DOCUMENT

DE TRAVAIL

N° 522

EURO AREA BUSINESS IN TURBULENT TIMES:

CONVERGENCE OR DECOUPLING?

Filippo Ferroni and Benjamin Klaus

November 2014

BANQUE DE FRANCE

EUROSYSTÈME

DIRECTION GÉNÉRALE DES ÉTUDES ET DES RELATIONS INTERNATIONALES

EURO AREA BUSINESS IN TURBULENT TIMES:

CONVERGENCE OR DECOUPLING?

Filippo Ferroni and Benjamin Klaus

November 2014

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

Filippo Ferroni

Banque de France and University of Surrey

Benjamin Klaus[*]

European Central Bank

Abstract

Nous étudions les propriétés des cycles économiques des quatre plus grandes économies européennes après les récents épisodes de récession. L'analyse est basée sur un modèle à facteurs estimés partir d'une riche base de données multi-pays et multi-secteur. Nous mesurons la similarité des cycles économiques en regardant la synchronisation des phases du cycle, la vitesse de convergence des fluctuations dún pays vers les cycles de la zone euro et la contribution du facteur de la zone euro à expliquer volatilités des produits bruits nationales. Alors que les fluctuations économiques des quatre états membres de la zone euro étaient similaires avant la crise financière, nous recueillons des preuves convaincantes d'un comportement asymétrique de fluctuations espagnoles par rapport à celui de la zone euro.

Mots-clés : Modèle à facteurs hiérarchique, Cycles économiques internationaux ; Synchronisation et Convergence

Code JEL : C51, E32, O52.

Abstract

We study the business cycles properties of the four largest European 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 GDPs volatilities. While the economic fluctuations of the four Euro Area members states were similar before the global financial turmoil, we gather compelling evidence of an asymmetric behavior of Spanish fluctuations relative to the Euro Area one.

Keywords: Hierarchical factor models; International business cycles; Synchronization and Convergence.

JEL Classification: C51, E32, O52

1 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 non-core European 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 comoving ? 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 of 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 European 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 comove strongly, to be well synchronized and to have converged to a common European 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 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 European countries, our subsample analysis locates the economic decoupling of Spain one 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 European 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.

2 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 non-core European 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 comoving ? 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 of 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 by using -say- GDP instead of unemployment rate or labor productivity[1]. Moreover, concentrating the analysis on macro variables is restrictive, given the predominant role that the financial sector had in the recent business cycles episodes. As an example, between 2000 and 2007 total credit growth in Spain was more than seven times higher than in Germany; it doubled during 2003 and 2006 for the former while it didn't change substantially for the latter[2]. Ignoring this feature might results 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 work of Moench, Ng and Potter (2013) or of Kose, Otrok and Prasad (2012)[3], so that we both avoid the curse of parameter dimensionality due to the rich data

---

[1]See section 3.1 for an empirical justification.

[2]These numbers are based on total credit (including bank credit and debt issuances) collected from the BIS, see http://www.bis.org/statistics/credtopriv/credtopriv.xlsx. 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

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 times 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 European economies. First, data support the idea of a substantial economic integration among France, Germany and (perhaps surplisingly) Italy. The estimated national and sector specific characteristics appear to comove strongly, to be well synchronized and to have converged to a common European 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 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 European countries, our subsample analysis locates the economic decoupling of Spain one 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 European 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 cross countries and cross 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 comove (i.e. France, Italy and Germany) can generate important fluctuations in neighboring 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 cycles dynamics and the cross country interdependencies. On a pure empirical grounds there are at least three popular methodological approaches that can can be used to tackle these topics, Global VAR (Pesaran, Schuermann and Weiner (2004)), panel VAR (Canova and Ciccarelli (2009) or Canova and Ciccarelli (2013) for a review) and factor models (Otrok, AER or Kose et al. (2012)). The first methods is fruitfully used

---

of economic data of one particular country, the United States. Kose et al. (2012) study the global interdependencies 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 structure using Euro Area data.

to capture the international transmission mechanisms of domestic and foreign structural identified shocks. However, prior restrictions are required to set the weights to construct foreign variables so 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 modeled 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 function of a small number of latent states, i.e. the ACBD solution of 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 GDPs volatilities and study if the globalization process favored a convergence process across the economies by comparing the variation of the contribution of 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 to 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 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. Viceversa, if the factor loading is close to zero, gap displays a longer memory process, implying that a longer time span is needed for the national economy to revert back to 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 factor are on the same phase. Finally, the contribution of the factors to the observables variance is a function of both the estimated factors and the loadings and hence to some extent a combination of these two concepts. In all, we provide three different statistics, which should provide a coherent picture of business cycles 'similarity'.

We conduct a series of robustness exercises. First, we flipped the ordering of the blocks. Instead

---

[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.

of considering a vertical structure of the type Euro-Country-Sector, we studies 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 times 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 sector we are implicity imposing some sort of 'structure'. It is then legitimate to ask if such structure is supported by the data. To this end we pool macro and financial variables together, extract a number of factors at the country level and try to provide interpretations. This analysis confirms that at country level the first two factors loads macro and financial variables respectively.

The paper is organized as follows. Section 3 presents the econometric setup and the quantities used to measure synchronization and convergence. Section 4 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 5 presents complementary exercises to investigate the robustness of our results. Section 6 draws a number of concluding remarks.

3   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 matrix loading the factors. We assume that at each layer of commonality errors evolve

---

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

as a autoregressive process so that

$$e_{csjt}^Z = \phi_{csj}^Z(L)e_{csjt-1}^Z + \eta_{csjt}^Z$$
$$e_{cst}^H = \phi_{cs}^H(L)e_{cst-1}^H + \eta_{cst}^H \tag{2}$$
$$e_{ct}^G = \phi_c^G(L)e_{ct-1}^G + \eta_{ct}^G$$
$$F_t = \phi^F(L)F_{t-1} + \eta_t^F$$

where η_t^X 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 setup. 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 $s = 1, \dots, N_{Hc}$ and $c = 1, \dots, N_c$

2. Conditional on Λ, Ψ Σ, $\{F_t\}$ and H_{cst}, draw $\{G_{ct}\}$ for $c = 1, \dots, N_c$

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 economic relevant questions. First, we express the system in terms of endogenous variables as function of the exogenous ones, i.e.

$$Z_{csjt} = \lambda_{csj}\mu_{cs}\nu_c F_t + \lambda_{csj}\mu_{cs}\, e_{ct}^G + \lambda_{csj}e_{cst}^H + e_{csjt}^Z$$
$$H_{cst} = \mu_{cs}\nu_c F_t + \mu_{cs}e_{ct}^G + e_{cst}^H \tag{3}$$
$$G_{ct} = \nu_c F_t + e_{ct}^G$$

Any observed times series Z_{csjt} - say GDP in France - can be decomposed into four exogenous components, a common cross country factor F_t, a national specific component G_{st}, a national-sector specific element H_{cst} and a pure idiosyncratic series-specific characteristic e_{csjt}^Z . Moreover, at the higher level of hierarchy the country-sector specific factor is generated by exogenous national-sector specific element, an exogenous national 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 times series. Moreover, we can study the impact of a variation in the factors to the observed country specific variables and measure spillover effects.

With this framework we can also verify if country factors tend to converge to the European factor. We define convergence as the situation where at some point in the future the gap between country and euro factors 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

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

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). Spelled 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 european 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 sample giving insights about country convergence properties. As an example, consider two extreme cases of large correlation, $\nu_c = 1$, and of low correlation between country and 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 provides 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 marginal likelihood of the restricted and an unrestricted empirical model that breaks the relationship as described above. However, the latter approach would be computationally cumbersome and requires a parametrization of the non-convergence 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 (2001) 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 values 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 non-synchronized (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 a-synchronization 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).

3.1   Why a data rich environment ?

Factor model setups 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 other), for deriving the driving forces behind economic fluctuations (Kose, Otrok and Whiteman (2003), Del Negro and Otrok (2008)), or to amend the non-fundamentalness of structural VAR shocks (see Forni and Gambetti (2011)).

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

---

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

and convergence are typically sensitive to variables selections and we prefer not to have a stand on that. As an example, we consider the extreme case of two different datasets that contains only a single country-specific times series, i.e. one set containing national GDPs, $\mathcal{I}_y$, and one labor 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 comovements, synchronization and convergence. In this setup, 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 times series, the country GDP in $\mathcal{I}_y$ and country labor productivity rate in $\mathcal{I}_p$. The original country specific variables and the factors estimated with

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.

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 dataset 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 gap for France and Spain behave differently if we consider GDP or productivity as observable.

In all, we believe that focusing the analysis on single variables might produce contradictory findings and we think that a more robust analysis can be carried by looking at a richer data structure.
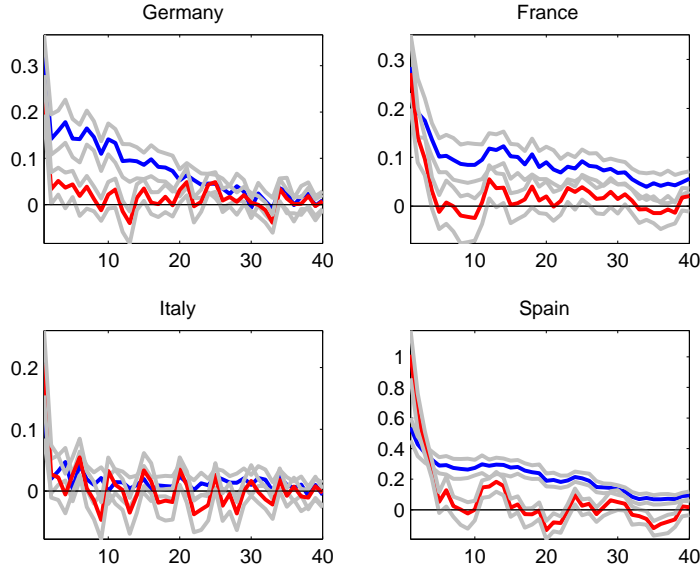
Figure 1: ACF of the convergence gaps using different information sets. From top left to bottom right Germany, France, Italy and Spain. In blue the ACF using GDPs and in red the ACF using productivity, in gray credible sets.

4 Data structure and Estimation Results

We study the time period that covers the past fourteen years of the euro experience of the four largest European economies, i.e. Germany, France, Italy and Spain from 1998:Q2 to 2012:Q2 at quarterly frequency[7]. The choice of the time span is partly due to data availability and partly 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 activity.

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 intend 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 participants' expectations on the profitability of banks and non-financial corporations and the sovereign risk pre-

---

[7]We estimated also a version where we can consider mixed frequency, quarterly data for macroeconomic series and monthly for financial series. See section 5 for a discussion.

mium 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.[8] We consider quarter on quarter variations, rate of changes for most of the variables and quarter on quarter changes of unemployment rate, 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 times 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[9]. We further assume one country specific factor and one European 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 are of order one.

4.1 Comovements, synchronization and convergence

Do European economies comove? Are economic fluctuations synchronized ? Is it reasonable to believe in the presence of a 'European factor' toward 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, Italy tend to comove, Spanish business cycles are decoupled from the other European countries. Relative to the common factor, the Spanish economy seems to be over-heated 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 European countries and still we do observe a 'convergence gap' to a common European business cycles 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 then and it is still significantly below the European aggregate.

---

[8]The definition of MFIs can be found in ? and a list of all MFIs is available on the ECB website.
[9]See the robustness section for a justification on the number of country specific factors.
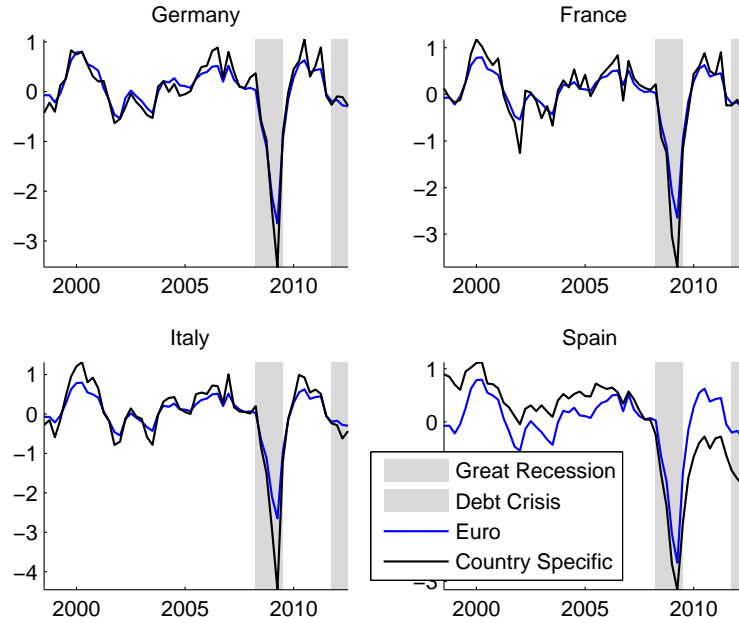
Figure 2: EA factor and country specific factors. From top left to bottom right Germany, France, Italy and Spain.

Conclusions drawn from a visual inspection of 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 down-scaled 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) 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 European ones. A more formal battery of tests for synchronization is presented in the next table 2 which reports the index of synchronization and the p-values of the test of strong perfect positive synchronization (SPPS) and strong non synchronization (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 strong perfect positive synchronization at 5% confidence level, the evidence in favor 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 non-synchronization for Italy, France and Germany. In the case of Spain, the evidence in inconclusive and there are estimate of the Spanish factors that are

14

Country	Index of Synchro	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 Strong Positive Perfect Synchronization and for Strong Non Synchronization of each country relative to the Euro Area factor. The 90% credible sets are reported in square brackets.

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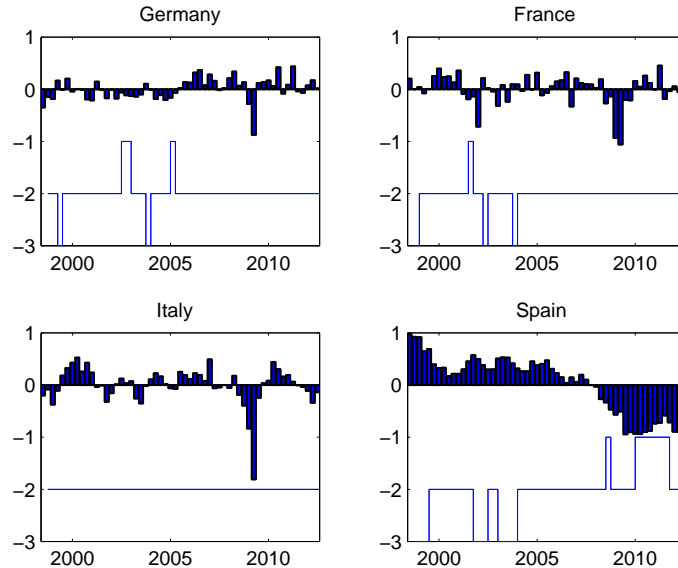

Figure 3: EA cycles gaps (vertical bars) and EA synchronization gap (lines). The EA synchronization gap is measured as the difference between the cyclical binary indicator of the country factor and the corresponding indicator of the Euro area factor down-scaled by 2. The EA cycles gaps is the difference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

If we focus on the estimated EA 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 EA 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. As argued in the previous section, the ACF
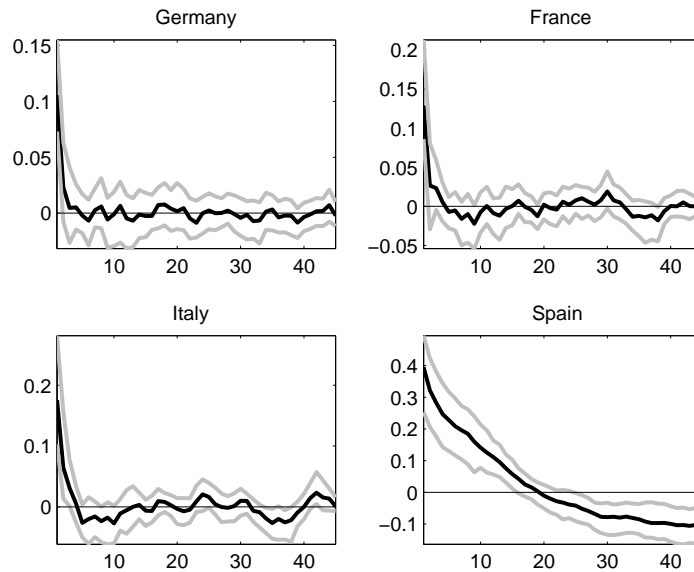

Figure 4: ACF of EA gaps, measured as the difference between country factor and Euro Area factor. From top left to bottom right Germany, France, Italy and Spain.

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.

4.2 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 provide similar results and is reported 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 European 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 between Germany, France and Italy, and one should expect strong co-movements amongst them; i.e.

Real GDP	Euro	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 in parenthesis.

if one country falls into a recession, there is a half percent chance that such recession is driven by the European factor and that it might have negative spillovers to neighboring 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 European factor has a limited impact (17%) in shaping Spanish real economic fluctuations. Moreover, the 'non-european' factors explain more than 80% of the volatility of Spanish GDP, suggesting that Spain appears to be decoupled relative to the core European countries.

Financial Variables	Euro	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 Decomposing 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 non-financial corporations (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.

4.3 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 European macroeconomic fluctuations?

Figure 6 displays the dynamic response over time of national GDPs to a negative impulse in the real activity of a neighboring country; from top to bottom row, 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. Results are twofold. On the one hand, we obtain that countries which comove (i.e. France, Italy and Germany) can generate important fluctuations in neighboring economies and typically the response is one fifth than the drop in output in the original country. On the other hand, Spanish fluctuations which only marginally co-moves with EA ones do not react to changes in the economic conditions of EA countries nor have sizable impact on neighboring economies. A deterioration of in 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 than 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 european country considered is able to generate statistically significant variations in the Spanish GDP.

A similar picture arises when investigating the financial sector. We study a deterioration in the financial sector that generates one 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 one 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 then 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, fluctuations in the financial factor originating in Spain cannot generate significant amplification to other European countries.

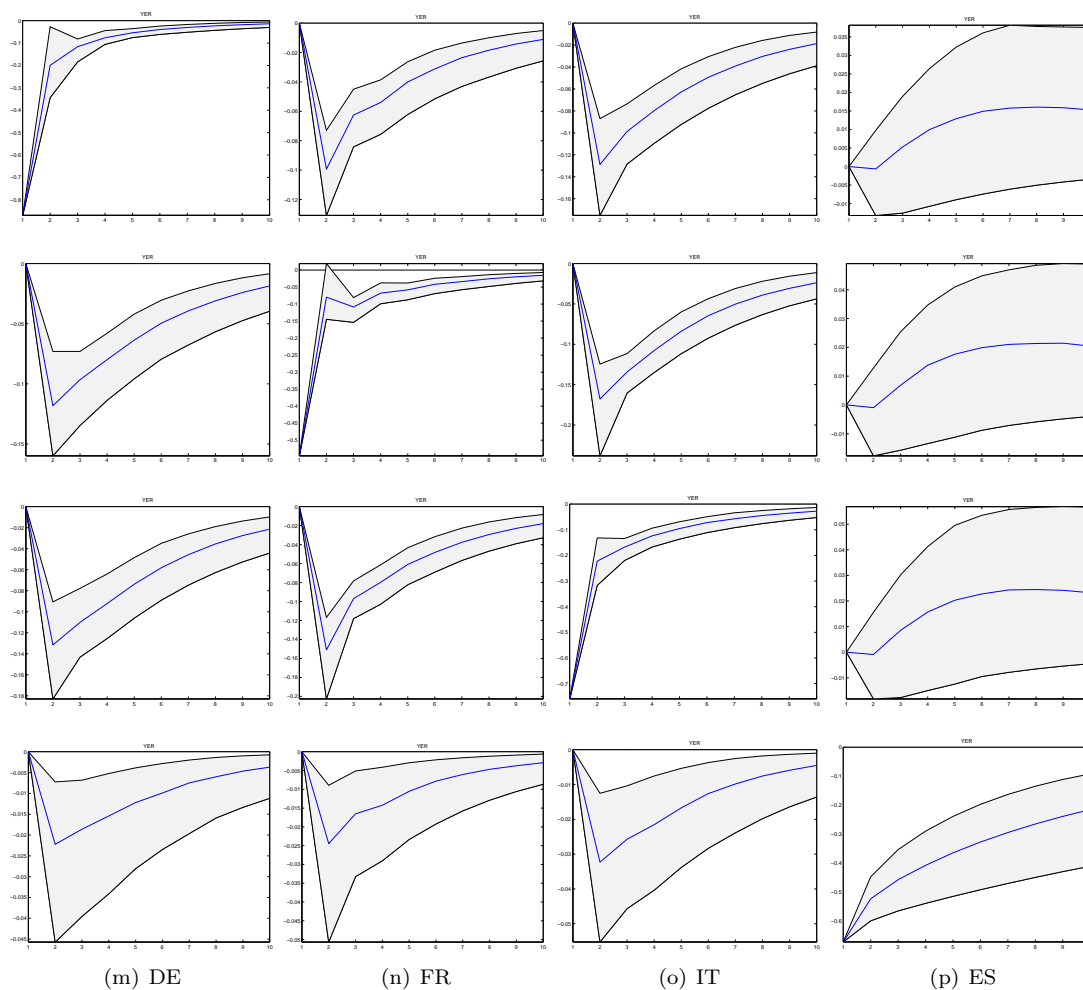(m) DE   (n) FR   (o) IT   (p) ES

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. Dotted lines 90% Bayesian credible sets.

4.4 When does the decoupling of Spain occur ?

A natural question that might arise is to which extent the Great Recession and the European sovereign debt crisis mattered for comovements, 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 CEPR dating. The Euro Area Business Cycle Dating Committee locates the onset of Great Recession in Europe on the second quarter of 2008 and identifies the European sovereign debt crisis on the third quarter of 2011. The committee judges that 2011q3 'marks the end of the

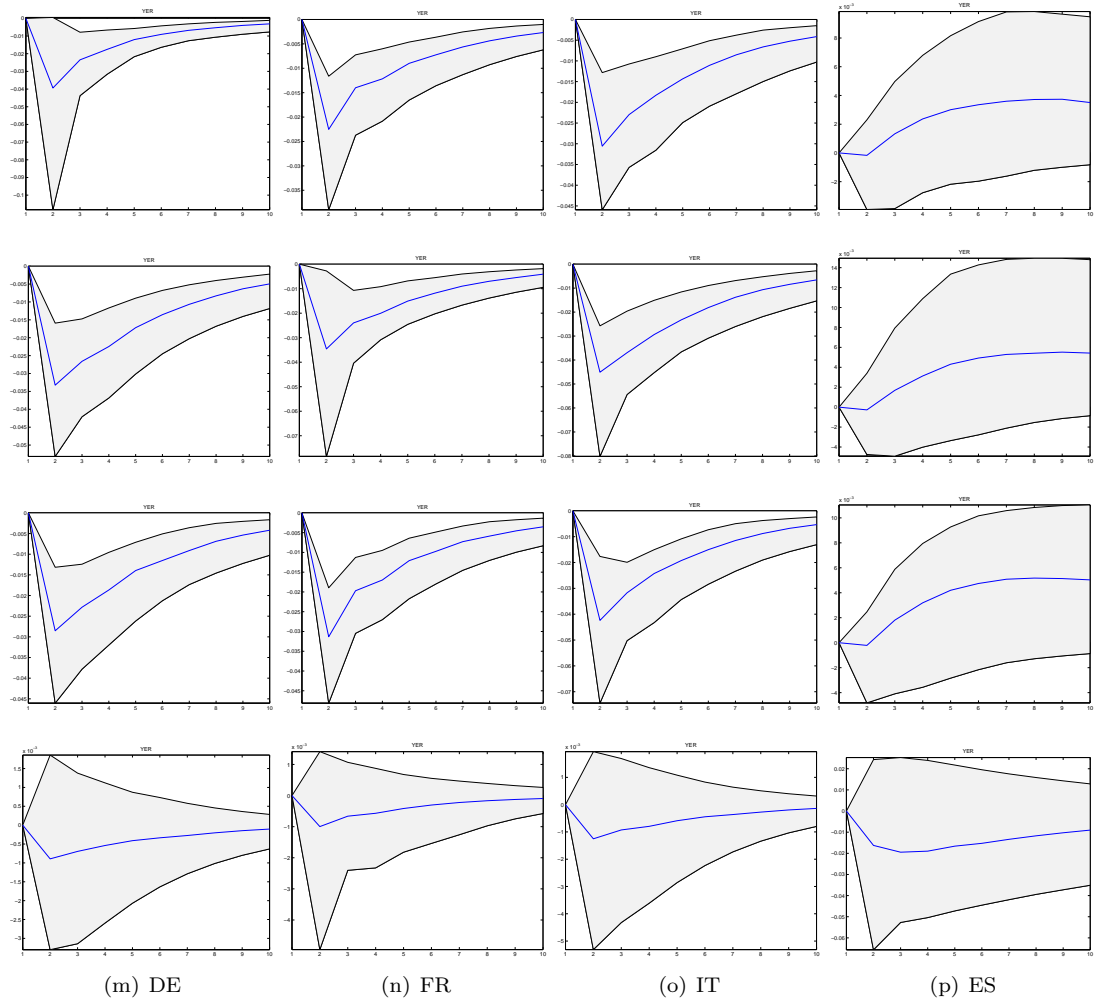(m) DE   (n) FR   (o) IT   (p) ES

Figure 6: 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. Dotted lines 90% Bayesian credible sets.

expansion that began in the second quarter of 2009 and the beginning of a euro-area recession'[10]. We estimate the factor model first using data up to 2008q2 and then up to 2011q3, compute the quantities of interest to measure comovements, 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 comoving. 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 between 2008q2 and 2009q3 represents a structural break witnessing the decoupling of the Spanish economy from the rest of the Euro Area

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

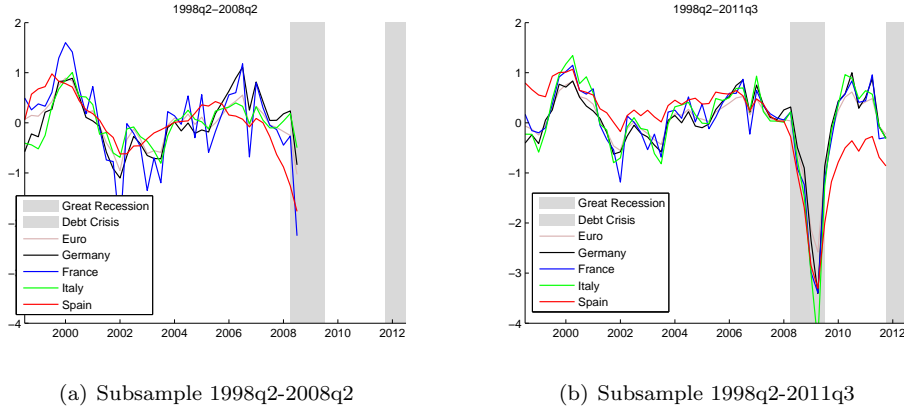(a) Subsample 1998q2-2008q2   (b) Subsample 1998q2-2011q3

Figure 7: Estimated Euro Area and country factors using different subsamples.

countries. Contrary to the common wisdom that the European Sovereign debt crisis triggered a growing gap between core and non-core countries we find evidence that locates the structural break on year before that. These informal considerations are supported by the figures on the degree of

Country	Index of Synchro	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.

synchronization and patterns of convergence. In the first subsample the Spanish fluctuations are very much aligned with European ups and downs; the index of synchronization is of the same order of magnitude as the other country considered. If we include the recovery period, then the index of synchronization drop by half an becomes statistically different from the other counties. We derive similar conclusions in terms of convergence 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 european Sovereign debt crisis the statistical properties

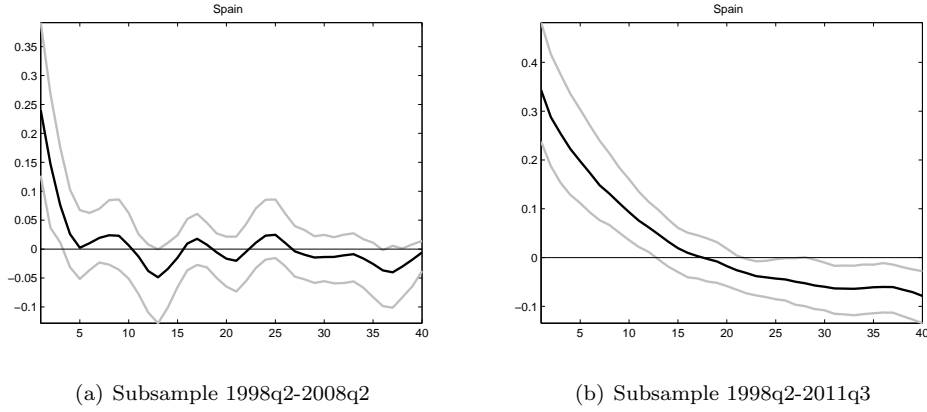(a) Subsample 1998q2-2008q2   (b) Subsample 1998q2-2011q3

Figure 8: ACF of the Spanish gap using different subsamples.

of the Spanish gap have changed from an idiosyncratic behavior to a very persistent pattern. Hence, deviations form the Euro Area cycles are not temporary and time is required for the economy to revert back to the Euro Area factor.

All in all, 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.

5   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 studies the implication of the structure Euro-Sector-Country. Second, we extended our analysis by stretching time dimensions using a mixed frequency database which consider 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 factor and their interpretation. This analysis confirms that at country level the first two factors loads macro and financial variables respectively.

5.1   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 studies 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 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
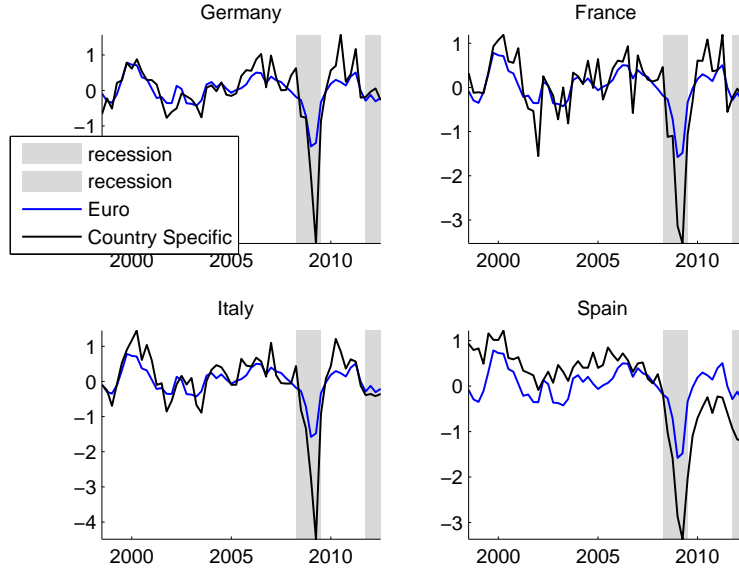
22

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

reports the variance decomposition of national GDP and the tests for synchronization. The variance decomposition of national outputs reveals that while the main contributors of GDP volatility of Germany, France and Italy is the European 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.

GDP	Variance Decomposition				Index of Synchronization
	Euro	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.

5.2 Mixed frequency setup

The starting data of our sample is the beginning of 1998. While macroeconomic times series are available before 1998, disaggregated data on loans 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 then 60 observation. We address the issue of short time dimension length by

stretching the sample size using jointly monthly and quarterly observations. We adapt the approach in Bańbura and Modugno (2012) 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 with missing observations. The country specific financial
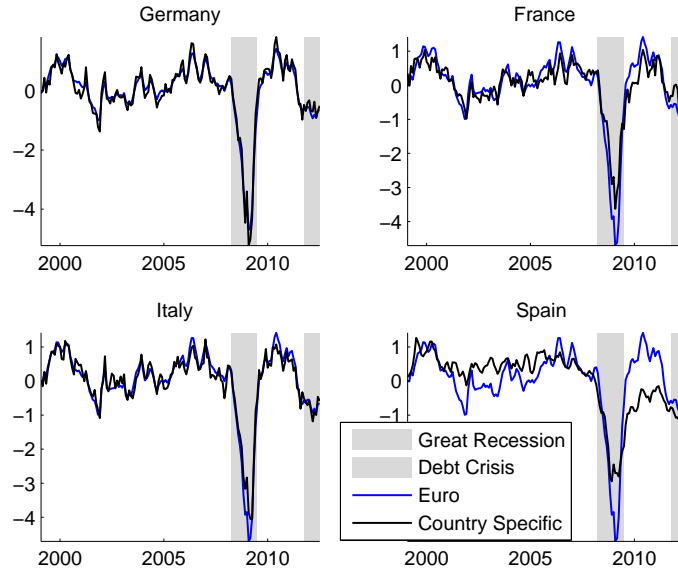

Figure 10: EA factor and country specific factors and EA gaps using mixed frequency observations. From top left to bottom right Germany, France, Italy and Spain.

sector variables are considered at monthly frequency in QoQ (%) changes. For the macroeconomic block we treat quarterly variables as monthly variables with missing observations in the first two 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 dataset 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 comovements and variance decomposition and degree of synchronization are reported in Figure 10 and table 7, respectively. The result 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).

GDP	Variance Decomposition				Index of Synchronization
	Euro	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.

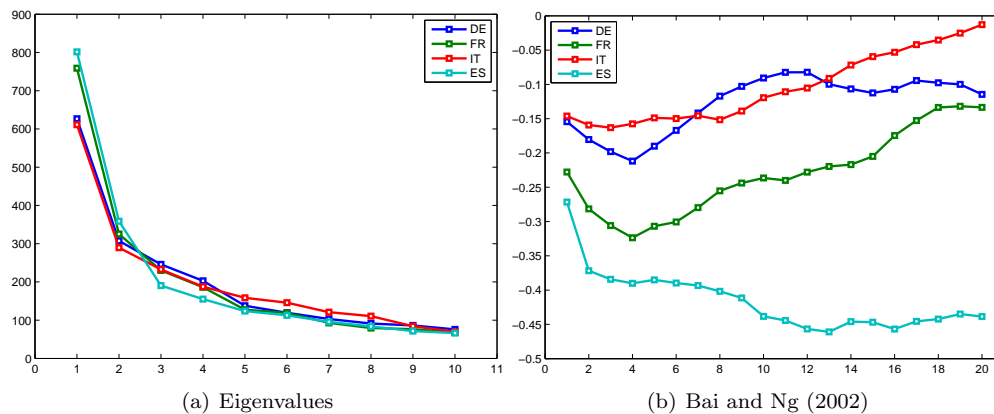(a) Eigenvalues   (b) Bai and Ng (2002)

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

5.3 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 sector we are implicity imposing a lot of structure. It is then appropriate and legitimate to ask if such 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 most simple 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 to 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 ten 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 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 left panel

25

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.
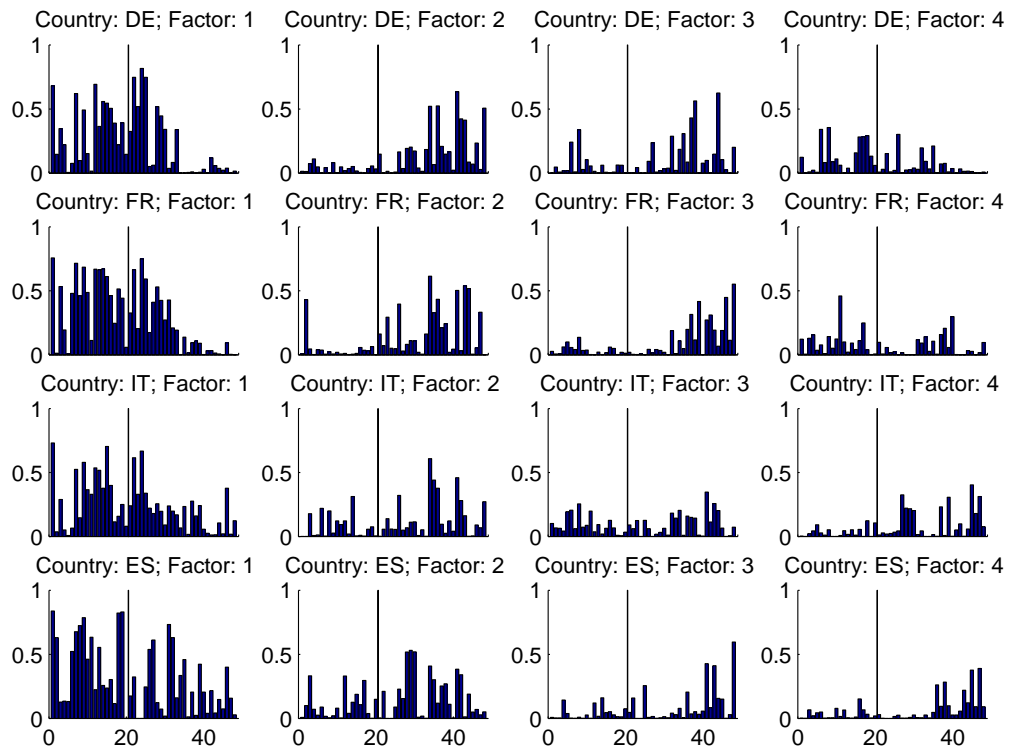

Figure 12: R-squared of the regressions of the 48 (46 in the case of Spain) individual time series against each of the first four factors

In order to provide additional information for deciding 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 in our analysis on two factors. 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 3 appears reasonable.

6 CONCLUSION

The recent recession episodes experienced by the Euro Area altered business cycles properties of member countries. While the business cycles of the four largest european economies were similar in the decade preceeding the global financial turmoil, we gather compelling evidence of an asymmetric behavior of Spanish economic fluctuations relative to Euro Area cycles in the aftermath. We measure alikeness of business cycle by studying the synchronization of up and down phases, the convergence properties of country factors toward the Euro Area and the contribution of the Euro Area factor to explain the national GDPs 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 cycles indicator is that 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 behavior of the estimated factors, the main driver of domestic fluctuations (for France, Germany and Italy) is the common European factor which explains half of the domestic GDP volatility. This suggests that there is an important degree of interdependence between Germany, France and Italy, and if one country falls into a recession, the chance that such recession is driven by the European factor is almost 50 per cent. Hence, it is likely to affect to neighboring 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 rest of the European economy 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 turbolent times and disaggregated information at country level is advisable.

Our findings suggest also 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 fledge 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.

<center>REFERENCES</center>

Altissimo, F., Bassanetti, A., Cristadoro, R., Forni, M., Hallin, M., Lippi, M., Reichlin, L. and Veronese, G.: 2001, Eurocoin: A real time coincident indicator of the euro area business cycle, *CEPR Discussion Papers 3108*, C.E.P.R. Discussion Papers.

Altissimo, F., Cristadoro, R., Forni, M., Lippi, M. and Veronese, G.: 2010, New eurocoin: Tracking economic growth in real time, *The Review of Economics and Statistics* **92**(4), 1024–1034.

Bai, J. and Ng, S.: 2002, Determining the number of factors in approximate factor models, *Econometrica* **70**(1), 191–221.

Bańbura, M. and Modugno, M.: 2012, Maximum likelihood estimation of factor models on datasets with arbitrary pattern of missing data, *Journal of Applied Econometrics* pp. 1–27.

Caggiano, G. and Leonida, L.: 2009, International output convergence: evidence from an autocorrelation function approach, *Journal of Applied Econometrics* **24**(1), 139–162.

Canova, F. and Ciccarelli, M.: 2009, Estimating Multi-country VAR models, *International Economic Review* **50**, 929–961.

Canova, F. and Ciccarelli, M.: 2013, Panel Vector of Autoregressive Models: A Survey, *Advance in Economerics* **31**.

Ciccarelli, M., Ortega, E. and Valderrama, M. T.: 2012, Heterogeneity and cross-country spillovers in macroeconomic-financial linkages, *Banco de España Working Papers 1241*, Banco de España.

Del Negro, M. and Otrok, C.: 2008, Dynamic factor models with time-varying parameters: measuring changes in international business cycles, *Technical report*.

Farhi, E. and Werning, I.: 2012, Fiscal Unions, *Nber working papers*, National Bureau of Economic Research, Inc.

Fernandez-Villaverde, J., Rubio-Ramirez, J., Sargent, T. and Watson, M.: 2007, The A,B,C and D for understanding VARs, *American Economic Review* **97**, 1021–1026.

Forni, M. and Gambetti, L.: 2011, Sufficient information in structural VARs, *Center for Economic Research (RECent) 062*, University of Modena and Reggio E., Dept. of Economics.

Geweke, J. and Zhou, G.: 1996, Measuring the pricing error of the arbitrage pricing theory, *Review of Financial Studies* **9**(2), 557–87.

Giannone, D., Reichlin, L. and Small, D.: 2008, Nowcasting: The real-time informational content of macroeconomic data, *Journal of Monetary Economics* **55**(4), 665–676.

<center>29</center>

Harding, D. and Pagan, A.: 2006, Synchronization of cycles, *Journal of Econometrics* **132**(1), 59–79.

Kose, M. A., Otrok, C. and Prasad, E.: 2012, Global business cycles: Convergence or decoupling?, *International Economic Review* **53**(2), 511–538.

Kose, M. A., Otrok, C. and Whiteman, C. H.: 2003, International business cycles: World, region, and country-specific factors, *American Economic Review* **93**(4), 1216–1239.

Ludvigson, S. C. and Ng, S.: 2009, Macro factors in bond risk premia, *Review of Financial Studies* **22**(12), 5027–5067.

Marcellino, M., Stock, J. H. and Watson, M. W.: 2003, Macroeconomic forecasting in the euro area: Country specific versus area-wide information, *European Economic Review* **47**(1), 1–18.

McKinnon, R.: 1963, Optimum currency areas, *Americal Economic Review* **53**(4), 717–725.

Moench, E., Ng, S. and Potter, S.: 2013, Dynamic hierarchical factor models, *Review of Economics and Statistics* **95**(5).

Mumtaz, H. and Surico, P.: 2012, Evolving international inflation dynamics: Evidence from a time-varying dynamic factor model, *Journal of European Economic Association* **10**, 716–734.

Mundell, R. A.: 1961, A theory of optimum currency areas, *Americal Economic Review* .

Pesaran, M., Schuermann, T. and Weiner, S.: 2004, Modeling regional interdependencies using a global error-correcting macroeconometric model., *Journal of Business and Economic Statistics* **22**, 129–162.

Stock, J. H. and Watson, M. W.: 2002, Macroeconomic forecasting using diffusion indexes, *Journal of Business and Economic Statistics* **20**(2), 147–162.

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
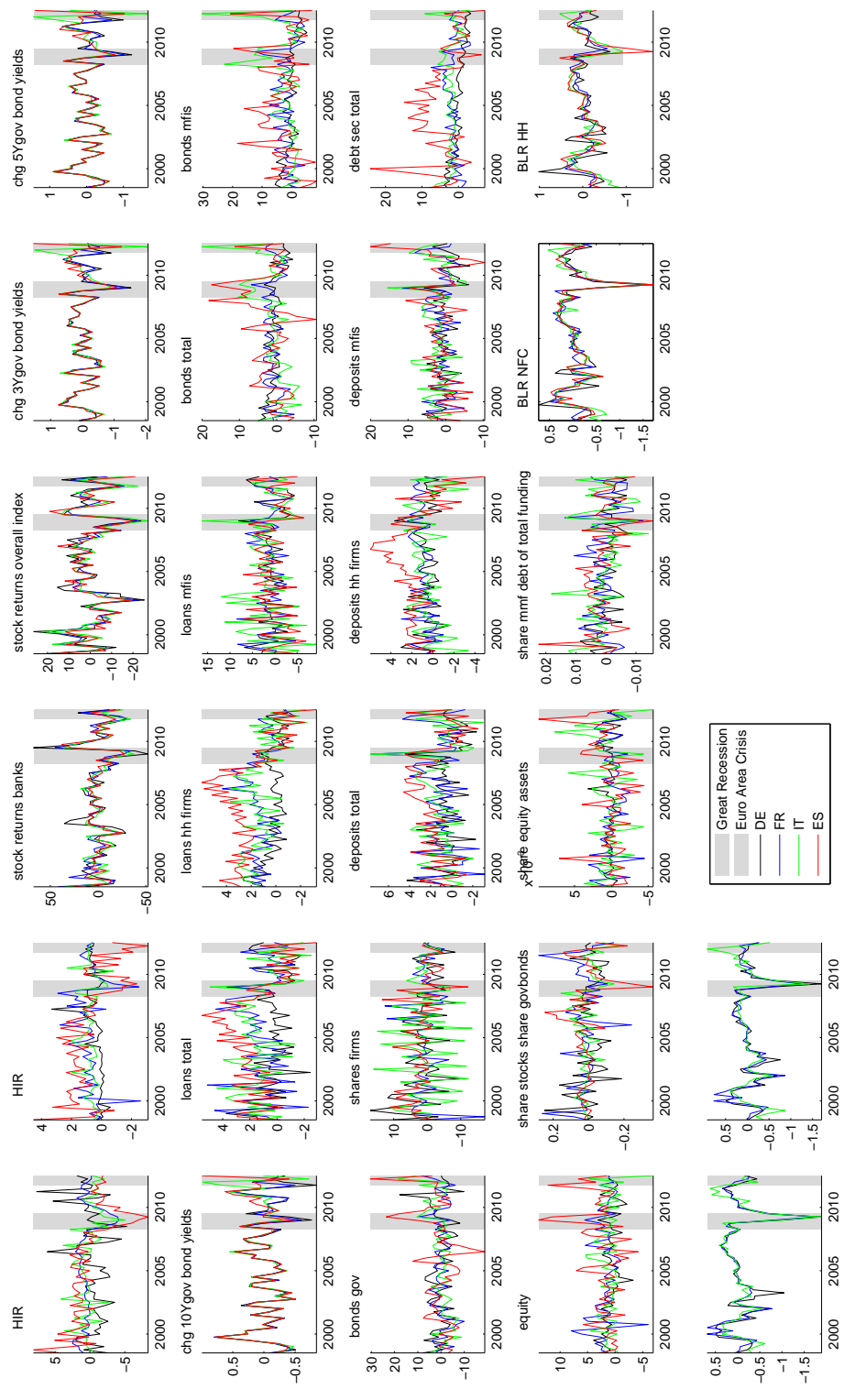
Figure 13: Financial Activity Data
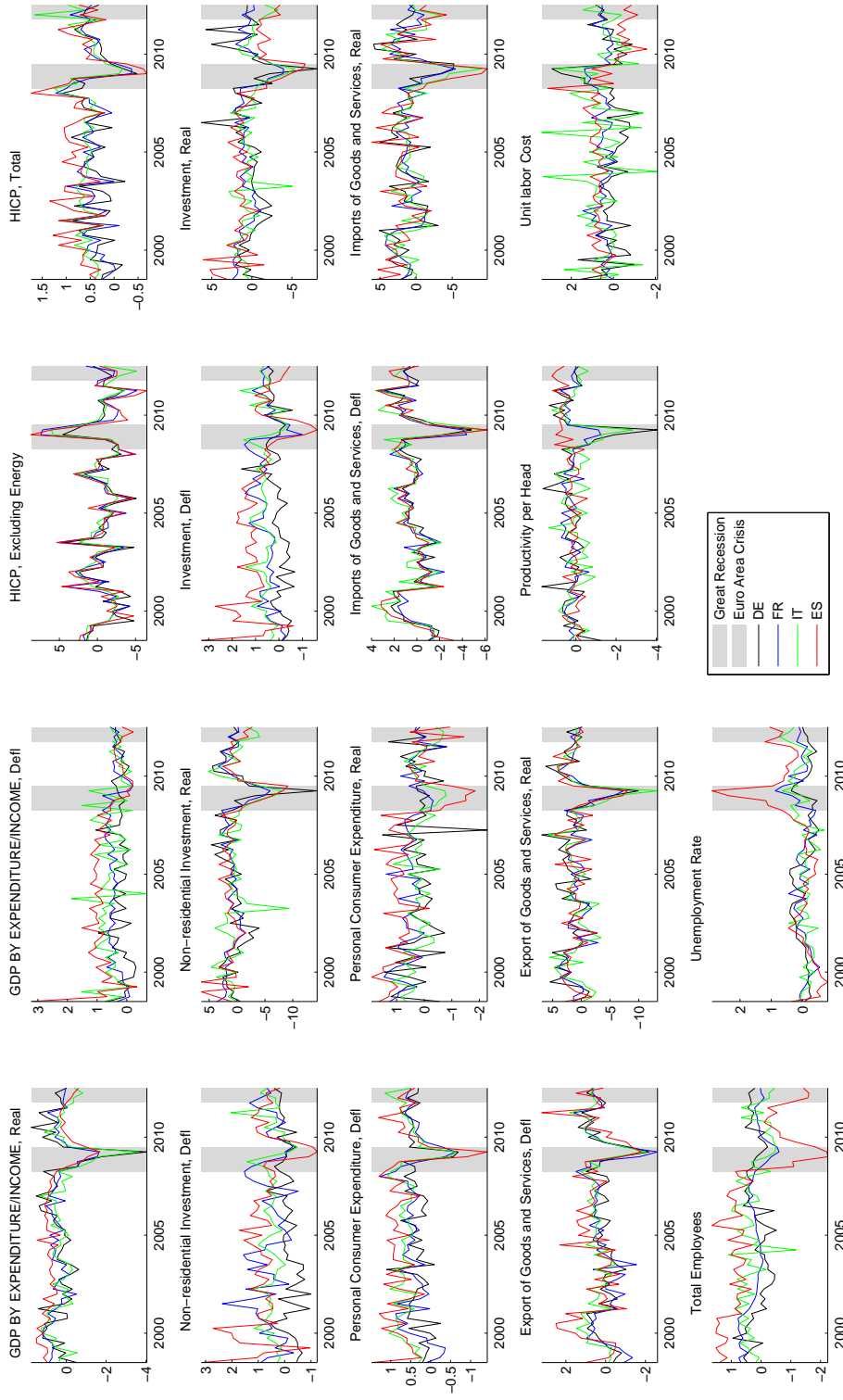
Figure 14: Real Activity Data

Real Variables	Euro	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 in parenthesis.

Documents de Travail

510. G. Bazot, M. D. Bordo and E. Monnet, "The Price of Stability. The balance sheet policy of the Banque de France and the Gold Standard (1880-1914) ," October 2014

511. K. Istrefi and A. Piloiu, "Economic Policy Uncertainty and Inflation Expectations," October 2014

512. C. Jardet and A. Monks, "Euro Area monetary policy shocks: impact on financial asset prices during the crisis?," October 2014

513. J. Dugast and T. Foucault, "False News, Informational Efficiency, and Price Reversals," October 2014

514. G. Cette, J. Lopez and J. Mairesse, "Product and Labor Market Regulations, Production Prices, Wages and Productivity," October 2014

515. L. Ferrara and C. Marsilli, "Nowcasting global economic growth: A factor-augmented mixed-frequency approach," October 2014

516. F. Langot and M. Lemoine, "Strategic fiscal revaluation or devaluation: why does the labor wedge matter? ," October 2014

517. J.-P. Renne, "Fixed-Income Pricing in a Non-Linear Interest-Rate Model," October 2014

518. J.-P. Renne, "Options Embedded in ECB Targeted Refinancing Operations," October 2014

519. A. Penalver, "Pre-crisis credit standards: monetary policy or the savings glut?," November 2014

520. C. Marsilli, "Variable Selection in Predictive MIDAS Models," November 2014

521. P. Lopez, "The Term Structure of the Welfare Cost of Uncertainty," November 2014

522. F. Ferroni and B. Klaus, "Euro Area business cycles in turbulent times: convergence or decoupling? ," November 2014