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Has the Euro Changed Business Cycle Synchronization? Evidence from the Core and the Periphery

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Abstract

Using a Bayesian dynamic factor model, I examine the comovement of output, investment and consumption growth among Euro area countries before and after the introduction of the Euro. For that purpose, I compare a pre-Euro period (1991–1998) to a Euro period (2000–2010) and identify a common Euro factor for each period separately. I find that the comovement of main macroeconomic variables and the common factor increases for core Eurozone countries from the first to the second period, while it decreases for most peripheral economies. This can be interpreted as a rise in business cycle synchronization for the core and a respective decline for the periphery.

Different to the implications made by the endogeneity argument of currency areas (Frankel and Rose, 1998), my evidence suggest that the introduction of the Euro has fostered imbalances between core and peripheral Eurozone countries.

JEL Classification: C11, C32, E32, F41, F42.
Keywords: European business cycles, Euro, optimum currency area, core and periphery, dynamic factor analysis.

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1 Introduction

The debate about the future of the Euro is on top of the economic agenda. The recent crisis illustrates the challenges faced by a monetary union that consists of many different and sovereign countries.

The costs and benefits of a currency union have been extensively analyzed in the literature and are closely related to the theory of optimum currency areas (OCA) pioneered by Mundell (1961). The OCA theory argues that the benefits of a currency union depend on the extent its member countries comply with certain criteria, the OCA properties. Among these properties, the similarity of business cycles plays an important role, because the more synchronized business cycles are, the smaller is the cost of giving up an independent monetary policy.

Frankel and Rose (1998) argue that the participation in a currency union may itself lead to a higher synchronization of business cycles. This is referred to as the *endogeneity* of the OCA properties. Considering the Euro area, one would therefore expect to see an increase in business cycle synchronization since the introduction of the Euro.

Given the recent European debt crisis, a new line of argument has been put forward. According to Sinn et al. (2011), the introduction of the Euro has promoted growing imbalances among member states regarding their current accounts, private capital flows and their competitiveness. Sinn et al. argue that excessive capital imports have boosted economies at Europe's periphery, in particular countries like Greece, Ireland, Portugal and Spain, the so called GIPS economies. At the same time, capital exporting countries at the core of the Eurozone have suffered from low investment rates, which resulted in an economic stagnation or even a slump. A change in the risk perception due to the crisis altered these patterns and led countries at the core to recover quickly, while the GIPS countries contracted. Similar arguments have also been put forward by Breuss (2011b), who point out that the introduction of the Euro brought to light the latent weaknesses in competitiveness of some peripheral member states. According to these line of arguments, the introduction of the Euro caused different patterns in business cycle activity in the core and peripheral Euro area member states. Instead of increased business cycle synchronization over all countries, one would rather expect less synchronization in economic activity between the core and the periphery of the Euro area.

The *endogeneity* argument and the reasoning by Sinn et al. (2011) lead to divergent expectations about the evolution of business cycle synchronization within the Eurozone since the introduction of the Euro. Using a *Bayesian dynamic factor model* this paper investigates whether there has been an increase or a decrease in business cycle comovement among the member countries of the Euro area since the introduction of the common currency regime.

The contribution to the literature is twofold. First, this paper is based on a rich data set, which makes it feasible to compare the extent of comovement in economic activity within the Euro area in a pre-Euro period (1991 - 1998) to the degree of synchronization in a Euro period (2000 - 2010). Using most recent data, it covers more than ten years of the European currency union. This enables reliable conclusions about the impact of the Euro on Euro area business cycle synchronization.[1] Moreover, the paper considers almost all Euro area countries that introduced the Euro in 1999.[2] It further discriminates between core and GIPS economies and is therefore able to contribute to the debate if the introduction of the Euro has led to imbalances between these two groups of countries.

The second contribution of this paper is that it identifies a common Euro area component using information contained in output, investment and consumption growth as opposed to using a univariate identification strategy based on output

[1] Covering such a long period, it can be assumed that the data captures also longer term developments induced by the Euro. For instance, the Euro may, by stimulating trade integration at the inter- and intraindustry level, affect the extent of specialization across countries and hence business cycle synchronization in the long run (see Krugman, 1993).

[2] I only lack Austria and Luxembourg. Note that Greece, which is part of the sample, introduced the Euro in 2001.

growth as the only observed variable. Although the univariate model is widely used in the literature (see e.g. Monfort et al., 2003 and Giannone et al., 2009) a *multivariate approach* as the one employed here is clearly preferable. It exploits more information and allows a better identification of the business cycle. The use of multiple macroeconomic indicators rather than just GDP to characterize business cycles can be traced back to the classical contribution of Burns and Mitchell (1946) and Zarnowitz (1992).

I follow the empirical approach pioneered by Kose et al. (2003) and set up a *dynamic factor model*. In particular, I decompose macroeconomic fluctuations in output, consumption and investment growth into different factors, these are (i) a Euro factor, which picks up fluctuations that are common across all variables and countries, (ii) country factors, that are common across aggregates in a given country, and (iii) idiosyncratic factors specific to each time series. These factors are then used to quantify the relative importance of the common and country components in explaining comovement in each observable variable. Business cycle synchronization is interpreted as a strong influence of the common component in driving fluctuations in most macroeconomic variables of a country, in particular in driving output growth variation.

The use of *dynamic factor analysis* is adequate for this kind of analysis because it allows a discrimination between different origins of commonality in the data set. This is needed to detect if the core and the periphery of the Eurozone show systematically different patterns in business cycle comovement. Correlation studies cannot meet these requirements, but can only capture one dimension of synchronization. Moreover, correlation analysis may be less adequate if one wishes to analyze the potential comovement of more than two countries at the same time. This is why *dynamic factor models* have become a popular econometric tool for quantifying the degree of comovement among a large set of macroeconomic time series.

There is a strand of literature using correlation analysis to study changes in European business cycles.[3] Artis and Zhang (1997), for instance, analyze the effect of the European exchange rate mechanism on business cycle correlations. Only few studies, however, use recent enough data to account for the effect of the introduction of the Euro on business cycle comovement. Among the most recent studies is Enders et al. (2010), who report an increase in the correlation of output and some of its components from a pre-Euro (1985-1996) to a Euro (1999-2007) period. They, however, do not focus on the difference between core and peripheral Euro area countries.[4]

Other studies use a dynamic factor approach to analyze synchronization in international business cycles. Forni and Reichlin (2001) study the comovement of output fluctuations in Europe at different levels of aggregation. Their analysis, however, is restricted to a period from 1977 to 1993. Mansour (2003) and Kose et al. (2003) consider a large set of countries in order to account for common fluctuations on a worldwide level. Both studies use annual data, which misses important short term dynamics. Moreover, their data sample is limited to the years 1989 and 1991, respectively, thereby not accounting for the process of European monetary integration. Monfort et al. (2003) and Kose et al. (2008) investigate the evolution of business cycles in G-7 countries. They base their analysis on quarterly data and examine, whether the common component has gained importance over time. Their analysis, however, is restricted up to the years 2002 and 2003, respectively.

In this paper, I consider ten Euro area countries which I group into core and peripheral economies. To measure the change in comovement before and after the introduction of the Euro, I estimate a factor model for the pre-Euro and for the Euro

[3] See de Haan et al. (2008) for an extensive review.

[4] Besides their empirical analysis, Enders et al. (2010) concentrate on explaining the underlying causes of changes in European business cycles by calibrating a general equilibrium model. They find that the Euro has a strong impact on the transmission mechanism as cross-country spillovers increase substantially under the common monetary regime, while the effect of domestic shocks declines. Other recent contributions that study possible effects of the Euro on changes in Euro area business cycles are Canova et al. (2009), Negro and Otrok (2008) and Giannone et al. (2009). All of these latter studies do not detect an impact of the Euro on Euro area business cycles. Another strand of literature focuses on determinants of business cycle synchronization. Examples are Frankel and Rose (1998), Imbs (2004) and Siedschlag and Tondl (2011), where the latter analyze the impact of trade, monetary integration and specialization on business cycle synchronization within the Euro Area.

period separately. In an extended approach, I add a control group of the remaining G-7 economies to my model. The purpose of this extension is to examine whether a potential change in the comovement is a distinct European feature or potentially a worldwide phenomenon.

The analysis yields the following results: I find an increase in the comovement of all macroeconomic variables with the common factor from the first to the second period for core Euro area countries. In particular, I show that the fluctuations in output growth which can be attributed to the common Euro factor rose, on average, from about 40% to about 75%. The same tendency, however, is also common to non Euro area countries of the control group. This suggests that the increase in business cycle synchronization reflects worldwide developments rather than the effects of the introduction of the Euro. I further find that the comovement of output and investment growth relative to the common component decreases for the GIPS country group. This is indicated by a decrease in the relevance of the Euro factor by, on average, 10% in explaining output and investment growth fluctuations. The analysis further reveals that Greece shows patterns in all three macroeconomic variables that are considerably different to the rest of the Eurozone.

The remainder of the paper is organized as follows: Section 2 describes the data and presents the model specification and estimation issues. Section 3 shows the estimation results and the final section offers some concluding comments.

2 Model specification and estimation

2.1 Data

My data sample comprises ten European countries. Nine out of them introduced the Euro in January 1999: Belgium, France, Finland, Germany, Ireland, Italy, the Netherlands, Spain and Portugal. Moreover, I include Greece, which adopted the Euro in 2001. I refer to Greece, Ireland, Portugal and Spain as peripheral or GIPS countries and consider the other six countries as core Euro area countries. As a control group, I include the remaining G-7 economies which are not part of the Eurozone: the United Kingdom, the United States, Canada and Japan. I draw quarterly data on output, consumption and investment from the OECD Economic Outlook database. Output is measured by real gross domestic product, consumption by total real private consumption expenditure and investment by total real private fixed capital formation.[5] I take logarithms and compute first differences to obtain growth rates. The sample covers data from 1991 to 2010. The starting point broadly coincides with the beginning of the first stage of the Economic and Monetary Union (EMU). On basis of the Delors Report, the first stage of the realization of the EMU started on 1. July 1990. Since data for Germany is only available since 1991, I take this as the beginning of the sample. Ending in 2010, the set comprises more than ten years of the common currency regime. I split the whole sample into two sub-periods. The first includes the run-up period to the introduction of the Euro, which I call the pre-Euro period (1991 - 1998). The second is the period of the common currency, which I refer to as the Euro period (2000 - 2010). Note that data for Greece is only available since the year 2000, which explains the beginning of the second sample. Greece is therefore only part of the Euro period.[6]

2.2 Methodology

Advantages of dynamic factor analysis. I set up a *dynamic factor model.* The advantages of choosing this approach become evident by contrasting it with some common alternative methods. A standard approach of measuring comovement is to calculate sets of bivariate correlations for all variables in a dataset. This can easily lead to a large number of bivariate correlation coefficients. One way to reduce this

[5] The exact source is OECD Economic Outlook No. 89 from June 2011. Note, that for Belgium, Portugal, Ireland and Spain quarterly series are only available from the mid-1990 onwards. For the preceding periods they are derived from annual data by the OECD.

[6] The results of the estimation are not sensitive to extending the sample to 1999 and excluding Greece.

number is to compute correlations against a reference country or aggregate. This, however, bears the problem that changes in the reference country or aggregate often lead to significantly different results. Factor models do not face these problems. They do not require to define a reference country. Instead, they are able to capture the extent of comovement between a large number of variables simultaneously.

Another popular approach to analyze business cycle synchronization are structural vector autoregressions (SVAR). This concept, however, always requires strong identifying assumptions about the propagation of shocks. Dynamic factor models are much more flexible and do not need to make strong assumptions about the identification scheme.

Model set-up. My model specification closely follows Kose et al. (2003).[7] Let N denote the number of countries, M the number of time series per country and T the length of the time series. Observable variables are denoted by $y_{i,t}$, for $i = 1, ...M \times N$ and $t = 1, ...T$. I adopt the following specification:

$$y_{i,t} = a_i + b_i^{euro} f_t^{euro} + b_i^{country} f_{i,t}^{country} + \varepsilon_{i,t} \tag{1}$$

with $E(\varepsilon_{i,t}, \varepsilon_{j,t-s}) = 0$ for $i \neq j$, where $y_{i,t}$ denotes the growth rate of the observable variable i at time t. This set-up implies that variation in each observable variable is explained by a specific Euro factor f_t^{euro} and a country specific factor $f_{i,t}^{country}$. The coefficients b_i^j are called factor loadings and reflect the degree to which variation in $y_{i,t}$ can be attributed to each factor. The idiosyncratic errors $\varepsilon_{i,t}$ are assumed to be normally distributed, yet they may be serially correlated. In particular, I assume that they follow an autoregressive process of order p:

$$\varepsilon_{i,t} = \phi_{i,1}\varepsilon_{i,t-1} + \phi_{i,2}\varepsilon_{i,t-2} + ... + \phi_{i,p}\varepsilon_{i,t-p} + u_{i,t} \tag{2}$$

with $E(u_{i,t}, u_{j,t-s}) = \sigma_i^2$ for $i = j$ and $s = 0$, 0 otherwise. The evolution of the factors

[7] I thank Christopher Otrok for providing me with the code of his model.

is similarly modeled as an autoregressive process of order q with normal errors:

$$f_{k,t} = \psi_{k,1} f_{k,t-1} + \psi_{k,2} f_{k,t-2} + ... + \psi_{k,q} f_{k,t-q} + u_{k,t} \tag{3}$$

with $E(u_{k,t}, u_{k,t}) = \sigma_k^2$, $E(u_{k,t}, u_{i,t-s}) = 0$ for all k, i, and s. All the error terms $u_{i,t}$ and $u_{k,t}$ are assumed to be zero mean, contemporaneously uncorrelated normal random variables. This implies that all comovement is captured by the factors. There are two related identification problems: neither the signs nor the scales of the factors are separately identified. As in Kose et al. (2003), I identify the signs by requiring one of the factor loadings to be positive for each of the factors. In particular, I require that the factor loading for the Euro factor is positive for German output; similarly, country factors are identified by positive factor loadings for output for each country. Following Sargent and Sims (1977) and Stock and Watson (1989), scales are identified by setting each σ_k^2 equal to a constant. I set the order of all autoregressive processes to four.[8]

Estimation. The estimation procedure I use for the *dynamic factor model* is a Bayesian method that exploits Gibbs sampling techniques. Since it is not feasible to derive the joint posterior of the factors and parameters analytically, I use numerical methods to simulate from the joint posterior distribution. In particular, I employ a "data augmentation" algorithm to generate draws from the joint posterior of the factors and parameters (see Tanner, 1982 and Otrok and Whiteman, 1998). The essential idea of this algorithm can be described as follows: If the factors were observable and under conjugate priors, the model (1) - (3) would be a system of regressions with Gaussian autoregressive errors. This structure makes it feasible to determine the conditional distribution of the parameters, given the factors and the

[8] Beside the model set-up presented in this paragraph, I consider another specification of the form $y_{i,t} = a_i + b_i^{euro} f_t^{euro} + b_i^{group} f_{g,t}^{group} + b_i^{country} f_{i,t}^{country} + \varepsilon_{i,t}$, where equations (2) and (3) still apply. That is, I additionally include two group factors, one for the core, and one for the GIPS countries. Identification of all these factors, however, turns out to be difficult. I therefore stick to the simpler model presented above.

data. In a next step, one can determine the conditional distribution of the factors given the data and the parameters of the model. It is then straightforward to make draws from this conditional distribution, and such draws can be used as stand-ins for the unobserved factors. Since the complete set of conditional distributions is known, the joint posterior distribution for the unknown parameters and unobserved factors can be sampled using a Markov-Chain Monte Carlo method.[9] I use 10500 draws, and discard the first 500, in the actual implementation of the Gibbs sampler. I check for convergence by running several replications and comparing the results.

The prior on all the factor loadings is $N(0, 1)$ and for the autoregressive parameters the prior is $N(0, \Sigma)$, where $\Sigma = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 0.25 \end{bmatrix}$. The prior on the innovation variances σ_i^2 is Inverted Gamma (6,0.001). All priors are therefore quite diffuse.

3 Estimation results

3.1 The evolution of the Euro factor

I estimate equations (1) - (3) and extract the common Euro factor and the individual country factors from the obtained distributions. Taking the medians as point estimates, I can plot the different factors over time. Figure 1 shows the evolution of the Euro factor over the whole sample period from 1991 to 2010.

It can be seen that the estimated common factor is able to track the major economic events over the last twenty years in the Euro area: It captures the recessionary period starting in the beginning of 1992 and the recovery thereafter in the years 1993 and 1994. Furthermore, it captures the expansionary period in the

[9]Taking starting values for the parameters and factors as given, I fist sample from the posterior distribution of the parameters, given the factors. Next, I take draws from the posterior distribution of the common factor conditional on the parameters and the country factors. Then, I sample each country factor conditional on the common factor and the parameters. The Markov chain converges and yields a sample from the joint posterior of the parameters and factors. For a detailed discussion of the estimation technique see Kim and Nelson (1999) and Otrok and Whiteman (1998).

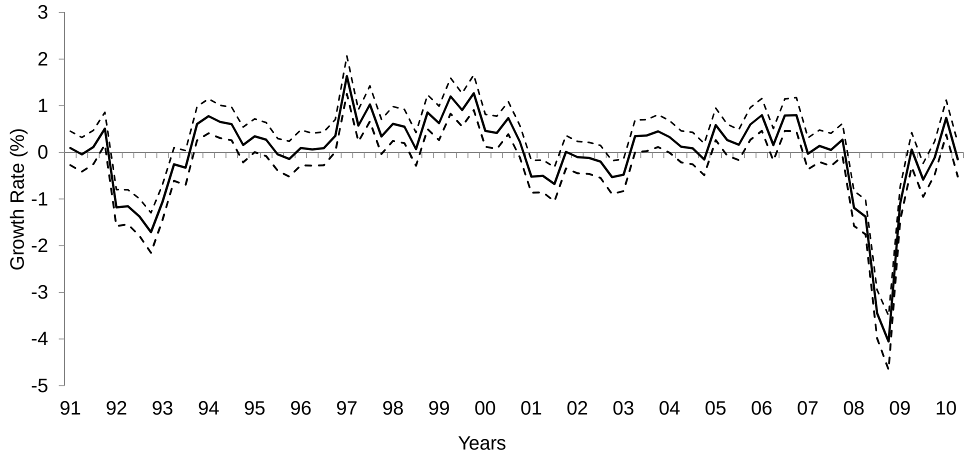

Fig. 1: Evolution of Euro factor

The solid line presents the median of the posterior distribution of the Euro factor, along with its 5 and 95-percent quantile bands.

mid and end 1990s and indicates the period of stagnation from 2001 to 2003 when the Euro area experienced a "prolonged pause in growth of economic activity" as it is pointed out by the Euro Area Business Cycle Dating Committee.[10] Moreover, the Euro factor clearly uncovers the latest recession that started at the beginning of 2008. Overall this consistency of the estimated common factor with the most important economic developments within the Euro area stresses the appropriateness of this estimation technique to conduct business cycle analysis.

3.2 The relevance of the Euro factor

Variance decompositions. Synchronization or comovement in business cycles can be interpreted as a strong influence of the common factor in driving variation in the underlying macroeconomic aggregates of individual countries. To quantify the relative importance of the three different factors for each aggregate and each country, I conduct variance decompositions. In particular, I decompose the variance of each observable $y_{i,t}$ into a fraction due to the common factor f_t^{euro}, a fraction that

[10] See http://www.cepr.org/data/dating/growth-pause.asp for details.

is due to the country specific factor $f_{i,t}^{country}$ and a share that can be attributed to the idiosyncratic component $\varepsilon_{i,t}$. Since the factors are orthogonal, the variance of observable i can be written as follows:

$$var(y_{i,t}) = (b_i^{euro})^2 var(f_t^{euro}) + (b_i^{country})^2 var(f_{i,t}^{country}) + var(\varepsilon_{i,t}). \tag{4}$$

The fraction of volatility that is due to the Euro factor is then:

$$\frac{(b_i^{euro})^2 var(f_t^{euro})}{var(y_{i,t})}. \tag{5}$$

I conduct such variance decompositions for both sub-periods.

The pre-Euro period. Table 1 presents summary measures of the variance decompositions for the pre-Euro period. There are two important results: First, the Euro factor on average explains a significant fraction of variation in all three macroeconomic aggregates.[11] Over all countries, 22% in variation of consumption and 31% in fluctuations of investment growth can be accounted for by the common factor. For output growth this fraction is even larger and accounts for 42%. These numbers already indicate that comovement in economic activity among the Euro area is quite substantial. Second, the two groups of countries, the core and the periphery, display very similar patterns regarding their business cycle comovement. In both groups, the Euro factor is the most important driving force for output growth. For the core countries, it accounts for 41% of the fluctuations, whereas the respective share for the peripheral economies lies at 43%. Moreover, consumption growth is largely driven by idiosyncratic factors in both country samples, 50% for the core group and 63% for the peripheral group. Thus, in this pre-Euro period the core and the periphery do not differ substantially regarding their business cycle comovement. Table 2 shows the variance decompositions for each country separately and high-

[11] The numbers reported below the 50% indication show the median of the estimated distributions and are taken as point estimates.

lights that the importance of the common factor differs across countries. In France, Belgium and Portugal the Euro factor accounts for more than 50% of fluctuations in output growth. In Germany and Finland, however, the influence of the common component is less than 30%. Regarding Germany, output and investment growth are primarily driven by country specific forces. This finding can be attributed to the special economic conditions after the German reunification. A similar picture emerges for Finland. Output growth is mainly driven by domestic components. This evidence underlines that Finland is less aligned to other Eurozone countries in this pre-Euro period. This might be due to its geographical remoteness and its economic alignment to other Nordic countries that are not included in this sample.

Table 1: Average group variance decompositions pre-Euro period (1991 - 1998)

		Output			Investment			Consumption		
		33%	**50%**	**66%**	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
CORE	Euro	38.35	41.06	43.74	27.59	30.01	32.53	22.06	23.94	25.86
	Country	20.68	26.22	32.19	17.52	23.41	29.54	20.73	25.35	30.92
	Idio.	26.28	31.91	37.30	40.09	45.81	51.41	44.35	49.80	54.61
GIPS[a]	Euro	40.55	43.40	46.37	28.96	31.73	34.61	16.91	18.57	20.32
	Country	27.22	32.35	37.35	32.41	38.46	44.44	12.38	17.31	23.49
	Idio.	19.05	23.70	28.52	23.96	29.20	34.72	57.33	63.45	68.55
TOTAL	Euro	39.08	41.84	44.62	28.05	30.58	33.22	20.34	22.15	24.01
	Country	22.86	28.27	33.91	22.48	28.42	34.51	17.95	22.67	28.44
	Idio.	23.87	29.18	34.37	34.71	40.28	45.85	48.68	54.35	59.25

Notes: The variance share attributable to the relevant factor is reported, where "Idio." is an abbreviation for "idiosyncratic factor". 33%, 50% and 66% correspond to the respective quantiles of posterior shares. The cross-sectional means are calculated for the relevant group of countries indicated in the first column. [a] Since there is no data for Greece for this pre-Euro period, the GIPS group only consists of Ireland, Portugal and Spain.

The Euro period. Table 3 gives the summary measures for the Euro period and Table 4 presents the variance decompositions for each country. There are two major insights: First, the core Euro area group shows a rise in the variance shares that are attributable to the common factor for all three macroeconomic aggregates. On average, 76% of the whole variation in output growth are accounted for by the

Table 2: Variance decompositions pre-Euro period (1991 - 1998)

		Output			Investment			Consumption		
		33%	**50%**	**66%**	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
GER	Euro	24.79	27.25	29.71	20.77	23.25	25.84	0.33	0.66	1.12
	Country	32.67	38.88	45.16	31.45	39.31	47.11	15.49	22.48	29.81
	Idio.	27.61	33.74	39.58	29.78	37.15	44.05	69.34	76.64	83.42
FR	Euro	55.04	58.14	61.19	43.42	46.75	50.13	1.90	2.88	4.07
	Country	25.75	29.02	32.23	16.84	19.90	22.88	70.43	75.99	80.80
	Idio.	10.36	12.39	14.56	30.40	32.77	35.26	16.22	20.85	26.07
IT	Euro	36.24	38.99	41.63	54.55	57.27	59.86	51.61	54.90	57.96
	Country	7.82	15.42	24.53	4.56	8.33	13.13	1.42	3.69	7.92
	Idio.	37.16	44.99	51.19	29.23	33.45	37.46	34.70	39.20	43.21
BEL	Euro	65.87	69.06	71.89	34.57	37.54	40.52	45.88	48.83	51.67
	Country	0.55	1.47	3.56	4.94	10.53	17.06	1.33	3.96	8.35
	Idio.	23.73	27.11	30.28	43.64	50.15	56.13	40.87	45.50	49.32
NL	Euro	28.68	31.29	34.04	3.85	5.01	6.37	3.23	4.25	5.36
	Country	18.55	27.66	37.06	18.22	27.64	36.21	5.64	10.87	18.89
	Idio.	31.10	40.32	49.62	58.57	66.73	75.81	76.52	84.37	89.24
FIN	Euro	19.47	21.64	24.01	8.40	10.26	12.44	29.39	32.13	34.96
	Country	38.75	44.90	50.58	29.09	34.74	40.87	30.09	35.11	39.73
	Idio.	27.70	32.93	38.55	48.93	54.63	59.74	28.44	32.21	36.38
IRE	Euro	38.21	41.49	44.90	23.04	25.78	28.66	5.53	6.91	8.43
	Country	37.09	41.78	46.25	54.02	59.65	65.13	17.61	22.83	28.33
	Idio.	12.37	16.31	20.36	9.18	13.86	19.19	64.54	69.65	74.70
POR	Euro	49.15	51.78	54.52	39.15	41.96	44.92	0.26	0.58	1.07
	Country	16.94	21.54	26.26	19.60	26.66	33.69	15.47	22.78	33.02
	Idio.	21.67	25.99	30.54	24.12	30.49	37.24	66.31	76.32	83.54
ESP	Euro	34.29	36.92	39.68	24.68	27.44	30.27	44.94	48.21	51.46
	Country	27.63	33.72	39.53	23.61	29.07	34.50	4.07	6.33	9.11
	Idio.	23.13	28.82	34.67	38.57	43.25	47.72	41.15	44.37	47.40

Notes: The variance share attributable to the relevant factor is reported, where "Idio." is an abbreviation for "idiosyncratic factor". 33%, 50% and 66% correspond to the respective quantiles of posterior shares. The variance shares are computed at each pass of the Markov chain.

Euro factor, while in the first period the respective share amounts to 41%. The rise in the comovement of output growth is therefore substantial. The increases for investment and consumption growth are moderate, from 30% to 40% and 24% to 25%, respectively.

Second, a completely different picture emerges for the GIPS country group. On average, the importance of the Euro factor has decreased for output growth from 43% in the first period to 32% in the second period. The same is true for investment growth, where the influence of the Euro factor decreased from 32% to 22%. At the same time, however, comovement of consumption growth has increased considerably from 19% to 33%. This evidence lends support to the hypothesis that the introduction of the Euro has caused different developments in business cycle comovement in the core and the periphery of the Eurozone.

The results for the individual countries yield the following patterns: In Germany and Finland economic activity is considerably more aligned to the other countries in this period than in the first period. The influence of the Euro factor has increased for all variables in both countries, while the country component has lost influence. Spain deserves some attention. Although it is part of the GIPS country group according to the debate of the European debt crisis, it displays patterns in economic activity that are more similar to other core Euro area countries than to the peripheral ones. Spain shows an increase in the comovement of all macroeconomic variables with the common factor from the first to the second period. Different developments are found for Ireland and Portugal: the influence of the Euro component on output growth decreased considerably in these countries, from 42% to 26% in Ireland and from 52% to 26% in Portugal. Note that Greece shows very special patterns in its economic activity. The Euro factor almost has no influence on the variation of any of the three macroeconomic aggregates: less than 10% of fluctuations in all variables can be attributed to the common factor. Variation in output, investment and consumption growth is primarily driven by idiosyncratic forces. This clearly points to the special economic situation of Greece and indicates that its business cycle is decoupled from the rest of the Euro area countries.[12]

Another interesting finding is related to the relevance of the country specific factors. The variance shares that are attributable to the respective components for output growth decline for almost all Euro area countries from the first to the second

[12]Of course, this finding does not imply that the Euro has no impact on the Greek business cycle. The results rather show that Greece displays patterns in economic activity that are considerably different to the developments in the other Euro area economies.

period (the only exceptions are Belgium and Portugal). Since the country component captures domestic shocks, these obviously loose influence in the Euro period. These patterns support the main finding by Enders et al. (2010). They report that cross-country spillovers of shocks increase substantially under EMU, while the effect of domestic shocks on domestic variables declines. The property that I can quantify the relative importance of common and domestic shocks underlines the advantages of my empirical approach over correlation analysis.

The fact that I find different developments in business cycle comovement for the core and most peripheral countries since the introduction of the Euro, lends support to the argument made by Sinn et al. (2011). At the same time, my results indicate that business cycle synchronization among the core Euro area countries has increased since the introduction of the Euro. To figure out if this increase can be attributed to the common currency regime or if it is rather due to worldwide developments, I extend my model and include a control group into my analysis.

Table 3: Average group variance decompositions Euro period (2000 - 2010)

		Output			Investment			Consumption		
		33%	**50%**	**66%**	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
CORE	Euro	74.26	75.66	77.04	38.15	39.50	40.87	23.84	24.97	26.12
	Country	6.94	8.75	10.74	4.76	7.53	11.09	15.31	20.46	26.23
	Idio.	13.20	15.22	17.23	49.17	52.56	55.23	48.79	54.51	59.52
GIPS	Euro	30.82	32.27	33.71	20.79	22.06	23.35	32.08	33.39	34.68
	Country	26.27	34.03	39.83	27.12	33.30	37.89	20.93	25.69	30.31
	Idio.	28.17	33.48	40.81	40.31	44.47	50.03	36.53	40.84	45.34

Notes: The variance share attributable to the relevant factor is reported, where "Idio." is an abbreviation for "idiosyncratic factor". 33%, 50% and 66% correspond to the respective quantiles of posterior shares. The cross-sectional means are calculated for the relevant group of countries indicated in the first column.

Extended model. Adding a control group consisting of the United Kingdom, the United States, Canada and Japan to the model, leads to the following results that are reported in Table 5 and Table 6: In the first period, the influence of the common

Table 4: Variance decompositions Euro period (2000 - 2010)

		Output			Investment			Consumption		
		33%	**50%**	**66%**	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
GER	Euro	69.87	71.52	73.18	41.83	43.32	44.91	0.00	0.01	0.01
	Country	10.53	13.44	16.24	11.05	14.75	18.68	12.83	18.52	25.25
	Idio.	12.20	14.79	17.53	38.35	41.79	44.99	74.25	80.89	86.47
FR	Euro	78.79	80.12	81.37	63.87	65.31	66.78	15.28	16.56	17.85
	Country	0.04	0.06	0.07	0.06	0.09	12.74	11.62	18.05	25.53
	Idio.	12.23	13.97	15.59	22.20	25.62	28.26	58.51	65.60	71.39
IT	Euro	83.87	85.16	86.32	43.43	45.00	46.56	38.92	40.44	41.93
	Country	0.00	0.01	0.02	0.01	0.02	0.04	12.53	19.50	26.32
	Idio.	12.10	13.34	14.55	49.33	51.54	53.39	33.30	40.31	46.84
BEL	Euro	64.14	65.68	67.23	14.98	15.93	16.90	34.53	36.12	37.72
	Country	13.15	15.76	18.47	0.55	1.21	2.22	28.93	33.89	38.77
	Idio.	15.99	18.49	20.93	80.87	82.41	83.76	25.42	30.12	34.82
NL	Euro	70.09	71.42	72.8	35.70	37.05	38.46	14.67	15.59	16.57
	Country	12.65	14.99	17.39	6.06	8.51	11.34	25.17	30.84	37.02
	Idio.	10.89	13.30	15.78	51.62	54.01	56.26	47.57	53.71	59.15
FIN	Euro	78.80	80.09	81.34	29.13	30.38	31.64	39.27	40.58	41.91
	Country	0.80	1.69	3.11	3.96	9.42	17.07	0.76	1.96	4.50
	Idio.	15.79	17.44	19.00	52.65	59.97	64.72	53.66	56.45	58.48
GRE	Euro	8.66	9.74	10.89	6.54	7.32	8.19	2.60	3.16	3.82
	Country	20.28	39.18	49.34	16.47	30.64	37.37	24.11	35.15	44.18
	Idio.	40.70	50.61	69.49	55.3	61.77	75.14	52.51	61.47	72.41
IRE	Euro	24.82	26.09	27.36	15.12	16.20	17.27	46.45	47.99	49.52
	Country	10.43	16.80	24.13	6.64	11.19	16.70	4.67	7.90	12.13
	Idio.	49.80	57.12	63.27	67.03	72.62	76.80	39.64	43.80	46.97
POR	Euro	24.94	26.14	27.34	14.93	15.85	16.79	28.03	29.36	30.62
	Country	53.23	56.63	59.87	45.29	48.24	51.37	30.47	33.13	36.15
	Idio.	14.09	17.10	20.29	32.92	35.87	38.64	34.78	37.52	40.05
ESP	Euro	64.84	67.11	69.27	46.59	48.86	51.15	51.23	53.03	54.77
	Country	21.14	23.51	26.00	40.07	43.12	46.10	24.45	26.57	28.79
	Idio.	8.09	9.10	10.20	6.00	7.62	9.55	19.19	20.56	21.92

Notes: The variance share attributable to the relevant factor is reported, where "Idio." is an abbreviation for "idiosyncratic factor". 33%, 50% and 66% correspond to the respective quantiles of posterior shares. The variance shares are computed at each pass of the Markov chain.

component on economic activity in the control group is very low. On average, less than 10% of fluctuations in all variables are accounted for by the common factor. Rather, country factors are important in driving economic activity, especially in the US and Japan. The second period shows a strong increase in the importance of the common component in all variables for all countries. This increase in the relevance of the common factor goes along with a decrease in the influence of country specific factors.

Table 5: Variance decompositions pre-Euro period (1991 - 1998) CONTROL group

		Output			Investment			Consumption		
		33%	**50%**	**66%**	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
UK	Common	8.15	9.86	11.69	15.34	17.18	19.14	1.79	2.55	3.47
	Country	12.26	16.12	20.48	26.75	33.14	39.78	43.51	53.88	62.45
	Idio.	69.16	73.46	77.43	42.62	49.5	55.87	34.62	43.28	53.62
US	Common	14.35	16.59	18.82	0.17	0.41	0.86	0.66	1.14	1.77
	Country	51.08	56.94	62.5	77.51	84.12	89.77	27.47	31.86	37.08
	Idio.	20.35	26.13	32.14	9.40	15.08	21.65	61.43	66.67	70.97
CAN	Common	6.45	8.20	10.03	5.48	6.77	8.14	11.6	13.21	14.74
	Country	4.47	10.15	21.86	2.59	5.79	15.21	3.64	7.86	13.23
	Idio.	68.96	80.28	86.19	77.73	86.14	89.67	72.87	78.24	82.41
JAP	Common	0.34	0.66	1.09	0.84	1.39	2.06	3.49	4.40	5.35
	Country	63.96	70.69	76.83	23.94	28.59	32.90	45.16	50.58	56.87
	Idio.	22.22	28.39	34.98	65.21	69.63	74.44	38.45	44.74	50.21
CONTROL	Common	7.32	8.83	10.41	5.46	6.44	7.55	4.38	5.33	6.33
	Country	32.94	38.48	45.42	32.70	37.91	44.41	29.95	36.05	42.41
	Idio.	45.17	52.07	57.68	48.74	55.09	60.41	51.84	58.23	64.3

Notes: The variance share attributable to the relevant factor is reported, where "Idio." is an abbreviation for "idiosyncratic factor". 33%, 50% and 66% correspond to the respective quantiles of posterior shares. The variance shares are computed at each pass of the Markov chain. The results for the Euro area countries in this extended model are not shown, since they do not differ substantially from the ones reported in Table 2. The complete set of results are available upon request from the author.

Obviously, the control group shows very similar patterns in the evolution of business cycle activity to the core Euro area group. Since the increase in business cycle synchronization is apparently not limited to the core Euro area countries, it can hardly be attributed to the introduction of the Euro. The evidence rather suggests that worldwide phenomenons such as increased trade and liberalization of capital markets are the source of increased business cycle synchronization from the first to the second period.[13] The results allow some further interpretation of the developments within the peripheral countries: Although there is an apparent

[13] This is in line with the evidence reported by Canova et al. (2009). They find a general process of European convergence which, however, cannot be linked to the introduction of the Euro. It also confirms the reasoning by Breuss (2011a) that there is still no common *Euro area business cycle*.

Table 6: Variance decompositions Euro period (2000 - 2010) CONTROL group

		Output			Investment			Consumption		
		33%	**50%**	**66%**	**33%**	**50%**	**66%**	**33%**	**50%**	**66%**
UK	Common	80.99	81.95	82.97	11.80	12.50	13.20	44.87	46.20	47.58
	Country	4.45	6.10	7.91	0.27	0.69	1.56	12.58	17.27	22.12
	Idio.	10.05	11.81	13.40	85.22	86.32	87.20	31.93	36.58	40.94
US	Common	50.26	51.37	52.48	72.07	73.18	74.32	38.43	39.64	40.88
	Country	18.81	23.08	27.67	3.31	4.80	6.45	18.06	22.45	27.21
	Idio.	21.15	25.57	29.68	20.18	21.74	23.24	33.36	38.24	42.36
CAN	Common	54.58	55.72	56.85	35.94	36.94	37.97	74.53	75.52	76.54
	Country	7.49	12.32	17.95	2.94	5.82	10.19	0.77	1.61	2.86
	Idio.	26.58	31.85	36.36	52.99	57.04	59.59	20.89	22.20	23.47
JAP	Common	55.94	57.15	58.33	39.95	41.05	42.13	30.87	31.94	32.99
	Country	27.36	29.82	32.27	0.09	0.21	0.43	41.22	44.94	48.63
	Idio.	10.69	12.99	15.37	57.42	58.51	59.61	19.71	23.19	26.81
CONTROL	Common	60.49	61.61	62.72	39.91	40.90	41.89	47.28	48.42	49.59
	Country	14.58	17.96	21.41	1.75	3.00	4.83	17.71	20.96	24.57
	Idio.	17.12	20.40	23.54	53.76	55.81	57.36	26.96	30.51	33.62

Notes: The variance share attributable to the relevant factor is reported, where "Idio." is an abbreviation for "idiosyncratic factor". 33%, 50% and 66% correspond to the respective quantiles of posterior shares. The variance shares are computed at each pass of the Markov chain. The results for the Euro area countries in this extended model are not shown, since they do not differ substantially from the ones reported in Table 4. The complete set of results are available upon request from the author.

worldwide increase in business cycle synchronization, Portugal, Ireland and Greece seem to be decoupled from these global influences. At the same time, the core countries are strongly influenced by these worldwide developments.

4 Conclusion

In this paper I analyze the evolution of business cycle synchronization within the Euro area before and after the introduction of the Euro. For this purpose I consider a pre-Euro period (1991 - 1998) and a Euro period (2000 - 2010) and estimate a *Bayesian dynamic factor model* for each sub-period separately. I show that there is strong comovement in output, consumption and investment growth for most Euro area countries already in the pre-Euro period. A comparison of the two sub-samples highlights that synchronization has further increased for the core Euro area group, while it has decreased for most of the peripheral countries. This finding supports the argument that the introduction of the Euro has promoted imbalances between the core and the periphery of the currency union. Taking the control group of G-7 economies into account, the results suggest that the detected increase in business cycle synchronization in the core group is due to a worldwide development of increased business cycle synchronization, instead of being a distinct feature of the core Eurozone. It underlines that the core countries are considerably influenced by worldwide forces, an indication of their integration into the world economy. For the peripheral countries, however, these global influences are less important.

The different exposure to worldwide shocks illustrates one aspect in which member countries of the Eurozone obviously differ considerably. This necessarily represents a challenge for the Euro area, since the European Central Bank (ECB) can react to shocks only with a common monetary policy. Overall, the different developments between the core and the periphery show the need of a higher degree of economic policy coordination and close cooperation between the Euro area member states and the ECB in order to prevent a breakup of the currency union.

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