FIW Working Paper N° 38
December 2009

Business Cycle Dynamics in the Euro Area: A Factor-SVAR Approach*

Atilim Seymen†

Abstract

The study investigates the business cycle dynamics in the euro area using an empirical framework which comprises common global and euro area shocks as well as allows bilateral spillovers of country-specific shocks across the member economies. Three core questions lie at the heart of the analysis: (i) To what extent are the business cycles of the euro area countries driven by commonand spillover shocks? (ii) What are the extent and sources of business cycle heterogeneity in the euro area ? (iii) Which mechanisms led to the moderation of business cycle activity in the euroarea until recently?

JEL Codes: E32, C32, F00, O52
Keywords: Euro Area Business Cycles; Common and Country-Specific Shocks; Spillovers; Factor-Structural Vector Autoregression

The author

I am greately indebted to Bernd Lucke for his comments and suggestions on earlier drafts of this work. The paper is heavily based on Chapters 2, 3 and 4 of my PhD thesis. Any errors are my own. †Address: Centre for European Economic Research (ZEW), P.O. Box 103443, D-68304 Mannheim, Germany. E-mail: seymen@zew.de

Business Cycle Dynamics in the Euro Area: A Factor-SVAR Approach*

Atılım Seymen†

This version: October 30, 2009

Abstract

The study investigates the business cycle dynamics in the euro area using an empirical framework which comprises common global and euro area shocks as well as allows bilateral spillovers of country-specific shocks across the member economies. Three core questions lie at the heart of the analysis: (i) To what extent are the business cycles of the euro area countries driven by common and spillover shocks? (ii) What are the extent and sources of business cycle heterogeneity in the euro area ? (iii) Which mechanisms led to the moderation of business cycle activity in the euro area until recently?

JEL classification: E32, C32, F00, O52

Keywords: Euro Area Business Cycles; Common and Country-Specific Shocks; Spillovers; Factor-Structural Vector Autoregression

*I am greately indebted to Bernd Lucke for his comments and suggestions on earlier drafts of this work. The paper is heavily based on Chapters 2, 3 and 4 of my PhD thesis. Any errors are my own.

†Address: Centre for European Economic Research (ZEW), P.O. Box 103443, D-68304 Mannheim, Germany. E-mail: seymen@zew.de

1. Introduction

An important prerequisite for a successfully functioning currency area is that its member countries' business cycles are sufficiently similar to each other.[1] This requirement can be fulfilled only when business cycles of member economies are driven by common (rather than idiosyncratic) sources. Therefore, many studies in the corresponding literature measure the share of common shocks in the business cycle fluctuations of the euro area countries. Theoretically, it is possible to distinguish between two types of shocks in economies: (i) common shocks of purely international nature hitting all countries at the same time; and (ii) country-specific shocks that may or may not be spilled over to other economies through channels such as trade, financial markets etc.[2] In the existing empirical literature on international business cycle international linkages are typically modelled via common shocks (factors), while spillovers of shocks are often ignored.[3] An important exception is the study by Stock and Watson (2005), who allow spillovers across the G7 economies in addition to common shocks.[4]

In this paper we employ a slightly modified version of the factor-structural vector autoregression (FSVAR) model of Stock and Watson (2005) to study the business cycle dynamics in the euro area. An important difference of our framework is that we distinguish between two different types of common shocks (global and euro area), since our model includes the US economy as well as six member economies of the euro area. This distinction makes sense given a number of studies that established a distinct world and/or euro area business cycle; it prevents a mingling of global and euro area phenomena.[5] The identification of the common

[1]The optimum currency area (OCA) theory sets some guidelines on the conditions that should be fulfilled for a successful monetary union. See, e.g., Mundell (1961).

[2]An oil price shock is a typical example of type (i), while a stock market shock hitting a major economy and then spreading to other economies is an example of type (ii). A shock that is not spilled over to other economies could be an earthquake or harsh weather conditions reducing the production capacity in a single economy.

[3]See, e.g., Gregory, Head, and Raynauld (1997), Kose, Otrok, and Whiteman (2003), Artis, Krolzig, and Toro (2004), Giannone and Reichlin (2006) and Del Negro and Otrok (2008).

[4]Models that contain only common shocks and do not allow spillover of shocks would possibly classify a portion of spillover shocks as common shocks, see the discussion in Stock and Watson (2005).

[5]This issue has often been ignored in the literature. For example, Stock and Watson (2005) report the emergence of a euro area group within the G7 but do not model a distinct euro area factor in their FSVAR. Kose, Otrok, and Prasad (2008), who specifiy (among others) region-specific factors as a potential source of business cycle fluctuations, do not include a euro area factor. In another example, Giannone and Reichlin (2006) estimate SVARs for the euro area economy with only a euro area shock as common shock but do not

shocks is achieved using the type of restrictions discussed in Giannone and Reichlin (2005, 2006). The first issue we investigate in our study is the shares of different types of shocks in output fluctuations of the euro area member countries corresponding to business cycle periodicities. We compute forecast error variance decompositions (FEVD) of some member countries' output to this end.

Note that being driven by common and/or spillover shocks is a necessary condition for the success of a currency area, but it is not sufficient. A high share of these shocks in business cycle fluctuations of member countries generates heterogeneous cycles when common and spillover shocks do not lead to similar dynamics across member economies, which would be an unfavourable situation according to the OCA theory.[6] Hence, the second issue we deal with in this study is the extent and sources of business cycle heterogeneity in the euro area. We compute, on the one hand, counterfactual correlations of output forecast errors across member countries, while, on the other hand, FEVDs of bilateral output *differentials* corresponding to busines cycle periodicities of the member countries.

The investigation covers the period 1970–2007 and is carried out with quarterly log real GDP data.[7] We find it important to include the aforementioned two different types of common shocks, since the European Monetary Union (EMU) process has been taking place concurrently with the globalisation phenomenon, and both of these processes are characterised by a stronger integration of world/European markets. We present statistics based on the entire sample at hand as well as two discrete sub-samples: 1970Q1–1990Q2 and 1990Q3–2007Q4.[8] Splitting the sample into two sub-samples as such allows us to capture changes that occurred in the business cycle dynamics of the euro area after the initiation of the EMU process. In this way, we are able to answer questions such as whether there has been an increase in the share of common euro area shocks in the cyclical fluctuations in the EMU

attempt at identifying a global component. All these models may mix up global and euro area phenomena by construction. Bovi (2005) emphasises, on the other hand, the importance of comparing the degree of globalisation and Europeanisation.

[6] Quoting Bayoumi and Eichengreen (1992), "If disturbances are distributed symmetrically across countries, symmetrical policy responses will suffice. [...] Only if disturbances are distributed asymmetrically across countries will there be occasion for an asymmetric policy response and may the constraints of monetary union bind."

[7] The data set is retrieved from Datastream, the original source being the OECD.

[8] 1999Q3 is the quarter at which the first stage of the EMU process has been initiated along the lines of the Delors report.

period, or whether sources of business cycle heterogeneity have changed in the latter period.[9]

Another advantage of splitting the sample is that it enables us to assess the sources of the moderation in business cycle volatility since the 1980s until a short time ago. While the current crisis seems to have brought an end to the period of the so-called Great Moderation, the phenomenon lasted for about two decades and deserves a scrutiny in the euro area context. Most of the studies on this subject concentrate on the US, the G7 countries or a sub-group of the OECD countries, while a euro area perspective has often been missing.[10] In this study, we also establish a decline in the volatility of output differential—a measure of heterogeneity—forecast errors corresponding to business cycle periodicities in the euro area, which must not necessarily follow as a by-product of a decline in the volatility of the output forecast errors as we argue. Moreover, the concurrence of the moderation in many countries makes the question interesting whether it is related to changes in international rather than domestic factors, while this perspective has been missing in many studies. Furthermore, we explore whether the decline in business cycle volatility has its roots in changes in shock propagation mechanisms or in changes in size of shocks. If the latter channel plays the main role, the Great Moderation can be interpreted to be related to good luck and/or good policy, while a dominant role of changes in shock propagation suggests that structural changes in economies is the main driving force of the Great Moderation.

The rest of the paper is structured as follows. We discuss the specification of our empirical model in the next section, which is followed by the presentation of the results in Section 3. Section 4 provides further insights on our discrete-sample results by reporting findings from rolling window samples. Section 5 concludes.

2. The factor-structural VAR model

The empirical approach underlying the estimations of this study is borrowed from Stock and Watson (2005). The point of departure is a seven-variable reduced-form VAR that contains the log output of the seven countries included in the analysis. The only deterministic

[9]Although we call the second sub-period the EMU period, it could also be called as the globalisation period due to the aforementioned concurrence of both phenomena.

[10]The study by Cabanillas and Ruscher (2008) is an exception.

term is assumed to be a constant in each equation. The moving average (MA) representation of the model is given by

$$y_t = \mu + \sum_{j=0}^{\infty} \phi_j u_{t-j}, \tag{1}$$

where the variables in (1) are ordered as

$$y_t = \begin{bmatrix} y_t^{US} & y_t^{bel} & y_t^{deu} & y_t^{esp} & y_t^{fra} & y_t^{ita} & y_t^{nld} \end{bmatrix}',$$

i.e., the log output of the US, Belgium, Germany, Spain, France, Italy and the Netherlands, respectively; μ is the 7×1 constant vector; ϕ_j for $j = 0, 1, \ldots$ are 7×7 the moving average coefficient matrices; and u_t is the 7×1 vector of VAR innovations.[11] In contrast to Stock and Watson (2005) who estimate their model comprising the log output of the G7 economies in first differences, we estimate our model in levels. This issue is important, since a VAR in first differences would be misspecified in case the underlying time series are cointegrated. Our investigation with smaller VARs containing only sub-groups of countries indeed hints at some cointegration within the group of countries we consider. Yet, it is hard to determine the cointegration rank for a model with seven variables and the short samples we have at hand. We therefore follow Giannone and Reichlin (2006) in estimating our VAR in levels instead of estimating a vector error correction model (VECM) where the number of cointegrating equations has to be determined beforehand.

The identification of common and country-specific shocks follows from a different procedure than in the case of a conventional SVAR model. It is assumed that the error terms u_t in (1) possess a factor structure given by

$$u_t = \Gamma f_t + \xi_t, \tag{2}$$

where f_t stands for a $k \times 1$ vector of common factors (shocks) at period t, Γ is a $7 \times k$ matrix of loadings, and ξ_t is a 7×1 vector of country-specific (idiosyncratic) shocks.[12] The common

[11] Note that the total output of the six euro area member economies in our data set constitutes about 90% of the euro area economy's output that consisted of 12 member economies until 2007.

Using quarterly data comes at the cost of losing some countries in the data set. The problematic led many authors to carry out their estimations with monthly industrial production or annual GDP data.

[12] See also Chamie, DeSerres, and Lalonde (1994), Xu (2006) and Seymen and Kappler (2009) for models

and country-specific shocks are assumed to be independent from each other as well as among each other such that $E(\xi_t f_t') = 0$, and their covariance matrices,

$$E(f_t f_t') = \begin{bmatrix} \sigma_{f_1} & & 0 \\ & \ddots & \\ 0 & & \sigma_{f_k} \end{bmatrix} \text{ and } E(\xi_t \xi_t') = \begin{bmatrix} \sigma_{\xi_1} & & 0 \\ & \ddots & \\ 0 & & \sigma_{\xi_7} \end{bmatrix},$$

are diagonal.[13] Notice that ϕ_0 in (1) is a 7×7 identity matrix in this framework. This implies that the impact effect of common shocks, represented here by the factors in f_t, is solely determined by the loadings in Γ, while no spillover to other countries of country-specific shocks is allowed at the impact period. However, country-specific shocks are spilled over to other countries after the impact period in the model, since ϕ_j are neither 7×7 zero matrices nor diagonal matrices for $j > 0$.[14]

An issue of concern when estimating the VAR underlying the MA representation in (1) is the number of lags p to be included in the estimation. The convention is that each equation has $7p$ regressors, which would obviously imply an ominously high number of regressors even for a small p given the length of the small samples at hand. We follow Stock and Watson (2005) and estimate a VAR(p_1, p_2) with GLS techniques, where p_1 is the number of lags of own output and p_2 is the number of lags of the other countries' outputs in each country's equation in the VAR. This structure decreases the number of coefficients to be estimated considerably. We report results from a VAR$(4, 1)$ estimation as suggested by various information criteria.

We estimate (2) by maximising the corresponding log-likelihood function using the Kalman filter and the EM-algorithm. (2) is the measurement equation, whereas the factors f_t stand for the unobservable state variables that are white noise. Likelihood ratio tests can be car-

connecting the shocks of structural VAR models in a similar manner.

[13] The common factors can be labelled as shocks in our framework. Note that we include enough lags in our VAR in order to assure the "white-noiseness" of u_t in (1). Hence, the factors cannot exhibit any autocorrelation.

[14] Note that we have also considered to augment our FSVAR model with the euro area output. However, including the euro area output in this model framework would have the implausible implication that there are euro-area-specific shocks with a non-zero impact effect on the entire euro area, but no impact effect on the individual member countries. Moreover, the likelihood ratio test did also not support a common factor structure for that eight-variable model.

ried out to determine the appropriate number of factors to be included in the model, since the model in (1) and (2) is overidentified if $k > 0$. Applying overidentification tests, we find that $k = 1$ is rejected neither for the full sample nor the first sub-sample, while it is rejected for the second sub-sample. $k = 2$ is not rejected for the first sub-sample but rejected for the second sub-sample when both factors are left unrestricted. However, it cannot be rejected when the second factor is not allowed to have an impact effect on the US output, i.e, $\Gamma(1, 2) = 0$ in any of the samples we consider. Such a structure implies that the first factor has a non-zero impact effect on the US as well as all euro area economies, whereas the second factor has no impact effect on the US economy but on the euro area economies. This is a structure advocated by Giannone and Reichlin (2005, 2006) as well as Perez, Osborn, and Artis (2006).[15] Giannone and Reichlin motivate the relationship between the US and the euro area with Granger causality tests (among others) and find that "the euro area rate of growth adjusts itself to the US growth while the US does not respond to shocks specific to the euro area".[16] Albeit we impose this restriction only with respect to the impact period, euro area shocks play an only negligible role in US output fluctuations in longer horizons as well. That common euro area shocks have an impact effect on all member countries but country-specific shocks can have an impact on the euro area only with a time lag is the restriction imposed by Giannone and Reichlin (2006) on bivariate VAR models containing the log output of the entire euro area and a member country.

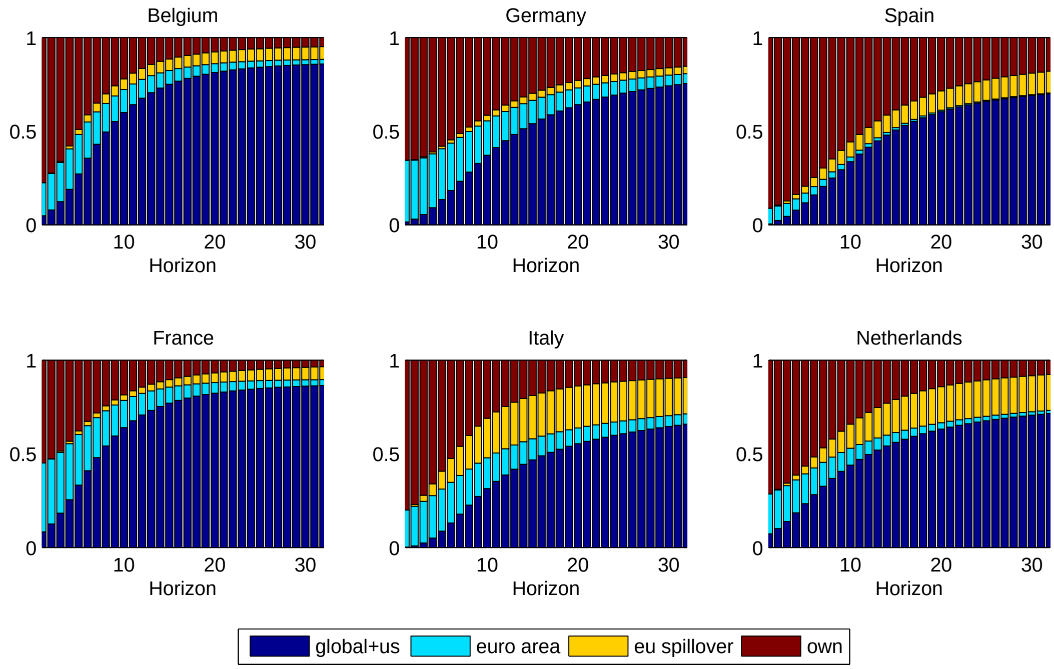
3. Results

3.1. Driving forces of output fluctuations

We start our analysis with driving forces of output fluctuations by computing FEVDs for a forecast horizon of up to 32 quarters. The estimates in Figure 1(a) are computed using the whole data set. These attribute a considerable share to global shocks in output

[15] Perez, Osborn, and Artis (2006) estimate trivariate VARs containing the log-output growth of the US, EU15 (the first fifteen members of the EU) and one of the G7 countries except the US, of which innovation they orthogonalise using the Cholesky decomposition. The first and second shocks are interpreted as global and European shocks by these authors.

[16] The Granger-causality tests of Giannone and Reichlin (2005) are carried out with yearly data. Tests based on quarterly data, of which results we do not report here, are also in accordance with this picture.

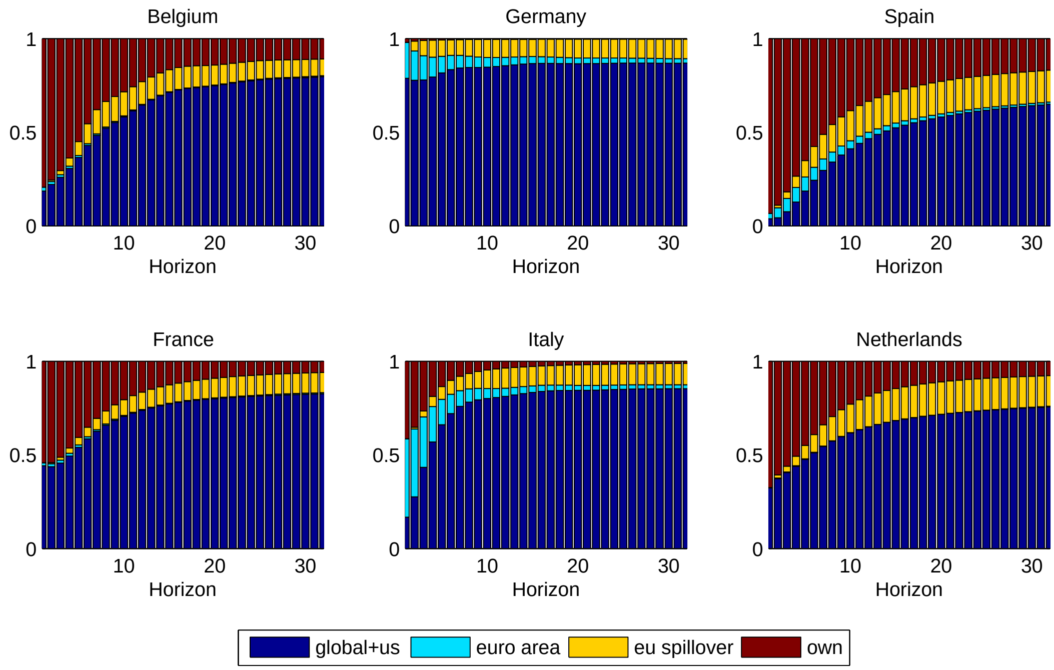


(a) Sample: 1970Q1–2007Q4

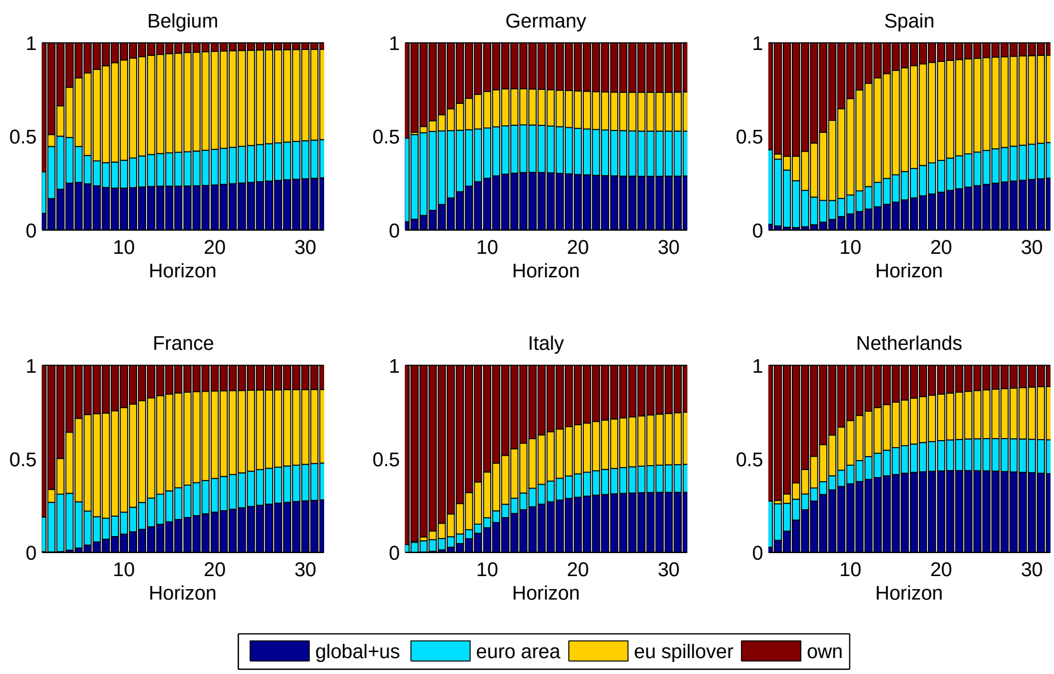
Figure 1: FEVD of output

forecast errors. The share of global (+US) shocks become higher with increasing forecast horizon for all member economies according to the entire-sample estimation, while the share of common euro area or euro area spillover shocks is negligible. Country-specific shocks are important for output fluctuations at shorter horizons, albeit the degree of their importance differs across the member economies. Spain is the member economy where own shocks play the most important role for output forecast error dynamics.

The first sub-sample estimates of the shares of shocks in output forecast error variance corresponding to the period 1970Q1–1990Q2, depicted in Figure 1(b), are broadly in line with the entire sample-estimates for Belgium, France and Spain. We observe, however, higher shares of global shocks in the output fluctuations of Germany, Italy and the Netherlands when the first sub-sample underlies the estimation in comparison to the estimation carried out using the entire sample. All other shocks, including the own shocks, play only negligible roles in the output forecast error variance for all forecast horizons in the extreme case of Germany.



(b) Sample: 1971Q1–1990Q2



(c) Sample:1990Q3–2007Q4

Figure 1: FEVD of output

The second sub-period FEVD estimates, depicted in Figure 1(c), correspond to the EMU period 1990Q3–2007Q4 and differ strongly from the former estimates. Shares of common euro area shocks are still often insignificant, but higher in terms of point estimates than in the former sample. More importantly, euro area spillover shocks are particularly important for the output fluctuations of Belgium, Spain and France in the second sub-period. In total, the output fluctuations of the member countries seem to be much more exposed to euro area dynamics, be it through common shocks or spillover of country-specific shocks within the euro area, in the second sub-period. Country-specific shocks seem to matter rather at shorter forecast horizons than at longer horizons as before, while global shocks still have statistically significant but low shares.

In order to quantify the significance of the change in shares of shocks in forecast error variance from the first sub-period to the second, we carry out Monte Carlo simulations. The results for 12-quarters-ahead forecast errors are reported in Table 1. We see a decline in the share of global shocks for each member country in the first row of the table. The decline is statistically significant in all member countries except the Netherlands. The change in the share of the common euro area shock is positive for all member countries; however, it is not statistically significant with the exception of Germany. An increase in the share of euro area spillover shocks is also registered for each member country; it is yet significant only in the cases of Belgium, Spain and France. Finally, we observe significant increases in the share of own shocks for Germany and Italy, whereas shares of own shocks have not significantly changed in the other member economies.

3.2. Heterogeneity

The foregoing findings point to an important role of common, particularly global, shocks in the first sub-period and equally important roles of common (both global + euro area) and country-specific (spillover + own) shocks in the second sub-period in the output dynamics corresponding to business cycle periodicities. However, the previous analysis does not give information on the extent to which these shocks lead to synchronous business cycle dynamics across the member economies. In the following, we compute counterfactual correlations of forecast errors with respect to different shocks as well as FEVDs of output *differentials* in

Table 1: Forecast error variance decomposition of output

	Change in the share of shocks over time					
	bel	deu	esp	fra	ita	nld
global + us	-0.42	-0.56	-0.35	-0.61	-0.63	-0.26
	(0.19)	(0.21)	(0.20)	(0.21)	(0.19)	(0.20)
euro area shock	0.16	0.21	0.09	0.14	0.03	0.12
	(0.10)	(0.13)	(0.12)	(0.12)	(0.11)	(0.09)
eu spillover	0.41	0.10	0.39	0.45	0.15	0.08
	(0.16)	(0.17)	(0.18)	(0.19)	(0.16)	(0.18)
country shock	-0.16	0.24	-0.12	0.03	0.45	0.06
	(0.13)	(0.12)	(0.19)	(0.15)	(0.17)	(0.15)

Notes: Shares of shocks in the period 1990Q3–2007Q4 subtracted by shares of shocks in the period 1970Q1-1990Q2. 12-quarters-ahead forecast errors underlie the computations. Approximate standard errors, shown in parentheses, are computed by Monte Carlo simulation. *Abbreviations*: bel: Belgium, deu: Germany, esp: Spain, fra: France, ita: Italy, nld: the Netherlands.

order to shed light on the sources of business cycle heterogeneity in the euro area.

3.2.1. Counterfactual correlations

The most widely-used tool for measuring synchronisation and assessing the heterogeneity is the unconditional Pearson correlation between each member country's cycle and a reference-country cycle as well as between cycles of country pairs. A disadvantage of this approach is that correlation analysis requires choosing a method among many alternatives for extracting the cyclical component of macroeconomic time series. It is, however, well-known that characteristics of cycles depend heavily on the method with which they are extracted.[17] Therefore, we follow den Haan (2000) and compute bilateral unconditional and conditional correlations of 12-quarters-ahead FSVAR forecast errors of output. In the following, conditional correlations refer to correlations that would have arised if only one of global, euro area or country-specific shocks took place.

The correlations corresponding to the first sub-period are reported in Table 2(a). The estimated unconditional bilateral correlations in the upper left panel are highly significant,

[17]See, e.g., Canova (1998).

the point estimates of 11 (out of 15) correlations being above 0.70. This suggests a high synchronicity of output fluctuations across the member countries before the initiation of the EMU. According to the estimates reported in the upper right panel, we would have observed even higher correlations if only global shocks had taken place in the first sub-period, many of them being even above 0.90. Note, however, that all bilateral correlations corresponding to Spain are estimated quite imprecisely, although the point estimates are high, which possibly reflects the different character of the Spanish economy from the other member economies in the first sub-period.

The counterfactual correlations with respect to the common euro area shock are reported in the lower left panel of Table 2(a). With the exception of the relationship between Belgium and France, all of these correlations are statistically insignificant. Indeed, the high standard errors reflect the fact that the euro area factor is redundant in the first sub-period as suggested also by the likelihood ratio tests used to determine the number of factors to be included in the FSVAR. Finally, country-specific shocks that take at least one quarter to spill over to other member economies would have also led to high and significant correlations of output fluctuations, if they had taken place alone in the first sub-period, as can be read from the lower right panel of the table. Note that the Spanish economy has statistically significant links to other member economies through this channel.

While an issue in the pre-EMU period was whether would-be members' business cycles were sufficiently synchronised, many studies have also investigated whether the EMU has led to a change in terms of business cycle synchronisation in the euro area. Ambigious results are registered in the literature in this respect. A comparison of the upper left panel of Table 2(b), corresponding to the second sub-period, with the same panel of Table 2(a) shows that some of the bilateral correlations increased, while others decreased, in the latter period. Yet, none of these changes are found to be statistically significant due to high standard errors.

Interestingly, important changes are found in the counterfactual correlations, although no statistically significant changes can be established for the unconditional correlations. For example, counterfactual correlations with respect to the global shock are very high in terms of point estimates, the lowest value being 0.79 for the relationship between Belgium and Spain, whereas many of these are insignificant in contrast to the first sub-period estimates.

Table 2: Correlations of output forecast errors in the euro area

	Unconditional					Only global shock				
	bel	deu	esp	fra	ita	bel	deu	esp	fra	ita
deu	0.81					0.93				
	(0.11)					(0.23)				
esp	0.69	0.52				0.82	0.82			
	(0.16)	(0.26)				(0.58)	(0.59)			
fra	0.84	0.89	0.68			0.96	0.98	0.87		
	(0.11)	(0.09)	(0.21)			(0.20)	(0.14)	(0.59)		
ita	0.86	0.88	0.61	0.91		0.98	0.96	0.85	0.99	
	(0.10)	(0.10)	(0.22)	(0.08)		(0.22)	(0.27)	(0.65)	(0.26)	
nld	0.71	0.76	0.76	0.76	0.75	0.83	0.97	0.76	0.92	0.86
	(0.14)	(0.14)	(0.13)	(0.14)	(0.15)	(0.21)	(0.17)	(0.46)	(0.13)	(0.30)

	Only euro area shock					Only country-specific shocks				
	bel	deu	esp	fra	ita	bel	deu	esp	fra	ita
deu	-0.63					0.83				
	(0.42)					(0.13)				
esp	0.65	-0.83				0.73	0.67			
	(0.51)	(0.63)				(0.16)	(0.27)			
fra	0.94	-0.74	0.66			0.80	0.90	0.74		
	(0.36)	(0.47)	(0.58)			(0.13)	(0.13)	(0.21)		
ita	0.55	-0.46	0.03	0.66		0.84	0.93	0.71	0.89	
	(0.32)	(0.57)	(0.55)	(0.35)		(0.12)	(0.13)	(0.23)	(0.11)	
nld	-0.41	-0.06	-0.22	-0.24	-0.06	0.67	0.72	0.82	0.71	0.74
	(0.38)	(0.48)	(0.44)	(0.36)	(0.48)	(0.17)	(0.19)	(0.13)	(0.17)	(0.18)

(a) Sample: 1970Q1–1990Q2

Notes: Unconditional and conditional correlations of 12-quarters-ahead forecast errors are reported in the table. Approximate standard errors, shown in parentheses, are computed by Monte Carlo simulation. See Table 1 for abbreviations.

Table 2: Correlations of output forecast errors in the euro area (cont.)

	Unconditional					Only global shock				
	bel	deu	esp	fra	ita	bel	deu	esp	fra	ita
deu	0.64					0.98				
	(0.15)					(0.32)				
esp	0.85	0.44				0.79	0.81			
	(0.10)	(0.22)				(0.48)	(0.61)			
fra	0.85	0.49	0.94			0.88	0.90	0.98		
	(0.09)	(0.21)	(0.04)			(0.30)	(0.48)	(0.31)		
ita	0.58	0.36	0.58	0.61		0.88	0.91	0.98	1.00	
	(0.20)	(0.25)	(0.21)	(0.19)		(0.54)	(0.52)	(0.65)	(0.61)	
nld	0.71	0.54	0.69	0.72	0.69	0.97	0.99	0.90	0.96	0.96
	(0.17)	(0.22)	(0.18)	(0.14)	(0.18)	(0.42)	(0.34)	(0.62)	(0.50)	(0.44)

	Only euro area shock					Only country-specific shocks				
	bel	deu	esp	fra	ita	bel	deu	esp	fra	ita
deu	0.76					0.47				
	(0.22)					(0.18)				
esp	0.98	0.81				0.86	0.28			
	(0.12)	(0.22)				(0.10)	(0.26)			
fra	0.97	0.80	0.99			0.83	0.31	0.93		
	(0.14)	(0.22)	(0.07)			(0.10)	(0.25)	(0.04)		
ita	0.94	0.87	0.97	0.99		0.45	0.07	0.47	0.49	
	(0.31)	(0.35)	(0.30)	(0.28)		(0.22)	(0.27)	(0.22)	(0.20)	
nld	0.94	0.57	0.93	0.88	0.80	0.56	0.26	0.65	0.67	0.61
	(0.33)	(0.33)	(0.31)	(0.28)	(0.29)	(0.20)	(0.26)	(0.18)	(0.16)	(0.18)

(b) Sample: 1990Q3–2007Q4

Another striking change occurs in the counterfactual correlations with respect to the common euro area shock, which are registered to be highly positive and significant in the second sub-period, with the exception of the relationship between Germany and the Netherlands with a point estimate of 0.57 and a standard error of 0.33. The counterfactual correlations with respect to country-specific shocks, i.e. spillovers, are also all positive and mostly significant, yet the corresponding point estimates are lower than the point estimates corresponding to the common shocks.

3.2.2. Output differentials

The main implication of the foregoing counterfactual correlation analysis is that common shocks (global shocks in the first sub-period and euro area shocks in the second sub-period) generate stronger correlation, at least in terms of point estimates, than country-specific shocks. However, a disadvantage of employing correlations for assessing business cycle heterogeneity is that correlation refers only to synchronicity of cycles, while there may still be a differential between the cycles of two countries even when they are perfectly correlated. As Massmann and Mitchell (2004) emphasise, any reduction in cyclical disparity may not necessarily be accompanied by an increase in correlations.[18] When cycles of member countries are not correlated at all but the discrepancy between them is very small, this would be a more favorable situation for the EMU than perfectly correlated cycles with large discrepancies. Therefore, we supplement the previous correlation analysis with an investigation of the driving forces of output differentials that correspond to business cycle periodicities in the following.

The FEVDs of output differentials are illustrated in the two panels of Figure 2 corresponding to our two sub-periods. A striking difference between both periods is noticeable. There are several differentials in the first sub-period, of which dynamics are driven to an important extent by the common shocks, see Figure 2(a). This result is particularly surprising given that high and significant counterfactual correlations had been obtained with respect to global shocks in the first sub-period. Own shocks, i.e. the shocks of the two countries

[18]Camacho, Perez-Quiros, and Saiz (2008) investigate the form of the cycles rather than their synchronisation in one rare study.

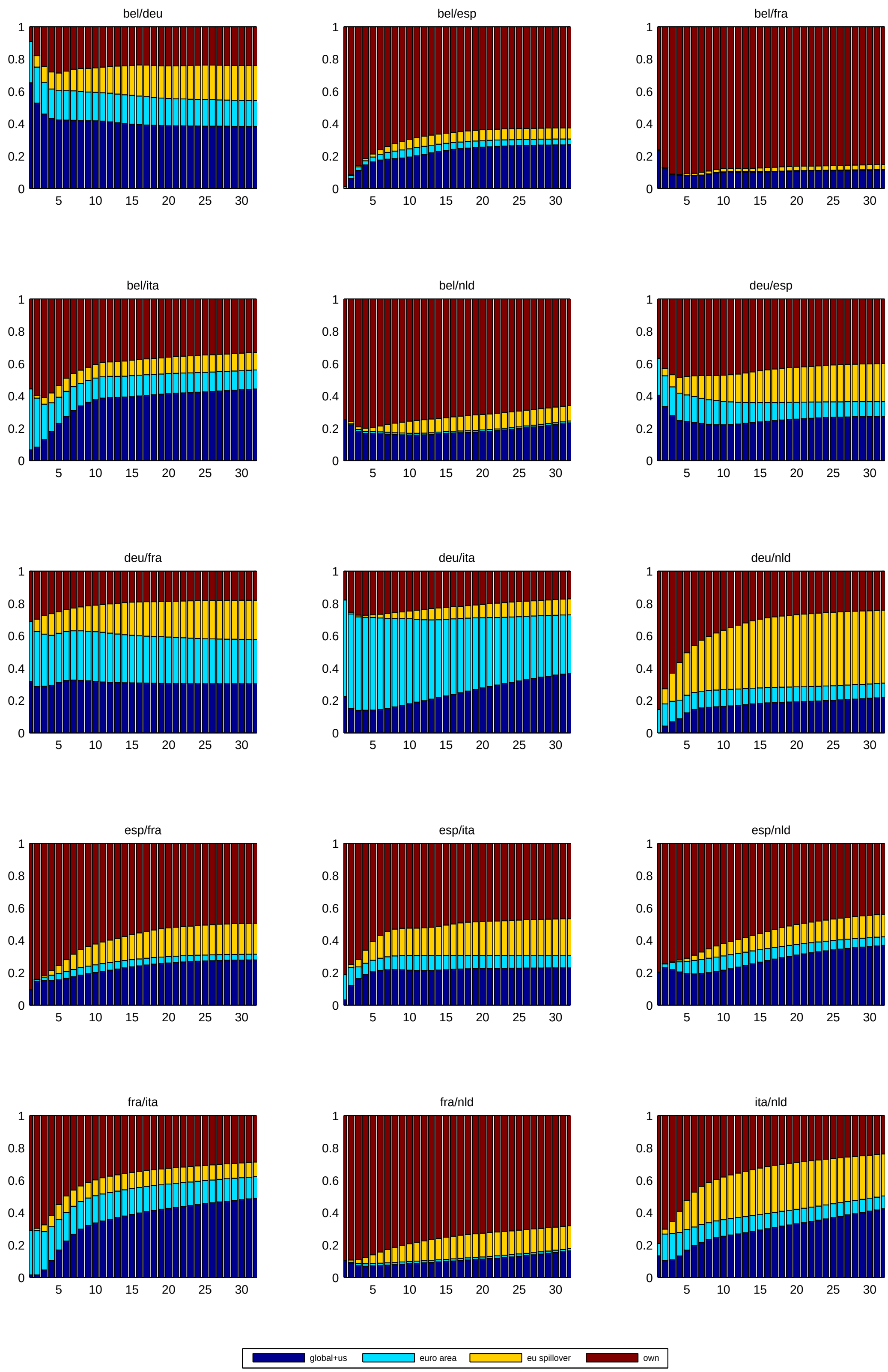
which are involved in a differential, play also a significant and often dominant role in the variance of differentials, whereas spillover shocks are much less important than own shocks. The results presented in Figure 2(b) point, however, to smaller and often negligible roles of common shocks in explaining the forecast error variance of output differentials. Dynamics of most differentials are dominated by own shocks in the second sub-period as indicated by the red areas in the graphs. A striking finding is that an important portion of output differential dynamics are attributable to spillover shocks. This suggests that country-specific shocks, when they are spilled over to other member economies, drive business cycles away from each other.

All in all, our counterfactual correlation and output differential FEVD findings imply that business cycle heterogeneity in the euro area is more due to country-specific shocks rather than heterogeneous responses to common shocks.

3.3. The Great Moderation

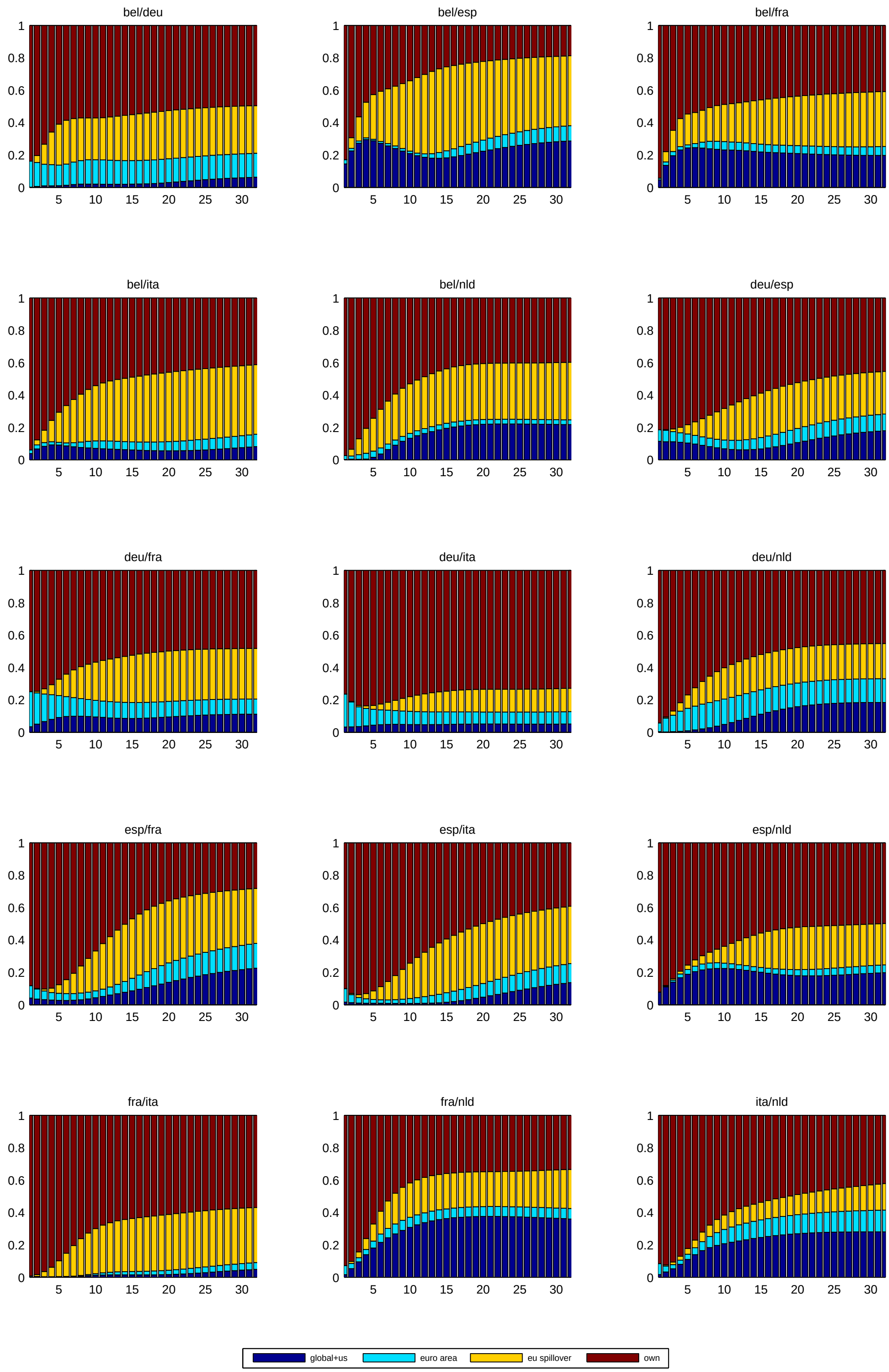
Cabanillas and Ruscher (2008), who focus exclusively on the Great Moderation in the euro area, emphasise the role of good luck, i.e. milder shocks, as well as good policy—particularly "improvements in the conduct of monetary policy and, to a lesser extent, more powerful automatic fiscal stabilisers"—in the moderation, whereas the role of changes in the shock propagation due to, e.g., changes in the sectoral composition or changes in inventory management, has also been put forward as a potential explanatory factor of the moderation.[19] Moreover, Stock and Watson (2005) emphasise the concurrence of the moderation in a number of countries, which might suggest the importance of international factors in that phenomenon. Since our empirical model does not allow us to identify policy shocks explicitly, we investigate the role of only two channels—changes in the size of shocks and changes in shock propagation—that could have potentially led to the Great Moderation. Obviously, we are not able to distinguish between good luck and good policy hypotheses in our analysis, but the role of both channels are collected under the former channel—changes in the size of shocks. The advantage of our model is, on the other hand, that it allows us to assess the extent to which the Great Moderation has been related to international factors.

[19] See Stock and Watson (2002) for a review on the business cycle moderation in the US economy.



(a) Sample: 1970Q1–1990Q2

Figure 2: FEVD of output differentials



(b) Sample:1990Q3–2007Q4

Figure 2: FEVD of output differentials (cont.)

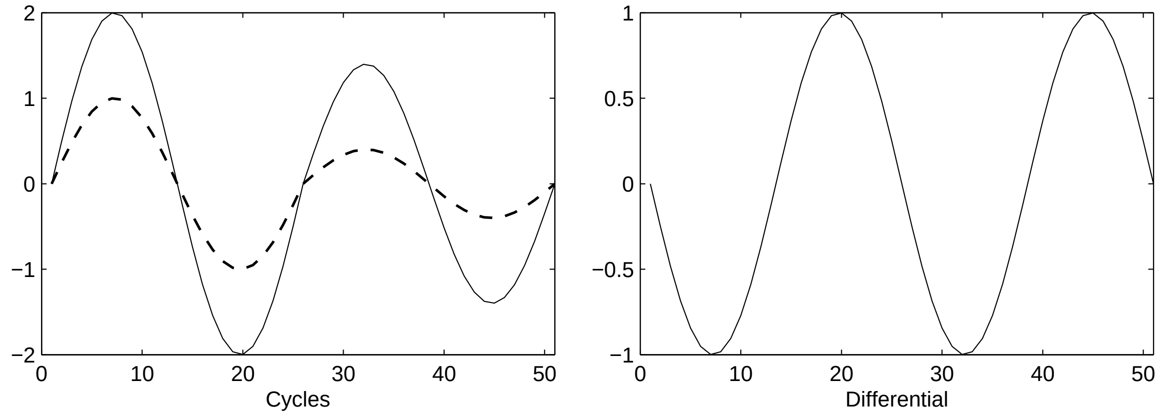


Figure 3: Output cycles and cycle differential of two hypothetical countries

Note that moderation in output fluctuations does not necessarily lead to a moderation in differentials. We illustrate this issue with a hypothetical example in Figure 3. The left panel shows the cycles of two hypothetical countries, the second of which have a lower amplitude than the first cycles. Yet, the differential, shown on the right panel, does not decrease in spite of the decreasing amplitude. One can even conceive cases where the cycles get smaller, but the differential gets wider. A novelty of our study is to include the analysis of volatility change in output differentials, one of our measures of heterogeneity, as well in the following.

3.3.1. Output fluctuations

In order to compute the weight of both aforementioned channels in the Great Moderation observed in each euro area country, we employ the decomposition suggested by Stock and Watson (2005). We write the variance of the output forecast error of a country for a chosen forecast horizon at period p, with $p = 1, 2$ corresponding to the first (1970Q1–1990Q2) and second (1990Q3–2007Q4) sub-periods, as

$$V_p = \sum_{k=1}^{K} V_{pk} \qquad (3)$$

where V_{pk} is the variance of output forecast error at period p with respect to the k^{th} shock, i.e., the variance that would have been observed if only the k^{th} shock took place. Note that the variance V_{pk} is given by $a_{pk}\sigma^2_{pk}$, a_{pk} being a quadratic term and σ^2_{pk} the variance of the

k^{th} shock in period p. We are interested in explaining the change (decline) in the variance of output forecast error variance in each euro area country. The linear structure allows us to write the change in the contribution of the k^{th} shock as

$$V_{2k} - V_{1k} = \left(\frac{a_{1k} + a_{2k}}{2}\right)\left(\sigma^2_{2k} - \sigma^2_{1k}\right) + \left(\frac{\sigma^2_{1k} + \sigma^2_{2k}}{2}\right)\left(a_{2k} - a_{1k}\right). \quad (4)$$

The first term on the right-hand side of (4) measures the contribution of the change in the standard deviation of the k^{th} shock, while the second term measures the contribution of the change in the propagation of the same shock.

The moderation dynamics of 12-quarters-ahead output forecast errors are reported in Table 3. The upper left panel shows the variance in the sub-periods as well as the difference between the variances of the second and first sub-periods. The decline is statistically significant at the 5-percent level for all member economies except for the Netherlands, for which the significance is obtained at the 10-percent level. The contribution to this decline of the change in shock variance is positive in total, see the lower left panel. However, a closer look to the decomposition shows that the common euro area and own shocks' contributions to the decline are negligible and often insignificant, whereas the contribution of global and spillover shocks is big and strongly significant. The contribution to the moderation of the change in shock propagation is in total either insignificant or negative, i.e., without changes in shock sizes we would have observed an increase instead of a decline in 12-quarters-ahead output forecast error variance. The decomposition of this channel with respect to the different types of shocks is also in accordance with this total picture.

The foregoing analysis shows that the Great Moderation in the euro area is due to a decline in the size of shocks. The other channel—changes in shock propagation—contributes, on the other hand either insignificantly or negatively to this phenomenon in the member economies. To answer our second question corresponding to the Great Moderation of whether it was driven more by national or international factors, we look at the upper right panel of Table 3 which shows the total contribution from both channels for each type of shock. The main contribution comes from global and spillover shocks according to our estimates, supporting the view that the Great Moderation has international roots. Common euro area

Table 3: Decomposition of change in output forecast error variance into change in size of shocks and change in propagation

	Variances			Total contribution from shocks			
	70Q1–90Q2	90Q3–07Q4	Change	global	eu	own	spillover
bel	5.99	2.17	-3.82	-0.92	0.34	-1.21	-2.02
	(0.78)	(0.31)	(1.79)	(0.70)	(0.33)	(1.26)	(0.50)
deu	7.88	2.00	-5.88	-2.72	0.16	0.46	-3.78
	(1.16)	(0.44)	(2.33)	(1.21)	(0.43)	(1.58)	(0.32)
esp	15.27	3.47	-11.80	-0.00	-0.10	-4.36	-7.33
	(1.82)	(0.41)	(4.38)	(1.24)	(0.81)	(3.21)	(1.24)
fra	5.78	1.71	-4.07	-1.57	0.22	-0.63	-2.10
	(0.79)	(0.18)	(1.77)	(0.80)	(0.34)	(1.23)	(0.45)
ita	9.97	1.82	-8.15	-3.08	-0.31	0.52	-5.28
	(1.24)	(0.34)	(2.75)	(1.38)	(0.40)	(1.96)	(0.38)
nld	6.99	3.63	-3.36	-0.20	0.43	-0.41	-3.19
	(0.74)	(0.53)	(1.85)	(0.83)	(0.42)	(1.38)	(0.44)

	Contribution of change in shock variance					Contribution of change in shock propagation				
	global	eu	own	spillover	total	global	eu	own	spillover	total
bel	-2.18	-0.04	0.49	-4.90	-6.63	1.26	0.37	-1.70	2.87	2.81
	(0.59)	(0.29)	(1.14)	(0.32)	(1.47)	(0.73)	(0.43)	(1.49)	(0.61)	(2.13)
deu	-3.43	-0.08	0.37	-3.82	-6.96	0.71	0.24	0.09	0.04	1.09
	(1.04)	(0.31)	(1.30)	(0.33)	(1.96)	(1.22)	(0.42)	(1.71)	(0.22)	(2.71)
esp	-1.33	-0.08	-3.49	-6.56	-11.47	1.33	-0.01	-0.87	-0.77	-0.33
	(0.93)	(0.45)	(1.87)	(0.82)	(2.49)	(1.25)	(0.79)	(2.99)	(0.90)	(3.96)
fra	-1.42	-0.03	-0.53	-3.46	-5.43	-0.15	0.25	-0.10	1.36	1.36
	(0.49)	(0.24)	(0.78)	(0.23)	(1.09)	(0.64)	(0.37)	(1.15)	(0.33)	(1.61)
ita	-2.62	-0.05	-0.10	-4.18	-6.95	-0.46	-0.26	0.62	-1.10	-1.20
	(0.84)	(0.23)	(1.12)	(0.42)	(1.62)	(1.05)	(0.38)	(1.68)	(0.33)	(2.48)
nld	-5.39	-0.05	-3.30	-5.99	-14.72	5.19	0.48	2.89	2.80	11.36
	(1.53)	(0.41)	(1.66)	(0.98)	(2.83)	(1.88)	(0.51)	(2.08)	(1.00)	(3.64)

Notes: 12-quarters-ahead forecast errors underlie the estimation. Approximate standard errors, shown in parentheses, are computed by Monte Carlo simulation. See Table 1 for abbreviations.

shocks, also an international source, do not contribute to it. Similarly, the contribution of own shocks is insignificant for all member countries.

3.3.2. Output differentials

As argued above, a moderation of output fluctuations does not necessarily imply a moderation of differentials. Therefore, we apply the decomposition in (4) also to 12-quarters-ahead bilateral output differential forecast errors, of which results are reported in Table 4. The change in 13 of the 15 output differentials, reported in the upper left panel of the table, is negative indicating a decline in the variance. However, only half of these changes are found to be significant. Changes in size of shocks deliver an important contribution to the moderation of output differential forecast errors, the contribution of this channel being statistically significant in 11 of the 15 cases. While global, own and spillover shocks seem to account for this picture in general, the contribution of the change in the variance of the common euro area shock is significant for none of the differentials. The contribution of the other channel—changes in shock propagation—to the moderation of output differential forecast errors is, on the other hand, in 12 of 15 cases insignificant. Hence, the first channel generally seems to be behind the moderation of output differential forecast errors according to the FSVAR estimates.

The contribution through both channels of global shocks, common euro area and euro area spillover shocks are significant in only four, two and two cases, respectively. Own shocks, i.e. the shocks of both countries corresponding to each differential, have, on the other hand, a significant contribution to the moderation in 10 of the 15 cases. Hence, it can be concluded that the moderation of output differential forecast errors is due to country-specific rather then international factors.

4. Alternative samples

The hitherto reported results are based on two sub-periods: 1970Q1–1990Q2 and 1990Q3–2007Q4. The most important reason for splitting the sample at 1990Q2 has been that it corresponds to the official kick-off of the EMU process, as suggested by the so-called Delors report. The report foresees three stages leading to the establishment of the euro area, the

Table 4: Decomposition of change in output differential forecast error variance

	Variances			Total contribution from shocks			
	70Q1–90Q2	90Q3–07Q4	Change	global	eu	own	spillover
bel/deu	2.74	1.49	-1.25	-0.68	-0.26	0.17	-0.47
	(0.54)	(0.34)	(0.87)	(0.28)	(0.29)	(0.43)	(0.45)
bel/esp	8.13	0.96	-7.16	-0.41	-0.38	-5.21	-1.17
	(1.52)	(0.15)	(2.38)	(0.57)	(0.52)	(1.14)	(1.40)
bel/fra	1.86	0.60	-1.26	-0.00	0.03	-1.34	0.06
	(0.51)	(0.14)	(0.66)	(0.13)	(0.17)	(0.21)	(0.52)
bel/ita	2.68	1.70	-0.98	-0.42	-0.27	-0.17	-0.12
	(0.48)	(0.34)	(0.80)	(0.24)	(0.25)	(0.41)	(0.45)
bel/nld	3.84	1.79	-2.05	-0.22	0.01	-2.00	0.16
	(0.81)	(0.34)	(1.19)	(0.35)	(0.35)	(0.50)	(0.77)
deu/esp	11.71	3.14	-8.57	-1.70	-1.39	-3.43	-2.06
	(1.91)	(0.73)	(3.34)	(0.98)	(0.99)	(1.85)	(1.42)
deu/fra	1.68	1.90	0.21	-0.15	-0.32	0.70	-0.01
	(0.32)	(0.48)	(0.77)	(0.25)	(0.25)	(0.44)	(0.40)
deu/ita	2.29	2.46	0.16	-0.18	-0.95	1.33	-0.04
	(0.46)	(0.67)	(1.01)	(0.36)	(0.52)	(0.41)	(0.68)
deu/nld	3.62	2.70	-0.92	-0.29	0.05	0.31	-0.99
	(0.61)	(0.56)	(1.24)	(0.39)	(0.38)	(0.71)	(0.52)
esp/fra	8.28	0.60	-7.68	-0.72	-0.36	-4.60	-1.99
	(1.37)	(0.10)	(2.37)	(0.57)	(0.58)	(1.28)	(1.09)
esp/ita	10.07	2.39	-7.69	-1.91	-0.83	-3.65	-1.30
	(1.67)	(0.40)	(2.83)	(0.88)	(0.76)	(1.45)	(1.22)
esp/nld	6.58	2.17	-4.41	-0.31	-0.49	-2.60	-1.01
	(1.02)	(0.46)	(1.65)	(0.47)	(0.49)	(0.86)	(0.91)
fra/ita	1.96	1.40	-0.57	-0.32	-0.30	0.19	-0.14
	(0.32)	(0.27)	(0.58)	(0.21)	(0.23)	(0.34)	(0.33)
fra/nld	3.15	1.74	-1.41	0.31	0.06	-1.77	-0.02
	(0.56)	(0.36)	(0.95)	(0.35)	(0.34)	(0.52)	(0.55)
ita/nld	4.51	1.88	-2.63	-0.61	-0.27	-0.52	-1.23
	(0.73)	(0.41)	(1.08)	(0.51)	(0.37)	(0.61)	(0.46)

Notes: 12-quarters-ahead forecast errors underlie the estimation. Approximate standard errors, shown in parentheses, are computed by Monte Carlo simulation. See Table 1 for abbreviations.

Table 4: Decomposition of change in output differential forecast error variance (cont.)

	Contribution of change in shock variance					Contribution of change in shock propagation				
	global	eu	own	spillover	total	global	eu	own	spillover	total
bel/deu	-0.39	-0.06	0.65	-1.03	-0.84	-0.29	-0.20	-0.48	0.56	-0.41
	(0.48)	(0.16)	(0.44)	(0.31)	(0.80)	(0.59)	(0.32)	(0.62)	(0.46)	(1.32)
bel/esp	-0.87	-0.04	-0.89	-1.24	-3.05	0.46	-0.34	-4.31	0.08	-4.12
	(0.37)	(0.19)	(0.62)	(0.54)	(1.07)	(0.50)	(0.41)	(0.82)	(1.27)	(1.95)
bel/fra	-0.51	-0.00	0.10	-0.62	-1.03	0.51	0.03	-1.44	0.67	-0.23
	(0.21)	(0.09)	(0.26)	(0.28)	(0.49)	(0.25)	(0.18)	(0.33)	(0.52)	(0.80)
bel/ita	-0.58	-0.04	0.17	-1.84	-2.29	0.16	-0.23	-0.35	1.73	1.31
	(0.48)	(0.19)	(0.78)	(0.37)	(1.09)	(0.58)	(0.32)	(1.01)	(0.43)	(1.53)
bel/nld	-1.23	-0.01	-2.44	-1.25	-4.93	1.01	0.02	0.44	1.41	2.88
	(0.75)	(0.22)	(0.61)	(0.92)	(1.66)	(0.87)	(0.33)	(0.86)	(1.09)	(2.26)
deu/esp	-1.50	-0.15	-2.19	-1.17	-5.01	-0.19	-1.24	-1.24	-0.89	-3.56
	(1.06)	(0.35)	(1.29)	(0.97)	(2.20)	(1.38)	(0.79)	(2.02)	(1.23)	(3.52)
deu/fra	-0.74	-0.06	0.33	-0.68	-1.16	0.59	-0.26	0.37	0.67	1.37
	(0.60)	(0.14)	(0.76)	(0.34)	(1.13)	(0.76)	(0.30)	(1.03)	(0.38)	(1.64)
deu/ita	-0.53	-0.12	0.16	-0.89	-1.37	0.35	-0.83	1.17	0.85	1.54
	(0.70)	(0.27)	(1.16)	(0.72)	(1.70)	(0.92)	(0.57)	(1.43)	(0.65)	(2.40)
deu/nld	-0.87	-0.07	-2.30	-1.32	-4.56	0.58	0.12	2.61	0.32	3.64
	(0.61)	(0.28)	(0.78)	(0.91)	(1.71)	(0.77)	(0.50)	(1.12)	(1.12)	(2.41)
esp/fra	-0.44	-0.04	-2.38	-0.51	-3.36	-0.28	-0.33	-2.23	-1.49	-4.32
	(0.29)	(0.19)	(0.49)	(0.52)	(0.88)	(0.41)	(0.44)	(1.04)	(0.66)	(1.75)
esp/ita	-0.89	-0.09	-3.39	-0.18	-4.54	-1.02	-0.74	-0.26	-1.12	-3.14
	(0.71)	(0.35)	(0.89)	(0.96)	(1.64)	(0.90)	(0.65)	(1.48)	(0.99)	(2.68)
esp/nld	-2.00	-0.05	-4.61	-0.35	-7.02	1.69	-0.44	2.01	-0.66	2.60
	(1.01)	(0.29)	(0.54)	(1.28)	(2.03)	(1.21)	(0.45)	(0.86)	(1.39)	(2.59)
fra/ita	-0.22	-0.03	-0.30	-0.64	-1.18	-0.10	-0.27	0.49	0.50	0.61
	(0.35)	(0.15)	(0.48)	(0.35)	(0.77)	(0.44)	(0.27)	(0.68)	(0.30)	(1.10)
fra/nld	-2.13	-0.01	-2.49	-1.53	-6.17	2.45	0.08	0.72	1.51	4.76
	(0.71)	(0.19)	(0.64)	(0.74)	(1.52)	(0.89)	(0.32)	(0.97)	(0.72)	(2.05)
ita/nld	-1.84	-0.06	-1.76	-1.55	-5.20	1.24	-0.21	1.24	0.31	2.58
	(0.56)	(0.25)	(0.68)	(0.60)	(1.28)	(0.70)	(0.37)	(0.94)	(0.60)	(1.76)

first of which was started on July 1, 1990. It is, however, obvious that other break dates could also have been chosen. Perez, Osborn, and Artis (2006) split their sample, for example, in 1979, the year of the commencement of the European Monetary System (EMS). On the other hand, many studies date 1984 as the start of the Great Moderation in the US. Another candidate year is 1993, which coincides with the establishment of the common market in the EU. However, besides being also somehow arbitrary, all these choices would render two sub-samples with unbalanced length.

Given that the choice of the sample-split date might affect our conclusions, we checked first results from two other discrete samples, 1980Q1–2007Q4 and 1993Q1–2007Q4. It turns out the the first of these sub-samples' results resemble very much the results of the entire sample as well as the the sample 1970Q1–1990Q2, while the results of the 1993Q1–2007Q4 sample are close to the results from the 1990Q3–2007Q4 sub-sample. Note that the 1993Q1–2007Q4 has the advantage of not including the effects of events such as the German reunification or the Exchange Rate Mechanism (ERM) crisis of the early 1990s. Yet, excluding these events has a negligible impact on our previous conclusions based on the 1990Q3–2007Q4 sample.

As another alternative approach for capturing changes in business cycle dynamics in the euro area, we present results from rolling window estimations in the following. Since the number of coefficients and parameters to be estimated is quite high in our empirical framework, we set the window length to 70 quarters in our rolling window estimations so that the first sample covers the period 1970Q1-1985Q2 and the last sample the period 1990Q3-2007Q4 corresponding to (roughly) pre-Great-Moderation and EMU periods, respectively.

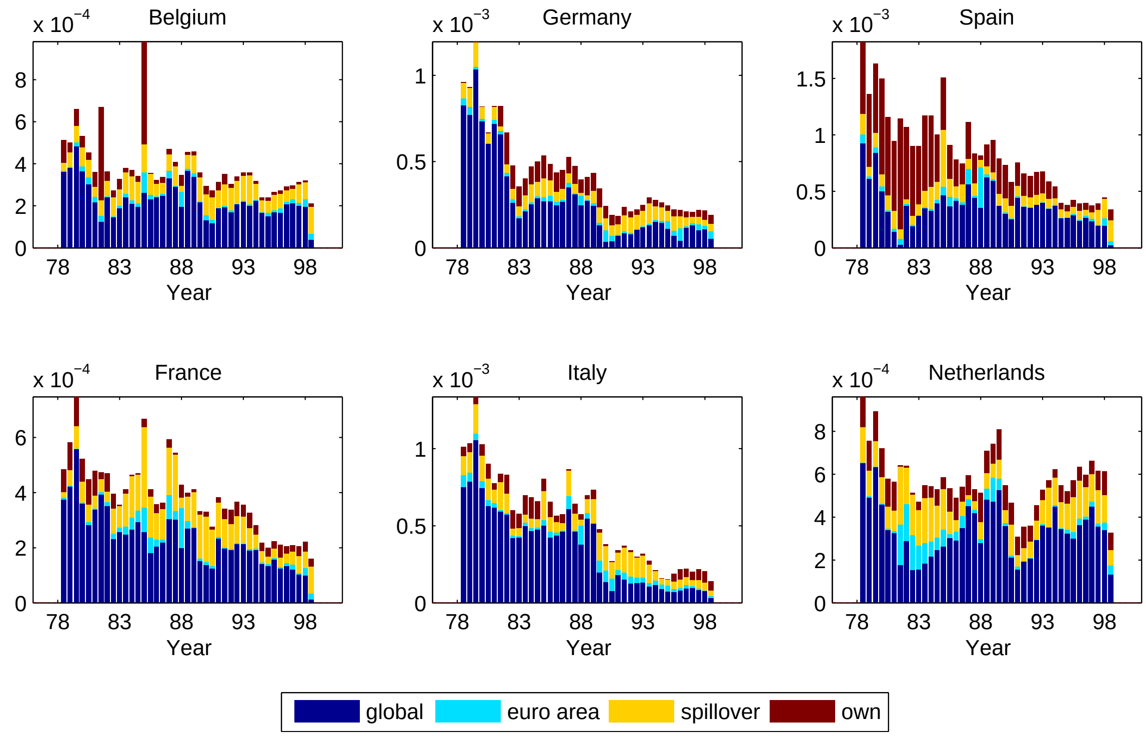
Figure 4(a) shows the variance of 12-quarters-ahead output forecast errors. Estimates corresponding to each rolling window are reported at the center of that window. Hence, the estimate using the data of the first window is reported at 1978Q3 and of the last window at 1999Q1. The decline in the output forecast error variance of each member country is evident. It is registered to be the weakest in the Dutch economy. The pattern of decline also varies across the member economies.

Shares of shocks in the 12-quarters-ahead output forecast error variance is illustrated in the lower panel of Figure 4. The main driver of this variance is the global shock for all member economies according to many 70-quarter rolling window estimates. On the other hand, the common euro area shock can be attributed only negligible shares. The own shock is the dominant driving force only in Spain in the early rolling windows, while it is also of some non-negligible importance in Germany in many rolling windows. The share of the own shock is negligible in the other member economies. Spillovers of country-specific shocks are of some importance in various rolling windows. It should be noted that the high share of spillovers in Belgium, Spain and France in the sub-period 1990Q3-2007Q4 we reported before in Figure 1 is a phenomenon that applies only to the last estimation window in Figure 4(b) as well as the shorter estimation windows starting after 1990Q3 such as 1993Q1–2007Q4 mentioned above.

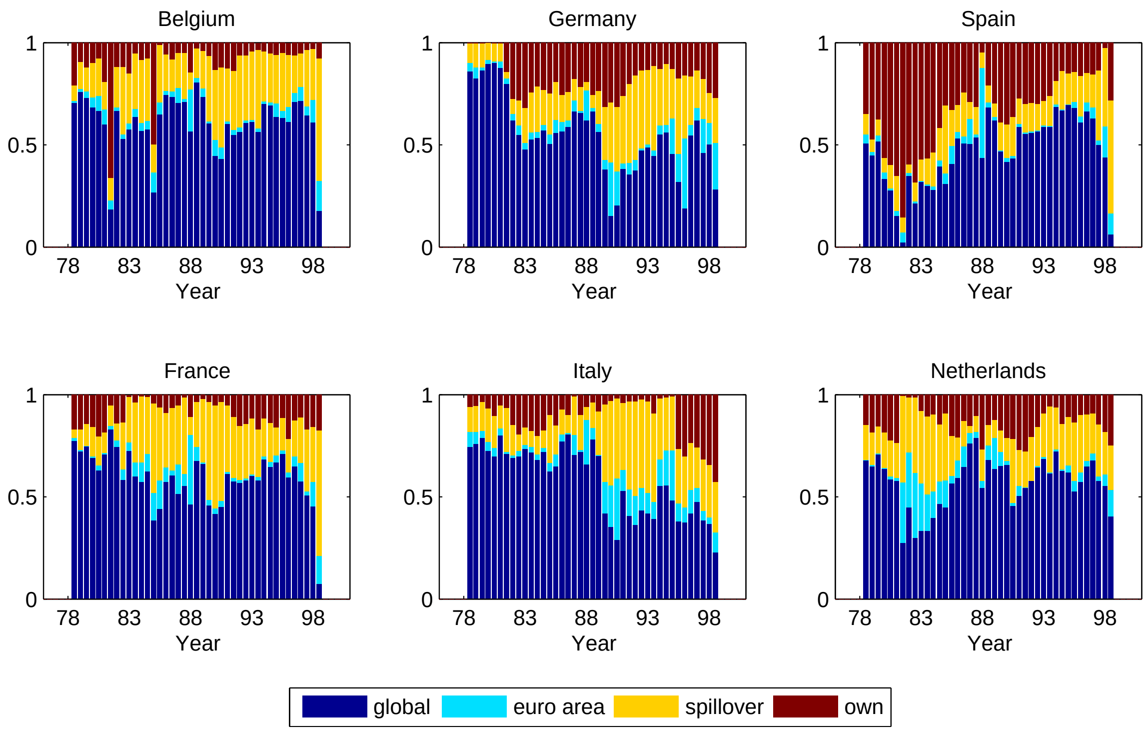
The unconditional bilateral correlations of 12-quarters-ahead output forecast errors depicted in Figure 4. suggest that these have not increased due to, e.g., the EMU or globalisation processes. While these correlations tend to move around a constant for some pairs such as Belgium and Germany, there are also pairs such as Germany and Italy for which the rolling window correlations decrease over time. In other cases such as the relationship between Belgium and the Netherlands a positive trend can be observed, but statistical significance is hard to establish as suggested by the high standard errors in Table 2. We skip reporting the counterfactual correlations with respect to the different types of shocks due to this high estimation uncertainty.

In Table 4, we had reported a significant decline from the first sub-period to the second in roughly half of the 15 output differential forecast error variances with, however, 13 of the 15 reported changes being negative. A declining pattern can generally be observed also in the rolling window estimates illustrated in Figure 6(a), although it is not evident for the German/French and German/Dutch differentials.

The output differentials are to a large extent driven by country-specific shocks as the red and yellow shaded areas in Figure 6(b) point to. Common shocks can be attributed also non-negligible shares in some episodes, but their contribution to the output differential dynamics is more limited in comparison to country-specific shocks.



(a) Variance of output forecast errors



(b) Shares of shocks in the variance

Figure 4: Variance decomposition of 12-quarters-ahead output forecast errors over 70-quarter rolling windows

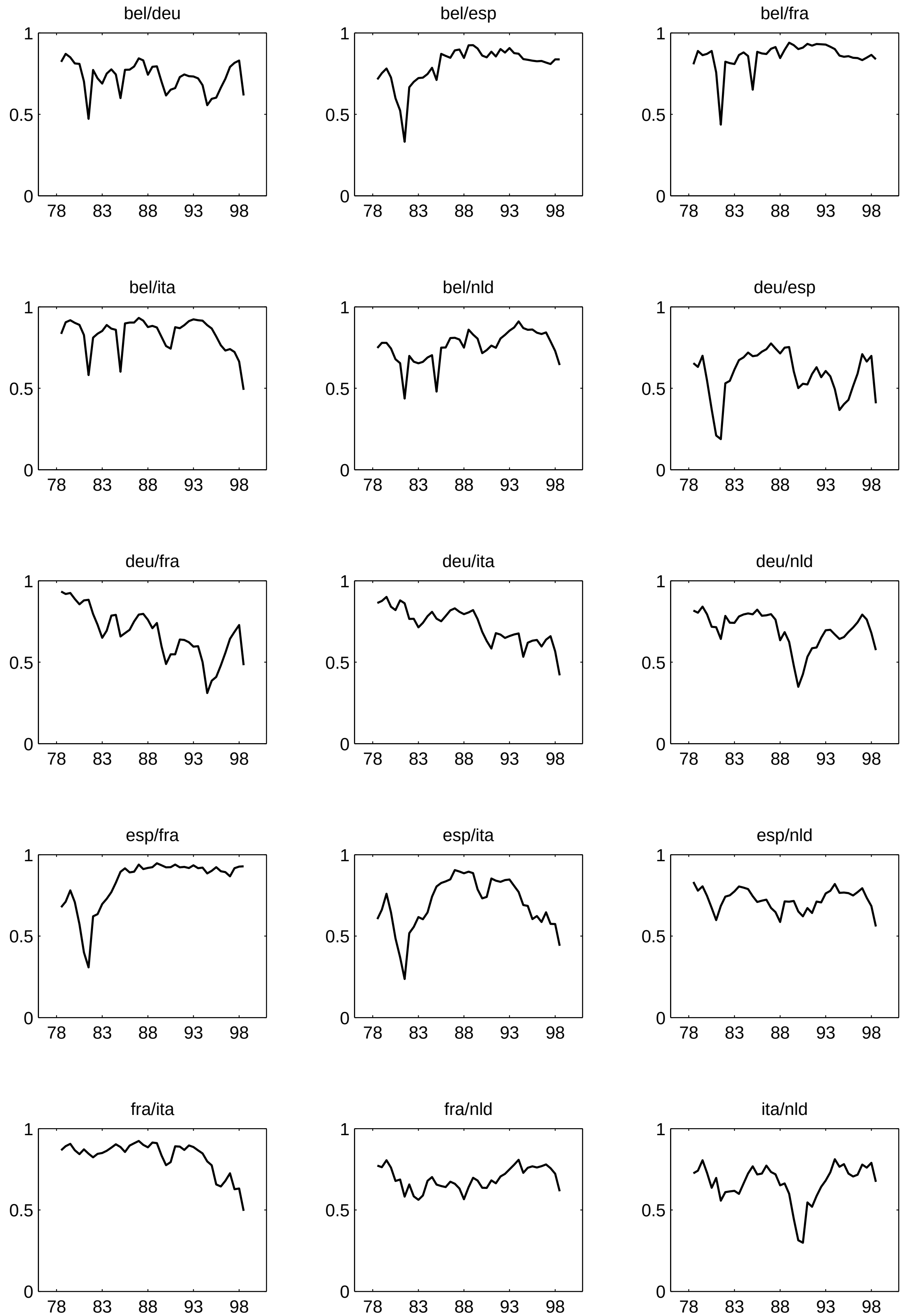
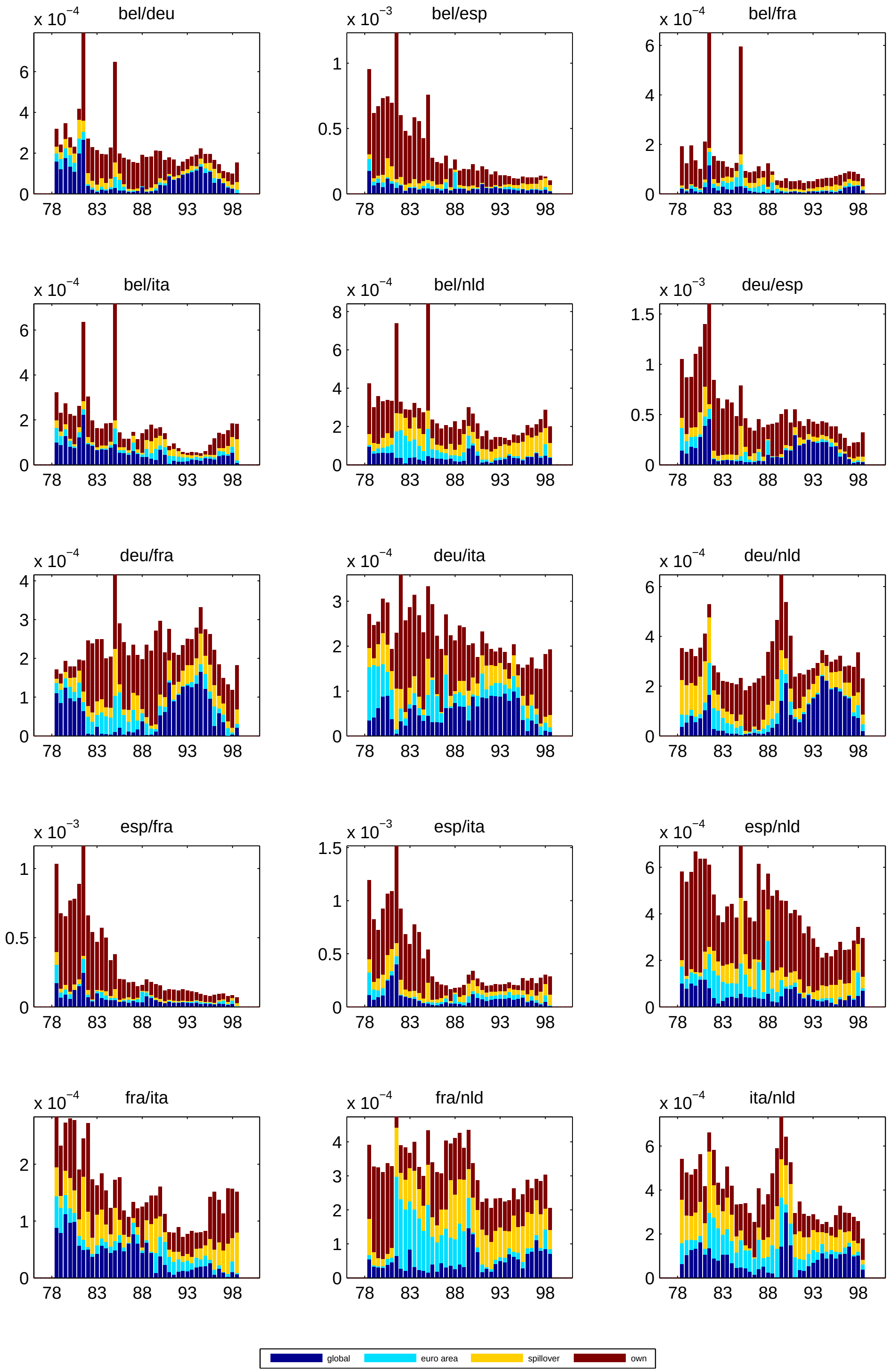
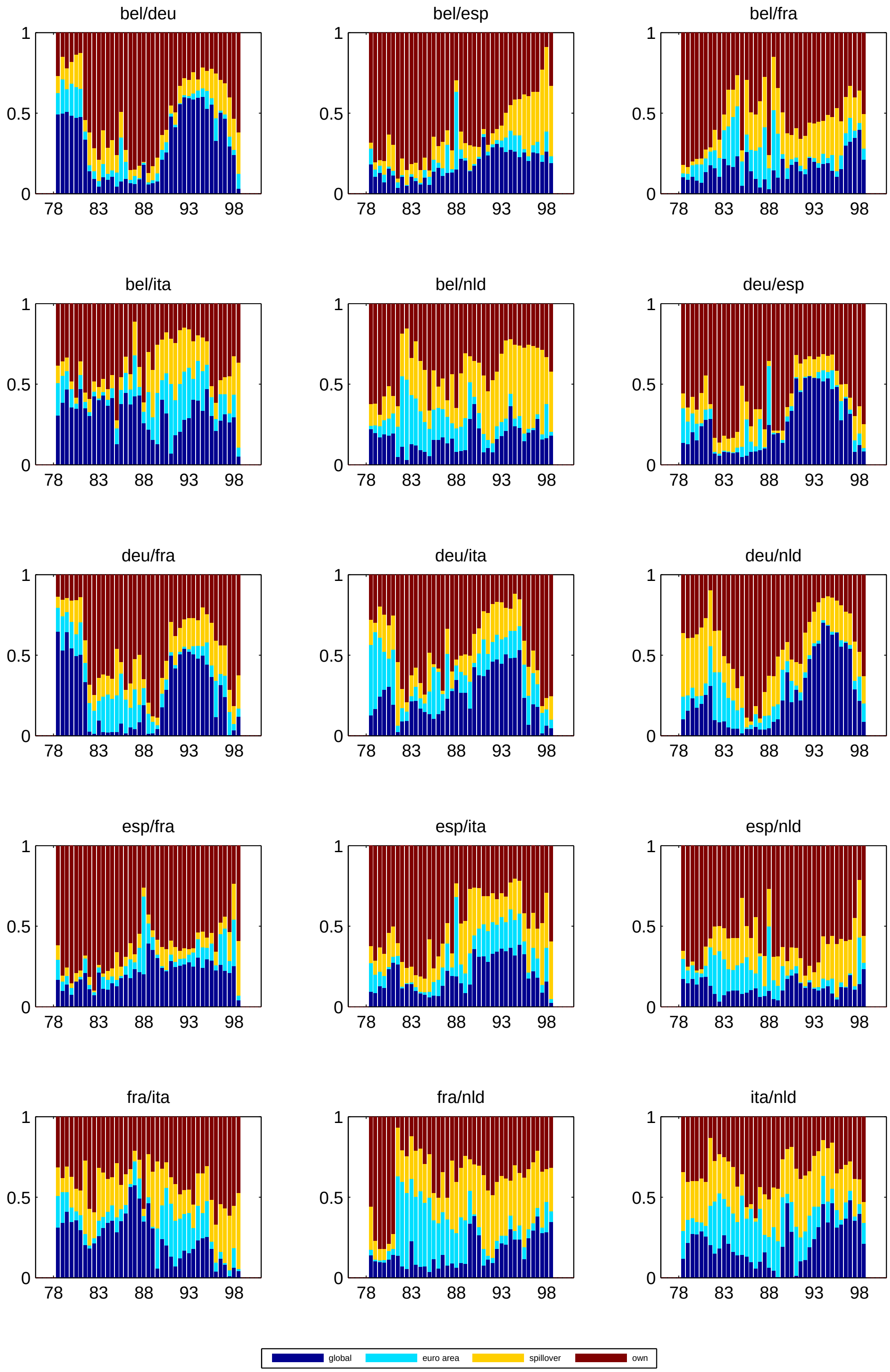


Figure 5: Unconditional correlation of 12-quarters-ahead output forecast errors over 70-quarter rolling windows



(a) Variance of output differential forecast errors

Figure 6: Variance decomposition of 12-quarters-ahead output differential forecast errors over 70-quarter rolling windows



(b) Shares of shocks in the variance

Figure 6: Variance decomposition of 12-quarters-ahead output differential forecast errors over 70-quarter rolling windows (cont.)

5. Concluding remarks

In this study, we addressed various aspects of the business cycle dynamics in the euro area in the period 1970–2007. An important property of the FSVAR model that underlied our analysis is that it distinguishes between (common) global and euro area shocks so that the potential impact of two concurrently running processes—the EMU and the globalisation—can be isolated from each other. Moreover, spillovers of country-specific shocks are allowed in addition to the common shocks in the FSVAR structure, a channel which has been missing in the majority of the empirical studies dealing with international business cycle dynamics. We carried out our initial analysis in two sub-periods corresponding to the pre-EMU and EMU periods as well as in rolling windows of 70 quarters in order to capture changes that might have occured in the business cycle dynamics of the euro area over time.

Given the prerequisite that the business cycles must be driven by common sources in a successfully operating currency area, we asked first to which extent the business cycles of the euro area countries are driven by common (global and euro area) and spillover shocks. We found a dominant role of global shocks in the pre-EMU period, which becomes smaller (but is still significant) in the EMU period. The common euro area shocks, on the other hand, were not found to be a major source of business cycle fluctuations in both periods, whereas the importance of spillovers across member countries seems to have increased significantly in the course of the years. The latter finding points to the importance of including the spillover channel in the empirical framework in this type of analysis.

We computed correlations of output forecast errors as well as forecast error variance decompositions of output differentials corresponding to business cycle periodicities. While we registered that correlations of output forecast errors were high in the pre-EMU period, we could not establish an increase in the correlations in later periods due to, e.g., the EMU or the globalisation. We found, on the other hand, a decline in output differential forecast errors at business cycle periodicities, which suggests a declining heterogeneity of business cycles in the euro area, although the synchronisation has not increased over time.

Finally, we found that the significant decline in output as well as output differential dynamics since the mid-1980s until a short time ago is basically due to changes in size of shocks, which is is supportive of the good luck/better policy hypotheses, while changes in shocks propagation were not found to have contributed to this moderation. Moreover, we found that the moderation of output fluctuations was basically due to international—global and euro area spillover—factors, while the moderation of output differential dynamics can be traced back to country-specific factors.

References

Artis, M., H.-M. Krolzig, and J. Toro, 2004, "The European Business Cycle," Oxford Economic Papers, 56(1), 1–44.

Bayoumi, T., and B. Eichengreen, 1992, "Shocking Aspects of European Monetary Unification," NBER Working Papers 3949.

Bovi, M., 2005, "Globalization vs. Europeanization: A Business Cycles Race," Oxford Bulletin of Economics and Statistics, 67(3), 331–345.

Cabanillas, L. G., and E. Ruscher, 2008, "The Great Moderation in the Euro Area: What Role Have Macroeconomic Policies Played?," European Economy Economic Papers 331.

Camacho, M., G. Perez-Quiros, and L. Saiz, 2008, "Do European business cycles look like one?," Journal of Economic Dynamics and Control, 32(7), 2165–2190.

Canova, F., 1998, "Detrending and Business Cycle Facts," Journal of Monetary Economics, 41, 475–512.

Chamie, N., A. DeSerres, and R. Lalonde, 1994, "Optimum Currency Areas and Shock Asymmetry: A Comparison of Europe and the United States," Bank of Canada Working Papers 94-1.

Del Negro, M., and C. Otrok, 2008, "Dynamic Factor Models with Time-Varying Parameters: Measuring Changes in International Business Cycles," Federal Reserve Bank of New York Staff Reports 326.

den Haan, W. J., 2000, "The comovement between output and prices," Journal of Monetary Economics, 46(1), 3–30.

Giannone, D., and L. Reichlin, 2005, "Euro Area and US Recessions, 1970-2003.," in Euro Area Business Cycle: Stylized Facts and Measurement Issues, ed. by L. Reichlin, pp. 83–93. CEPR.

——— , 2006, "Trends and Cycles in the Euro Area: How Much Heterogeneity and Should We Worry about it?," ECB Working Paper Series 595.

Gregory, A. W., A. C. Head, and J. Raynauld, 1997, "Measuring World Business Cycles," International Economic Review, 38(3), 677–701.

Kose, M. A., C. Otrok, and E. S. Prasad, 2008, "Global Business Cycles: Convergence or Decoupling?," NBER Working Papers 14292.

Kose, M. A., C. Otrok, and C. H. Whiteman, 2003, "International Business Cycles: World, Region, and Country-Specific Factors," American Economic Review, 93(4), 1216–1239.

Massmann, M., and J. Mitchell, 2004, "Reconsidering the Evidence: Are Euro Area Business Cycles Converging?," Journal of Business Cycle Measurement and Analysis, 1(3), 275–307.

Mundell, R. A., 1961, "A Theory of Optimum Currency Areas," American Economic Review, 51(4), 657–665.

Perez, P., D. Osborn, and M. Artis, 2006, "The International Business Cycle in a Changing World: Volatility and the Propagation of Shocks in the G-7," Open Economics Review, 17(3), 255–279.

Seymen, A., and M. Kappler, 2009, "The Role of Structural Common and Country-Specific Shocks in the Business Cycle Dynamics of the G7 Countries," ZEW Discussion Papers 09-015.

Stock, J. H., and M. W. Watson, 2002, "Has the Business Cycle Changed and Why?," NBER Working Papers 9127.

——— , 2005, "Understanding Changes in International Business Cycle Dynamics," Journal of the European Economic Association, 3(5), 968–1006.

Xu, X., 2006, "A Currency Union for Hong Kong and Mainland China?," Journal of International Money and Finance, 25(6), 894–911.