Business Cycle Dynamics in the Euro Area*

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Abstract

We investigate the properties of business cycle dynamics in the euro area with the aid of structural VAR models. The role of world, euro area and country-specific shocks in business cycle dynamics of the euro area are assessed. We find that euro area shocks became a much more important factor behind cyclical fluctuations in many euro area countries recently. Moreover, while the great moderation in the euro area is found to be related to changes corresponding to world and country-specific shocks, euro area shocks do not play a significant role in this phenomenon. Finally, the differentials of output gaps between the entire euro area and each member country are driven mainly by country-specific shocks. The same shocks also play the largest role in the great moderation of the differentials observed recently.

JEL classification: C32, E32

Keywords: International Business Cycles; World, Euro Area and Country-Specific Shocks; Structural Vector Autoregression Models

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1. Introduction

This paper investigates several issues related to the business cycle dynamics from the 1970s to today in the euro area. The period of interest witnessed three important macroeconomic phenomena that have been the subject of a large literature. The first phenomenon is the European Monetary Union (EMU) process which started in the early 1990s and led to the using of a common currency – the Euro – in meanwhile 15 countries. Second, the phenomenon called globalisation took place at an accelerated pace. The period has been characterised by features such as a substantial increase in international capital flows and trade relative to former times, stronger financial market integration, higher mobility of labor, etc. across industrialised as well as developing countries. Finally, volatility of business cycles declined significantly in the industralised countries after roughly the second half of the 1980s or the first half of the 1990s until a short time ago, the so-called Great Moderation phenomenon.

Extensive macroeconomic research has been conducted on these three phenomena. An important question in this regard is the extent to which business cycles of industrialised countries are driven by a common world factor. In case of the euro area countries, the issue becomes even more complicated since the EMU and globalisation have been taking place concurrently. One challenge for macroeconomists is to isolate the effects of these two phenomena on the business cycle dynamics of the euro area countries, which requires the measurement, if there is any, of a euro area factor as an additional potential driving force of business cycles in the euro area. Another question of interest is the extent to which the Great Moderation has its roots in international or country-specific shocks. The concurrence of the decline in business cycle volatility in many countries makes the question interesting whether the Great Moderation is related to changes in the size of international or country-specific shocks as well as their transmission channels.

It is known from a large empirical literature that business cycles of industrialised countries, including the members of the euro area, are in general positively correlated. However, that the correlations are typically not perfect reflects the fact that there is still some heterogeneity involved. One of our aims in this study is to assess the extent and sources of business cycle heterogeneity in the euro area and to explore whether heterogeneity became stronger or weaker during the EMU process and in relation the Great Moderation. The subject is interesting not least because of the fact that common currency and common monetary policy may have – near positive impacts – adverse effects on some of the member countries of a monetary union when their business cycles are not sufficiently synchronised. In particular, the member countries do not pursue own exchange rate and monetary policies in a monetary union and may therefore lack some flexibility when confronted with shocks.[1] Two extreme situations can be the driving force of business cycle heterogeneity: (i) countries may be subject to common shocks, but their response to those shocks may differ substantially; or (ii) countries may be hit by asymmetric shocks. Both mechanisms are likely to play some role in reality, and our analysis sheds light on the extent to which these mechanisms explain the observed heterogeneity in the euro area. In this study, two measures of heterogeneity are used. One measure is the correlation between each member country's cycle and the euro area cycle. The other measure is the differential between the euro area business cycle and the business cycle of individual countries.

We are also interested in the changes in business cycle dynamics over time in the euro area. Both the EMU process and the Great Moderation are relevant in this context. We investigate the extent to which the Great Moderation can be attributed to world, euro area and country-specific shocks in the euro area. In particular, whether the decline in output gap volatility has its roots in changes in shock propagation mechanisms and/or in changes in size of shocks is explored. Furthermore, we check whether business cycle synchronisation has become stronger in the euro area recently, and whether euro area shocks became more important in comparison to world and country-specific shocks in explaining business cycles.

We start our analysis by modifying the framework of Giannone and Reichlin (2006), who investigate the level of business cycle heterogeneity with the aid of bivariate vector autoregression (VAR) models comprising the euro area output and the output of a member country of the euro area. By modifying the approach of Stock and Watson (2005), Giannone and Reichlin distinguish between euro area and country-specific shocks. The euro area shocks

[1]The optimum currency are theory sets some guidelines on the conditions that should be fulfilled for a successful monetary union.

are defined as shocks that affect the entire euro area as well as the individual countries in the period they occur, while country-specific shocks are labelled as such since they are spilled over from a certain country of origin to the rest of the euro area with a time lag. An important methodological handicap of this approach is that it takes into account only two sources of shocks – euro area and country-specific – which brings two disadvantages for our analysis. First, we want to assess the role of world and euro area shocks in business cycle volatility and co-movement in the euro area. Business cycle synchronisation may get stronger, for example, due to both global and euro area shocks over time, but the bivariate model may falsely attribute it to euro area shocks or spillovers from country-specific shocks. Second, from a technical point of view, the model may suffer from omitted-variables bias if world shocks have indeed a significant explanatory power for the dynamics. In order to overcome these potential shortcomings, we augment the bivariate framework of Giannone and Reichlin (2006) with US output following Giannone and Reichlin (2005, 2006) and Perez et al. (2006). Three types of shocks – world, euro area and country-specific shocks – are estimated. World shocks are labelled as such since they influence the output in the US, the euro area and individual euro area countries in the period they take place. The euro area and country-specific shocks are defined in the same manner as described above.

We start our analysis by discussing the properties of business cycles in the euro area in the next section. In Section 3, the model with which we explore the dynamics underlying euro area business cycles is presented. Section 4 is devoted to the presentation and discussion of the results. Section 5 summarises the findings.

2. Data

We start our analysis with some descriptive statistics of output gaps in the euro area. Note that the euro area consists of 15 countries currently but only the first 12 member countries are considered in our study, since the history of the most recent three member countries is possibly not sufficient enough to show an EMU effect for large parts of our sample that spans the period from 1970Q1–2007Q4. In order to simplify the presentation, we sometimes distinguish between "core" countries – Belgium, Germany, France, Italy, Luxemburg and the Netherlands – and countries in the "periphery" – Austria, Spain, Finland, Greece, Ireland

and Portugal. The latter group comprises countries that became EU member at a later stage than the core countries.

We report statistics from two sub-periods, from 1970Q1–1990Q2 and from 1990Q3–2007Q4 throughout the paper. Splitting the entire sample into two sub-periods allows us to capture changes in business cycle dynamics over time. Although we can observe a significant moderation of business cycles in every member country, it is obvious even without referring to any statistical test that the 12 countries do not share a common structural break in that sense, see Figure 1 which shows the output gap of the entire euro area together with the output gap of each member country. The most important reason for splitting the sample at 1990Q2 is that after this period exchange controls were abolished and capital could move freely in then the European Economic Community, which constituted the first big practical step towards the creation of the euro. Note that this time period also coincides roughly with the collapse of the Iron Curtain and, hence, a new wave in globalisation. It is also the quarter immediately before the German reunification, of the country with highest economic weight in the euro area. Yet, our choice of splitting the sample at 1990Q2 is still arbitrary. Therefore, we check the robustness of our results with respect to this break date and try out some other important dates within the EMU process.

The measure of business cycle is the asymmetric filter suggested by Christiano and Fitzgerald (2003) for the benchmark results of this study. This linear filter brings the advantage that we do not lose observations at the both ends of the sample when we employ it. However, we carry out a robutsness check also with respect to the underlying business definition, since our conclusions may depend on the definition we choose.[2] In particular, we check if the results alter substantially when the business cycle is defined by the Hodrick and Prescott (1997), Baxter and King (1999) and Random Walk filters.

Looking at Figure 1, it immediately catches one's eye that output gaps of member countries are generally strongly correlated with the output gap of the entire euro area, although the correlation is typically not perfect. Table 1 quantifies this observation. Only the correlation of Finland and Ireland (with coefficients of 0.33 and 0.26, respectively) with the euro area is below 0.50 over the entire sample period. The core countries generally exhibit

[2]See Canova (1998).

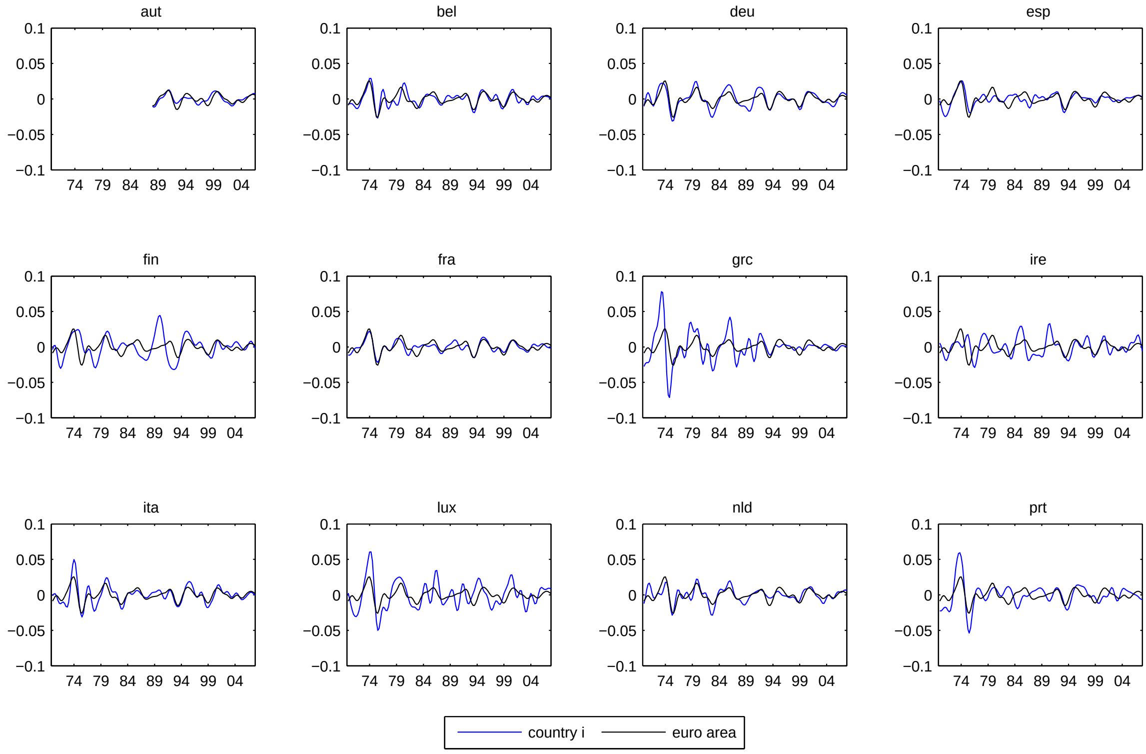

Figure 1: Output gap of individual countries and euro area

Table 1: Output gap correlation with the euro area aggregate

	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
1970Q1–2007Q4	–	0.80	0.87	0.63	0.33	0.82	0.55	0.26	0.83	0.70	0.75	0.66
1970Q1–1990Q2	–	0.79	0.90	0.56	0.52	0.86	0.57	0.15	0.83	0.82	0.76	0.71
1990Q3–2007Q4	0.74	0.89	0.94	0.82	0.38	0.86	0.37	0.56	0.91	0.40	0.82	0.54

stronger correlation with the euro area than the countries in the periphery. The output gaps of Spain and Ireland became more similar to the euro area output gap in the second sub-period relative to the first sub-period, while the output gaps of Finland, Greece and Portugal decoupled to some extentrom the euro area output gap recently. In the second sub-period, the output gaps of all core countries but Luxemburg were related to the euro area output gap at least as strongly as in the first sub-period. The correlation of Luxemburg has decreased, however, from 0.82 to 0.40.

Table 2 reports the volatility of output gaps in the euro area in the two sub-periods. The first row shows the standard deviation of the output gap of each euro area country in the

Table 2: Output gap volatility

	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
1970Q1–1990Q2	–	1.13	1.26	1.13	1.31	0.82	2.81	1.24	1.50	2.33	1.13	2.16
1990Q3–2007Q4	0.58	0.73	0.80	0.64	1.15	0.61	1.26	0.89	0.82	1.36	0.55	0.90

first sub-period, according to which output gaps of Greece, Luxemburg and Portugal show a higher dispersion than output gaps of the other member countries. It is already visible from Figure 1 that the volatility of output gaps decreased in every member country roughly in the second half of the sample. The reported correlations in Table 2 confirm this result, too. In some member countries, the decrease in the standard deviation was even more than 50 percent. Yet, the output gaps of Finland, Greece and Luxemburg were still somewhat more volatile than the gaps of the other member countries in the second sub-period.

Investigation of output gap differentials in the euro area also provides information on business cycle heterogeneity in the euro area. Differentials are computed by subtracting the realisation of the cyclical measure, i.e. the output gap computed with the Christiano-Fitzgerald filter, in the euro area from its counterpart in a member country. For example, if the realisation of the euro area output gap is 0.01 in a certain time period, this means that the euro area output is 1 percent above its long-run trend. When the output gap in Germany is 0.006 in the same period, i.e. 0.6 percent above its long-run trend, the output gap differential between the euro area and Germany is $0.01 - 0.006 = 0.004$, i.e. 0.4 percent. Thus, the output gap differential shows what should happen in a member country so that its business cycle state coincides exactly with the business cycle state in the entire euro area.

Figure 2 allows us to make comparisons of the levels of output gap differentials across the member countries. A look into the figure makes immediately clear that the amplitude of differentials changes from country to country. The output gap differentials of Belgium, Germany, Spain, France, Italy and the Netherlands exhibit rather similar amplitudes, with their standard deviations being close to each other and lower than the standard deviations of the other countries in both sub-periods, see Table 3. Austria also joins this group in the second sub-period.

A striking observation following from Figure 2 is that the volatility of output gap differentials has decreased in many countries in the first half of the 1990s and stayed lower

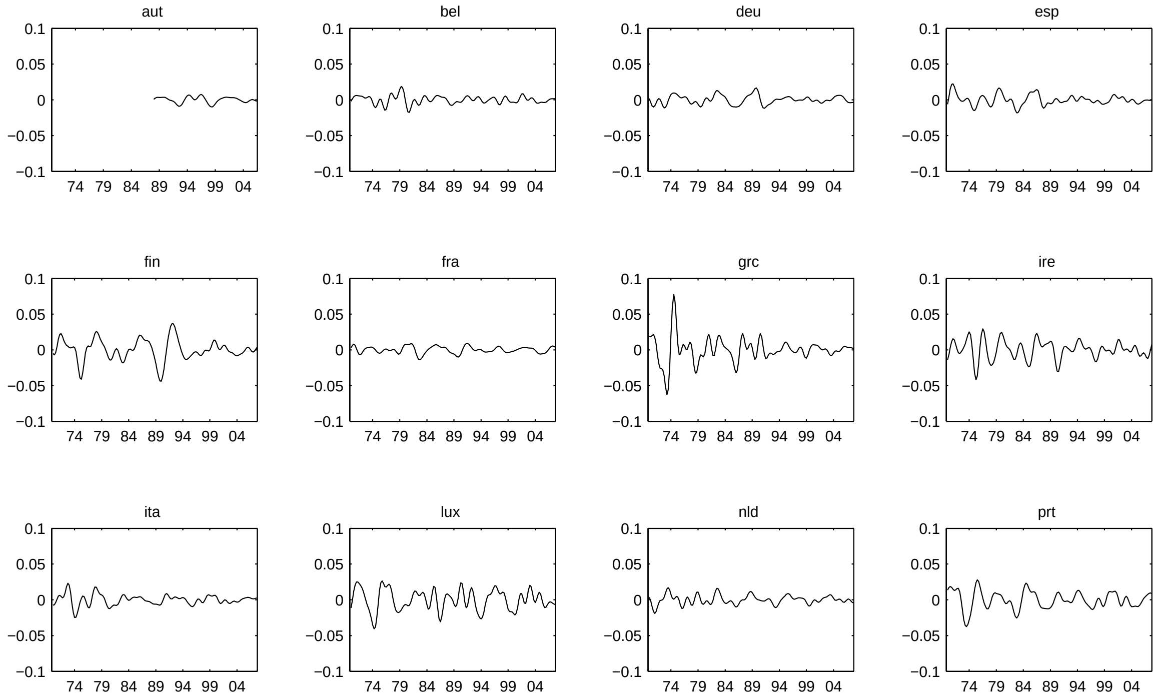

Figure 2: Output gap differentials in the euro area

Table 3: Output gap differential volatility

	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
1970Q1–1990Q2	–	0.69	0.57	0.99	1.16	0.49	2.39	1.45	0.88	1.64	0.74	1.62
1990Q3–2007Q4	0.44	0.34	0.30	0.38	1.08	0.33	1.18	0.75	0.36	1.25	0.36	0.77

thereafter. Such a pattern is clearly visible for Germany, Spain, Finland, Greece, Ireland, Italy and Portugal; weakly visible for Belgium, France, Luxemburg and the Netherlands; and not visible for Austria due to the lack of data. This picture speaks, in spite of many sources of heterogeneity in the euro area, for a stronger integration of the individual countries into the euro area in the second half of the sample period. The result is obviously related to the Great Moderation. Note, however, that the driving force behind the Great Moderation in output gap differentials must not necessarily be the same as the driving force behind the Great Moderation in output gaps.

To summarise, the properties of both output gaps and the output gap differentials between member countries and the aggregate euro area have changed substantially after the 1990s. In Section 4, we show the extent to which these developments are driven by world, euro area and country-specific shocks.

3. Econometric Methodology

We modify the SVAR approach of Giannone and Reichlin (2005, 2006) and Perez et al. (2006) to explore the afore presented dynamics of business cycles in the euro area. In the following, we first present the bivariate model suggested by Giannone and Reichlin (2006) for investigating the sources of business cycle heterogeneity in the euro area. The model allows us to distinguish between euro area and country-specific shocks. Next, we incorporate the identification scheme of Giannone and Reichlin (2005) into a trivariate model, which accounts for world as well as euro area and country-specific shocks. Our trivariate model resembles the one suggested by Perez et al. (2006).

3.1. Bivariate Models

We start our empirical investigation by using a modified version of the model of Giannone and Reichlin (2006), which is itself a simpler version of the strategy followed by Stock and Watson (2005). The moving average representation of the bivariate model underlying the empirical analysis is given by

$$\begin{bmatrix} \Delta y_t^{EA} \\ \Delta y_t^i \end{bmatrix} = \begin{bmatrix} \mu^{EA} \\ \mu^i \end{bmatrix} + \sum_{j=0}^{\infty} \begin{bmatrix} \Theta_{j,11} & \Theta_{j,12} \\ \Theta_{j,21} & \Theta_{j,22} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{EA} \\ \varepsilon_t^i \end{bmatrix} \tag{1}$$

where Δy_t^{EA} and Δy_t^i stand respectively for the first-differenced log output of the euro area and country i at period t, μ^{EA} and μ^i stand for the constant terms, $\Theta_{j,ik}$ is the (i,k) element of the j^{th} moving average coefficient matrix, and ε_t^{EA} and ε_t^i are defined as euro area and country-i shocks, respectively. The crucial identification restriction in this system is that country-specific shocks affect the euro area aggregate only with a lag of one quarter. Therefore, the immediate effect of a country-specific shock on the euro area in the period it occurs is limited to the population share of the country the shock stems from. Formally,

$$\Theta_0 = \begin{bmatrix} \Theta_{0,11} & p_i\Theta_{0,22} \\ \Theta_{0,21} & \Theta_{0,22} \end{bmatrix} \tag{2}$$

where p_i is the population share of country i in the euro area.

Five important differences to the study of Giannone and Reichlin in our application are that (i) we work with quarterly data as is typical in studies dealing with business cycles, while Giannone and Reichlin use annual data; (ii) we estimate the VARs in first differences or a cointegrated VAR depending on the results of corresponding statistical tests, while Giannone and Reichlin estimate them in levels which may potentially lead to spurious results due to unit roots in the data; (iii) our bivariate VAR models include four lags of the endogenous variables, while Giannone and Reichlin assume only one lag; as we argue later, this is an important point since the assumption of one lag may drive one of the findings of Giannone and Reichlin; (iv) we estimate the model in sub-periods in order to capture the potential changes in the size of shocks as well as their transmission so that the driving forces of the Great Moderation can be detected; and (v) we compare output gaps in the euro area computed with the Christiano-Fitzgerald filter, while Giannone and Reichlin concentrate on output level or growth. Hence, our measurements are directly related to the so-called business cycle frequencies.

Giannone and Reichlin (2006) investigate with a similar model the business cycle relationships between the US and the euro area. It reads

$$\begin{bmatrix} \Delta y_t^{US} \\ \Delta y_t^{EA} \end{bmatrix} = \begin{bmatrix} \mu^{US} \\ \mu^{EA} \end{bmatrix} + \sum_{j=1}^{p} \begin{bmatrix} a_{p,11} & a_{p,12} \\ a_{p,21} & a_{p,22} \end{bmatrix} \begin{bmatrix} \Delta y_{t-j}^{US} \\ \Delta y_{t-j}^{EA} \end{bmatrix} + \begin{bmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{US} \\ \varepsilon_t^{EA} \end{bmatrix} \tag{3}$$

so that euro area shocks are spilled over to the US with only one lag while the world (US) shock affect both the US and the euro area in the period they occur.

3.2. Trivariate Model

The bivariate model in (1) does not allow us to distinguish between world and euro area shocks which may bias our conclusions. Therefore, we find it useful to augment it with another variable – the US output – in the way the model in (3) suggests. This enables us to isolate the effects of world (US), euro area and country-specific shocks for each member country.

Note that the trivariate model we work with is indeed a natural extension of the strategy followed by Giannone and Reichlin (2006). It combines the aforementioned two types of bivariate models those authors work with. Furthermore, the model resembles the model employed by Perez et al. (2006), who work with trivariate VARs containing the output of the US, EU15 and one of the G7 countries except the US. Our innovation is (i) to consider the euro area instead of the EU15, since the euro area is a more coherent group in terms of being subject to common policy and is our subject of interest; (ii) to take into account the population shares of the member countries in the identification scheme in the way Giannone and Reichlin (2006) do, which is a more reasonable restriction than the zero restriction that Perez et al. (2006) use for the impact of German, French and Italian shocks on EU15 output.

The trivariate model is given by

$$\begin{bmatrix} \Delta y_t^{US} \\ \Delta y_t^{EA} \\ \Delta y_t^{i} \end{bmatrix} = \begin{bmatrix} \mu^{US} \\ \mu^{EA} \\ \mu^{i} \end{bmatrix} + \sum_{j=0}^{\infty} \begin{bmatrix} \Theta_{p,11} & \Theta_{p,12} & \Theta_{p,13} \\ \Theta_{p,21} & \Theta_{p,22} & \Theta_{p,23} \\ \Theta_{p,31} & \Theta_{p,31} & \Theta_{p,33} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{US} \\ \varepsilon_t^{EA} \\ \varepsilon_t^{i} \end{bmatrix}, \quad (4)$$

which is hence analogous to (1), the only difference being that the US output, the corresponding coefficients as well as a US shock (which we assume to represent a world shock) are now a part of the VAR too. In this case,

$$\Theta_0 = \begin{bmatrix} \Theta_{0,11} & 0 & 0 \\ \Theta_{0,21} & \Theta_{0,22} & p_i\Theta_{0,33} \\ \Theta_{0,31} & \Theta_{0,32} & \Theta_{0,33} \end{bmatrix}. \quad (5)$$

The zero entries in the first row of Θ_0 that determines the impact effects of shocks imply that euro area and country-specific shocks do not influence the US economy in the period they occur.

3.3. Business Cycle Generating Process

In this paper, we employ a novel approach proposed by Seymen (2009) for exploring the properties of business cycle dynamics in the euro area. The approach is based on deriving the business cycle generating process in line with a specific SVAR process and a chosen business cycle definition. Clearly, the specific SVAR process is the one given in (4) and the business cycle definition the one that follows from Christiano and Fitzgerald (2003) filter in this paper. Once the business cycle generating process is derived, statistics such as counterfactual correlations can be computed, variance decompositions as well as decompositions of changes in cyclical dynamics can be carried out as is done in the next section of this paper.

We illustrate the idea of a business cycle generating process in a simple framework in the following. Let y_t be an infinite order univariate moving average process

$$y_t = \sum_{i=0}^{\infty} \Theta_i^* \varepsilon_{t-i}, \tag{6}$$

where Θ_i^* are moving average coefficients, and ε_{t-i} stand for error terms with standard statistical properties. The cyclical component of y_t according to a linear filter with symmetric weights on leads and lags is given by

$$y_t^c = -\sum_{k=-\kappa}^{-1} a_k y_{t-k} + (1 - a_0)\, y_t - \sum_{k=1}^{\kappa} a_k y_{t-k}. \tag{7}$$

Inserting the process in (6) into (7), Seymen (2009) derives the business cycle generating process for y_t as

$$y_t^c = \sum_{i=1}^{\infty} \Psi_{-\kappa-i} \varepsilon_{t-\kappa-i} + \Psi_{-\kappa} \varepsilon_{t-\kappa} + \cdots + \Psi_0 \varepsilon_t + \cdots \Psi_\kappa \varepsilon_{t+\kappa} \tag{8}$$

with

$$\begin{aligned}
\Psi_{-\kappa-i} &= -a_\kappa\Theta_i^* - \cdots - a_1\Theta_{i+\kappa-1}^* + (1-a_0)\,\Theta_{i+\kappa}^* - a_{-1}\Theta_{i+\kappa+1}^* - \cdots - a_{-\kappa}\Theta_{i+2\kappa}^* \\
\Psi_{-\kappa} &= -a_\kappa\Theta_0^* - \cdots - a_1\Theta_{\kappa-1}^* + (1-a_0)\,\Theta_\kappa^* - a_{-1}\Theta_{\kappa+1}^* - \cdots - a_{-\kappa}\Theta_{2\kappa}^* \\
\Psi_{-\kappa+1} &= -a_{\kappa-1}\Theta_0^* - \cdots - a_1\Theta_{\kappa-2}^* + (1-a_0)\,\Theta_{\kappa-1}^* - a_{-1}\Theta_\kappa^* - \cdots - a_{-\kappa}\Theta_{2\kappa-1}^* \\
&\vdots \\
\Psi_{-1} &= -a_1\Theta_0^* + (1-a_0)\,\Theta_1^* - a_{-1}\Theta_2^* \cdots - a_{-\kappa}\Theta_{\kappa+2}^* \\
\Psi_0 &= (1-a_0)\,\Theta_0^* - a_{-1}\Theta_1^* - \cdots - a_{-\kappa}\Theta_{\kappa+1}^* \\
\Psi_1 &= -a_{-1}\Theta_1^* - \cdots - a_{-\kappa}\Theta_{\kappa-1}^* \\
&\vdots \\
\Psi_\kappa &= (-a_{-\kappa}\Theta_0^*)\,.
\end{aligned}$$

Note that although the illustration here is with a symmetric linear filter, a business cycle generating process following from an autoregressive model can be derived with any type of linear filter. Moreover, the business cycle generating process for the i^{th} variable of a K-dimensional SVAR model, is merely the sum of K sub-components with respect to K structural shocks. Hence, we write the output gap of country i, $y_{i,t}^c$, in each of our trivariate VAR models for the euro area member countries as

$$y_{i,t}^c = \sum_{k=-\infty}^{\kappa} \Psi_{i,US,k}\varepsilon_{US,t+k} + \sum_{k=-\infty}^{\kappa} \Psi_{i,EA,k}\varepsilon_{EA,t+k} \sum_{k=-\infty}^{\kappa} \Psi_{i,i,k}\varepsilon_{i,t+k} \tag{9}$$

each term on the right-hand-side of (9) being orthogonal to each other due to the orthogonality of the structural shocks by construction. $\Psi_{i,j,k}$ for $j = US, EA, i$ are analogous to the Ψ_i reported for the univariate process in (8), and $\varepsilon_{j,t+k}$ stand for US, euro area and country-specific shocks.

4. Results

The following analysis of the euro area dynamics is carried based on two different types of trivariate models. Model specification criteria lead us to estimate the VAR in first differences for the period 1970Q1–1990Q2, i.e. cointegration cannot be obtained in most of the models, while for the sub-period 1990Q3–2007Q4, a cointegration rank of one seems to be common to most of the models. Information criteria suggest different lag orders across the trivariate models, we assume a lag order of four in order to guarantee comparibility of the results.

4.1. Counterfactual Correlations

In order to investigate the asymmetries in the euro area, Giannone and Reichlin (2006) compute counterfactual correlations. Our estimated trivariate models all imply that the output gaps of the US, the euro area and a member country comprise three counterfactual series, i.e. series that would have been observed if only one of the three structural shocks had taken place in the past. The counterfactual correlations are correlations that are computed between such series with respect to one of the shocks. Formally,

$$corr\left(y_{i,t}^{c}, y_{k,t}^{c}|j\right) = \frac{cov\left(y_{i,t}^{c}, y_{k,t}^{c}|j\right)}{\sqrt{var\left(y_{i,t}^{c}|j\right) var\left(y_{k,t}^{c}|j\right)}}, \tag{10}$$

where $corr\left(y_{i,t}^{c}, y_{k,t}^{c}|j\right)$ stands for the correlation between the output gap of countries i and k when only the j^{th} shock occurs and the other shocks are set to zero. Since we are interested in this paper in the relationship between a member country and the entire euro area, we compute such correlations only between member countries' and the euro area's output gaps with respect to each shock. Note that given the business cycle generating process in (9),

$$cov\left(y_{i,t}^{c}, y_{EU,t}^{c}|j\right) = \left(\sum_{k=-\infty}^{\kappa} \Psi_{i,j,k}\Psi_{EA,j,k}\right)\sigma_j^2 \tag{11}$$

and

$$var\left(y_{i,t}^{c}|j\right) = \left(\sum_{k=-\infty}^{\kappa} \Psi_{i,j,k}^2\right)\sigma_j^2 \tag{12}$$

with σ_j^2 being the standard deviation of the j^{th} shock. Moreover, both sums in (11) and (12) are finite, see Seymen (2009).[3] The term counterfactual correlation refers to the fact

[3]In practice, we set κ sufficiently large, to 60 in this study, and the sums run from $-\kappa$ to κ. Choosing κ large implies that the filter we impose is practically indistinguishable from the ideal band-pass filter. Since $\kappa = 60$, the first 121 moving average coefficient matrices from the VAR are employed in the computations

Table 4: True and counterfactual correlations of output gaps with the euro area

	Sample: 1970Q1–1990Q2											
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
true	–	0.86	0.91	0.60	0.44	0.91	0.57	0.21	0.84	0.74	0.84	0.85
only world shock	–	0.99	0.99	0.87	0.57	1.00	0.88	0.48	0.97	0.98	0.97	0.98
only euro area shock	–	0.90	0.98	0.60	0.67	0.99	0.17	0.49	0.92	0.92	0.99	0.86
only country shock	–	0.95	0.64	0.98	0.23	0.96	0.59	-0.27	0.90	0.89	0.56	0.99

	Sample: 1990Q3–2007Q4											
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
true	0.77	0.90	0.92	0.86	0.75	0.91	0.54	0.61	0.91	0.57	0.76	0.71
only world shock	0.96	0.86	0.97	0.90	0.77	0.98	0.70	0.79	0.90	0.78	0.78	0.93
only euro area shock	0.94	0.96	0.99	0.96	0.95	0.99	0.87	0.80	0.97	0.36	0.89	0.84
only country shock	0.72	0.85	0.91	0.82	0.92	0.69	0.32	0.11	0.92	0.66	0.09	0.06

that those correlations correspond to only one aspect of reality. A high/low counterfactual correlation between the same sub-components of two countries implies similar/diverse shock propagation over the business cycle with respect to the corresponding structural shock.

Table 4 shows the true and counterfactual correlations based on the trivariate models of the euro area countries in the two sub-periods. In both panels, the first row contains the true correlations between the output gap of a member country and the euro area output gap in the corresponding period. [4] The second, third and fourth rows show the counterfactual correlations with respect to world, euro area and country-specific shocks, respectively. For example, we would have observed a correlation of 0.57 between the output gaps of Finland and the euro area if only world shocks had taken place in the first sub-period; however, the respective correlation would have been 0.23 if only the country-specific shock of Finland had occurred.

A comparison of the two panels in Table 4 makes the importance of splitting the sample clear. The relationship between the euro area and some member countries underwent obviously some important changes so that some of the reported correlations change substantially from the first period to the second. For example, the correlation with respect to the

which do typically converge to their long-run values within this range.

[4]Note that the reported true correlations in Table 4 follow directly from the ideal estimated business cycle generating process. The weights of the filter correspond to the symmetric weights of the asymmetric Christiano-Fitzgerald filter for a sample of size $2\kappa + 1$, see the previous footnote. Hence, the reported true correlationsin Table 4 are slightly different from the ones reported in Table 1 which follow from the asymmetric Christiano-Fitzgerald filter applied to the data directly.

country-specific shock of Greece changes to 0.32 in the second sub-period from 0.59 in the first sub-period

The counterfactual correlations with respect to common shocks, i.e. world and euro area shocks, have generally been quite high in both sub-periods for the member countries. The expections in this respect are Greece with respect to the euro area shocks in the first sub-period with a counterfactual correlation of 0.17 and Luxemburg again with respect to euro area shocks in the second sub-period with a counterfactual correlation of 0.36.

The counterfactual correlations with respect to country-specific shocks are more diverse and on average lower than the counterfactual correlations with respect to the common shocks. Interesting is that in some cases the true correlation is lower than all reported counterfactual correlations in both sub-periods. Yet, this result should not be surprising, because the counterfactual correlations are computed under the assumption that a member country and the euro area are both subject to only one and the same shock (world, euro area or country-specific of the particular country), while the true correlations are generated when the series are subject to common euro area as well as 12 different country-specific shocks. The 12 country-specific shocks have mixed effects on the individual countries as well as the euro area, which can unfortunately not be explicitly measured by our empirical model. Indeed, an important remark (which cannot be read explicitly from Table 4) is that the response of the euro area output to different country-specific shocks varies depending on the country the shocks are stemming from. For example, the response of the euro area output to a country-specific shock stemming from Germany is quite different from the output response to a shock originating in Greece. Hence, we also conclude, like Giannone and Reichlin (2006), that "asymmetries are explained by idiosyncratic shocks rather than heterogeneous responses to common shocks and that, therefore, area wide shocks propagate similarly across Euro Area countries" over the business cycle with the exceptions of Greece in the first and Luxemburg in the second sub-samples.

4.2. Variance Decomposition

While counterfactual correlations give us an idea on the co-movement of business cycles in the euro area, they do not tell much on volatility, which summarises another important characteristic of business cycles. The business cycle variance decomposition (BCVD) analysis of this section sheds light on whether world, euro area or country-specific shocks are playing a more important role in the cyclical fluctuations of a country.

Recall from above that the variance of $y_{i,t}^c$ is given by

$$var\left(y_{i,t}^{c}\right)=\sum_{j=1}^{K}\left[\left(\sum_{i=-\infty}^{\kappa}\Psi_{i,jk}^{2}\right)\sigma_{j}^{2}\right], \tag{13}$$

where $var\left(\varepsilon_{j,t}\right)=\sigma_j^2$. This linear decomposition tells us that the variance of an output gap is the sum of the variances of its sub-components with itself. Hence the share of the j^{th} structural shock on that variance is nothing but

$$\left(\sum_{i=-\infty}^{\kappa}\Psi_{i,jk}^{2}\right)\sigma_{j}^{2}/\sum_{j=1}^{K}\left[\left(\sum_{i=-\infty}^{\kappa}\Psi_{i,jk}^{2}\right)\sigma_{j}^{2}\right]. \tag{14}$$

Table 5 shows the shares of shocks in the output gap variance of the euro area countries in the two sub-periods. The importance of adding a world factor to the bivariate model is immediately clear, since it explains the output gap variance of some member countries in both sub-periods. It is confirmed also by this variance decomposition exercise that splitting the sample in two sub-samples is important for catching changes the euro area economies underwent over the entire sample period. In the first period, country-specific shocks are the main driving force of output gap fluctuations in all countries but Germany and France. In the latter countries, world shocks have the biggest weight and euro area shocks are also important. Euro area shocks have small or sometimes even negligible impacts in most of the countries in the first sub-period, while world shocks are comparatively more important in the member countries with the exception of Belgium, where euro area shocks together with own shocks explain a significant amount of business cycle volatility.

The picture changes substantially in the second sub-period. The share of country-specific shocks in the output gap variance decreases in most of the member countries abstracting from Germany, Italy and Luxemburg. There is virtually no change in that share in France, which was already low in the first period. Another striking observation is the increase in the share of euro area shocks in the output gap variance of many countries. The most significant

Table 5: Shares of shocks in output gap variance of euro area countries

	Sample: 1970Q1–1990Q2											
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
world shock	–	0.21	0.59	0.10	0.33	0.37	0.18	0.31	0.30	0.27	0.37	0.14
euro area shock	–	0.38	0.28	0.08	0.14	0.36	0.06	0.11	0.12	0.13	0.24	0.02
country shock	–	0.40	0.13	0.82	0.53	0.28	0.76	0.58	0.58	0.60	0.39	0.84

	Sample: 1990Q3–2007Q4											
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
world shock	0.08	0.16	0.08	0.15	0.34	0.30	0.09	0.26	0.07	0.18	0.34	0.24
euro area shock	0.37	0.58	0.36	0.58	0.15	0.47	0.27	0.37	0.29	0.07	0.51	0.48
country shock	0.55	0.26	0.55	0.28	0.51	0.23	0.64	0.36	0.64	0.75	0.16	0.28

changes occur in Belgium, Spain and the Netherlands, where euro area shocks respectively have weights over 0.5 in the second sub-period. Excluding Findland and Luxemburg, the estimated shares of euro area shocks range between 0.29 and 0.58 in the second period, which is much higher than in the first period where the highest share of euro area shocks is 0.38.

4.3. Changes in Size of Shocks and Shock Propagation

The hitherto presented results point to important changes in business cycle dynamics since the 1970s. Those changes may be traced back to two principal channels: changes in the size of shocks and changes in shock transmission in each member country. In order to understand the nature of observed changes, we turn our attention to these issues in the following.

4.3.1. Size of Shocks

The widely used approach in the SVAR literature is to set the standard deviation of structural shocks to 1. Such a normalisation does not affect the impulse response functions, variance decompositions or counterfactual correlations. In this study, however, we are interested in changes in the shock propagation as well as the size of shocks. Therefore, we carry out a different type of normalisation. Instead of assuming that the covariance matrix of structural shocks is an identity matrix, we assume that the covariance matrix is diagonal but the diagonal elements are not set to 1. In order to make an exact identification possible, we normalise the contemporaneous relationships among the endogenous variables of the VAR.

Table 6: Standard deviation of shocks

Sample: 1970Q1–1990Q2												
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
world shock	–	8.53	8.75	8.94	8.86	8.74	8.74	8.97	8.90	8.82	8.69	8.91
euro area shock	–	4.53	3.16	4.54	4.87	4.20	3.95	4.76	4.03	4.74	4.40	4.29
country shock	–	2.18	4.51	5.67	10.83	3.15	25.96	2.57	6.58	3.87	10.08	3.12

Sample: 1990Q3–2007Q4												
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
world shock	3.72	4.07	3.97	3.75	3.99	3.79	3.96	4.09	4.15	4.12	3.88	3.88
euro area shock	2.44	2.36	1.37	2.31	2.30	2.03	2.81	2.36	1.94	2.22	2.46	2.57
country shock	1.69	2.65	2.95	2.58	4.86	2.47	9.03	12.82	3.16	10.51	3.50	5.36

Relative standard deviation between two sub-periods												
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
world shock	–	2.09	2.20	2.38	2.22	2.31	2.21	2.19	2.14	2.14	2.24	2.30
euro area shock	–	1.92	2.31	1.97	2.11	2.07	1.40	2.01	2.08	2.14	1.79	1.67
country shock	–	0.82	1.53	2.19	2.23	1.27	2.87	0.20	2.08	0.37	2.88	0.58

The first two panels of Table 6 show the estimated standard deviations of world, euro area and country-specific shocks for the two sub-periods. The last panel shows the relative standard deviation between the two sub-periods, i.e., the standard deviation in each entry in the first panel divided by the corresponding standard deviation in the second panel. Thus, a figure higher than 1 in the last panel indicates that the standard deviation of the corresponding shock has decreased in the second period relative to the first period. Note that the ideal situation would be that the entries that corresponding to world and euro area shocks in the first and second rows of each panel are exactly the same. This is, however, not possible with the simple methodology that we apply. Yet, the reported values are generally roughly close to each other. Looking at the last panel, two important changes regarding the size of shocks can be read out. First, the standard deviation of both world and euro area shocks decreased in the second sub-period relative to the first sub-period. The relative decline was higher in the case of world shocks, that is, their standard deviation decreased more strongly. Second, the size of country-specific shocks decreased as well in all countries except Belguim, Ireland, Luxemburg and Portugal. The decline in France was, however, relatively weaker in comparison to the other member countries where the size of country-specific shocks became smaller.

4.3.2. *Shock Propagation*

The conventional tool employed by macroeconomists for examining the shock propagation is the impulse response function. Figures 3a-3c show the response of output in the euro area countries to a one-unit world, euro area and country-specific shock for the first (red line) and the second sub-period (green line), respectively. Thus, we can assess whether the euro area economies underwent structural changes over time. We have normalised the impulse responses such that they are most of the time positive.[5] This allows us to make direct comparisons of the effects of shock propagation on variance decomposition in the two sub-periods. For example, if the response to a certain shock at the second sub-period period is lower than in the first sub-period this implies, evertyhing else staying equal, that the share of that shock in the variance of output fluctuations has decreased due to the change in the propagation of the shock. Moreover, we can also see whether the change is only quantitative, i.e. in the magnitude of the impulse response, and/or also qualitative, i.e. in the shape of the impulse response in a certain country. In general, it is hard to draw conclusions from Figures 3a-3c that apply to the core and periphery groups. Every country seems to have rather its own peculiar story. Therefore, we use a tool for assessing the impact of changes in magnitude of shocks as well as in their transmission which encompasses both effects in a unifying framework in the next sub-section.

4.4. *Driving Force of the Great Moderation*

Quoting Stock and Watson (2005), "the variance of [output gap] in a given country can change because the magnitude of the shocks impinging on that economy have changed or because the effects of those shocks have changed." The foregoing findings show that both effects are relevant for the euro area economies: on the one hand, the volatility of world, euro area and country-specific shocks and, on the other, the response of the economies to those shocks underwent changes. In order to compute the weight of both channels in the Great Moderation observed in every euro area country, we employ a similar methodology to Stock and Watson (2005). Analogous to them, we write the variance of the output gap of a

[5] This normalisation does not effect the results we have presented previously. See Christiano et al. (1999) on the uniqueness of identification in SVAR models only up to a certain sign restriction.

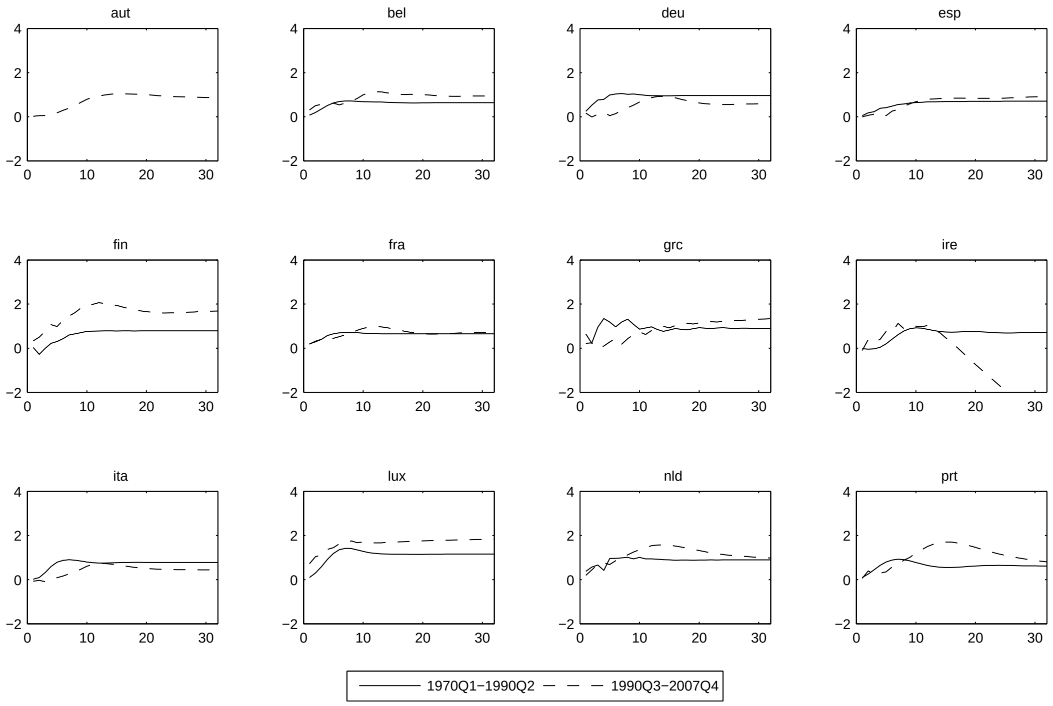

Figure 3a: Response to world shock

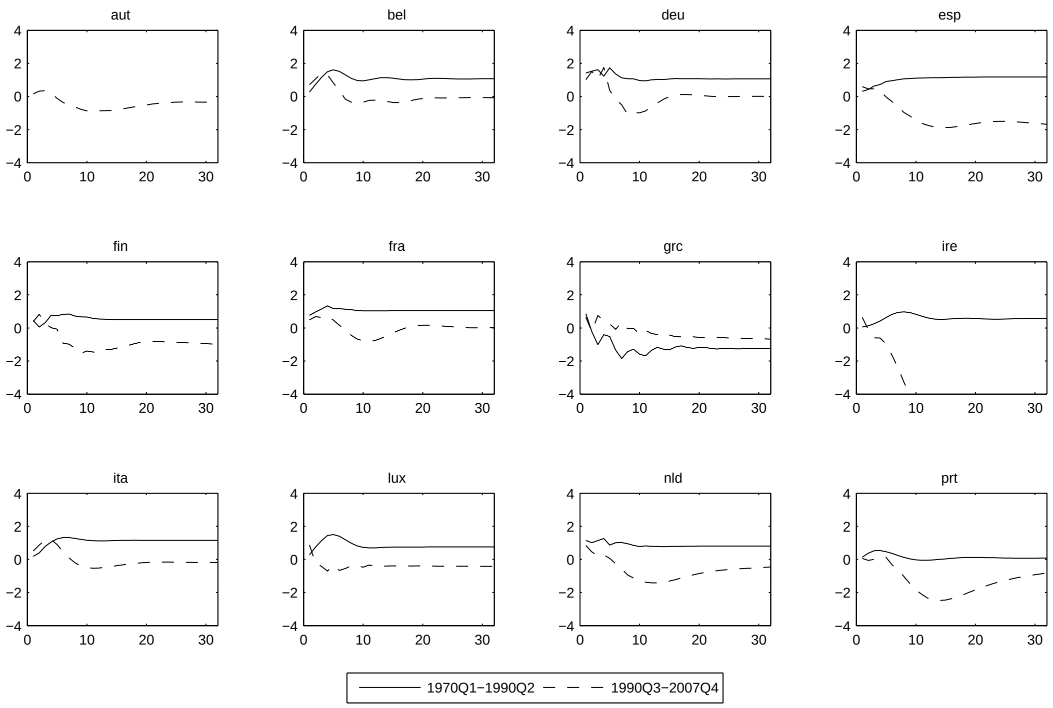

Figure 3b: Response to euro area shock

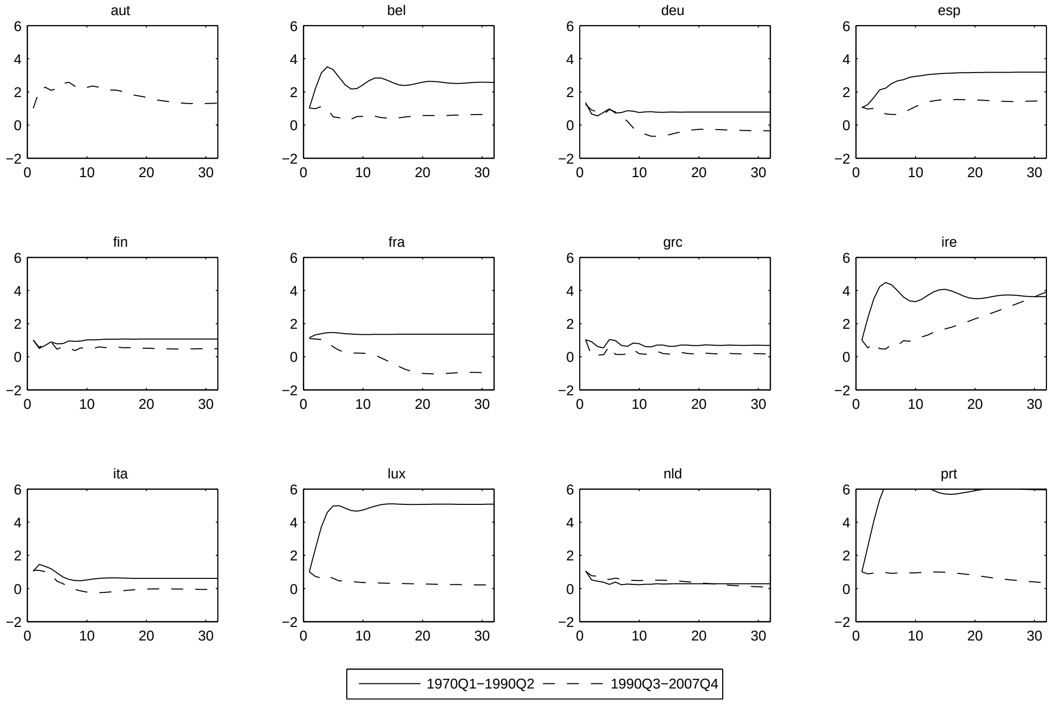

Figure 3c: Response to country-specific shock

country at period p, with $p = 1, 2$ corresponding to the first (1970Q1–1990Q2) and second (1990Q3–2007Q4) sub-periods, as

$$V_p = V_{p1} + V_{p2} + V_{p3}, \tag{15}$$

where V_{pj} is the variance of output gap at period p with respect to the j^{th} shock, i.e. the variance that would have been observed if only the j^{th} shock took place. (15) is obviously analogous to (13). Note that the variance V_{pj} is written as $b_{pj}\sigma^2_{pj}$, b_{pj} being a quadratic term and σ^2_{pj} the variance of the j^{th} shock in period p. We are interested in explaining the change – decline – in the variance of output gap in each euro area country. The linear structure allows us to write the change in the contribution of the j^{th} shock as

$$V_{2j} - V_{1j} = \left(\frac{b_{1j} + b_{2j}}{2}\right)\left(\sigma^2_{2j} - \sigma^2_{1j}\right) + \left(\frac{\sigma^2_{1j} + \sigma^2_{2j}}{2}\right)\left(b_{2j} - b_{1j}\right) \tag{16}$$

following Stock and Watson (2005). The first term on the right-hand side of (16) measures the contribution of the change in the standard deviation of the j^{th} shock, while the second term measures the contribution of the change in the shock propagation.

The first box in the upper panel of Table 7 shows the change in absolute change in output gap volatility of the euro area countries from the first to the second sub-period according to the estimated business cycle generating process given in (9) for each country. The decline in output gap volality, the so-called Great Moderation, in every euro area country except Ireland is obvious. Since the change in Ireland is virtually not different from zero, we do not further interpret the corresponding erratic results in the following. The first and second boxes of the lower panel in Table 7 respectively show the relative, i.e. percentage, contributions of changes in shock variance as well as shock propagation to the output gap volatility decline. A positive (negative) value in these two boxes indicates that the corresponding factor has led to a decline (increase) in the corresponding output gap volatility, while a negative (positive) value indicates the opposite.

We had reported in Table 6 that the magnitude of world and euro area shocks had declined in the second sub-period. This is reflected in the first two columns of the first box of the lower panel of Table 7 as a positive contribution to the decline in output gap volatility in most cases. In two countries – Luxemburg and Portugal – where the magnitude of country-specific shocks has increased in the second sub-period relative to the first sub-period, the contribution of the change in shock variance to the output gap volatility decline is negative. In Belgium, changes in the size own shocks contributed negatively to the Great Moderation, but the overall contribution of the change in shock variance is positive.

The second box in the lower panel of Table 7 shows the contribution of the change in shock propagation to the decline in output gap volatility. It is interesting that the change in the propagation of shocks led in many cases to an increase of the output gap volatility. Hence, we can conclude that the Great Moderation is owed rather to a decrease in the size of shocks, while the contribution of change in shock propagation is either small or even negative.

In the second box in the upper panel of Table 7, we present the total contribution from world, euro area and country-specific shocks, i.e. the total of the contributions of changes in the magnitude of shocks and their propagation. The picture that arises is that the Great Moderation is caused mainly by changes related to world and country-specific shocks in the

Table 7: Decomposition of change in output gap variance into change in size of shocks and change in propagation

	Variances			Total contribution from shocks		
	1970–1990	1991–2007	Change	World	Euro Area	Own
bel	1.62	0.62	-1.00	0.25	0.26	0.49
deu	1.28	0.50	-0.78	0.91	0.24	-0.14
esp	1.69	0.27	-1.42	0.09	-0.01	0.92
fin	1.29	1.11	-0.18	0.29	0.09	0.63
fra	0.92	0.45	-0.47	0.44	0.25	0.32
grc	8.16	0.22	-7.94	0.19	0.05	0.76
ire	2.39	2.43	0.04	-2.89	18.04	-14.15
ita	2.24	0.56	-1.68	0.37	0.07	0.56
lux	5.71	1.77	-3.95	0.31	0.15	0.54
nld	1.51	0.54	-0.98	0.39	0.10	0.51
prt	5.97	0.94	-5.03	0.12	-0.06	0.94

	Contribution of change in shock variance				Contribution of change in shock propagation			
	World	Euro Area	Own	Total	World	Euro Area	Own	Total
bel	0.30	0.71	-0.18	0.82	-0.05	-0.45	0.68	0.18
deu	0.49	0.69	0.30	1.47	0.42	-0.45	-0.44	-0.47
esp	0.11	0.20	0.49	0.80	-0.03	-0.21	0.43	0.20
fin	5.17	2.03	7.96	15.16	-4.89	-1.94	-7.33	-14.16
fra	0.91	1.01	0.17	2.10	-0.48	-0.77	0.14	-1.10
grc	0.08	0.02	0.41	0.50	0.11	0.03	0.36	0.50
ire	-41.87	-41.16	470.59	387.56	38.98	59.20	-484.74	-386.56
ita	0.20	0.22	0.65	1.08	0.17	-0.15	-0.10	-0.08
lux	0.30	0.13	-2.92	-2.49	0.01	0.03	3.46	3.49
nld	0.60	0.44	0.58	1.62	-0.21	-0.33	-0.07	-0.62
prt	0.17	0.09	-0.98	-0.73	-0.04	-0.15	1.92	1.73

euro area, while common euro area shocks did generally have less or no significant effect on the output gap volatility decline in the member countries. This finding also explains why the share of euro area shocks in output gap volatility has increased in the second subperiod as reported in Table 5. The contribution of world shocks to the Great Moderation is highest in the economically large countries of the euro area – Germany and France– while the country-specific shocks dominate the scene from this perspective in the rest of the euro area countries.

4.5. Driving Force of Differentials

We turn our attention now to the differentials between the output gap of the entire euro area and the output gaps of the individual countries. We have seen in Section 2 that the

Table 8: Shares of shocks in output gap differential variance of euro area countries

	Sample: 1970Q1–1990Q2											
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
world shock	–	0.08	0.19	0.15	0.30	0.22	0.10	0.24	0.10	0.10	0.07	0.03
euro area shock	–	0.30	0.19	0.20	0.21	0.06	0.11	0.12	0.09	0.04	0.02	0.02
country shock	–	0.62	0.62	0.65	0.49	0.72	0.79	0.64	0.82	0.87	0.90	0.95

	Sample: 1990Q3–2007Q4											
	aut	bel	deu	esp	fin	fra	grc	ire	ita	lux	nld	prt
world shock	0.03	0.26	0.09	0.38	0.33	0.09	0.18	0.21	0.09	0.12	0.29	0.12
euro area shock	0.45	0.21	0.04	0.28	0.05	0.17	0.48	0.23	0.10	0.15	0.31	0.29
country shock	0.52	0.53	0.87	0.34	0.63	0.75	0.34	0.56	0.82	0.73	0.40	0.59

output gap differentials became smaller over time, i.e. they underwent a great moderation like the output gaps did. Nevertheless, there is no a priori reason that the driving force of output gap differentials as well as the source of decline in their size is the same as for output gaps.

According to Table 8, which shows the shares of shocks in the output gap differential variance of the euro area countries, the driving force of this variance is the own shock for every member country in the first sub-period, while the impact of world and euro area shocks is relatively small. The picture changes to some extent in the second sub-period. Own shocks remain still the main driving force of differentials in all member countries but Greece, where the euro area shocks have a share of 0.48. In some other countries too, world and/or euro area shocks gain in importance in the volatility of output gap differentials such as Belgium, Spain, the Netherlands and Portugal. Particularly in Spain, world and euro area shocks become as important as the own shocks in the fluctuations of the differentials in the second sub-period.

Table 9 is analogous to Table 7 and shows the decomposition of change in output gap differential variance into change in size of shocks and change in shock propagation. We had seen that world shocks and country-specific shocks were together the main contributors to the Great Moderation in output gap variances. According to Table 9, however, country-specific shocks clearly dominate the Great Moderation of each output gap differetials in the euro area, world and/or euro area shocks being of import in only few cases. The main contribution generally comes from the decline in size of shocks rather than from changes in

Table 9: Decomposition of change in output gap differential variance into change in size of shocks and change in propagation

	Variances			Total contribution from shocks		
	1970–1990	1991–2007	Change	World	Euro Area	Own
bel	0.41	0.12	-0.29	0.01	0.33	0.65
deu	0.21	0.09	-0.13	0.26	0.29	0.46
esp	1.14	0.11	-1.03	0.12	0.20	0.68
fin	1.31	0.50	-0.80	0.29	0.31	0.41
fra	0.18	0.08	-0.10	0.32	-0.02	0.70
grc	5.83	0.36	-5.46	0.09	0.09	0.82
ire	2.72	1.56	-1.16	0.27	-0.02	0.75
ita	0.72	0.11	-0.61	0.10	0.09	0.81
lux	3.14	1.22	-1.92	0.08	-0.03	0.95
nld	0.46	0.25	-0.21	-0.17	-0.31	1.49
prt	2.63	0.47	-2.17	0.00	-0.03	1.03

	Contribution of change in shock variance				Contribution of change in shock propagation			
	World	Euro Area	Own	Total	World	Euro Area	Own	Total
bel	0.22	0.27	-0.24	0.25	-0.21	0.06	0.90	0.75
deu	0.24	0.19	0.70	1.13	0.01	0.09	-0.24	-0.13
esp	0.16	0.12	0.35	0.63	-0.03	0.07	0.33	0.37
fin	0.59	0.18	1.10	1.87	-0.31	0.12	-0.69	-0.87
fra	0.30	0.25	0.42	0.97	0.03	-0.27	0.28	0.03
grc	0.06	0.04	0.45	0.56	0.03	0.04	0.37	0.44
ire	0.77	0.57	-18.33	-16.98	-0.50	-0.59	19.08	17.98
ita	0.07	0.07	0.60	0.74	0.03	0.02	0.21	0.26
lux	0.20	0.19	-4.72	-4.33	-0.12	-0.22	5.67	5.33
nld	0.73	0.42	2.55	3.70	-0.91	-0.73	-1.06	-2.70
prt	0.07	0.06	-1.17	-1.03	-0.07	-0.10	2.19	2.03

shocks propagation as in the case of the Great Moderation of output gap volatility except in Ireland, Luxemburg and Portugal. However, the weight of the decline in size of shocks is lower relative to the case of output gap volatility decline.

4.6. Sensitivity of Results

Finally, we check the sensitivity of our conclusions with respect to the number of lags in the VAR, the cointegration rank and the business cycle definition that underlies the analysis. Our conclusions are generally robust to lower or higher lag orders or a different cointegration rank. Although some of the reported statistics alter across different business cycle definitions based on Hodrick and Prescott (1997), Baxter and King (1999) and Random Walk filters, the general conclusions that we draw remain robust.

5. Summary

We investigated the properties of business cycle dynamics in the euro area with the aid of structural VAR models. We first established the statistical properties of the cyclical fluctuations and then assessed the role of world, euro area and country-specific shocks in those. We found that euro area shocks became a much more important factor behind cyclical fluctuations in many euro area countries recently. Moreover, while the great moderation in the euro area was found to be related to changes corresponding to world and country-specific shocks, it was found that euro area shocks did not play a significant role in this phenomenon. Finally, differentials between the output gaps of the euro area and member countries are driven mainly by country-specific shocks. Changes in the dynamics related to these shocks did also mainly lead to the great moderation of output gap differentials.

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