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Euro area business cycles in turbulent times: convergence or decoupling?

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Abstract

We study the business cycle properties of the four largest euro area economies in the wake of the recent recession episodes. The analysis is based on the factors estimated from a multi-country and multi-sector data-rich environment. We measure alikeness of business cycles by studying the synchronization of up and down phases, the convergence properties of country fluctuations towards the euro area cycles and the contribution of the euro area factor to national GDP volatilities. While the economic fluctuations of the four euro area member states were similar before the global financial turmoil, we gather compelling evidence of an asymmetric behaviour of Spanish fluctuations relative to the euro area one.

JEL Classification: C51, E32, O52

Keywords: Hierarchical factor models, International business cycles, Synchronization and Convergence

Non-Technical Summary

Between the summer of 2008 and the end of 2013 the euro area went through two consecutive and intense recessions. Macroeconomic imbalances materialized and many economic commentators argued that the crisis episodes triggered a decoupling process between core and noncore euro area countries. Much of this debate focuses on cross-country differentials of single variables, e.g. unemployment rates or long-term bond yields. While suggestive, such measures are not unambiguous indications of diverging cycles and an empirical assessment of the degree of real and financial asymmetries is lacking, e.g. are euro area economic cycles co-moving? Are they synchronized? Are they converging towards a 'reference' growth cycle? If euro area business cycles are not (anymore) synchronized, possibly as a result of asymmetric shocks or different economic structures and policies, a common monetary policy monitoring aggregate inflation and output may create conflicts across countries and increase the instability in economic outcomes. The similarity of business cycles is one of the criteria required for an optimal currency area, and hence for a successful common monetary policy.

The paper studies the statistical properties of the business cycles of the four largest euro area economies, Germany, France, Italy and Spain in the wake of the recent recession episodes. In particular, we study the degree of (a)symmetry by looking at the synchronization of up and down phases, the convergence properties of country fluctuations towards the euro area cycles and the contribution of the euro area factor to the volatility of national GDPs. Our empirical investigation brings the following results for the four largest euro area economies. First, data support the idea of a substantial economic integration among France, Germany and (perhaps surprisingly) Italy. The estimated national and sector-specific characteristics appear to co-move strongly, to be well synchronized and to have converged to a common euro area factor. Conversely, Spanish business cycles appear to be decoupled from the rest of the euro area; in particular, the Spanish economic activity seemed to be overheated before the crisis and over-depressed in the aftermath. Our empirical evidence supports the view of an imperfect synchronization relative to the euro area factor and suggests a sluggish and incomplete convergence of the Spanish factor to the euro area one. Moreover, contrary to the common wisdom that identifies the European sovereign debt crisis as the trigger of the growing gap among euro area countries, our subsample analysis locates the economic decoupling of Spain 1 year before that. Second, in accordance with the behaviour of the estimated factors, the main driver of domestic fluctuations (for France, Germany and Italy) is the common euro area factor which explains more than half of the domestic GDP volatility and its components. The fluctuations of Spanish GDP are only partly explained by a common factor, and the vast majority of cyclical fluctuations are generated by national characteristics.

1 Introduction

Between the summer of 2008 and the end of 2013, the euro area went through two consecutive and intense recessions. Macroeconomic imbalances materialized and many economic commentators argued that the crisis episodes triggered a decoupling process between core and noncore euro area countries. Much of this debate focuses on cross-country differentials of single variables, e.g. unemployment rates or long term bond yields. While suggestive, such measures are not unambiguous indications of diverging cycles and an empirical assessment of the degree of real and financial asymmetries is lacking, e.g. are euro area economic cycles co-moving? Are they synchronized? Are they converging towards a 'reference' growth cycle? If euro area business cycles are not (anymore) synchronized, possibly as a result of asymmetric shocks or different economic structures and policies, a common monetary policy monitoring aggregate inflation and output may create conflicts across countries and increase the instability in economic outcomes. The similarity of business cycles is one of the criteria required for an optimal currency area, see Mundell (1961) and McKinnon (1963), and hence for a successful common monetary policy. Moreover, as argued in Farhi and Werning (2012), strong asymmetries among members of a currency union might build a case for fiscal intervention and the creation of a fiscal union within the currency area.

The paper studies the statistical properties of the business cycles of the four largest euro area economies, Germany, France, Italy and Spain, in the wake of the recent recession episodes. In particular, we study the degree of (a)symmetry by looking at the synchronization of up and down phases, the convergence properties of country fluctuations towards the euro area cycles and the contribution of the euro area factor to the volatility of national GDPs. We do so in a data-rich environment, for various reasons. First, focusing on a single variable might be misleading and different conclusion can be reached using -say- GDP instead of unemployment rate or labour productivity.[1] Moreover, concentrating the analysis on macro variables is restrictive, given the predominant role that the financial sector had in the recent business cycle episodes. As an example, between 2000 and 2007, total credit growth in Spain was more than seven times higher than that in Germany; it doubled during 2003 and 2006 for the former, while it did not change substantially for the latter.[2] Ignoring this feature might result in incorrect inference and conclusions.

To estimate euro area-, country- and sector-specific factors, we adopt a multi-country, multi-sector factor model structure, similar to the work of Moench, Ng and Potter (2013) or that of Kose, Otrok and Prasad (2012),[3] so that we both avoid the curse of parameter dimensionality due

[1] See section 2.1 for an empirical justification.

[2] These numbers are based on total credit (including bank credit and debt issuances) collected from the BIS. In particular, we computed annual growth rates based on the outstanding amounts. In our analysis, we use loan growth from the MFI data, which is a narrow credit definition focusing on bank credit.

[3] Moench et al. (2013) use the dynamic hierarchical factor model to explore the different blocks/sectors in a large set of economic data of one particular country, the United States. Kose et al. (2012) study the global interdependencies

to the rich data environment, and, by exploiting the block structure of the data, we achieve a better identification of the factors. We specify four layers of factors, so that each time series - say GDP of France - is explained by a common cross-country factor, by a country-specific factor, by a country-sector-specific factor (macroeconomic or financial) and by an idiosyncratic component.

Our empirical investigation brings the following results for the four largest euro area economies. First, data support the idea of a substantial economic integration among France, Germany and (perhaps surprisingly) Italy. The estimated national and sector-specific characteristics appear to co-move strongly, to be well synchronized and to have converged to a common euro area factor. Conversely, Spanish business cycles appear to be decoupled from the rest of the euro area; in particular, the Spanish economic activity seemed to be overheated before the crisis and over-depressed in the aftermath. Our empirical evidence supports the view of an imperfect synchronization relative to the euro area factor and suggests a sluggish and incomplete convergence of the Spanish factor to the euro area one. Moreover, contrary to the common wisdom that identifies the European sovereign debt crisis as the trigger of the growing gap among euro area countries, our subsample analysis locates the economic decoupling of Spain 1 year before that. Second, in accordance with the behavior of the estimated factors, the main driver of domestic fluctuations (for France, Germany and Italy) is the common euro area factor which explains more than half of the domestic GDP volatility and its components. The fluctuations of Spanish GDP are only partly explained by a common factor, and the vast majority of cyclical fluctuations are generated by national characteristics. Third, we find important spillover channels both across countries and across sectors. However, there is a wide heterogeneity and not all countries respond in the same way to similar shocks. In particular, we find that countries which co-move (i.e. France, Italy and Germany) can generate important fluctuations in neighbouring countries. Conversely, Spanish macroeconomic or financial cycles cannot generate sizable transmission mechanisms. Moreover, we find that the transmission of financial shocks affects national GDPs, so that not only real international cycles seem to matter, but also financial cycles have important real spillovers, in accordance with the results of Ciccarelli, Ortega and Valderrama (2012).

Our paper is related to the literature on international business cycle dynamics and the cross-country interdependencies. On pure empirical grounds, there are at least three popular methodological approaches that can be used to tackle these topics, global vector autoregression (GVAR) (Pesaran, Schuermann and Weiner (2004)), panel vector autoregression (panel VAR) (Canova and Ciccarelli (2009), or Canova and Ciccarelli (2013), for a review) and factor models (Kose, Otrok and Whiteman (2003) or Kose et al. (2012)). The first method is fruitfully used to capture the in-

of output, consumption and investment of 100 countries categorizing the layers of commonalities into country specific, regional specific (industrialized, emerging markets and developing economies) and a global factor. In this paper, we combine the multi-country and the multi-sector structures using euro area data.

ternational transmission mechanisms of domestic and foreign structural identified shocks. However, prior restrictions are required to set the weights to construct foreign variables to shrink the large-dimension parameter space. While in GVAR, a great deal of arbitrariness might enter into play, in factor models the weights on variables are estimated and hence determined on statistical grounds. Relative to panel VAR, the complex structure of dynamic interdependencies is not modelled and is instead captured with a set of unobservable factors. Regressors in the panel VAR are combinations of the lags of the right-hand side variables and thus observable. Being unobservable, factors are typically estimated using weighted averages of (subsets) of the current values of endogenous variables.[4] Moreover, factor models have another appealing feature: their framework is consistent with economic structural models, where the dynamics of a large number of endogenous variables are typically a function of a small number of latent states, i.e. the ACBD solution of dynamic stochastic general equilibrium (DSGE) models (see Fernandez-Villaverde, Rubio-Ramirez, Sargent and Watson (2007)).

In a work closely related to ours, Kose et al. (2012) study the coupling and decoupling processes of a large panel of world economies using a hierarchical factor model structure. In particular, they look at the contribution of the global factor in shaping GDP volatilities and study if the globalization process favoured a convergence process across the economies by comparing the variation of the contribution of the global factor in the pre- and post-globalization subsample. In this paper, we do a similar exercise but we try to distinguish between two concepts, *convergence*, defined as the short or long memory process of the gap between the euro area and national cycles, and *synchronization*, which reflects the timing of turning points. Both notions are associated with the idea of 'alikeness' of business cycles but are related to different objects in the factor model structure. The former is ultimately linked to the factor loadings. If the country loading is close to one (or in general to the normalization value used), then the gap between the national economy and the euro area follows a low-persistency process. Hence, the time required for national economies to close the gap with the euro area factor, given a one-time deviation from it, is short. Vice versa, if the factor loading is close to zero, the gap displays a longer memory process, implying that a longer time span is needed for the national economy to revert back to the euro area cycle. The notion of synchronization instead is constructed on the estimated factors and the frequency of their up and down phases. We wish to verify the likelihood that the country and the euro area factors are on the same phase. Finally, the contribution of the factors to the observable variance is a function of both the estimated factors and the loadings and hence, to some extent, a combination of these two concepts. In sum, we provide three different statistics, which should provide a coherent picture of business cycle 'similarity'.

[4] Hence, panel VAR and factor models are likely to have different characteristics and span a different informational space. Whether lags or current values of the endogenous variables provide superior information for the states of a theoretical model is an open question.

We conduct a series of robustness exercises. First, we flipped the ordering of the blocks. Instead of considering a vertical structure of the type Euro-Country-Sector, we study the implication of the structure Euro-Sector-Country. Second, we try to address the issue of short-time dimension length by allowing a mixed-frequency database, i.e. using monthly and quarterly time series jointly. Results are robust to these exercises. Finally, despite the parsimonious nature of factor models, by splitting the data into blocks and by identifying them as macro and financial sectors, we are implicitly imposing some sort of 'structure'. It is then legitimate to ask if such a structure is supported by the data. To this end, we pool the macro and financial variables together, extract a number of factors at the country level and try to provide interpretations. This analysis confirms that at the country level, the first two factors loads macro and financial variables, respectively.

The paper is organized as follows. Section 2 presents the econometric set-up and the quantities used to measure synchronization and convergence. Section 3 presents the data structure and discusses the main results of our empirical investigation in terms of estimated factors, the degree of synchronization, the convergence patterns, the variance decomposition and transmission mechanisms. Section 4 presents complementary exercises to investigate the robustness of our results. Section 5 draws a number of concluding remarks.

2 Econometric Methodology

We consider a multi-country multi-sector framework. We assume that the data are generated by four layers of factors, so that each observed time series,[5] Z_{csjt}, belongs to a country-sector-specific unobserved block (i.e. either country-macroeconomic or country-financial), H_{cst}, each country-sector-specific factor is explained by country-specific unobserved factors, G_{st}, and country-specific factors are explained by common cross-country unobserved characteristics, F_t. We have for $j = 1, \ldots, N_{Zcs}$, $s = 1, \ldots, N_{Hc}$ and $c = 1, ..., N_c$

$$\begin{aligned} Z_{csjt} &= \lambda_{csj} H_{cst} + e^Z_{csjt} \\ H_{cst} &= \mu_{cs} G_{ct} + e^H_{cst} \\ G_{ct} &= \nu_c F_t + e^G_{ct} \end{aligned} \tag{1}$$

where H_{cst} is a $N_{Hcs} \times 1$ vector, G_{ct} is a $N_{Gs} \times 1$ vector, F_t is a $N_F \times 1$ vector and λ_{csj}, μ_{cs} and ν_c are suitable matrices loading the factors. We assume that at each layer of commonality errors

[5] See tables 8 and 9 for an overview of all variables.

evolve as an autoregressive process, so that

$$\begin{aligned} e^Z_{csjt} &= \phi^Z_{csj}(L)e^Z_{csjt-1} + \eta^Z_{csjt} \\ e^H_{cst} &= \phi^H_{cs}(L)e^H_{cst-1} + \eta^H_{cst} \\ e^G_{ct} &= \phi^G_c(L)e^G_{ct-1} + \eta^G_{ct} \\ F_t &= \phi^F(L)F_{t-1} + \eta^F_t \end{aligned} \tag{2}$$

where η^X_t are i.i.d. normal shocks with $\Sigma_{\eta,X}$ variance for $X = Z, H, G, F$.

Loadings and dynamic factors are estimated in a Bayesian set-up. We use the Gibbs sampler and exploit the block recursive structure of the model for an efficient estimation. Let $\Lambda = (\lambda, \mu, \nu)$ contain all the factor loadings, $\Psi = (\phi^F, \phi^G, \phi^H, \phi^Z)$ the autoregressive coefficients and $\Sigma = (\Sigma_{\eta,F}, \Sigma_{\eta,G}, \Sigma_{\eta,H}, \Sigma_{\eta,Z})$ the standard deviations. The main steps of the Gibbs sampler are

1. Conditional on Λ, Ψ Σ, $\{G_{ct}\}$ and the data Z_{csjt}, draw $\{H_{cst}\}$ for $s = 1, \ldots, N_{Hc}$ and $c = 1, ..., N_c$
2. Conditional on Λ, Ψ Σ, $\{F_t\}$ and H_{cst}, draw $\{G_{ct}\}$ for $c = 1, ..., N_c$
3. Conditional on Λ, Ψ Σ, $\{G_{ct}\}$, draw $\{F_t\}$
4. Conditional on $\{F_t\}$, $\{G_{ct}\}$ and H_{cst}, draw Λ, Ψ Σ

After a suitable number of iterations, the Monte Carlo Markov Chain generated by the Gibbs sampler converges to the target posterior distribution of factors and loadings.

The block-recursive structure can be rewritten in a companion form in order to address a number of economically relevant questions. First, we express the system in terms of endogenous variables as a function of the exogenous ones, i.e.

$$\begin{aligned} Z_{csjt} &= \lambda_{csj}\mu_{cs}\nu_c F_t + \lambda_{csj}\mu_{cs}\ e^G_{ct} + \lambda_{csj}e^H_{cst} + e^Z_{csjt} \\ H_{cst} &= \mu_{cs}\nu_c F_t + \mu_{cs}e^G_{ct} + e^H_{cst} \\ G_{ct} &= \nu_c F_t + e^G_{ct} \end{aligned} \tag{3}$$

Any observed time series Z_{csjt} - say GDP in France - can be decomposed into four exogenous components, a common cross-country factor F_t, a nation-specific component G_{st}, a national sector-specific element H_{cst} and a pure idiosyncratic series-specific characteristic e^Z_{csjt}. Moreover, at the higher level of hierarchy, the country-sector-specific factor is generated by an exogenous national-sector-specific element, an exogenous nation-specific component and by a common factor. This framework allows us to compute the contribution of each component both to the level and to the second moments of the observed time series. Moreover, we can study the impact of a variation in the factors on the observed country-specific variables and measure spillover effects.

With this framework, we can also verify if country factors tend to converge to the euro area factor. We define convergence as the situation where at some point in the future the gap between the country and the euro area factor becomes unpredictable with today information or, in other words, the information contained in the euro area factor is sufficient for predicting national characteristics. More formally, we assume convergence when

$$\lim_{m \to \infty} E_t \left(G_{c,t+m} - F_{t+m} \right) = 0 \tag{4}$$

provided that the gap process has a finite variance $var(G_{c,t} - F_t) = \sigma < \infty$. This implies that there exists a τ^* finite such that the autocorrelation function (ACF) of $G_{c,t} - F_t$ is zero from then onward, i.e. $\rho(\tau) = 0$ for all $\tau > \tau^*$ (see Caggiano and Leonida (2009), for a discussion). Put differently, the time required for the ACF to go to zero is a measure of the time required for national economies to revert back to the euro area factor, given a one-time deviation from it. Convergence requires that departures from the euro area factor are temporary, implying that the ACF becomes zero in the observed sample. The assumptions of our empirical model imply that the condition in (4) is verified, provided that the autoregressive part is stationary. However, the speed at which the country factor converges to the euro area factor might be very different and convergence might not be statistically visible in short samples, giving insights about country convergence properties. As an example, consider two extreme cases of high correlation, $\nu_c = 1$, and of low correlation between the country and the euro area factor, $\nu_c = 0$. In the former case, the gap process coincides with $e^G_{c,t}$ and inherits all its statistical properties. So if $e^G_{c,t}$ is an AR(1) process, so is the gap featuring an ACF decaying at the rate of the autoregressive coefficient. In the case of low correlation, the gap process is the sum of two AR(1), which give rise to an ARMA(2,1) process with a slower ACF decaying structure. Therefore, the differences in the long memory structure give us valuable information about the speed of country convergence to the euro area factor and provide us with indications about the convergence properties in short samples.

Alternatively, the convergence hypothesis breaks down if the exogenous processes are non stationary, if the exogenous processes at the country level feature drifts, or if there is time variation in the loading or autoregressive coefficients. An alternative way to test for convergence is to contrast the marginal likelihood of a restricted and an unrestricted empirical model that breaks the relationship as described above. However, the latter approach would be computationally cumbersome, and require a parameterization of the nonconvergence process. The ACF plot is agnostic in this respect and provides a fast and easy-to-check measure to study convergence.

Following Harding and Pagan (2006), we measure the degree of synchronization by focusing on turning points and by defining a dating rule for up and down phases. Once we have identified the phases of the cycle, we can associate them with a binary random variable S_t that takes the values unity and zero. In Harding and Pagan (2002), they work through the case where the dating rule is that a recession involves two successive quarters of negative growth and y_t, which could refer to the level of output, is a random walk with drift. The natural adaptation of their rule to our context is to define a recession involving two consecutive quarters of a negative value for the estimated factor. More formally,

$$S_{x,t} = 1 \quad if \ x_t < 0 \ \ x_{t-1} < 0$$
$$S_{x,t} = 0 \quad elsewhere$$

where x_t can be the country, G_c, or the euro area factor, F. A definition of strong perfect positive synchronization (SPPS) is represented by the case when the two random variables $S_{x,t}$ and $S_{y,t}$ are identical; cycles that instead are strongly nonsynchronized (SNS) might then be regarded as the case when $S_{x,t}$ and $S_{y,t}$ are independent. The main quantities that characterize the degree of synchronization and their relative test are[6]

$$SPPS \ : \ \mu_{S_x} - \mu_{S_y} = 0$$
$$SNS \ : \ \rho_S = 0$$

where μ_{S_x} and μ_{S_y} are the sample means of $S_{x,t}$ and $S_{y,t}$, respectively and ρ_S is the correlation coefficient. Conclusions about perfect synchronization and strong asynchronization can be drawn by testing for equality in the means of the frequency of turning points in the former case and for zero correlation between country and the euro area factor in the latter, taking care of possible heteroscedasticity in the construction of the binary indicator. Moreover, by concentrating upon ρ_S, we also provide a natural index of synchronization, which is small (large) when ρ_S is close to zero (one).

2.1 Why a data-rich environment?

Factor model set-ups have been proved to be powerful tools in a wide spectrum of exercises, i.e. for dating business cycles and extracting cyclical indicators (Altissimo, Bassanetti, Cristadoro, Forni, Hallin, Lippi, Reichlin and Veronese (2001), or recently Altissimo, Cristadoro, Forni, Lippi and Veronese (2010)), for forecasting purposes (Marcellino, Stock and Watson (2003)), for nowcasting macroeconomic aggregates (Giannone, Reichlin and Small (2008), among others), for deriving the driving forces behind economic fluctuations (Kose et al. (2003), Del Negro and Otrok (2008)), or to amend the nonfundamentalness of structural VAR shocks (see Forni and Gambetti (2014)).

In this section, we justify the use of a rich data structure to measure synchronization and convergence. Our main concern of a smaller information set is that conclusions, in terms of synchronization and convergence, are typically sensitive to variable selection and we prefer not to have a stand on

[6] For a more comprehensive discussion, see Harding and Pagan (2006).

that. As an example, we consider the extreme case of two different data sets that contains only a single country-specific time series, i.e. one set containing national GDPs, $\mathcal{I}_y$, and one labour productivity, $\mathcal{I}_p$. Both variables are *a priori* informative on the state of the economy and thus provide reliable statistics on the degree of co-movements, synchronization and convergence. In this set-up, the factor structure includes only one layer of commonality representing the common cross-country factor, and the factor model structure to estimate simplifies to

$$G_{ct} = \nu_c F_t + e_{ct}^G$$

where G_{ct} represents the observed country-specific time series, the country GDP in $\mathcal{I}_y$ and the country labour productivity rate in $\mathcal{I}_p$. The original country-specific variables and the factors

Country	Index of synchronization, $\widehat{\rho}_S$	
	GDP	Labor productivity
Germany	0.43 [0.361 , 0.493]	0.44 [0.318 , 0.537]
France	0.45 [0.387 , 0.504]	0.37 [0.346 , 0.412]
Italy	0.74 [0.651 , 0.808]	0.56 [0.427 , 0.627]
Spain	0.53 [0.462 , 0.622]	-0.06 [-0.219 , 0.118]

Table 1: Index of synchronization using different information sets (the 90% confidence bands are reported in square brackets)

estimated with different information sets can be used to measure synchronization and convergence. Table 1 presents the index of synchronization of the country-specific variables to the euro area factor estimated with the productivity and the GDP information set, respectively. Not surprisingly, the information set matters for the empirical conclusions. While with the GDP data set we tend to accept a mild degree of cross-country synchronization, using productivity we are prone to conclude that Spain is not well synchronized with respect to the cross-country factor (i.e. the index is statistically zero). Similarly, we might draw different implications in terms of convergence if we consider the gap of productivity as opposed to the gap of GDPs. Figure 1 presents the ACF of the gaps between the country-specific variables and the cross-country factor; in blue the GDP information set and in red the productivity information structure. The ACF of the gap for France and Spain behaves differently if we consider GDP or productivity as the observable.

In sum, we believe that focusing the analysis on single variables might produce contradictory findings and we think that a more robust analysis can be carried out by looking at a richer data structure.

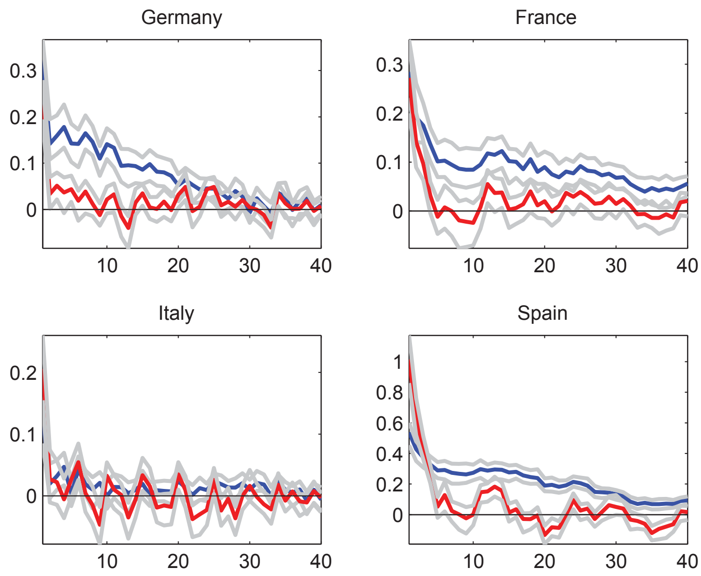


Figure 1: ACF of the convergence gaps using different information sets. From top left to bottom right - Germany, France, Italy and Spain. In blue the ACF using GDPs and in red the ACF using productivity, in grey credible sets.

3 Data structure and Estimation Results

We study the time period that covers the past 14 years of the euro experience of the four largest euro area economies, i.e. Germany, France, Italy and Spain from 1998Q2 to 2012Q2 at quarterly frequency.[7] The choice of the time span is partly due to data availability and partly due to the desire to consider a relatively homogeneous period of time. For each country, we employ a number of variables capturing both the macroeconomic and the financial activities.[8]

For the macroeconomic sector, we consider measures of core and headline inflation, investment, consumption, GDP, imports and exports, relative deflators, productivity and labour market variables. The financial data series used in this analysis intends to capture, broadly speaking, the evolution of financial sector conditions in a specific country. The data series can be split into four main categories: (1) interest rates (deposits and lending rates), (2) housing investment and prices, (3) market prices of traded instruments and (4) banks' balance sheet information aggregated at the country level. The third category contains equally weighted stock returns of the major banks, returns of the benchmark stock index covering the largest companies and changes in the yields of government bonds at different maturities (3, 5 and 10 years). These series basically capture market

[7]We also estimated a version where we can consider mixed-frequency, quarterly data for macroeconomic series and monthly for financial series. See section 4 for a discussion.

[8]The time series of real and financial variables are shown in the appendix (Figures 13 and 14).

participants' expectations on the profitability of banks and nonfinancial corporations (NFCs), and the sovereign risk premium reflecting macroeconomic fundamentals. Since the data is available at a higher frequency, we use average prices or yields observed during each quarter. The fourth category contains real growth rates of banks' major asset and liability side items, percentage changes in several balance sheet ratios capturing risk-taking, capital adequacy and liquidity. The data is available from the European Central Bank's (ECB) balance sheet statistics for monetary financial institutions (MFIs) and aggregates the data from individual credit institutions and money market funds for the specific country.[9] We consider quarter-on-quarter variations, rate of changes for most of the variables and quarter-on-quarter changes of unemployment rates, interest rates and government bond yields. Data are standardized prior to estimation by subtracting the mean and dividing by the standard deviation for each series. The total number of time series used is 200 and more details on data construction and relative transformations are reported in the appendix.

We assume two sub-blocks per country, a macroeconomic and a financial sector, and one factor per subblock.[10] We further assume one country-specific factor and one euro area common factor. To achieve identification, we assume that the matrix loadings are lower triangular where the elements on the diagonal have a fixed sign, e.g. Geweke and Zhou (1996). We further assume that innovations to factors have fixed variance. Finally, we postulate that the autoregressive part of the exogenous components is of order one.

3.1 Co-movements, synchronization and convergence

Do euro area economies co-move? Are economic fluctuations synchronized? Is it reasonable to believe in the presence of a 'euro area factor' towards which the regional fluctuations are converging? Figure 2 reports the estimated commonality and the country-specific characteristics over time, from top left to bottom right for Germany, France, Italy and Spain.

By looking at the graphs, it is easy to notice sensible differences among euro area countries; while Germany, France and Italy tend to co-move, Spanish business cycles are decoupled from the other euro area countries. Relative to the common factor, the Spanish economy seems to be overheated before the first crisis and extremely depressed in the aftermath. This suggests that in the past decade there has been only a partial synchronization among euro area countries and still we do observe a 'convergence gap' to a common euro area business cycle for the case of Spain. This gap is also reflected in the dating of the business cycles and in the assessment of whether a country is in a recession or not. For example, while in Italy, Germany and France, the 2009 recession was followed by a period of mild recovery, it seems that the Spanish economic activity has not recovered since

[9] The definition of MFIs can be found in European Central Bank (2012) and a list of all MFIs is available on the ECB website.

[10] See section 4 for a justification on the number of country-specific factors.

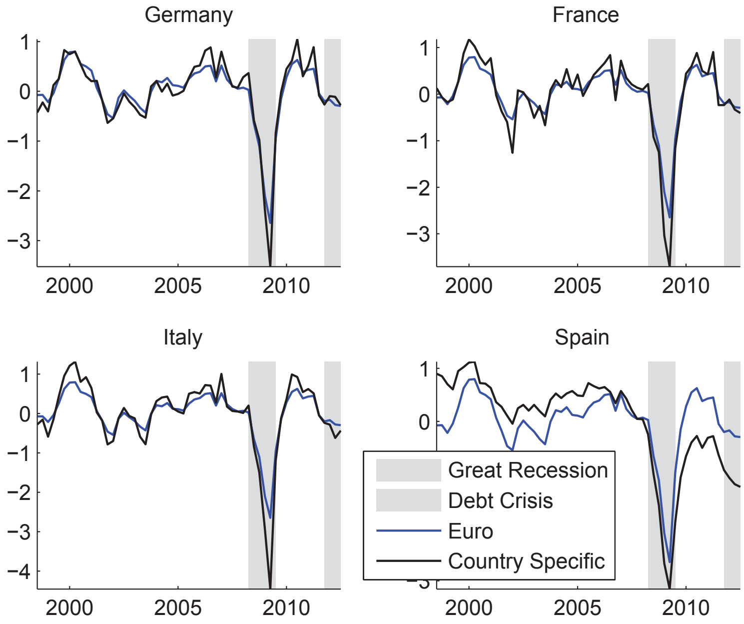


Figure 2: Euro area factor and country specific factors. From top left to bottom right Germany, France, Italy and Spain.

then and it is still significantly below the euro area aggregate.

Conclusions drawn from a visual inspection of the euro area and the country factors are complemented with a more formal analysis discussed above. Figure 3 reports the difference between the cyclical binary indicator of the country factor and the corresponding indicator of the euro area factor downscaled by 2, i.e. $S_{G_c,t} - S_{F,t} - 2$, so that when it is equal to -2, euro and country cycles are on the same phase; when it is equal to -1 (-3), the country factor is (not) in recession while the euro are factor is not (is). As it stands out, there are different degrees of synchronization and while for France, Germany and Italy, there are few episodes of uneven phases, Spanish ups and downs are different from the euro area ones. A more formal battery of tests for synchronization is presented in table 2, which reports the index of synchronization and the p-values of the test of SPPS and SNS across different estimates of the factors; we report mean values as well as the upper and lower 90% percentiles, which capture the uncertainty surrounding the estimated factors. There are three important results that stand out. First, the degree of synchronization varies substantially, from 0.30 for Spain to 0.72 for France and Italy, and it is statistically different across countries. Second, while we tend to accept the hypothesis of SPPS at 5% confidence level, the evidence in favour of it is inconclusive, since there are estimates of the factor that fall in the rejection area. Third, we do obtain robust rejection of perfect nonsynchronization for Italy, France and Germany. In the case of Spain, the evidence is inconclusive and there are estimates of the Spanish factors that

Country	Index of synchronization	SPPS	SNS
Germany	0.67 [0.451 , 0.844]	0.14 [0.045 , 0.206]	0.00 [0.000 , 0.001]
France	0.72 [0.527 , 0.880]	0.12 [0.045 , 0.194]	0.00 [0.000 , 0.002]
Italy	0.72 [0.528 , 0.880]	0.13 [0.056 , 0.203]	0.00 [0.000 , 0.001]
Spain	0.30 [0.128 , 0.486]	0.14 [0.044 , 0.206]	0.08 [0.000 , 0.314]

Table 2: Index of synchronization, the *p-values* for the test for SPPS and SNS of each country relative to the euro area factor (the 90% credible sets are reported in square brackets)

are statistically perfect nonsynchronized and some that are not. All in all, this suggests that in the past decade, we have observed only an incomplete synchronization of country-specific cycles and only Germany, France and Italy appear to be strongly synchronized with euro area cycles.

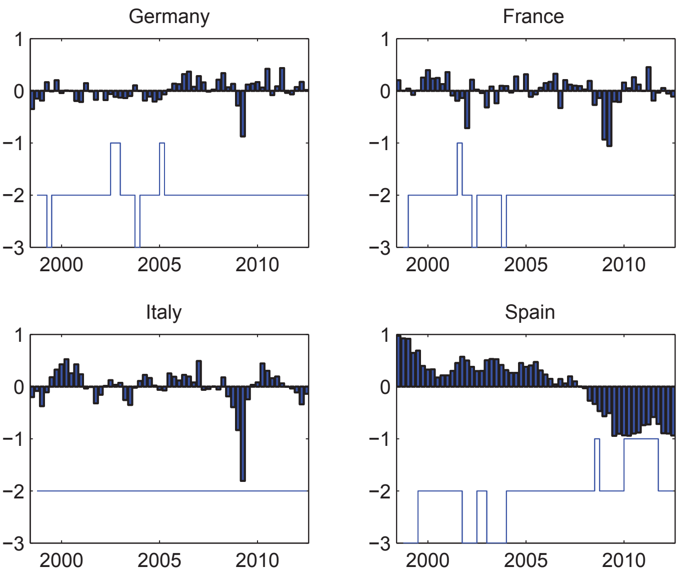


Figure 3: Euro area cycle gaps (vertical bars) and euro area synchronization gaps (lines). The euro area synchronization gap is measured as the difference between the cyclical binary indicator of the country factor and the corresponding indicator of the euro area factor downscaled by 2. The euro area cycle gap is the difference between the country factor and the euro area factor. From top left to bottom right - Germany, France, Italy and Spain.

If we focus on the estimated euro area gaps, i.e. the difference between the country factor and the euro area factor, we notice that while for France, Germany and Italy the euro area gap looks like white noise and thus unpredictable, the Spanish gap is persistent and displays a lot of structure. This suggests the idea that the euro area factor predicts Spanish characteristics only to some extent. A formal investigation of the convergence patterns is provided in figure 4, where we contrast the autocorrelation function of $G_{c,t} - F_t$ until the lag 45.

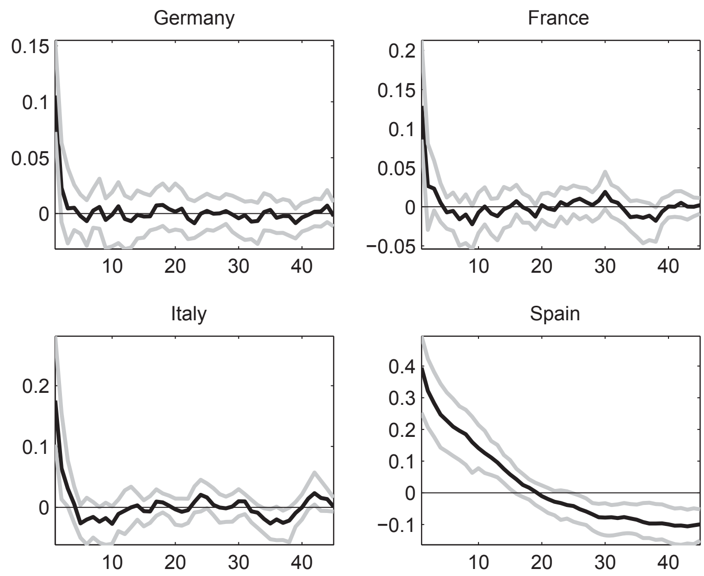


Figure 4: ACF of euro area gaps, measured as the difference between country factor and euro area factor. From top left to bottom right - Germany, France, Italy and Spain.

As argued in the previous section, the ACF represents a neat way to discriminate if the country factor is converging to the reference factor and at which speed. In particular, convergence is attained if the ACF reaches zero. The picture confirms our previous (qualitative) results and suggests that Germany, Italy and France converged indeed to the euro area factor. While there is some heterogeneity amongst them, the convergence is fast. In Spain, convergence in sluggish and not visible in the observed sample. This may signal the existence of important country-specific structural characteristics.

3.2 Drivers of macroeconomic and financial cycles

What are the main drivers of economic cycles in Europe? Common or idiosyncratic features? Table 3 reports the variance decomposition of real GDP in each country, median values and the 90% credible sets are reported in parenthesis. The decomposition of the main GDP components provides similar results and is reported in table 10 in the appendix.

First, in agreement with the estimated factors, most of the variation in the German, French and Italian output is explained by a common source, i.e. the euro area factor. Second, at the aggregate level, country-specific, sector-specific and pure idiosyncratic characteristics together only explain half of the GDP fluctuations. This suggests that there is an important degree of interdependence among Germany, France and Italy, and one should expect strong co-movements amongst them; i.e.

Real GDP	Euro area	Country	Macro sector	Idiosyncratic
Germany	45 [34 , 54]	19 [15 , 23]	18 [14 , 22]	18 [6 , 32]
France	59 [48 , 71]	13 [11 , 17]	13 [10 , 17]	14 [6 , 23]
Italy	61 [51 , 70]	11 [8 , 14]	11 [8 , 13]	16 [10 , 25]
Spain	17 [5 , 30]	62 [42 , 79]	12 [7 , 17]	9 [4 , 14]

Table 3: Variance decomposition of GDP. The median values are reported and 90% credible sets are in parenthesis.

if one country falls into a recession, there is a 0.5% chance that such recession is driven by the euro area factor and that it might have negative spillovers to neighbouring countries. A different picture arises if we look at the variance decomposition of the Spanish GDP. In fact, the volatility of Spanish GDP is mainly explained by a country specific factor, i.e. more than 60%, and the euro area factor has a limited impact (17%) in shaping Spanish real economic fluctuations. Moreover, the 'non-euro area' factors explain more than 80% of the volatility of Spanish GDP, suggesting that Spain appears to be decoupled relative to the other three euro area countries.

Financial Variables	Euro area	Country	Financial sector	Idiosyncratic
			Germany	
chg 3Ygov bond yields	11 [2 , 21]	5 [1 , 9]	78 [63 , 91]	6 [3 , 8]
loans total	1 [0 , 5]	1 [0 , 2]	12 [3 , 27]	86 [67 , 95]
deposits total	1 [0 , 3]	0 [0 , 1]	6 [1 , 16]	92 [78 , 99]
			France	
chg 3Ygov bond yields	9 [2 , 18]	2 [1 , 4]	25 [9 , 40]	63 [46 , 85]
loans total	0 [0 , 4]	0 [0 , 1]	1 [0 , 10]	98 [84 , 100]
deposits total	0 [0 , 3]	0 [0 , 1]	1 [0 , 8]	99 [88 , 100]
			Italy	
chg 3Ygov bond yields	8 [3 , 16]	2 [1 , 3]	24 [11 , 37]	66 [46 , 83]
loans total	1 [0 , 5]	0 [0 , 1]	3 [0 , 10]	96 [85 , 100]
deposits total	1 [0 , 5]	0 [0 , 1]	3 [0 , 11]	95 [81 , 100]
			Spain	
chg 3Ygov bond yields	0 [0 , 2]	1 [0 , 7]	94 [84 , 97]	5 [3 , 7]
loans total	0 [0 , 1]	0 [0 , 2]	24 [9 , 37]	79 [61 , 90]
deposits total	0 [0 , 1]	0 [0 , 3]	31 [15 , 47]	69 [51 , 85]

Table 4: Variance decomposition of financial variables, median values.

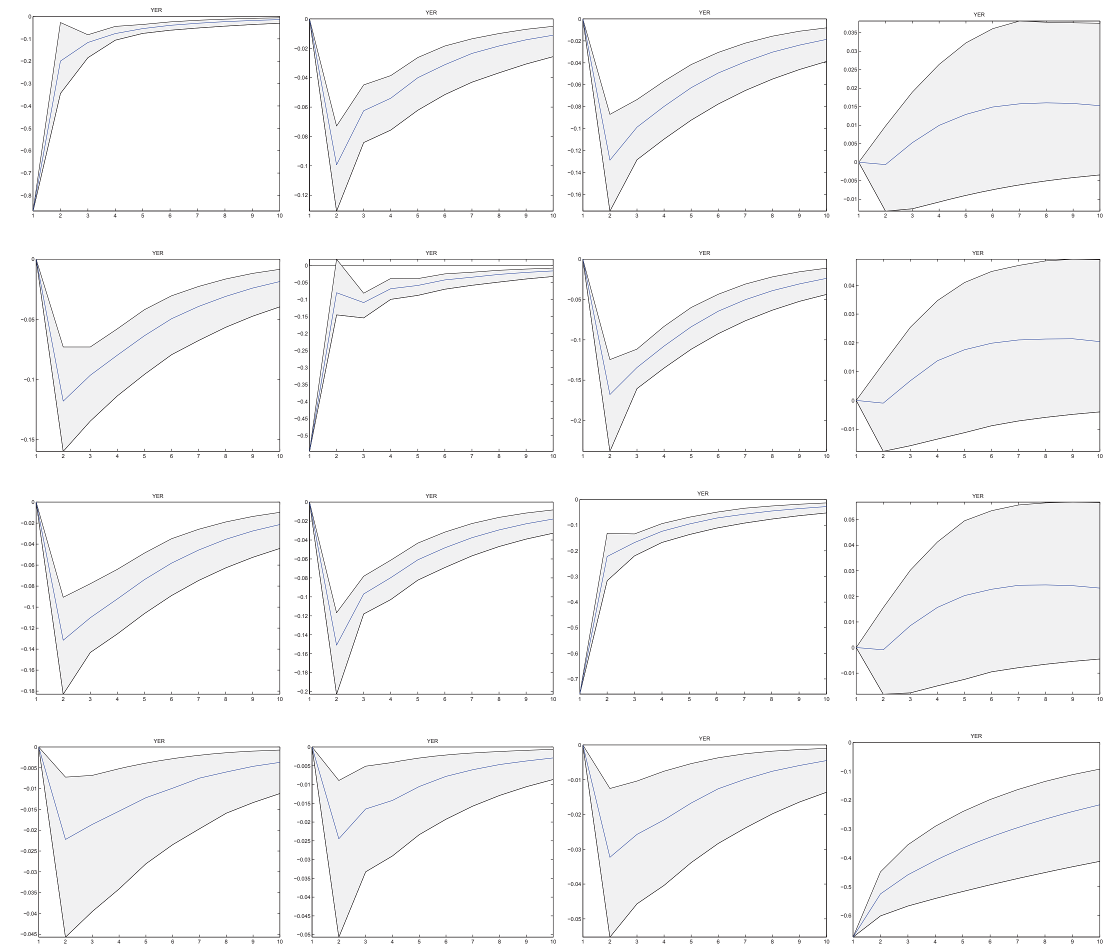
Before looking at the cross-country spillovers, it is instructive to inspect the decomposition of financial cycles. Table 4 reports selected financial variables and their variance decomposition for each country. We find that the financial factor loads on the long-term yields that proxy the risk premium in the sovereign bond market, which is ultimately linked to the expectations on each country's macroeconomic fundamentals (see Ludvigson and Ng (2009)). In Spain, the financial factor loads also on total loans and deposits. The latter result is consistent with a narrative explanation of the Spanish experience, where the housing bubble, in early 2000, has increased the relative importance of the construction sector and tightened it with the banking system which was granting loans to households and NFCs. Once the bubble burst and the global turmoil materialized, both the macroeconomic environment and the sustainability of the financial system degraded and pushed the Spanish economy into a deep recession.

3.3 Cross-country and Cross-sector Spillover

Does a deterioration in the macroeconomic activity in Italy have an impact on Germany? How large is the pass-through of euro area macroeconomic fluctuations?

Figure 5 displays the dynamic response over time of national GDPs to a negative impulse in the real activity of a neighbouring country; from top to bottom rows, we generate a 1 GDP standard deviation decline in the Germany-macro factor, the France-macro factor, the Italy-macro factor and the Spain-macro factor. The results are twofold. On the one hand, we obtain that countries which co-move (i.e. France, Italy and Germany) can generate important fluctuations in neighbouring economies and typically the response is one-fifth of the drop in output in the original country. On the other hand, Spanish fluctuations, which only marginally co-move with euro area ones, do not react to changes in the economic conditions of euro area countries nor have a sizable impact on the neighbouring economies. A deterioration of the macroeconomic factor of Spain has - even if significant - a negligible impact, i.e. in the worst case, the order of magnitude is 0.05%, hence one-twentieth of the original domestic shock. In other words, it means that in the worst scenario, Spanish GDP has to drop by 20% in order to generate a 1% decline in the French, German or Italian GDP. Similarly, none of the euro area countries considered is able to generate statistically significant variations in the Spanish GDP.

A similar picture arises when investigating the financial sector (see Figure 6). We study a deterioration in the financial sector that generates a 1 standard deviation decline in the return of the national stock market (since the loadings are normalized relative to the stock price). The figure suggests two things: first, there are important propagation mechanisms from the financial sector to the real economy, and typically a deterioration in the country-specific financial factor generating a 1 standard deviation decline in domestic stock returns triggers a decline in domestic GDP of 0.03 on average. Second, the financial cross-country pass-through seems to be more important than the macroeconomic one. While a drop in the financial factor in Italy generates an average decline of GDP of 0.04 in Italy, 0.03 in France and 0.03 in Germany, a drop in the macroeconomic factor in Italy triggers a drop in GDP of 0.8 in Italy, 0.14 in France and 0.13 in Germany (and no significant reaction in Spain). As for macroeconomic fluctuations, variations in the financial factor originating in Spain cannot generate significant amplification to other euro area countries.



(m) DE (n) FR (o) IT (p) ES

Figure 5: Response of national GDPs to a negative 1 GDP standard deviation in the country-macro-specific factor. From top to bottom row, 1% decline in the Germany-macro factor, the France-macro factor, the Italy-macro factor and the Spain-macro factor. Grey areas represent 90% credible sets.

3.4 When does the decoupling of Spain occur?

A natural question that might arise is to which extent the Great Recession and the euro area sovereign debt crisis mattered for co-movements, synchronization and convergence and if those turbulent times have had a significant impact on the empirical conclusions drawn from the full sample period analysis. In particular, we are interested in verifying if the observed economic decoupling of Spain is linked to the crisis episodes. To this end, we estimate the factor model structure using information up to the beginning of the crisis episodes and the precise timing of the recession is taken from the Centre for Economic Policy Research (CEPR) dating. The CEPR Euro Area Business Cycle Dating Committee locates the onset of the Great Recession in the euro area in the second quarter of 2008 and identifies the euro area sovereign debt crisis in the third quarter of 2011. The committee judges

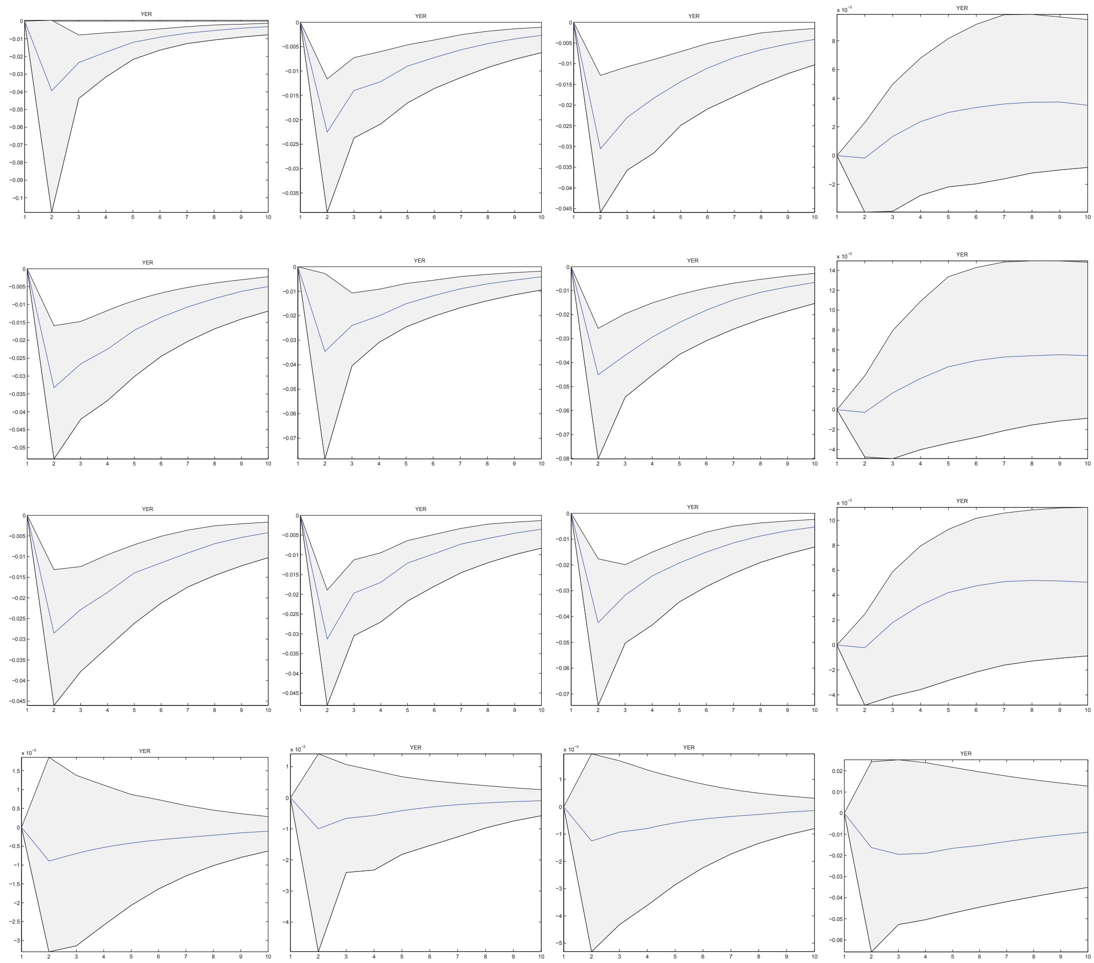


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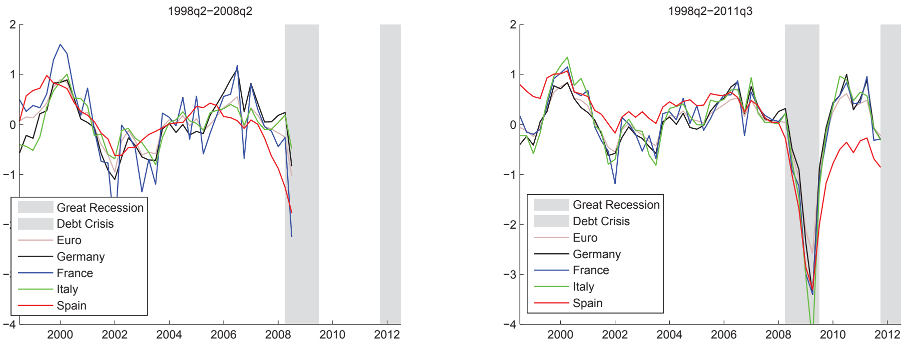
Figure 6: Response of national GDPs to a negative 1 GDP standard deviation in the country-financial-specific factor. From top to bottom row, 1% decline in the Germany-financial factor, the France-financial factor, the Italy-financial factor and the Spain-financial factor. Grey areas represent 90% credible sets.

that 2011Q3 'marks the end of the expansion that began in the second quarter of 2009 and the beginning of a euro-area recession'.[11] We estimate the factor model first using data up to 2008Q2 and then up to 2011Q3, compute the quantities of interest to measure co-movements, synchronization and convergence. Figure 8 and table 5 report the estimated factors and synchronization tests with different subsamples. From a visual inspection of the two subperiod estimates of the euro area and country factors, it stands out that before the Great Recession episode, the four countries were all pretty much aligned and co-moving. In the aftermath of the first crisis, the Spanish economy responded weakly and did not recover as much as the other economies. It seems that the period

[11] Quoting from Committee findings release available at CEPR Webpage



(a) Subsample 1998Q2-2008Q2

(b) Subsample 1998Q2-2011Q3

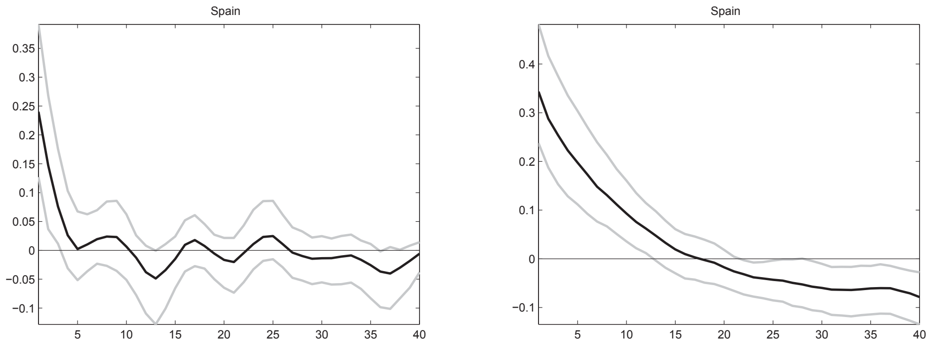
Figure 7: Estimated euro area and country factors using different subsamples: (a) subsample 1998Q2-2008Q2 and (b) subsample 1998Q2-2011Q3

between 2008Q2 and 2009Q3 represents a structural break witnessing the decoupling of the Spanish economy from the rest of the euro area countries. Contrary to the common wisdom that the euro area sovereign debt crisis triggered a growing gap between core and noncore countries, we find evidence that locates the structural break in the year before that. These informal considerations

Country	Index of synchronization	SPPS	SNS
	Subsample 1998Q2-2008Q2		
Germany	0.51 [0.251 , 0.761]	0.12 [0.040 , 0.209]	0.03 [0.000 , 0.160]
France	0.71 [0.495 , 0.899]	0.12 [0.044 , 0.207]	0.00 [0.000 , 0.002]
Italy	0.42 [0.088 , 0.743]	0.12 [0.040 , 0.209]	0.07 [0.000 , 0.312]
Spain	0.52 [0.126 , 0.811]	0.12 [0.033 , 0.209]	0.03 [0.000 , 0.237]
	Subsample 1998Q2-2011Q3		
Germany	0.67 [0.469 , 0.852]	0.13 [0.045 , 0.203]	0.00 [0.000 , 0.002]
France	0.70 [0.505 , 0.867]	0.12 [0.043 , 0.200]	0.00 [0.000 , 0.003]
Italy	0.71 [0.517 , 0.872]	0.13 [0.050 , 0.203]	0.00 [0.000 , 0.000]
Spain	0.26 [0.049 , 0.477]	0.13 [0.052 , 0.203]	0.14 [0.000 , 0.376]

Table 5: Index of synchronization, the *p-values* for the synchronization tests for the two subperiods.

are supported by the figures on the degree of synchronization and patterns of convergence. In the first subsample, the Spanish fluctuations are very much aligned with euro area ups and downs; the index of synchronization is of the same order of magnitude as for the other countries considered. If we include the recovery period, then the index of synchronization drops by half and becomes statistically different from the other counties. We derive similar conclusions in terms of convergence



(a) Subsample 1998Q2-2008Q2 (b) Subsample 1998Q2-2011Q3

Figure 8: ACF of the Spanish gap using different subsamples: (a) subsample 1998Q2-2008Q2 and (b) subsample 1998Q2-2011Q3

when looking at the post Great Recession. Figure 8 plots the ACF of the Spanish gap in the two subsamples. While in the pre-crisis period there is evidence of convergence, at the onset of the euro area sovereign debt crisis the statistical properties of the Spanish gap have changed from an idiosyncratic behaviour to a very persistent pattern. Hence, deviations from the euro area cycles are not temporary and time is required for the economy to revert back to the euro area factor.

In sum, this analysis suggests that in the aftermath of the global financial turmoil, the Spanish economy has decoupled from the rest of the euro area countries.

4 Robustness

We challenged our results along a number of dimensions. First, we considered a different ordering of the blocks. Instead of considering a vertical structure of the type Euro-Country-Sector, we study the implication of the structure Euro-Sector-Country. Second, we extended our analysis by stretching the time dimensions using a mixed-frequency database which considers jointly monthly and quarterly observations. Overall, the results are in line with the core exercise. Finally, we pursued a complementary analysis aimed at identifying the number of factors and their interpretation. This analysis confirms that at the country level, the first two factors load on macro and financial variables, respectively.

4.1 Different ordering of the blocks

In this section, we considered a different ordering of the blocks. Instead of considering a vertical structure of the type Euro-Country-Sector, we study the implication of the structure Euro-Sector-Country. More precisely, we assume that there are two large blocks, a macro and a financial sector, and within each sector, there are four sub-blocks identified by the countries. Figure 9 reports the

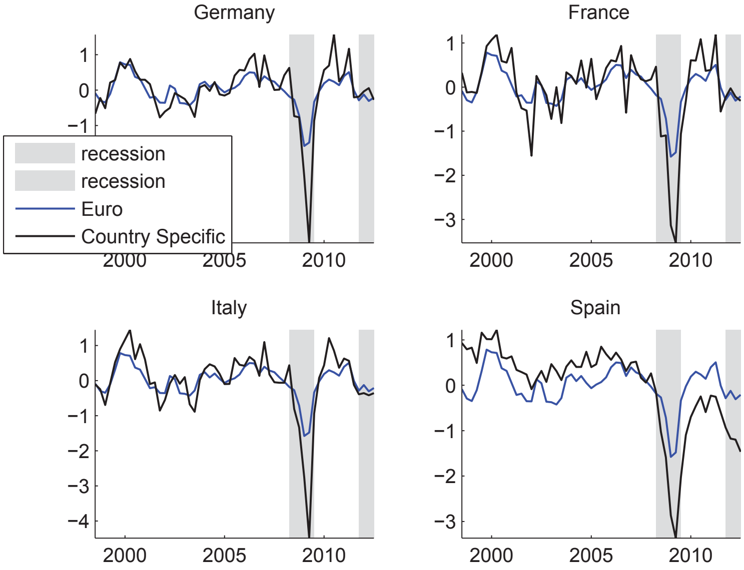


Figure 9: Euro area factor, country-specific factors and euro area gaps using a hierarchical structure of the type Euro-Sector-Country. From top left to bottom right - Germany, France, Italy and Spain.

estimated commonality and the macro country specific characteristics over time, from top left to bottom right, Germany, France, Italy and Spain. There are unappreciable differences relative to the core exercise, and the decoupling of Spanish fluctuations is still visible. Similarly, Table 6 reports the variance decomposition of national GDP and the tests for synchronization. The variance decomposition of national outputs reveals that while the main contributor of GDP volatility of Germany, France and Italy is the euro area factor, the national factor explains the main bulk of Spanish fluctuations. Similarly, the table suggests that in the past decade, we have observed only a partial synchronization of country-specific cycles, regardless of the specific ordering of the factor hierarchical structure.

	Variance decomposition				Index of synchronization
GDP	Euro area	Macro sector	Country	Idiosyncratic	
Germany	32 [20 , 46]	25 [17 , 34]	17 [14 , 20]	25 [15 , 35]	0.48 [0.3 , 0.7]
France	35 [23 , 49]	27 [18 , 40]	17 [13 , 21]	19 [13 , 29]	0.52 [0.3 , 0.7]
Italy	36 [23 , 49]	28 [18 , 39]	14 [11 , 17]	22 [14 , 31]	0.50 [0.27 , 0.72]
Spain	8 [2 , 15]	6 [2 , 12]	76 [61 , 90]	10 [5 , 16]	0.16 [-0.09 , 0.4]

Table 6: Variance decomposition of GDP and synchronization index.

4.2 Mixed-frequency set-up

The starting date of our sample is the beginning of 1998. While macroeconomic times series are available before 1998, disaggregated data on loan volumes, deposits and bank lending rates are more difficult to gather. As a consequence of that, the sample length along the time dimension is relatively short, i.e. less than 60 observations. We address the issue of short-time dimension length by stretching the sample size using joint monthly and quarterly observations. We adapt the approach in Bańbura and Modugno (2014) designed for maximum likelihood estimation to the Bayesian Gibbs sampler. The idea is to consider as time unit the one of the higher frequency variables and treat low frequency variables with the same time unit as missing observations. The country-specific financial

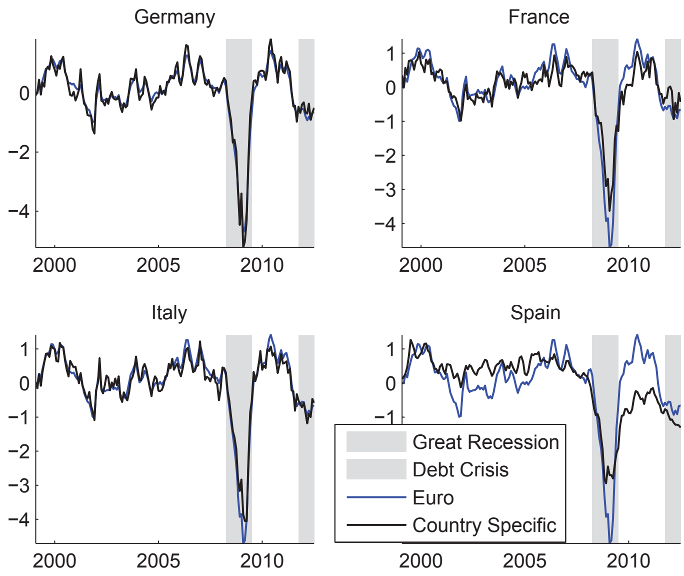
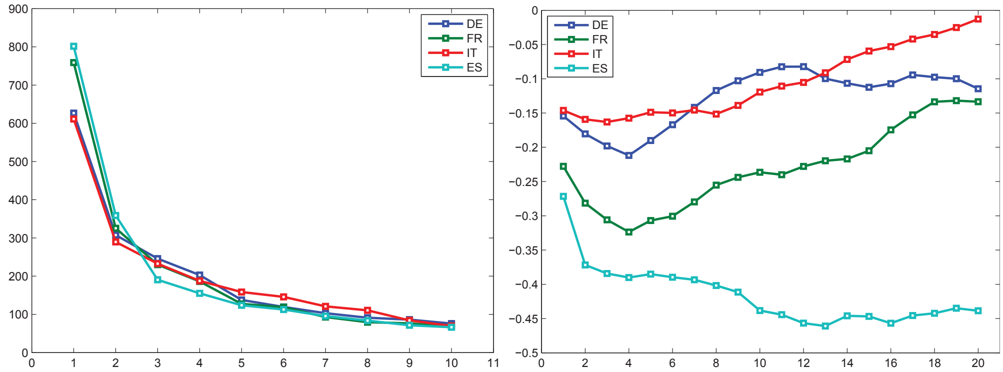


Figure 10: Euro area factor, country-specific factors and euro area gaps using mixed-frequency observations. From top left to bottom right - Germany, France, Italy and Spain.

sector variables are considered at a monthly frequency in QoQ (%) changes. For the macroeconomic block, we treat quarterly variables as monthly variables with missing observations in the first 2 months of the quarter. The latter applies to the variables belonging to national accounts, i.e. GDP components and deflators. Prices and unemployment rates are available instead at monthly frequency. The macroeconomic database contains many missing observations relative to the financial one. In order to reduce the noise generated by the missing digits, we augment the macroeconomic data set with additional monthly variables such as the production index, the construction index, the European Commission Economic Sentiment indicators and the disaggregated surveys at sectorial level, i.e. industry, service, retail, consumption and construction. Results in terms of co-movements



(a) Eigenvalues (b) Bai and Ng (2002)

Figure 11: The left panel displays eigenvalues corresponding to the first 10 latent factors for the different countries. The right panel reports Bai and Ng (2002) criterion for the first 20 factors for each country

and variance decomposition and degree of synchronization are reported in Figure 10 and Table 7, respectively. The results are in line with the core exercise and the only visible difference is that the contribution of the idiosyncratic part to the volatility of GDP is reduced (except for France).

	Variance decomposition				Index of synchronization
GDP	Euro area	Country	Sector	Idiosyncratic	
Germany	75 [67 , 81]	13 [9 , 17]	12 [9 , 16]	0 [0 , 0]	0.70 [0.60 , 0.78]
France	43 [24 , 67]	23 [12 , 54]	18 [9 , 27]	6 [2 , 15]	0.53 [0.20 , 0.77]
Italy	66 [55 , 75]	17 [11 , 22]	17 [11 , 21]	0 [0 , 1]	0.68 [0.53 , 0.79]
Spain	8 [0 , 29]	72 [51 , 85]	19 [13 , 25]	0 [0 , 0]	0.34 [0.21 , 0.43]

Table 7: Variance decomposition of GDP and synchronization index.

4.3 Choosing and interpreting the number of factors

Despite the parsimonious nature of factor models, by splitting the data into blocks and by identifying them as macro and financial sectors, we are implicitly imposing a lot of structure. It is then appropriate and legitimate to ask if such a structure is supported by the data. To this end, we pool macro and financial variables together and extract a number of factors at the country level. In order to decide how many factors are needed to appropriately capture the information in the underlying time series for each country, we use different procedures. The simplest way to identify the appropriate number of factors is to use a scree plot, which shows the ordered eigenvalues against the corresponding order value, and look for a natural break between the large and the small eigenvalues. The left panel of Figure 11 shows the eigenvalues corresponding to the first 10 latent factors for the different countries.

The usual recommendation, based on a visual inspection of this graph, is to retain those eigenvalues in the steep part of the curve before the first one on the straight line. The idea behind this is to assess visually the marginal contribution to the explained variance of the respective factor. Based on this one would retain two factors for Germany, France and Italy, and three factors for Spain. A formal way is to use the information criteria developed by Bai and Ng (2002). The right panel of Figure 11 shows the IC_2 criterion for the first twenty factors for each country. According to this criterion, the data for Germany and France are captured appropriately by four factors, the data for Italy is captured by three factors and the data for Spain is captured by 13 factors.

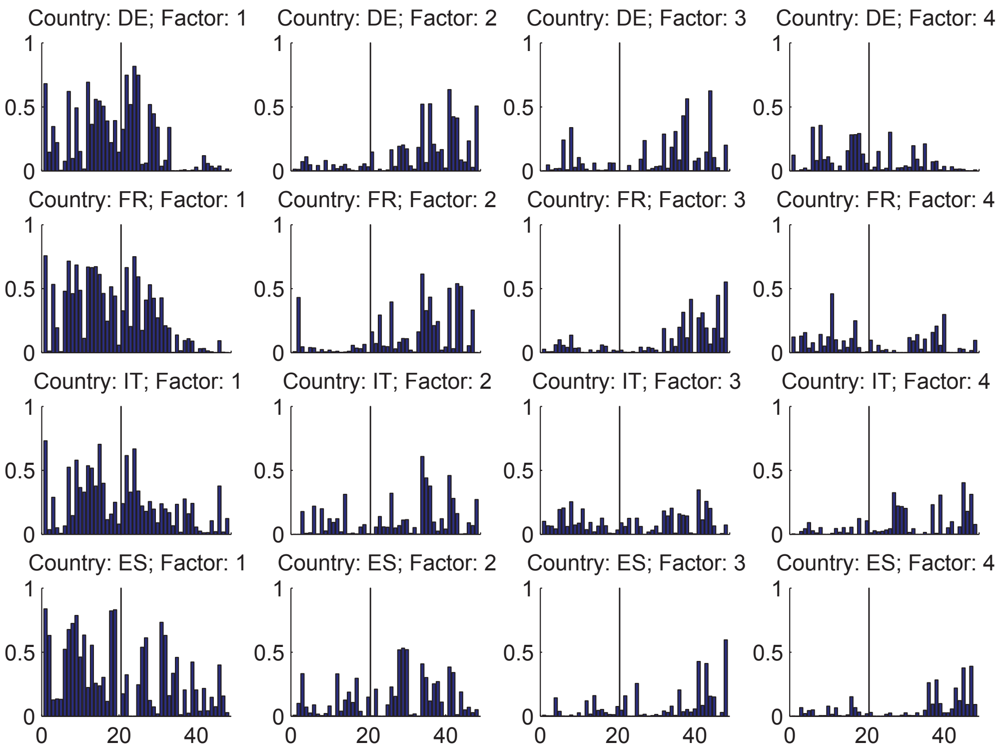


Figure 12: *R-squared* of the regressions of the 48 (46 in the case of Spain) individual time series against each of the first four factors

In order to provide additional information for choosing the number of factors, we follow the procedure suggested by Stock and Watson (2002) to regress the individual variables on each latent factor to understand which of the time series are most closely related to each factor. Even though the factors are identified only up to an $r \times r$ matrix and thus a detailed interpretation of the factors would be inappropriate, it is useful to briefly characterize the factors in the way that they are related to the underlying time series. Figure 12 shows the *R-squared* of the regressions of the 48 (46 in the case of Spain) individual time series against each of the first four factors. The rows in the subplots correspond to the four countries, Germany, France, Italy and Spain, while the columns correspond to the four latent factors. The vertical line in each chart indicates the block of macroeconomic (the first 20 bars) and financial time series (the remaining bars). Broadly speaking, it becomes obvious that the first factor loads primarily on macroeconomic series, while the second factor loads on financial series. Being a bit more specific, the first factor also loads on financial market series (such as overall stock market or bank returns), while the second factor loads mainly on series capturing information on bank balance sheets. Trying to interpret the factors beyond the second one in a meaningful way appears a bit more difficult, which is why we decide to focus on two factors in our analysis. That means we decide to let the data of all four countries be driven by two factors, which account for between 36% of the variance in the case of Italy and 48% in the case of Spain. This also enhances the comparability of the results and basically confirms that splitting the data into one block of real and one block of financial variables, as done in section 2, appears reasonable.

5 Conclusion

The recent recession episodes experienced by the euro area altered business cycle properties of member countries. While the business cycles of the four largest euro area economies were similar in the decade preceding the global financial turmoil, we gather compelling evidence of an asymmetric behaviour of Spanish economic fluctuations relative to euro area cycles in the aftermath. We measure alikeness of business cycles by studying the synchronization of up and down phases, the convergence properties of country factors towards the euro area and the contribution of the euro area factor to explain the national GDP volatilities. The analysis is based on the factors estimated from a rich multi-country and multi-sector data environment. We believe that the latter approach delivers a more reliable set of statistics than tackling the same problem with an arbitrary selection of variables.

One of the findings that stands out from the visual inspection of the national economic business cycle indicator is that the Spanish economy was overheated before the financial distress and over-depressed in the aftermath. Moreover, the credit growth profile in Spain appears to have loaded significantly on the financial factor and hence contributed to shape the estimated path of the national factor over the full sample. Moreover, our empirical evidence suggests that the financial crisis of 2008-2009 is timely coincident with the undoing of the Spanish economic integration process. In particular, we locate a break in the synchronization and convergence process for Spain during the recovery path in between the two recessions.

Moreover, in accordance with the behaviour of the estimated factors, the main driver of domestic fluctuations (for France, Germany and Italy) is the common euro area factor which explains half of the domestic GDP volatility. This suggests that there is an important degree of interdependence among Germany, France and Italy, and if one country falls into a recession, the chance that such a recession is driven by the euro area factor is almost 50%. Hence, it is likely to affect the neighbouring countries. The fluctuations of Spanish GDP are only partly explained by a common factor and the vast majority of cyclical fluctuations are generated by national characteristics. Finally, the magnitudes of cross-border spillovers depend on the degree of comovements. Being decoupled, Spanish macroeconomic cycles cannot generate sizable amplifications to the other three euro area economies considered.

Our empirical evidence implies that one of the requirements of an optimal currency area is violated, namely that member countries have similar business cycles. The alikeness of business cycles allows the common central bank to promote growth in downturns and to contain inflation in booms, otherwise an optimal monetary policy is more difficult to implement. Hence, cyclical policy rules based on euro area aggregates might not be sufficient statistics in turbulent times and disaggregated information at country level is advisable.

Our findings also suggest that structural breaks can materialize and country-specific components cannot be ignored even if there is evidence of convergence in the observed sample. A fully fledged factor model allowing for time variation (as in Del Negro and Otrok (2008) or Mumtaz and Surico (2012)) or regime switching in the loading matrix could potentially account for structural changes and provide the probability of being in a coupling or decoupling regime.

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A Data Construction

Description	Category	Transformation
Return of broad stock market index	Market data	QoQ return
Equally weighted stock return of banks	Market data	QoQ return
Yield of 3, 5 and 10 year government bonds	Market data	QoQ change
MFIs total loans	MFI balance sheet data	real % QoQ
MFIs loans to households and firms	MFI balance sheet data	real % QoQ
MFIs loans to financial corporations	MFI balance sheet data	real % QoQ
MFIs total bond holdings	MFI balance sheet data	real % QoQ
MFIs financial corporation bond holdings	MFI balance sheet data	real % QoQ
MFIs government bond holdings	MFI balance sheet data	real % QoQ
MFIs corporate stock holdings	MFI balance sheet data	real % QoQ
MFIs total deposits	MFI balance sheet data	real % QoQ
MFIs deposits to households and firms	MFI balance sheet data	real % QoQ
MFIs deposits to financial corporations	MFI balance sheet data	real % QoQ
MFIs total debt securities issued	MFI balance sheet data	real % QoQ
MFIs total equity	MFI balance sheet data	real % QoQ
Ratio of stocks to government bonds	MFI balance sheet data	QoQ changes
Ratio of equity to total assets	MFI balance sheet data	QoQ changes
Ratio of loans to deposits	MFI balance sheet data	QoQ changes
Ratio of money market liabilities + total debt to total liabilities	MFI balance sheet data	QoQ changes
Outstanding amount of the main refinancing operation	Liquidity operations data	QoQ changes
Outstanding amount of the longer-term refinancing operation	Liquidity operations data	QoQ changes
Bank Leding Rate, NFC	Interest Rates	QoQ changes
Bank Leding Rate, Household	Interest Rates	QoQ changes
Time Deposit Rates, New Business coverage, NFC	Interest Rates	QoQ changes
Time Deposit Rate, New Business coverage, HH	Interest Rates	QoQ changes
Housing Investment, Real	Housing Data	real % QoQ
Housing Investment, Deflator	Housing Data	real % QoQ

Table 8: Financial data

Description	Category	Transformation
HICP, CORE	Real Activity	% change QoQ
HICP, Total	Real Activity	% change QoQ
Private-sector non-residential Investment, Deflator	Real Activity	% change QoQ
Private-sector non-residential Investment, Real	Real Activity	% change QoQ
Investment, Deflator	Real Activity	% change QoQ
Investment, Real	Real Activity	% change QoQ
Personal Consumer Expenditure, Deflator	Real Activity	% change QoQ
Personal Consumer Expenditure, Real	Real Activity	% change QoQ
GDP BY EXPENDITURE/INCOME, Deflator	Real Activity	% change QoQ
GDP BY EXPENDITURE/INCOME, Real	Real Activity	% change QoQ
Imports of Goods and Services, Deflator	Real Activity	% change QoQ
Imports of Goods and Services, Real	Real Activity	% change QoQ
Export of Goods and Services, Deflator	Real Activity	% change QoQ
Export of Goods and Services, Real	Real Activity	% change QoQ
Productivity per Head, whole economy	Real Activity	% change QoQ
Effective Exchange rate	Real Activity	% change QoQ
Unit labor Cost	Labor Market	% change QoQ
Total Employees	Labor Market	% change QoQ
Unemployment Rate	Labor Market	change QoQ

Table 9: Real activity data

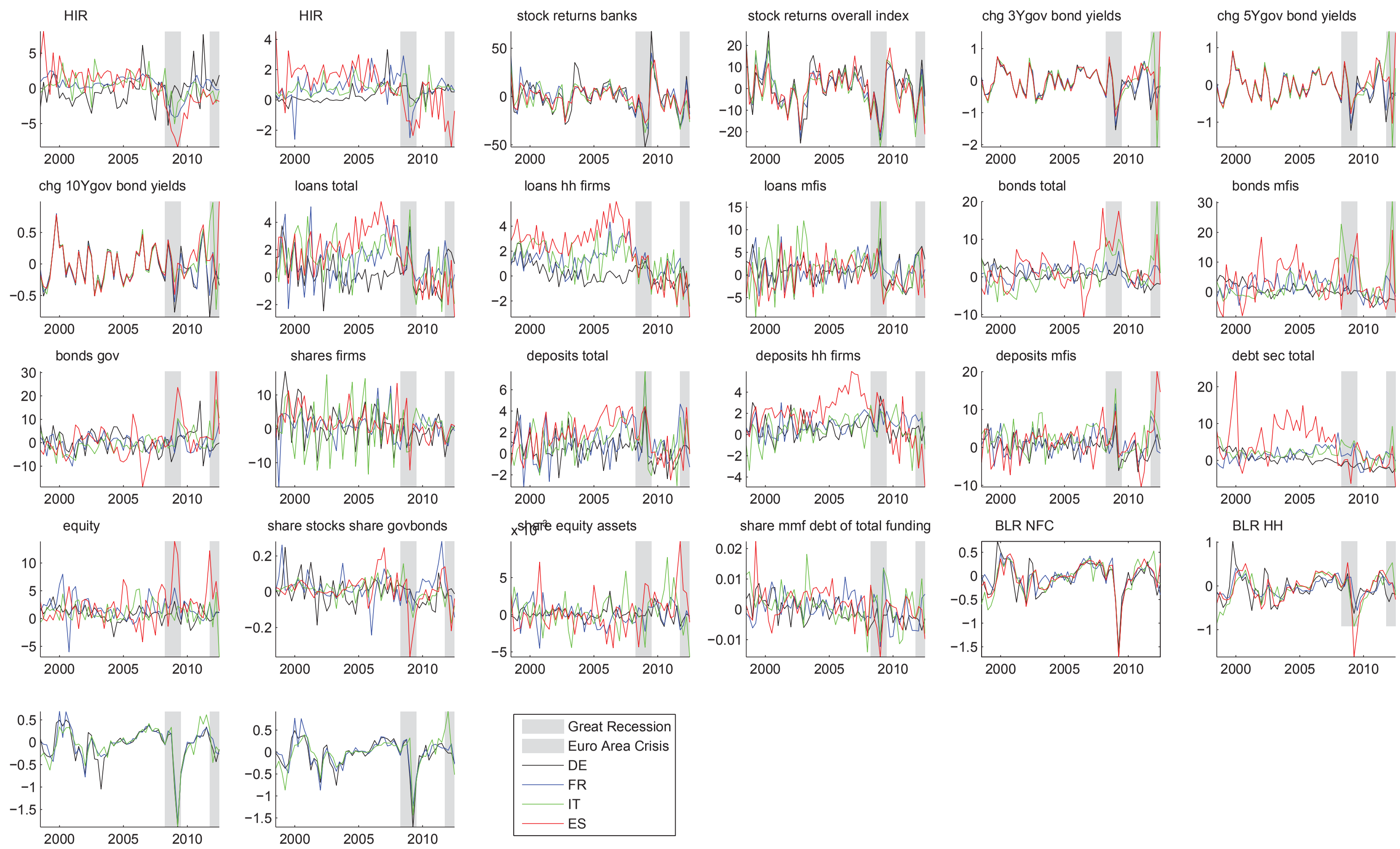

Figure 13: Financial activity data

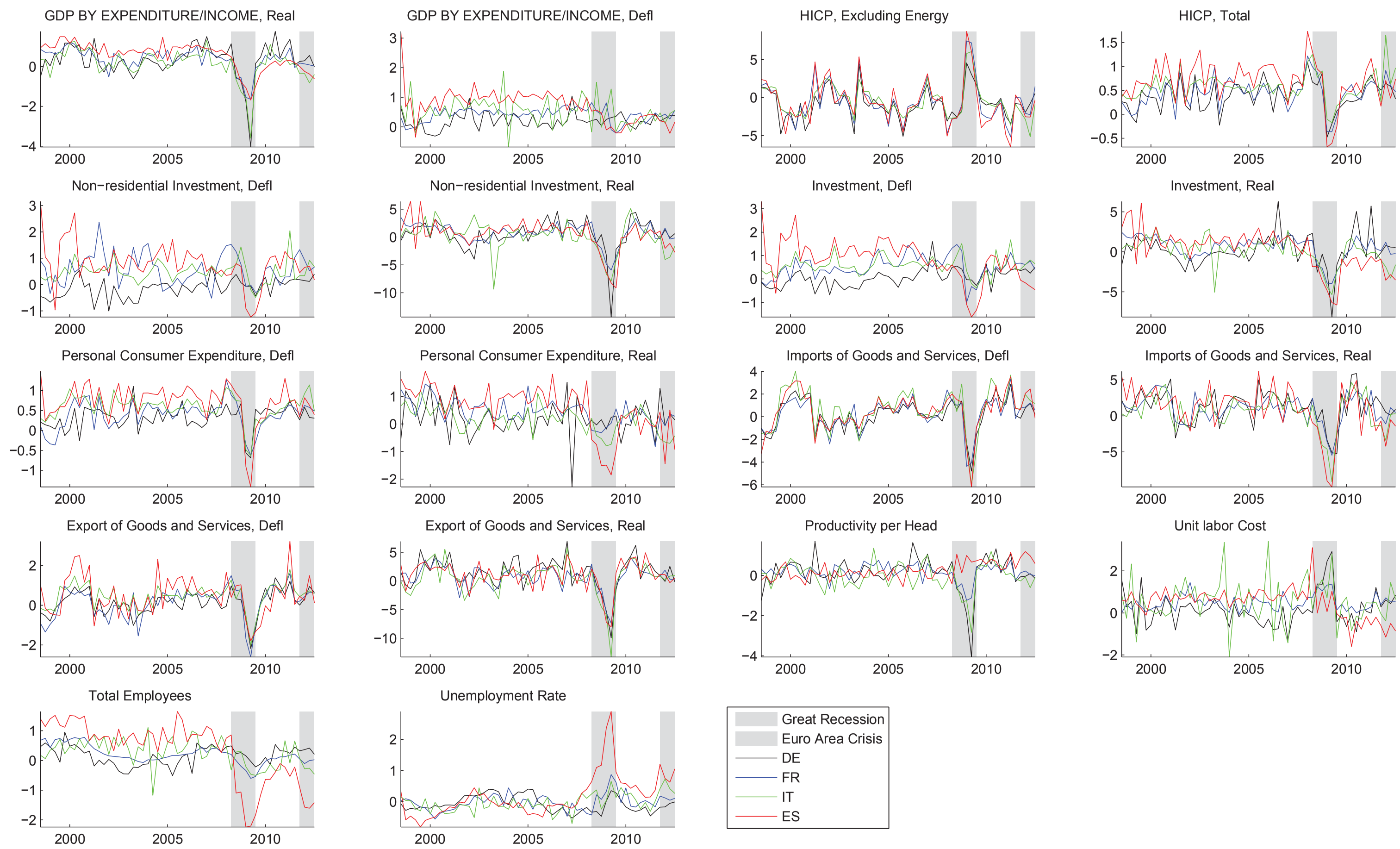

Figure 14: Real activity data

Real Variables	Euro area	Country	Sector	Idiosyncratic
		Germany		
GDP BY EXPENDITURE/INCOME, Real	45 [34 , 54]	19 [15 , 23]	18 [14 , 22]	18 [6 , 32]
Non-residential Investment, Real	33 [23 , 43]	14 [9 , 19]	13 [10 , 17]	39 [26 , 56]
Investment, Real	29 [17 , 36]	12 [8 , 16]	12 [8 , 13]	48 [37 , 66]
Personal Consumer Expenditure, Real	1 [0 , 2]	0 [0 , 1]	0 [0 , 1]	99 [95 , 100]
Imports of Goods and Services, Real	17 [9 , 25]	7 [4 , 12]	7 [3 , 10]	68 [50 , 84]
Export of Goods and Services, Real	31 [20 , 40]	13 [10 , 17]	13 [9 , 16]	43 [32 , 57]
Productivity per Head	40 [27 , 47]	17 [13 , 20]	15 [12 , 20]	27 [15 , 45]
Unit labor Cost	26 [14 , 36]	11 [7 , 15]	11 [6 , 13]	52 [37 , 70]
		France		
GDP BY EXPENDITURE/INCOME, Real	59 [48 , 71]	13 [11 , 17]	13 [10 , 17]	14 [6 , 23]
Non-residential Investment, Real	44 [32 , 56]	10 [7 , 13]	10 [7 , 13]	34 [24 , 52]
Investment, Real	35 [24 , 49]	8 [6 , 11]	8 [6 , 11]	49 [32 , 63]
Personal Consumer Expenditure, Real	14 [3 , 26]	3 [1 , 6]	3 [1 , 6]	81 [61 , 95]
Imports of Goods and Services, Real	47 [36 , 58]	11 [8 , 14]	11 [7 , 14]	31 [21 , 43]
Export of Goods and Services, Real	50 [39 , 60]	11 [8 , 14]	11 [8 , 14]	28 [18 , 38]
Productivity per Head	50 [41 , 63]	12 [9 , 15]	12 [8 , 14]	26 [19 , 33]
Unit labor Cost	32 [19 , 44]	7 [4 , 11]	7 [4 , 10]	52 [39 , 71]
		Italy		
GDP BY EXPENDITURE/INCOME, Real	61 [51 , 70]	11 [8 , 14]	11 [8 , 13]	16 [10 , 25]
Non-residential Investment, Real	32 [19 , 45]	6 [4 , 9]	6 [4 , 8]	57 [39 , 72]
Investment, Real	34 [23 , 48]	6 [4 , 10]	6 [4 , 9]	53 [37 , 68]
Personal Consumer Expenditure, Real	20 [6 , 33]	4 [1 , 6]	4 [1 , 5]	72 [57 , 90]
Imports of Goods and Services, Real	44 [34 , 56]	8 [6 , 10]	8 [6 , 10]	39 [27 , 51]
Export of Goods and Services, Real	58 [49 , 68]	11 [8 , 14]	11 [8 , 13]	20 [13 , 29]
Productivity per Head	44 [32 , 55]	8 [6 , 10]	8 [6 , 10]	39 [27 , 54]
Unit labor Cost	8 [3 , 16]	2 [0 , 3]	2 [0 , 3]	88 [79 , 95]
		Spain		
GDP BY EXPENDITURE/INCOME, Real	17 [5 , 30]	62 [42 , 79]	12 [7 , 17]	9 [4 , 14]
Non-residential Investment, Real	12 [3 , 22]	45 [29 , 66]	9 [5 , 12]	33 [20 , 45]
Investment, Real	13 [4 , 26]	51 [32 , 73]	10 [6 , 14]	25 [14 , 40]
Personal Consumer Expenditure, Real	13 [4 , 25]	49 [29 , 69]	9 [6 , 13]	28 [15 , 37]
Imports of Goods and Services, Real	10 [3 , 19]	39 [22 , 58]	8 [5 , 11]	41 [27 , 54]
Export of Goods and Services, Real	5 [1 , 10]	17 [5 , 41]	3 [1 , 6]	72 [47 , 89]
Productivity per Head	5 [1 , 12]	19 [9 , 41]	4 [2 , 6]	70 [48 , 86]
Unit labor Cost	2 [0 , 5]	7 [1 , 21]	1 [0 , 3]	89 [69 , 99]

Table 10: Variance decomposition of GDP and components. The median values are reported and 90% credible sets are in parenthesis.

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