorption of funds. Therefore, in this subsection, we consider



(a) In percent of euro area GDP.



(b) Monetary values.

Fig. 11. Smoothed annual total euro area transfers.

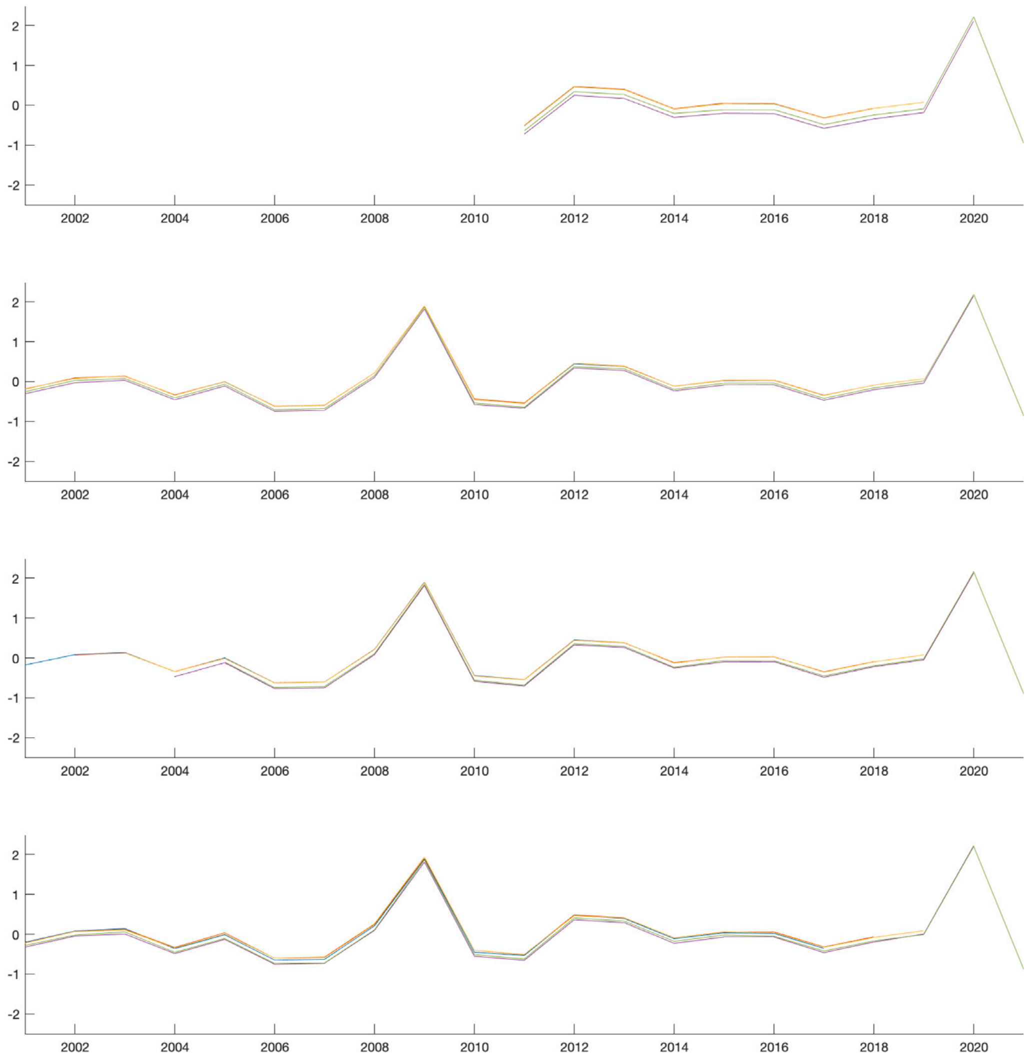


Fig. 12. Real-time implementation of the scheme. Aggregate CFC transfers with expanding, rolling window and time-varying intercept added to the model. First panel: sample starts in 2011 and new data are added, year by year, as of 2017. Second panel: sample starts in 2001 and new data are added, year by year, as of 2017. Third panel: the scheme starts in 2017, and transfers are calculated based on a fixed window of 16 years. Fourth panel: the scheme starts in 2017, expanding sample and time-varying intercept added to model (1).

the case in which transfers are smoothed over some years. Specifically, actual transfers in period t are now a weighted average of the original transfers from $t-s$ up to and including t, $s \in \mathbb{N}$, with weights $v_k = 1/2^k \times \sum_{i=0}^{s} 1/2^i$, $k \in (t-s, t-s+1, \dots, t)$.

Fig. 11 displays the smoothed transfers aggregated at the eurozone level. Not surprisingly, compared with Fig. 9, the peaks in the transfers, both positive and negative, are smaller. Importantly, in the first year of recovery from the GFC, aggregate transfers are close to zero, while the year following the Covid-19 shock they are still positive. This suggests that the smoothing of the original transfers could be beneficial in terms of GDP returning to its trend level after a severe shock.

9. Real-time implementation

In the preceding sections transfers were calculated retrospectively over the past two decades using the complete sample period 2001–2021. The practical introduction of the scheme requires real-time implementation based on new data coming in each period. Political acceptability of the scheme is served if a recalculation based on new data does not lead to major shifts in past transfers — otherwise, some countries may come to regret having been part of the scheme and may decide that it is better to quit the arrangement. This section explores the stability of past transfers under real-time implementation based on sample data. Besides this, it is interesting to see how transfers evolve under real-time implementation over our sample period.

The top and second panels of Fig. 12 below provide an illustration using schemes for which the real-time implementation starts in 2017, based on samples beginning in 2011 and 2001, respectively. We observe that while there would have been some retroactive

Fig. 13. Real-time implementation of the scheme. Aggregate CFC transfers over the regions for each country with expanding window. Three vintages are shown, with samples running from 2001 to 2017, 2019, and 2021, respectively.

adjustment of the aggregate transfers based on the short data sample, aggregate transfers based on the longer sample are very stable, also during the crisis periods. This is even though the gradual addition of data from the Covid-19 period may lead to a change in mean growth rates over the included sample period. As before, we see that the system borrows heavily during the global financial crisis, after which some repayment takes place before the eurozone debt crisis starts in earnest. Aggregate borrowing increases again during the Covid-19 period. At a more general level, starting a central fiscal capacity of this type in a new monetary union based on a short data history might be politically difficult to justify for the reason given above, but this should not be the case in a mature union where real-time implementation can be based on a long data sample. Fig. 13 repeats the second panel of Fig. 12, with aggregate transfers over the regions for each country. We show three samples, starting from 2001 and ending in 2017, 2019 and 2021, respectively. We observe that also at the level of each individual country, the aggregate transfers are very stable when new data are added to the original sample.

The occurrence of a crisis may affect average GDP growth calculated over the data sample. Also, trend growth may change over time, possibly as a result of a structural break or for other reasons. Working with a rolling window based on a fixed sample length allows to deal with changing trend as the calculated sample mean gradually adjusts to the shifting trend. The third panel of the figure again depicts the aggregate transfers when real-time implementation starts in 2017. However, the estimation is now based on a fixed window of sixteen years. The sample underlying the first year of implementation is therefore 2001–2017, that of the second year is 2002–2018, etc. The final window ends in 2021 and therefore includes the Covid-19 crisis. We observe, though, that the aggregate transfers remain stable and very similar to those in the second panel.

Finally, when a region experiences a large shock or a change in trend growth, the previously calculated average growth may affect the calculation of the appropriate level of the transfers. Expected transfers would then start to deviate from zero. To address this, we estimate a variant in which we include time-varying regional intercepts in Eq. (1). This way, changes in trend growth are automatically captured such that the scheme targets deviations from trend growth only. Similar to Del Negro and Otrok (2008), the time-varying parameters are defined as a random walk process, where we assume for identification purposes a unit variance, analogous to the factor process parameters. The fourth panel of Fig. 12 depicts the aggregate transfers of the CFC when the estimated decomposition allows for time-varying intercepts. As in the second panel, we allow the real-time implementation to start in 2017, and expand the sample with the addition of new observations, year by year. The aggregate transfers are very similar to those in the preceding two panels.

10. Conclusions

This paper has presented a proposal for a central fiscal capacity that can be implemented at the euro area (or EU) level, where transfers are based on the exposure of the cyclical component of regional output growth to area-wide factors, country-specific factors and region-specific factors. The stabilisation of the latter has so far not received much attention in the academic literature and in the policy debate, even though these shocks can be substantial.

Estimating the model over the period 1999–2021, it emerges that the proposed CFC has a number of desirable features. First, cumulated over time, transfers tend to zero at the end of the sample period. This is the result of transfers being based on deviations from mean growth, hence positive and negative transfers will roughly cancel over time. Second, transfers are positive and sizeable during when it is most needed, *e.g.*, during deep crises such as the GFC and the Covid-19 pandemic. In these periods, the CFC would need to borrow on the capital market or use funds accumulated earlier. Instead, in periods with above average growth, the CFC may accumulate funds or pay off its debts. Third, substantial stabilisation can already be obtained with a borrowing capacity comparable to a fraction of the EU's RRF, which was implemented in the context of the Covid-19 pandemic. Finally, stabilisation of the euro area and the regional factors is on average about equally effective, while stabilisation of the country factor is on average about half as effective, because country-specific shocks turn out to be less destabilising over this sample. Because the regional factors are mutually orthogonal, substantial stabilisation of regional shocks can be achieved with very little aggregate financing need.

One might ask whether our estimated spending multipliers are the correct objects to investigate the degree of stabilisation achieved through our CFC, as there are delays associated with the real-time measurement of the shock, the disbursement of transfers and their composition. Semi-automatic, fast disbursement of transfers could take place in response to abrupt, negative shocks for which there is little doubt about their impact as was the case with the Covid-19 crisis. Even if transfers materialise with some delay, they will stabilise the regional economy, as shocks tend to be persistent. While we did not make explicit assumptions about how the transfers are spent, one could, for example, think of sending cheques to households, temporary compensation to firms if they maintain their workforce or regional government purchases. Cheques have an immediate positive effect on purchasing power and can stimulate the economy with only little delay, as the U.S. experience during the Covid-19 crisis shows. Similarly, the European Commission's SURE initiative and comparable support at the national level helped to immediately dampen the negative Covid-19 crisis outfall. All in all, our estimates provide only an indication of the stabilising power of the transfers.

Our proposal for a CFC fits well within the current discussion in the EU. Various international institutions view a CFC as a beneficial complement to the EU fiscal architecture. The value-added of a CFC would be particularly high in the presence of extreme shocks when at the same time governments find it difficult to borrow on the capital market. Deploying the CFC in these circumstances would be more effective than counting on the indirect stimulus from countries with fiscal space, if these are prepared to expand at all. However, the eventual political feasibility of a future CFC will crucially depend on how well the current EU's RRF is implemented. The latter is quite widely perceived as an embryo of a potential CFC, and how well it is implemented will affect possible perceptions of moral hazard associated with a CFC, as well as confidence in EU instruments in general.

All in all, while our analysis focuses on the euro area, the findings of this paper could potentially also provide useful insights into the construction of centralised fiscal capacities in other federations.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.euroecorev.2024.104721.

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