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EVIDENCE FROM EUROPE** 2009

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**Documentos de Trabajo  
N.º 0921**

**BANCO DE ESPAÑA**  
Eurosistema



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(\*) We would like to thank G. Amisano, D. Giannone, S. Eickmeier, G. Primiceri and the participants of a number of conferences for useful comments and suggestions. Canova acknowledges the financial support of the Spanish Ministry of Education, through the grant SEJ-2004-21682-E, of the CREI and of the Barcelona Graduate School of Economics. This paper should not be reported as representing the views of the Banco de España, the European Central Bank, or the Eurosystem.

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ISSN: 0213-2710 (print)

ISSN: 1579-8666 (on line)

Depósito legal: M. 39818-2009

Unidad de Publicaciones, Banco de España

**Abstract**

We study the effects that the Maastricht treaty, the creation of the ECB, and the Euro changeover had on the dynamics of European business cycles using a panel VAR and data from ten European countries - seven from the Euro area and three outside of it. There are slow changes in the features of business cycles and in the transmission of shocks. Time variations appear to be unrelated to the three events of interest and instead linked to a process of European convergence and synchronization.

**Keywords:** Business cycles, European Monetary Union, Panel VAR, Structural changes.

**JEL classification:** C15, C33, E32, E42.

# 1 Introduction

There are many studies showing that real activity in developed countries displays common characteristics. Using different econometric techniques, Del Negro and Otrok (2003), Giannone and Reichlin (2006) and Canova et al. (2007) among others have shown that the cyclical features of output and industrial production are similar within Euro area countries and between the Euro area and the US. There is also mounting evidence that the cyclical characteristics of real fluctuations are changing over time. These variations involve the features of the cycles, the nature of the phenomena and the causes of fluctuations. For example, Helbling and Bayoumi (2003) find a substantial increase in synchronization of OECD cycles after 2000; Stock and Watson (2003) highlight changes in the volatility of G-7 cycles in the 1990s, and Canova et al. (2007) document variations in the correlation of G-7 cyclical fluctuations since the end of the 1980s.

Why are the cyclical features of industrialized economies changing? At least three possibilities come to mind. It could be that variations in structural characteristics or in the operational features of markets have altered the transmission of shocks within and across countries. For instance, changes in the preferences of the monetary authority have been often invoked to explain the “Great inflation” of the 1970s and the subsequent period of more stable and predictable macroeconomic environment in the US and other countries (see e.g. Lubik and Schorfheide, 2004, or Cogley and Sargent, 2005). Changes in the operational features of markets, on the other hand, have been used to explain the dynamics of wage inequalities (see e.g. Greenwood and Yorokoglu, 1997). An alternative possibility is that the characteristics and the frequency of the shocks hitting developed economies has dramatically changed. Sims and Zha (2006) and Canova and Gambetti (2009) among others, argued that changes in the volatility of macroeconomic shocks could be responsible for the changes in volatility and persistence of output and inflation in the US; Stock and Watson (2003) suggested that changes in the shock volatility affected the magnitude and the direction of the international correlation among macroeconomic variables; and Helbling and Bayoumi (2003) claimed that common shocks are now more

frequent than used to be. Finally, institutional events may have altered the nature and the causes of cyclical fluctuations. To the best of our knowledge, this last option has received little empirical attention and this seems an important shortcoming since, at least in Europe, the political arena has witnessed dramatic changes over the last 20 years.

Perhaps, it is not too surprising to find that the literature has largely shied away from the topic. Institutions typically change slowly making it difficult to pin down a potential break point date and select subsamples over which to compare business cycle features. Furthermore, these variations may affect cycles with much longer periodicity than the ones typically associated with business fluctuations and externalities and threshold effects may matter when measuring the quantitative importance of these events. Finally, institutional changes never come in a vacuum and this makes it particularly difficult to attribute observed variations to these factors.

This paper sheds some light on the effect that institutional changes have on the dynamics of business cycles by focusing on the consequences that the Maastricht treaty, the creation of the ECB and the Euro changeover had for European real cyclical fluctuations. We put the stress on the real effects of these institutional events since they affect monetary institutions and, hence, their effects on the nominal side of the economy, such as inflation and nominal interest rates, is obvious.

Investigating the consequences of these events for the real economy is relevant from, at least, three different perspectives. First, since these changes were brought about by national politicians and were, to a large extent, exogenous with respect to the dynamics of the European economies, the experience is unique to verify some well known implications of the common currency area literature. Does real convergence precede the establishment of common monetary institutions or the reverse holds true? Second, the ability of monetary factors to affect real variables at business cycle frequencies has been extensively studied and limited effects typically found. However, the nature of the events we consider is substantially different from those typically examined and their consequences are a-priori comparable to the establishment of the Fed or the breakdown of the gold standard, which have made quite a difference for world cyclical fluctuations (see e.g. Bergman, et al., 1998).

Third, in macroeconomic analyses it is common to separate business cycles from other types of fluctuations claiming that the mechanism generating the two types of movements is different. If institutional changes, besides affecting medium-long run tendencies, also exercise a significant impact on the business cycle, such a practice should be reconsidered.

Since the subject is largely unexplored, this paper limits attention to three somewhat narrow questions. Has there been any tendency for European and national cycles to change in correspondence with these institutional changes? Is there a clean structural break in their properties at the time when these events occurred? Is there any difference in the relative impact that these changes had on the cyclical characteristics of the data?

To study these questions we employ the panel VAR model of Canova and Ciccarelli (2004) and Canova et al. (2007). The setup is useful because i) it handles large scale models displaying unit specific dynamics and cross country lagged interdependencies; ii) it flexibly allows for time variations in the correlation structure across variables and units; and iii) it features an index structure, where the distribution of European, Euro area and national specific cyclical indicators can recursively be constructed. Data from Germany, France, Italy, Spain, Belgium, the Netherlands, Finland, the UK, Denmark and Sweden for output, employment, industrial production, consumption and investment is employed and distributional measures of cyclical fluctuations constructed for the sample 1970:1-2007:3. We perform forecasting exercises with information available before each event and trace out the effect of interesting shocks before and after the events. Since both Euro area and non-Euro countries are used, the analysis has the potential to provide important information about the cyclical consequences of institutional changes.

The features of European and national cycles have changed over time. There are many dimensions over which these changes are measurable. For instance, one can observe a decrease in the volatility and variations in the persistence of the fluctuations of both European and national cycles, a higher conformity between national and European cycles, and important changes in the transmission of certain shocks. However, these variations do not relate well with the institutional changes we consider. From a reduced form point of view, there are little changes in the features of the cyclical fluctuations when the sample



is broken at the time the ECB was created or the Euro introduced. Some variations are detectable when pre and post-Maastricht samples are considered but similar changes also emerge when the sample is split in the middle of the 1980s.

From an unconditional forecasting perspective, we are able to predict both the direction and the magnitude of the variations in the five variables for the Euro countries after each event with similar precision while, for the control group of non-Euro countries, variations become more predictable as time went by. In terms of the transmission of shocks, a significant convergence process is taking place. Responses of countries belonging to the Euro area are now more similar than they were in past, but neither the beginning of this process nor changes in its speed can be associate with the three institutional changes of interest, especially because Euro and non-Euro countries behave in a similar way.

The rest of the paper is organized as follows: the next section presents the model specification, the technique used to construct the cyclical indicators, and the procedure employed to compute unconditional and conditional forecasts. Section 3 presents the data and some specification checks. Section 4 contains the results and section 5 concludes.

## 2 The empirical model

The empirical framework employed in the analysis has the form:

$$y_{it} = D_{it}(L)Y_{t-1} + F_{it}(L)W_{it} + e_{it} \quad (1)$$

where  $i = 1, \dots, N$  refers to countries and  $t = 1, \dots, T$  to time;  $y_{it}$  is a  $G \times 1$  vector for each  $i$  and  $Y_t = (y'_{1t}, y'_{2t}, \dots, y'_{Nt})'$ ;  $D_{it,j}$  are  $G \times NG$  matrices for each lag  $j = 1, \dots, p$ ,  $W_{it}$  is a  $Mq \times 1$  vector of exogenous variables and  $F_{it,j}$  are  $G \times M$  matrices each  $j = 1, \dots, q$  and  $e_{it}$  is a  $G \times 1$  vector of random disturbances.

The model displays three important ingredients which makes it ideal for our purposes. First, coefficients are allowed to vary over time. Without this feature, one attribute changes in business cycle features which smoothly take place over time to the once-and-for-all institutional changes we are concerned with. Second, the dynamic relationships are allowed to be unit specific. Without such a structure, heterogeneity biases may be present,

making the economic conclusions one reaches distorted. Third, whenever the  $NG \times NG$  matrix  $D_t(L) = [D_{1t}(L), \dots, D_{Nt}(L)]'$ , is not block diagonal for some  $L$ , cross-unit lagged interdependencies matter. With this structure, dynamic feedback across units are allowed for and this greatly expands the type of interactions the model can account for.

While these ingredients add realism to the specification, and avoid the “incredible” short-cuts that the literature has often taken (see Canova and Ciccarelli, 2004, for discussion), they are not costless: the number of parameters is large (there are  $k = NGp + Mg$  parameters in each equation) and there is only one time period per unit to estimate them. It is convenient to rewrite (1) in a simultaneous equations format:

$$Y_t = Z_t \delta_t + E_t \quad E_t \sim N(0, \Omega) \quad (2)$$

where  $Z_t = I_{NG} \otimes X_t'$ ;  $X_t' = (Y'_{t-1}, Y'_{t-2}, \dots, Y'_{t-p}, W'_t, W'_{t-1}, \dots, W'_{t-q})$ ,  $\delta_t = (\delta'_{1t}, \dots, \delta'_{Nt})'$  and  $\delta_{it}$  are  $Gk \times 1$  vectors containing, stacked, the  $G$  rows of the matrix  $D_{it}$  and  $F_{it}$ , while  $Y_t$  and  $E_t$  are  $NG \times 1$  vectors of endogenous variables and of random disturbances.

## 2.1 The factorization of the coefficient vector

Since  $\delta_t$  varies with cross-sectional units in different time periods, it is impossible to estimate it using unrestricted classical methods. However, even if  $\delta_t$  were time invariant, its sheer dimensionality prevents any meaningful unconstrained estimation. To solve this problem we assume that  $\delta_t$  has a flexible factor structure of the form:

$$\delta_t = \Xi_1 \lambda_t + \Xi_2 \alpha_t + \Xi_3 \rho_t + \Xi_4 \psi_t + u_t \quad (3)$$

where  $\Xi_1, \Xi_2, \Xi_3, \Xi_4$  are matrices of dimensions  $NGk \times s, NGk \times N, NGk \times G, NGk \times 1$  respectively and  $\lambda_t, \alpha_t, \rho_t, \psi_t$  are mutually orthogonal. Here  $\lambda_t$  captures movements in the coefficient vector which are common across countries and variables (or groups of them) and is of dimension  $s$ ;  $\alpha_t$  captures movements in the coefficient vector which are common within countries and its dimension equals to  $N$ ;  $\rho_t$  captures movements in the coefficient vector which are variable specific and its dimension is equal to  $G$ ; while  $\psi_t$  is a scalar process which captures movements in the coefficients due to the  $M$  exogenous variables.

Finally,  $u_t$  captures all the unmodelled features of the coefficient vector, which may have to do with lag specific, time specific or other idiosyncratic effects.

Factoring  $\delta_t$  as in (3) is advantageous in many respects. Computationally, it reduces the problem of estimating  $NGk$  coefficients into the one of estimating  $s + N + G + 1$  factors characterizing their dynamics. Practically, the factorization (3) transforms an overparametrized panel VAR into a parsimonious SUR model where the regressors are averages of certain right-hand side VAR variables. Using (3) in (2) we have

$$Y_t = \mathcal{Z}_{1t}\lambda_t + \mathcal{Z}_{2t}\alpha_t + \mathcal{Z}_{3t}\rho_t + \mathcal{Z}_{4t}\psi_t + v_t \quad (4)$$

where  $\mathcal{Z}_{1t} = Z_t\Xi_1$ ,  $\mathcal{Z}_{2t} = Z_t\Xi_2$ ,  $\mathcal{Z}_{3t} = Z_t\Xi_3$ ,  $\mathcal{Z}_{4t} = Z_t\Xi_4$  capture respectively, common, country specific, variable specific and exogenous specific information present in the data, and  $v_t = E_t + Z_t u_t$ . Economically, the decomposition in (4) is convenient since it allows us to measure the relative importance of common and country specific influences for fluctuations in  $Y_t$  and therefore to examine whether institutional events affect them differently. In fact,  $WLI_t = \mathcal{Z}_{1t}\lambda_t$  plays the role of a common indicator, while  $CLI_t = \mathcal{Z}_{2t}\alpha_t$  plays the role of a vector of country specific indicators. Both coincident and leading versions of these indicators can be designed using time  $t - h$ ,  $h = 0, 1, 2, \dots$  information (see Canova and Ciccarelli, 2004), and are constructed recursively, given a law of motion of  $\lambda_t$  and  $\alpha_t$ . Note that  $WLI_t$  and  $CLI_t$  are correlated by construction - the same variables enter in both  $\mathcal{Z}_{1t}$  and  $\mathcal{Z}_{2t}$  - but become uncorrelated as the number of units becomes large.

## 2.2 An example

To illustrate the structure of the  $\Xi$ 's and the nature of  $\mathcal{Z}_{jt}$ 's, suppose there are  $G = 2$  variables,  $N = 2$  countries,  $s = 1$  common component,  $p = 1$  lags, no exogenous variables and an intercept of the form

$$\begin{bmatrix} y_t^1 \\ x_t^1 \\ y_t^2 \\ x_t^2 \end{bmatrix} = \begin{bmatrix} d_{1,1,t}^{1,y} & d_{2,1,t}^{1,y} & d_{1,2,t}^{1,y} & d_{2,2,t}^{1,y} \\ d_{1,1,t}^{1,x} & d_{2,1,t}^{1,x} & d_{1,2,t}^{1,x} & d_{2,2,t}^{1,x} \\ d_{1,1,t}^{2,y} & d_{2,1,t}^{2,y} & d_{1,2,t}^{2,y} & d_{2,2,t}^{2,y} \\ d_{1,1,t}^{2,x} & d_{2,1,t}^{2,x} & d_{1,2,t}^{2,x} & d_{2,2,t}^{2,x} \end{bmatrix} \begin{bmatrix} y_{t-1}^1 \\ x_{t-1}^1 \\ y_{t-1}^2 \\ x_{t-1}^2 \end{bmatrix} + \begin{bmatrix} c_1^y \\ c_1^x \\ c_2^y \\ c_2^x \end{bmatrix} + e_t \quad (5)$$

Here  $\delta_t = [d_{1,1,t}^{1,y}, d_{2,1,t}^{1,y}, d_{1,2,t}^{1,y}, d_{2,2,t}^{1,y}, c_1^y, d_{1,1,t}^{1,x}, d_{2,1,t}^{1,x}, d_{1,2,t}^{1,x}, d_{2,2,t}^{1,x}, c_t^x, d_{1,1,t}^{2,y}, d_{2,1,t}^{2,y}, d_{1,2,t}^{2,y}, d_{2,2,t}^{2,y}, c_2^y, d_{1,1,t}^{2,x}, d_{2,1,t}^{2,x}, d_{1,2,t}^{2,x}, d_{2,2,t}^{2,x}, c_2^x]'$  is a  $20 \times 1$  vector and the typical element of  $\delta_t$ ,  $\delta_{l,s,t}^{i,j}$ , is indexed by the country  $i$ , the variable  $j$ , the variable in an equation  $l$  (independent of the country), and the country in an equation  $s$  (independent of variable). If we are not interested in modelling all these aspects and call  $u_t$  all unaccounted features, one possible factorization of  $\delta_t$  is

$$\delta_t = \Xi_1 \lambda_t + \Xi_2 \alpha_t + \Xi_3 \rho_t + u_t \quad (6)$$

where for each  $t$ ,  $\lambda_t$  is a scalar,  $\alpha_t$  is a  $2 \times 1$  vector,  $\rho_t$  is a  $2 \times 1$  vector,  $\Xi_1$  is a  $20 \times 1$  vector of ones, and

$$\Xi_2 = \begin{matrix} (20 \times 2) \\ \begin{bmatrix} \iota_1 & 0 \\ \iota_1 & 0 \\ 0 & \iota_2 \\ 0 & \iota_2 \end{bmatrix} \end{matrix} \quad \Xi_3 = \begin{matrix} (20 \times 2) \\ \begin{bmatrix} \varkappa_1 & 0 \\ 0 & \varkappa_2 \\ \varkappa_1 & 0 \\ 0 & \varkappa_2 \end{bmatrix} \end{matrix}$$

with  $\iota_1 = (1 \ 1 \ 0 \ 0 \ 0)'$ ,  $\iota_2 = (0 \ 0 \ 1 \ 1 \ 0)'$ ,  $\varkappa_1 = (1 \ 0 \ 1 \ 0 \ 0)'$  and  $\varkappa_2 = (0 \ 1 \ 0 \ 1 \ 0)'$ . Hence, the VAR (5) can be rewritten as

$$\begin{bmatrix} y_t^1 \\ x_t^1 \\ y_t^2 \\ x_t^2 \end{bmatrix} = \begin{bmatrix} \mathcal{Z}_{1t} \\ \mathcal{Z}_{1t} \\ \mathcal{Z}_{1t} \\ \mathcal{Z}_{1t} \end{bmatrix} \lambda_t + \begin{bmatrix} \mathcal{Z}_{2,1,t} & 0 \\ \mathcal{Z}_{2,1,t} & 0 \\ 0 & \mathcal{Z}_{2,2,t} \\ 0 & \mathcal{Z}_{2,2,t} \end{bmatrix} \alpha_t + \begin{bmatrix} \mathcal{Z}_{3,1,t} & 0 \\ 0 & \mathcal{Z}_{3,2,t} \\ \mathcal{Z}_{3,1,t} & 0 \\ 0 & \mathcal{Z}_{3,2,t} \end{bmatrix} \rho_t + v_t \quad (7)$$

where  $\mathcal{Z}_{1t} = y_{t-1}^1 + x_{t-1}^1 + y_{t-1}^2 + x_{t-1}^2 + 1$ ,  $\mathcal{Z}_{2,1,t} = y_{t-1}^1 + x_{t-1}^1$ ,  $\mathcal{Z}_{2,2,t} = y_{t-1}^2 + x_{t-1}^2$ ,  $\mathcal{Z}_{3,1,t} = y_{t-1}^1 + y_{t-1}^2$ ,  $\mathcal{Z}_{3,2,t} = x_{t-1}^1 + x_{t-1}^2$  and  $v_t = e_t + Z_t' u_t$ . When  $\lambda_t$  is large relative to  $\alpha_t$ ,  $y_t^1$  and  $x_t^1$  comove with  $y_t^2$  and  $x_t^2$ . On the other hand, when  $\lambda_t$  is zero,  $y_t^1$  and  $x_t^1$  may drift apart from  $y_t^2$  and  $x_t^2$ . Note that, when  $p > 1$ , lags can be weighted using a decay factor as in Doan et al., 1984.

As the notation used in the example makes it clear, the regressors in (4) are combinations of lags of the right hand side variables of the VAR, while  $\lambda_t, \alpha_t, \rho_t, \psi_t$  are time varying loadings. Using averages as regressors is common in the factor model literature (see e.g. Stock and Watson, 1989, or Forni and Reichlin, 1998) and in the signal extraction literature (see e.g. Sargent, 1989). However, five important differences between (4) and standard factor models need to be noted. First, the indicators equally weight the

information in all variables. The equal weighting scheme comes directly from (3) and the fact that all variables are measured in the same units (all variables will be demeaned and standardized). Second, our indices dynamically span lagged interdependencies across countries and variables. Third, they are observable. Fourth, our loadings are allowed to be time varying. Finally, our averaging approach creates moving average terms of order  $p$  in the regressors of (4). Therefore, our indicators eliminate high frequency variability from the right hand side variables of the VAR.

### 2.3 The complete model

To complete the specification we need to describe the evolution of  $\lambda_t, \alpha_t, \rho_t, \psi_t$  over time and the features of their (prior) distribution. Write (3) compactly as:

$$\delta_t = \Xi\theta_t + u_t \quad u_t \sim N(0, \Sigma \otimes V) \quad (8)$$

where  $\Xi = [\Xi_1, \Xi_2, \Xi_3, \Xi_4]$ ,  $\theta_t = [\lambda_t, \alpha'_t, \rho'_t, \psi'_t]'$ , and  $V$  is a  $k \times k$  matrix and let

$$\theta_t = \theta_{t-1} + \eta_t \quad \eta_t \sim N(0, B_t). \quad (9)$$

Assume that  $\Sigma = \Omega$  and  $V = \sigma^2 I_k$ ,  $\sigma^2$  unknown;  $B_t = \gamma_1 * B_{t-1} + \gamma_2 * \bar{B}$ ,  $\gamma_1, \gamma_2$  known; that  $\bar{B} = \text{diag}(\bar{B}_1, \bar{B}_2, \bar{B}_3, \bar{B}_4)$ , and that  $E_t, u_t$  and  $\eta_t$  are mutually independent.

In (9) the factors evolve over time as random walks. We stick to this simple setup since experimentation with more complicated structures did not produce important improvements in the results. The spherical assumption on  $V$  reflects the fact that the factors have similar units, while setting  $\Sigma = \Omega$  is standard (see e.g. Kadiyala and Karlsson, 1997). The variance of  $\eta_t$  is allowed to be time varying to account for ARCH-M type effects and other generic volatility clustering. Time invariant structures ( $\gamma_1 = \gamma_2 = 0$ ), and homoskedastic variances ( $\gamma_1 = 0$  and  $\gamma_2 = 1$ ) are special cases of the assumed process. The block diagonality of  $\bar{B}$  guarantees orthogonality of the factors, which is preserved a-posteriori, and hence their identifiability. Finally, independence among the errors is standard.

To summarize, our reparametrized empirical model has the state space structure:

$$\begin{aligned} Y_t &= (Z_t \Xi) \theta_t + v_t \\ \theta_t &= \theta_{t-1} + \eta_t \end{aligned} \quad (10)$$

where  $v_t \sim (0, \Omega)$ . While the model (10) can be estimated both with classical and Bayesian methods, the latter approach is preferable since the exact small sample distribution of the objects of interest can be obtained with relatively small  $T$  and  $N_s$ .

## 2.4 Prior information

To compute posterior distributions for the unknowns we need prior densities for  $\phi_0 = (\Omega, \bar{B}, \theta_0)$ . We let  $\bar{B}_i = b_i * I$ ,  $i = 1, 2, 3, 4$ , where  $b_i$  is a parameter which controls the tightness of factor  $i$  in the coefficients, and  $p(\Omega^{-1}, b_i, \theta_0) = p(\Omega^{-1})p(\theta_0) \prod_i p(b_i)$  with  $p(\Omega^{-1}) = Wi(z_1, Q_1)$ ,  $p(b_i) = IG\left(\frac{\varpi_0}{2}, \frac{\delta_0}{2}\right)$  and  $p(\theta_0 | \mathcal{F}_{-1}) = N(\bar{\theta}_0, \bar{R}_0)$  where  $N$  stands for Normal,  $Wi$  for Wishart and  $IG$  for Inverse Gamma distributions, and  $\mathcal{F}_{-1}$  denotes the information available at time  $-1$ . The prior for  $\theta_0$  and the law of motion for the coefficient factors imply that  $p(\theta_t | \mathcal{F}_{t-1}) = N(\bar{\theta}_{t-1|t-1}, \bar{R}_{t-1|t-1} + B_t)$ . We have experimented with both loose but informative and noninformative priors. We report results obtained with the former set of priors.

We collect the hyperparameters of the prior in the vector  $\mu$  and assume that the elements of  $\mu$  are either known or can be estimated in a training sample of the data. The values used are:  $z_1 = N \cdot G + 50$ ,  $Q_1 = \hat{Q}_1$ ,  $\varpi_0 = 10^6$ ,  $\delta_0 = \gamma_1 = 1.0$ ,  $\gamma_2 = 0$ ,  $\bar{\theta}_0 = \hat{\theta}_0$  and  $\bar{R}_0 = I_J$ . Here  $\hat{Q}_1$  is the estimated variance-covariance of the time invariant version of (1),  $\hat{\theta}_0$  is obtained with a sequential OLS on (1), over the sample 1975-1980, and  $J$  is the dimension of  $\theta_t$ . The remaining hyperparameters have been chosen using previous experience.

## 2.5 Posterior distributions

To calculate the posterior distribution for  $\phi = (\Omega^{-1}, b_i, \{\theta_t\}_{t=1}^T)$ , we combine the prior with the likelihood of the data, which is proportional to

$$L \propto |\Omega|^{-T/2} \exp \left[ -\frac{1}{2} \sum_t (Y_t - W_t \Xi \theta_t)' \Omega^{-1} (Y_t - W_t \Xi \theta_t) \right] \quad (11)$$

where  $Y^T = (Y_1, \dots, Y_T)$  denotes the data. Using Bayes rule,  $p(\phi | Y^T) = \frac{p(\phi)L(Y^T|\phi)}{p(Y^T)} \propto p(\phi)L(Y^T|\phi)$ . Given  $p(\phi | Y^T)$ , the posterior distribution for the elements of  $\phi$ ,  $p(\Omega | Y^T)$

,  $p(b_i | Y^T)$ , and  $p(\{\theta_t\}_{t=1}^T | Y^T)$ , can be obtained by integrating out nuisance parameters from  $p(\phi | Y^T)$ . Once these distributions are found, location and dispersion measures for  $\phi$  and for any interesting continuous function of them can be obtained.

For the model we use, it is impossible to compute  $p(\phi | Y^T)$  analytically. A Monte Carlo techniques which is useful in our context is the Gibbs sampler, since it only requires knowledge of the conditional posterior distribution of  $\phi$ . Denoting  $\phi_{-\kappa}$  the vector  $\phi$  excluding the parameter  $\kappa$ , these conditional distributions are

$$\begin{aligned} \theta_t | Y^T, \phi_{-\theta_t} &\sim N(\bar{\theta}_{t|T}, \bar{\mathbf{R}}_{t|T}) \quad t \leq T, \\ \Omega^{-1} | Y^T, \phi_{-\Omega} &\sim Wi\left(z_1 + T, \left[\sum_t (Y_t - W_t \Xi \theta_t)(Y_t - W_t \Xi \theta_t)' + Q_1^{-1}\right]^{-1}\right) \\ b_i | Y^T, \phi_{-b_i} &\sim IG\left(\frac{\varpi^i}{2}, \frac{\sum_t (\theta_t^i - \theta_{t-1}^i)' (\theta_t^i - \theta_{t-1}^i) + \delta_0}{2}\right) \end{aligned} \quad (12)$$

where  $\bar{\theta}_{t|T}$  and  $\bar{\mathbf{R}}_{t|T}$  are the one-period-ahead forecasts of  $\theta_t$  and the variance-covariance matrix of the forecast error, respectively, calculated with a simulation smoother, as described in Chib and Greenberg (1995), and  $\varpi^1 = T + \varpi_0$ ,  $\varpi^2 = Tg + \varpi_0$  and  $\varpi^3 = TN + \varpi_0$ .

Under regularity conditions (see Geweke, 2000), cycling through the conditional distributions in (12) produce in the limit draws from the joint posterior of interest. From these, marginal distributions can be computed averaging over draws nuisance dimensions. Thus, using the draws, the posterior distributions of  $\lambda_t$  and  $\alpha_t$  can be estimated using kernel methods and, in turns, the posterior distributions of  $WLI_t$  and  $CLI_t$  can be obtained. For example, a credible 90% interval is obtained ordering the draws of  $WLI_t^h$  and  $CLI_t^h$  for each  $t$  and taking the 5th and the 95th percentile of the distribution. We have performed standard convergence checks: increasing the length of the chain, splitting the chains in pieces after a burn-in period and calculating whether the mean and the variances are similar; checking if cumulative means settle at some value. The result are based on chains with 300000 draws: 3000 blocks of 100 draws were made and the last draw for each block is retained after discarding the first 1000. Hence, 2000 draws are used at each  $t$  to conduct posterior inference.

## 2.6 Summary Statistics

Besides characterizing the time profile of the posterior distribution of interesting cyclical indicators, we will be interested in computing predictive distributions for  $Y_{t+\tau}$ ,  $\tau > 0$ , both unconditionally and conditionally. These distributions can be obtained numerically using the structure of the model (10) and draws for the posterior of the parameters and/or the shocks. For example,  $f(Y_{t+\tau}) = \int f(Y_{t+\tau}|Y_t, \phi_{t+\tau})g(\phi_{t+\tau}|Y_t)d\phi_{t+\tau}$ , is the unconditional predictive distribution, where  $t$  takes different values and  $\tau$  runs from 1 to 20 (quarters). To draw from this predictive densities, we condition on  $\theta_{t+\tau} = \theta_t$ .

To study features of conditional predictive distributions, we produce impulse responses. These are computed as the difference between two conditional forecasts: one where a particular variable (or set of variables) is shocked and one where the disturbance is set to zero. Formally, let  $y^t$  be a history for  $y_t$ ;  $\theta^t$  be a trajectory for the coefficients up to  $t$ ,  $y_{t+1}^{t+\tau} = [y'_{t+1}, \dots, y'_{t+\tau}]'$  a collection of future observations and  $\theta_{t+1}^{t+\tau} = [\theta'_{t+1}, \dots, \theta'_{t+\tau}]'$  a collection of future trajectories for  $\theta_t$ . Here too we condition on  $\theta_{t+\tau} = \theta_t$ . Let  $\mathcal{W}_t = (\Omega, B_t)$ ; set  $\xi_t^l = [v'_{1t}, v'_{2t}, \eta'_t]$ , where  $v_{1t}$  are the shocks to the endogenous variables and  $v_{2t}$  the shocks to exogenous variables. Let  $\xi_{j,t+1}^\delta$  be a realization of  $\xi_{j,t+1}$  of size  $\delta$  and let  $\mathcal{F}_t^1 = \{y^t, \theta^t, \mathcal{W}_t, J_t, \xi_{j,t}^\delta, \xi_{-j,t}, \xi_{t+1}^{t+\tau}\}$  and  $\mathcal{F}_t^2 = \{y^t, \theta^t, \mathcal{W}_t, J_t, \xi_t, \xi_{t+1}^{t+\tau}\}$  be two conditioning sets, where  $\xi_{-j,t}$  indicates all shocks, excluding the one in the  $j$ -th component and  $J_t$  is an identification matrix satisfying  $J_t J_t' = \Omega$ . Then, responses at horizon  $\tau$  to an impulse in  $\xi_{j,t}^\delta$ ,  $j = 1, \dots$  are

$$IR_y^j(t, \tau) = E(y_{t+\tau}|\mathcal{F}_t^1) - E(y_{t+\tau}|\mathcal{F}_t^2) \quad \tau = 1, 2, \dots \quad (13)$$

When the coefficients are constant (i.e when shocks only affect endogenous variables), (13) collapses to the traditional impulse response function to unitary structural shocks.

In this paper, two types of structural shocks are considered: domestic German disturbances and US short term interest rate shocks, all lasting one period. The domestic German shock is defined as the shock which simultaneously increase all German variables and it is identified with a block-Choleski decomposition of  $\Omega$ , placing German variables first with respect to the rest of the countries. A US interest rate shocks is, instead, an



innovation in one of the variables belonging to  $W_t$ .

### 3 The data and the specification selection criteria

The endogenous variables of the model are demeaned and standardized year-on-year quarterly growth rates of output, industrial production, employment, consumption and investment for Germany, France, Italy, Spain, Belgium, Netherlands, Finland, the UK, Denmark and Sweden for the period 1970Q1 to 2007Q3. Industrial production is measured by its index and employment by the total employment index, both from OECD Main Economic Indicators. Output is measured by real GDP, consumption by total real private consumption expenditure and investment by real gross fixed capital formation. All three are measured in 2000 prices and taken from the OECD Economic Outlook database.

The exogenous variables are the growth rates of non-energy commodity prices, of oil prices, of the world trade, of US GDP, of the NY stock market index and the level of the US nominal interest rate. Non-energy commodity prices measure world prices of primary commodities, excluding energy, and are from OECD Economic Outlook. Oil prices are quarterly average prices and obtained from the IMF International Financial Statistic. World trade is measured by the total volume of world trade in goods and services in 2000 prices, and taken from the OECD Main Economic Indicators. US GDP data comes from the Bureau of Economic Analysis. The US interest rate measures 3-month nationally traded certificates of deposit issued by commercial banks, and the series is obtained from the Federal Reserve Board <sup>1</sup>. We use one lag of both endogenous and exogenous variables. Hence, each of the 50 equations of the system has  $50 \times 1 + 6 \times 1 = 56$  coefficients.

Since the sample of countries covers most of the Euro Area and the three most relevant countries which declined joining the zone, we can test the relevance and the scope of the institutional changes for real fluctuations by comparing statistics across group of countries before and after the events.

The sample is long enough to perform meaningful pre and post-institutional changes

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<sup>1</sup>Since some variables display seasonality despite being reported as seasonally adjusted at the source, we prefilter questionable series with TRAMO-SEATS.

exercises in all cases. The Maastricht Treaty was signed on February 7, 1992, but we take 1993Q4 as the cut-off point since it became effective only on November 1st, 1993; the ECB creation occurred on June 1st, 1998 (we take as cut-off point 1998Q3); and the Euro changeover occurred on January 1, 2002 (we take as cut-off point 2002Q1).

Before analyzing the questions of interest, it is useful to study the properties of the empirical model. Documenting the fit of the model is important because the credibility of our conclusions will be enhanced if the model captures the data well and if our indicators reproduce important cyclical statistics of the data.

After some experimentation, the benchmark structure employed is one where the decomposition (3) is exact (hence we set  $\sigma^2 = 0$ ). The model used in the exercises in section 4 was selected with a specification search where different specifications were compared via marginal likelihood (ML). The marginal likelihood of model  $M_i$  is  $f(Y|M_i) = \int L(y|\phi_i, M_i)g(\phi_i|M_i)d\phi_i$ , where  $\phi_i = [\phi_{1i}, \dots, \phi_{ti}]$  is the vector of the parameters of  $M_i$ .  $M_i$  is preferred to  $M_{i'}$  if the Bayes factor  $BF(M_i, M_{i'}) = \frac{f(Y|M_i)}{f(Y|M_{i'})}$  substantially exceeds 1.

The alternative specifications considered include a model with no country-specific dynamics (ML = -5723); a model with no variable-specific effects (ML = -5486); a model where there is no factor for the exogenous variables and their coefficients are treated in the same way as the coefficients on lagged endogenous variables (ML = -5343). The marginal likelihood of the model including unit-specific dynamics, one common factor and specific factors for the country, variable and exogenous components is highest (ML = -5308).

We have also experimented with two specifications for the common component: a single common cycle one  $s = 1$ ; and an alternative one,  $s = 2$ , where there is Euro cycle and a non-Euro cycle. The latter model has ML = -5336. Thus, the evidence in favor of the single European factor is overwhelming (log Bayes factor of 29). Figure 1, which plots the posterior median of the European indicator  $Z_{1t}\lambda_t$  (labelled '*common all*'), together with the posterior median of the two separate Euro and non-Euro indicators  $Z_{11t}\lambda_{1t}$  and  $Z_{12t}\lambda_{2t}$  (labelled '*common EMU*' and '*common non EMU*,' respectively) shows why the single common specification is preferred.

The Euro and non-Euro indicators are similar and display fluctuations which are highly

in phase with the single common indicator. Fluctuations in the Euro indicator are less volatile than those in the non-Euro indicators up to the early 1990s, but after that date no difference is noticeable. This result already provides important information on the issues we care about. As the dynamics of business cycles in Euro area and non-Euro area countries are similar since the early 1990s, it is unlikely that the creation of the ECB and the Euro changeover are crucial factors in understanding variations of European business cycle characteristics.

## 4 The results

To examine whether the Maastricht treaty, the creation of the ECB and the Euro changeover have anything to do with the properties of European cycles, we proceed in three steps. First, we informally examine the dynamics of the estimated common and country specific indicators. Then we conduct forecasting exercises around the time when these institutional changes took place and examine the dynamic responses of certain shocks, again around the time when these changes occurred. Darker areas in figure 2 capture recessions according to the CEPR classification ([www.cepr.org](http://www.cepr.org)). Darker areas in figure 3 represent official recessions periods as reported by the Economic Cycle Research Institute (ECRI)([www.businesscycle.com](http://www.businesscycle.com)); these are absent from the plots for the Netherlands, Belgium, Denmark and Finland since no official dating is available for these countries.

### 4.1 Background evidence

To start with we want to show that our European and national indicators capture important features of European and national business cycles. First, the time path of the (common) European indicator shares important similarities with the synthetic Euro area GDP growth series (which we take from the Area Wide Model dataset of the ECB). As shown in the last column in Table 1, the two series are highly correlated, show similar serial correlation even though the synthetic Euro area GDP growth series is more volatile and slightly leads the common indicator.

Second, European indicator has four clear expansion phases (1985-90, 1995-96, 1998-

2001, 2006-07), two strong recessions (1981-84, 1991-94) and a much milder one (2001-05) (see figure 2). The recession dates roughly correspond to those reported by the CEPR - no dating is available from that source after 2000 - even though the methodology used to date turning points is different. The business cycle phases of the national indicators are also highly synchronized with those reported by ECRI. In fact, if we allow for one quarter (two quarters) of maximum discrepancy, the average coincidence between our dating and the ECRI dating across countries is 58% (63%) (see Table 1). Thus, our estimated European and national indicators captures important features of European and national business cycles.

## 4.2 Time Variations

The estimated European indicator is characterized by different phases. Until the mid-1980s, fluctuations were volatile and the series crossed the zero line often. Afterwards, the indicator stays away from the zero line for longer periods and fluctuates much less, particularly after the exchange rate crisis of early 1990s. Hence, while a “European cycle” is present throughout the period, it is only since the early 1990s that it acquires typical cyclical features. The estimated national indicators, instead, display “cyclical” features throughout the sample. As intuition would suggest, these indicators are quite heterogeneous in terms of timing, amplitude and duration of the fluctuations. However, one can notice that the characteristics of indicators of major countries tend to become more similar as time goes by.

The volatilities of both the European and the national indicators fall considerably in the late 1980s and fall even further after 2000 (the exception here is Germany). This fall is in line with the reduction in the real business cycle volatility documented, e.g., in Stock and Watson (2003). However, as table 1 indicates, rather than happening in the early 1980s, the volatility reduction we observe takes place in the late 1980s and is therefore distinct from the phenomena widely referred to as the Great Moderation. The reduction in volatility of the European indicator is accompanied by an increase in its persistence. On the contrary, national indicators display an initial reduction in persistence which, in

Germany and Denmark, is reverted in the last five years of the sample.

Despite these important variations, business cycles phases in both the European and the national indicators are roughly invariant over time. Notice that the length of recessions and expansions is roughly similar in all the national indicators and this is true regardless of the sample we consider - exceptions here are Germany and Spain where longer expansions in the latter part of the sample are noticeable (see table 2).

The time variations we have highlighted square reasonably well with what is known in the literature. For example, in line with Canova et al. (2007), the strengthening of a common pattern in cyclical fluctuations does not imply that national cycles are disappearing. In fact, the stronger cyclicalities displayed by the European indicator is not the result of an increase in the synchronization of business cycle phases across countries - the maximum correlation between the European and the national indicators was almost always contemporaneous. Instead, it comes from more intense comovements across countries - the contemporaneous correlation of almost all national indicators with the European indicator increases over time.

### **4.3 Institutional changes and real fluctuations**

Artis and Zhang (1997) analyzed business cycles statistics before and after 1979 - the period of the first European Monetary System (EMS). They find an increase in the degree of conformity and of synchronization in the fluctuations of the countries participating to the first monetary system, an increase which was not present in non-EMS countries. Table 1 shows that the post-Maastricht, post-ECB and post-Euro samples roughly display similar volatility and persistence in both European and national indicators and, more importantly, that there is very little difference in the dynamic features of business cycles between Euro and non-Euro area countries. Consequently, it is difficult to claim that the creation of the ECB or the Euro changeover had important consequences on European business cycles.

On the other hand, Table 1 could, at first sight, support the view that the implementation of the Maastricht treaty mattered for real fluctuations: the dynamics of the indicators

in any of the post-Maastricht samples are different from those of the pre-Maastricht sample. Besides the above mentioned reduction in the volatility of the European indicators, one can in fact observe a decline in volatility and an increase in the correlations of the indicators of both Euro area and non-Euro area countries.

However, a closer look at the evidence indicates that most of these changes predate the event of interest. European and the national indicators are, in fact, highly in phase since the mid-1980s and cyclical fluctuations have become more synchronized in all countries roughly at the same time, probably because the shocks hitting various economies were more similar. Since the timing of the changes predate by quite a lot the implementation of the Maastricht Treaty, we have doubts about the possibility that also this event had any important repercussion on the nature and the characteristics of European business cycles.

In sum, European business cycles appear to change over time and the changes go in the direction of making national cycles more similar among each other and, as a consequence, to the European one. However, the changes we detect start taking place in the middle of the 1980s, appear to be largely completed by the middle of the 1990s. Hence, both the timing and the nature of the changes provide, *prima facie*, strong evidence against the idea that the creation of the ECB and the Euro changeover generated major variations in European business cycles. The evidence for the Maastricht treaty is more difficult to interpret since its consequences may have been predictable - and agents could have started changing their actions well before the change occur. However, given the uncertainty surrounding the process that lead to the signing of the Treaty, it is hard to believe that such anticipatory effects could begin up to eight years before it was finally implemented.

To acquire more evidence on the potential effects that institutional changes had on cyclical fluctuations, we now turn to two alternative exercises. In the first one we try to assess whether a structural change took place at the time when the institutional changes occurred by unconditionally forecasting the endogenous variables using information available prior to these dates. If we can reasonably predict the time path of real series, it becomes hard to claim that the three events had any effects on the business cycles in

Europe. In the second exercise, we examine the transmission of two types of shocks over time. Again, if the events of interest matter for cyclical fluctuations, we should see significant changes in the shape, the sign or the magnitude of the responses in correspondence with the three events of interest.

#### 4.4 Unconditional out-of-sample predictions

We forecast the five endogenous variables using the information available prior to the Maastricht treaty, the creation of the ECB and the Euro changeover. In particular, given the information available at 1993Q4, 1998Q3 and 2002Q1, we compute out-of-sample predictive distributions up to 5 years ahead. We then check whether the actual path of the variables falls within the tunnel constructed using the 90 percent predictive bands. If it does, at most of the horizons, no once-and-for-all change exist. If it does not, a break can be identified in correspondence with the three events of interest. Since future parameter uncertainty is averaged out when predictive distributions are constructed, the bands reflect only data uncertainty, conditional on the exogenous variables taking the values actually realized in the forecasting sample. Also, given that results do not depend on the variable we choose to forecast, we report predictive distributions for GDP growth only.

Figure 4 suggests that the three events did not produced a clean, once-and-for-all structural break in the dynamics of GDP growth. In fact, the predictive bands for GDP growth have the right direction and contain the actual values in most countries, at most horizons and for all selected dates. In other words, the forecasting performance of the model is roughly unchanged over time for many countries. Perhaps more revealing for our purposes is the fact that for Euro area countries, no institutional change had any effect on the forecasting accuracy of the model and that conclusions are insensitive to the dates we choose to forecast. For example, if we anticipate the forecasting dates by up to 4 quarters, no changes are visible.

It is useful to emphasize how the information contained in figure 4 complements the evidence of table 1. Table 1 reports information constructed in-sample and on average over

periods. Figure 4 instead presents case study exercises, where the out-of-sample predictive ability of the model is measured at particular dates. Hence, in-sample average variations can coexist with unchanged unconditional forecasting ability at particular dates, especially once it is taken into account that the model has time varying coefficients.

#### **4.5 The transmission of shocks**

Unconditional forecasting exercises are a useful benchmark to detect breaks. However, by their very same nature they will not be particularly informative, for example, about variations in the transmission of certain types of shocks. An unchanged unconditional forecasting performance could in fact be consistent with varying transmission patterns as long as the changes in the dynamic responses approximately average out across shocks.

To gather more information about the relationship between institutional changes and business cycles, we examine the transmission of a temporary German shock, where by this we mean a shock that simultaneously increases all five German variables; and the transmission of an external shock - a temporary increase in the US nominal interest rate. These two shocks are chosen among the many potential available options because, in addition to shedding light on the questions of interest, they provide information about the nature of the intraeuropean and transatlantic transmission of disturbances, the magnitude of the synchronization and the qualitative nature of the heterogeneities present in the cyclical component of European countries.

Once again, given the large number of variables in the system, we need to select which responses to report and at which date. Figure 5 presents the responses of GDP growth to a German shock using the information available at 1993Q4, 1998Q3, 2002Q1 and at the end of sample. Figure 6 the responses of GDP growth to a US interest rate shock at the same dates.

There are significant changes in the transmission of a German shock over time. With information up to 1993Q4, spillovers are generally idiosyncratic, typically negative, and for many countries statistically insignificant. This is true even for major European players, like the UK or Italy. Thus, cross country interdependencies within European countries ap-



pear to be small up to that date. With information up to 1998Q3, cross country responses become more synchronized, are now generally positive and definitively larger, more persistent, and statistically significant up to five quarters in Germany, Italy, France, Belgium - for Netherlands and Spain transmission takes one period but the effect is significant up to 5 quarters. Non-Euro GDP growth responses remain quite heterogeneous and a German shock still appears have little repercussions also after the creation of the ECB - one can conjecture that domestic monetary and/or exchange rates policies could be the responsible for this outcome. Finally, the responses after the creation of the ECB and the Euro changeover are qualitatively similar. Quantitatively, the spillover effects is reduced in Euro area countries but, overall, the change is modest. Finally, in the last five years of the sample spillovers increase but, qualitatively, the same differences between Euro and non-Euro are countries remain.

An unexpected increase in US interest rates has, roughly, the same qualitative effects at all dates we examine. Responses are typically hump-shaped and sufficiently long lasting, a patterns with is consistent with the fact that, after such an increase, the dollar appreciates, the price-competitiveness of European countries increase making GDP growth raise for a number of quarters. Quantitatively, the magnitude of the responses changes over time. With information up to 1993Q4, responses are large in Italy, Belgium and Spain, and in the non-Euro countries. With information up to 1998Q3, GDP growth responses in all countries are significantly reduced and after the Euro changeover, the magnitude of the responses is further diminished with inflation targeting non-Euro countries slightly more affected. At the end of the sample, however, this final reduction is reversed and responses are similar to those obtained after the creation of the ECB.

In sum, an important convergence process appear to have taken place in Europe and the transmission of shocks has become more similar for countries that now belong to the Euro area. During this process, at lot of the idiosyncrasies in GDP growth responses to a German shock have disappeared, although the process is non-monotonic. External shocks have smaller effects in the latter part of the sample and non-Euro countries are slightly more insulated than Euro area countries from these shocks. However, it is hard to relate

this convergence process with the three events of interest, both in terms of timing as well as changes in the speed or the nature of the convergence process.

## 5 Conclusions

This paper sheds some light on the effect that institutional changes may have on the dynamics of business cycles by focusing on the recent European experience and three events occurred in the last 20 years: the Maastricht treaty, the creation of the ECB and the Euro changeover. We limit our attention to three somewhat narrow questions. Has there been any tendency for European and national cycles to change in correspondence of these events? Is there a clean structural break in their properties at the time when these institutional changes occurred? Is there any difference in the relative impact that these events had on the cyclical characteristics of the data?

To study these questions a panel VAR model is estimated for the sample 1970:1-2007:3 using data for five variables in ten European countries, seven which adopted the Euro and three which did not. We document the evolution over time of European and national cyclical fluctuations, report reduced form statistics characterizing their features over different subsamples, conduct unconditional forecasting exercises and trace out the dynamics of the endogenous variables in response to two types of shocks, using the information available at various dates.

The features of European and national cycles have changed over time. There are many dimensions over which changes are measurable. For instance, one can observe a decrease in the volatility and variations in the persistence of the fluctuations of both European and national cycles, a higher conformity between national and European cycles, and important changes in the transmission of certain shocks. However, these variations do not relate well with the institutional changes we consider. From a reduced form point of view, there are little differences in the features of the cyclical fluctuations when the sample is broken at the time the ECB was created or the Euro introduced. Some variations are detectable when pre and post-Maastricht samples are considered but similar changes also emerge when the sample is split in the middle of the 1980s.

From an unconditional forecasting perspective, we are able to predict both the direction and the magnitude of the variations after the three events in the five variables for the Euro countries with similar precision while, for the non-Euro countries, variations become more predictable as time went by. In terms of the transmission of shocks, a significant convergence process is taking place. Responses of countries belonging to the Euro area are now more similar than they were in past, but neither the beginning of this process nor changes in its speed can be related with the three institutional changes we examine.

While the evidence regarding the creation of the ECB and the Euro changeover is quite unidirectional, one may have some residual doubts about the consequences of the Maastricht Treaty. We have argued that most of the detected variations began in the mid 1980s, and this may be too early to appeal to the potential predictability of the event, especially taking into account that, in the late 1980s, there was considerable uncertainty about the feasibility of the treaty. However, one has to admit that little is known about the empirical consequences of institutional changes predictability. Leeper et al. (2008) have shown that perfect foresight variations produce MA components in the VAR of the data and that invertibility issues could become important. Given that our reparametrized model features MA components by construction, we are sufficiently confident that, if invertibility problems existed, our estimated structure would be able to account for them when they occurred. In general, the evidence is consistent with a simple and appealing story where a process of cyclical convergence has taken place in Europe since the mid 1980s due, in part, to a larger conformity of the disturbances hitting the various economies.

The evidence this paper presented has important implications for the literature concerned with common currency areas, the effects of large monetary events, the relationship between business and medium term cycles and the effects of national idiosyncrasies. In fact, the process of real convergence predates the three institutional changes we consider; large monetary events have little effects for real fluctuations; national idiosyncrasies matter less but that they are not fading away; and business cycles are more similar across countries but not necessarily related to those medium term fluctuations, which have been of recent attention in the literature (see Gertler and Comin, 2006). Both academic and

policymakers should pay attentions to these results since they depart somewhat to what the conventional wisdom likes to stress.

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**Table 1. Basic statistics of the cycle indicators.**

	Common DE	FR	IT	ES	BE	NL	FI	UK	DK	SE	EMUgdp	
<b>Full sample: 1971Q1--2007Q3</b>												
S.D.	2.8	5.2	6.3	4.6	6.1	5.4	4.2	6.1	6.3	6.4	5.4	15.7
AR(1)	0.89	0.89	0.90	0.89	0.94	0.89	0.79	0.91	0.87	0.85	0.87	0.88
Corr(lag)		0.73 (0)	0.84 (0)	0.66 (1)	0.74 (0)	0.88 (0)	0.71 (0)	0.54 (0)	0.60 (0)	0.63 (-1)	0.64 (0)	0.90 (-1)
Coin ±1Q:		59 %	42.1%	40 %	66.7 %				38 %		40.9%	
Coin ±2Q:		63.6%	63.1%	50 %	71.4%				71.4%		59 %	
P-T	6.3Q	7.5Q	6.1Q	5.6Q	7.6Q	5.4Q	6.2Q	5.9Q	4.7Q	5Q	8.5Q	
T-P	5.7Q	9.4Q	4.7Q	5.4Q	9Q	5.8Q	5.7Q	7.4Q	6.4Q	6Q	6.6Q	
<b>1985Q3--2007Q3</b>												
S.D.	2.2	4.7	5.7	3.2	5.1	4.0	3.6	6.9	5.4	6.0	6.0	12.3
AR(1)	0.91	0.89	0.92	0.88	0.92	0.88	0.86	0.95	0.94	0.81	0.93	0.88
Corr(lag)		0.69 (0)	0.88 (0)	0.84 (0)	0.82 (-1)	0.84 (0)	0.63 (0)	0.70 (-1)	0.59 (-2)	0.45 (-1)	0.86 (0)	0.86 (-1)
<b>Pre-Maastricht: 1971Q1--1993Q3</b>												
S.D.	3.2	5.8	6.9	5.3	7.1	6.3	4.3	7.0	7.8	7.7	5.6	18.2
AR(1)	0.88	0.89	0.89	0.88	0.94	0.90	0.72	0.90	0.87	0.89	0.85	0.87
Corr(lag)		0.73 (0)	0.84 (0)	0.70 (1)	0.74 (0)	0.88 (0)	0.71 (0)	0.54 (0)	0.60 (0)	0.61 (-1)	0.64 (0)	0.92 (-1)
<b>Post-Maastricht: 1993Q4--2007Q3</b>												
S.D.	2.2	3.8	5.3	2.4	3.6	3.6	4.1	3.6	2.2	4.9	4.5	9.9
AR(1)	0.89	0.86	0.90	0.82	0.92	0.81	0.92	0.87	0.82	0.70	0.86	0.87
Corr(lag)		0.86 (0)	0.85 (0)	0.86 (0)	0.80 (0)	0.86 (0)	0.65 (0)	0.88 (0)	0.68 (-1)	0.62 (-1)	0.89 (0)	0.93 (-1)
<b>Post-ECB creation: 1998Q3--2007Q3</b>												
S.D.	2.0	4.1	4.8	1.9	2.3	3.6	4.3	2.7	2.3	4.0	3.6	10.7
AR(1)	0.91	0.92	0.93	0.82	0.91	0.80	0.95	0.87	0.84	0.65	0.89	0.91
Corr(lag)		0.91 (0)	0.86 (0)	0.85 (1)	0.90 (-1)	0.85 (0)	0.77 (0)	0.87 (0)	0.75 (0)	0.52 (0)	0.95 (0)	0.93 (-1)
<b>Post-Euro changeover: 2002Q1--2007Q3</b>												
S.D.	1.65	4.3	2.1	1.4	1.49	3.6	2.2	2.5	1.8	4.3	3.3	8.6
AR(1)	0.93	0.96	0.70	0.73	0.91	0.86	0.77	0.86	0.74	0.81	0.93	0.91
Corr(lag)		0.95 (1)	0.88 (0)	0.85 (0)	0.91 (-1)	0.87 (0)	0.73 (1)	0.91 (0)	0.58 (0)	0.87 (-1)	0.97 (0)	0.96 (-1)

S.D. is the unconditional standard deviation, AR(1) the first autoregressive coefficient, CORR(lag) the largest correlation with the common cyclical indicator and the lag at which it occurs, Coin is how coincident are the turning points of our indicators with the turning points reported by ECRI, P-T and T-P are the average length in quarters of recessions and expansions, respectively.

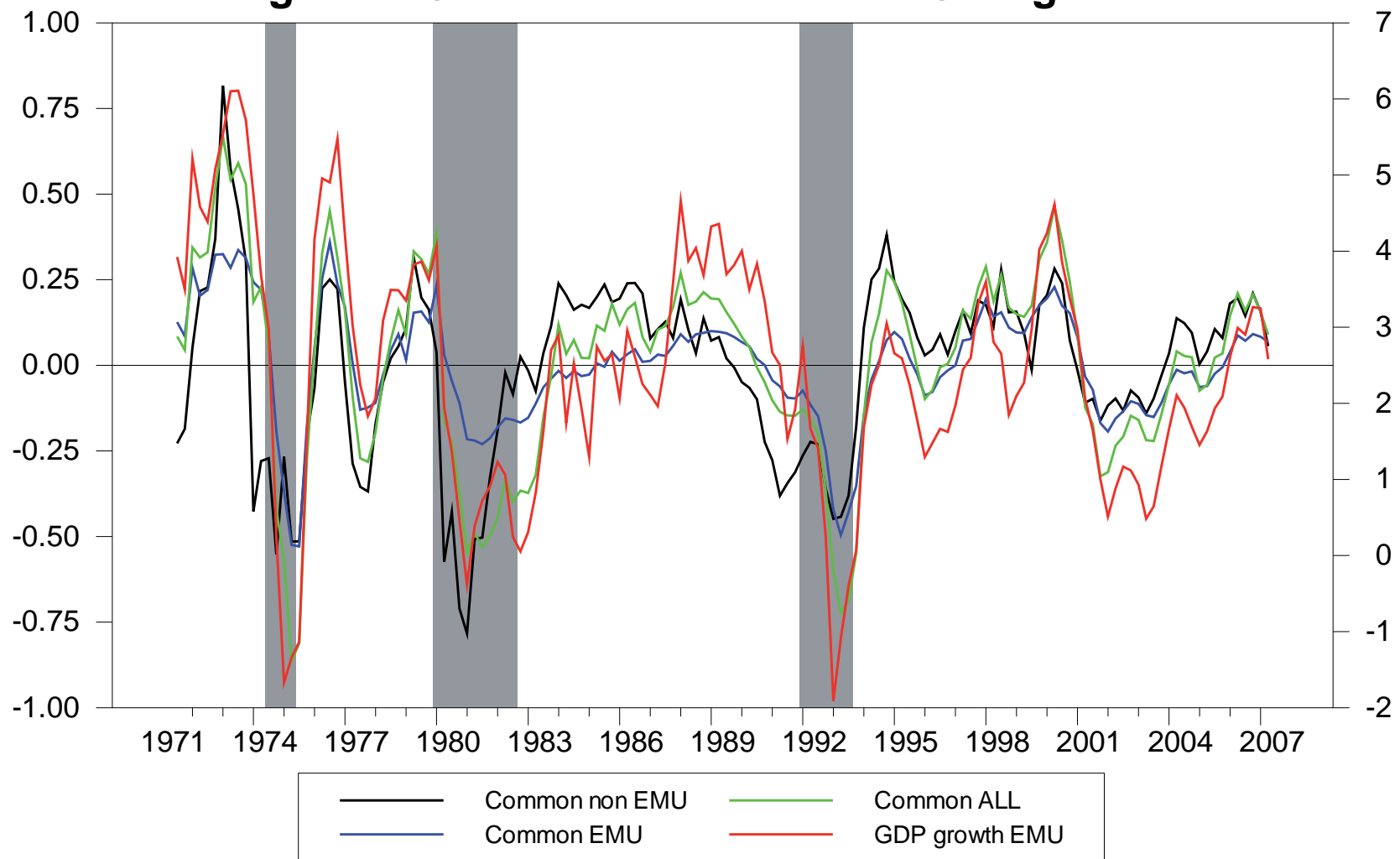
**Table 2. Growth rate cycle turning points. Full sample: 1971Q1-2007Q3**

Growth cycle dating of the Economic Cycle Research Institute in italics

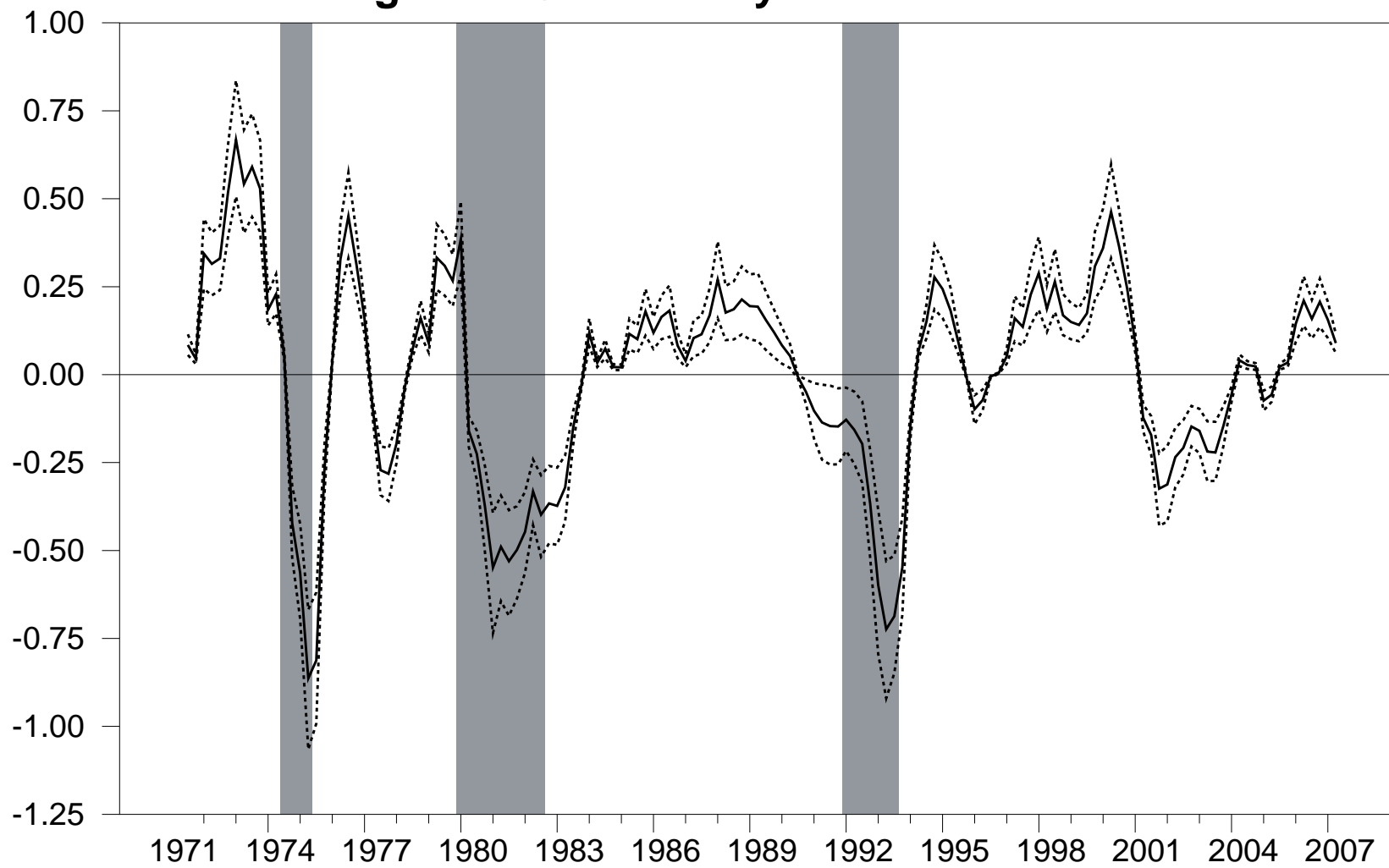
PERIOD	Peak or Trough	COMMON	DE	DE	FR	FR	IT	IT	ES	ES	BE	NL	FI	UK	UK	DK	SE	SE
71-73	P																	
	T			<i>71Q3</i>	72Q3	<i>71Q1</i>	72Q3	<i>71Q1</i>				72Q1			<i>71Q1</i>			
73-75	P	73Q2	73Q4	<i>73Q1</i>	73Q3	<i>73Q1</i>	74Q2	<i>73Q4</i>	73Q1	<i>73Q1</i>	73Q2	74Q1	73Q1	73Q2	<i>73Q1</i>	73Q2	73Q3	
	T	75Q3	75Q3	<i>74Q4</i>	75Q3	<i>75Q1</i>	75Q4	<i>75Q2</i>	75Q4	<i>75Q1</i>	75Q3	75Q4	75Q4	74Q2	<i>75Q2</i>	75Q1	74Q2	
75-77	P	76Q4	76Q3	<i>76Q2</i>	76Q4	<i>76Q3</i>	76Q4	<i>77Q1</i>	76Q4	<i>76Q3</i>	76Q4	76Q4	76Q4	75Q2	<i>76Q3</i>	76Q3	74Q4	<i>74Q2</i>
	T										77Q4	77Q4	77Q4	75Q4	<i>77Q2</i>	77Q3		
77-79	P											78Q4		77Q1				
	T	78Q1	78Q2	<i>77Q3</i>	78Q2		78Q1	<i>77Q4</i>	79Q2	<i>79Q1</i>		79Q2	78Q1	78Q1			78Q1	<i>77Q2</i>
79-81	P	79Q3	79Q3	<i>79Q2</i>	79Q1		80Q2	<i>79Q4</i>	80Q2	<i>80Q1</i>	80Q2	80Q2	79Q4	79Q3	<i>79Q2</i>	79Q2	79Q4	<i>80Q1</i>
	T	81Q2			81Q2	<i>80Q2</i>		<i>81Q2</i>	81Q2	<i>81Q3</i>	81Q4		81Q4	81Q2	<i>80Q2</i>	81Q1	81Q4	<i>81Q2</i>
81-83	P				82Q3	<i>82Q2</i>		<i>82Q2</i>	83Q3	<i>83Q2</i>	82Q4		83Q1			83Q1		
	T		82Q4	<i>82Q4</i>	83Q3		83Q2	<i>82Q3</i>			83Q3	82Q1				83Q3		
83-85	P	84Q2	84Q1		84Q2		84Q2	<i>84Q3</i>				82Q4		84Q1	<i>83Q4</i>	85Q1	84Q2	<i>84Q3</i>
	T	85Q2	84Q3		85Q1	<i>84Q4</i>	85Q1	<i>86Q2</i>	84Q3	<i>84Q2</i>		85Q4	84Q1	85Q1	<i>84Q3</i>	85Q2		
85-87	P	86Q4	86Q2	<i>86Q2</i>	86Q3	<i>85Q4</i>	86Q2	<i>86Q3</i>			86Q1	86Q4	85Q3	85Q4	<i>85Q2</i>	86Q3		
	T	87Q2	87Q2	<i>87Q1</i>	87Q2	<i>87Q1</i>	87Q4	<i>87Q3</i>			87Q1	87Q4	86Q3	86Q2	<i>85Q4</i>	88Q1	86Q1	<i>86Q2</i>
87-89	P	88Q2				<i>88Q1</i>		<i>88Q1</i>	87Q4	<i>87Q3</i>	88Q4			88Q2	<i>88Q1</i>	89Q1	88Q1	<i>87Q1</i>
	T							<i>89Q2</i>	89Q1	<i>88Q4</i>						90Q1	88Q4	<i>88Q1</i>
89-91	P		90Q4	<i>91Q1</i>	89Q2		89Q1	<i>90Q2</i>	89Q3	<i>89Q2</i>		89Q3	89Q4			90Q4	89Q3	<i>89Q2</i>
	T						91Q1	<i>91Q2</i>			91Q4			91Q3	<i>91Q2</i>	91Q3		<i>91Q4</i>
91-93	P						92Q1	<i>92Q1</i>			92Q2					92Q3		<i>92Q1</i>
	T	93Q3	93Q2	<i>93Q1</i>	93Q3	<i>93Q2</i>	93Q3	<i>92Q4</i>	93Q2	<i>93Q1</i>	93Q3	93Q2	92Q1			93Q4	93Q2	<i>93Q2</i>
94-96	P	95Q1	95Q1	<i>94Q4</i>	95Q2	<i>95Q1</i>	95Q2	<i>96Q1</i>	95Q2	<i>94Q4</i>	95Q3	95Q1	95Q2	94Q4	<i>94Q3</i>	95Q1	95Q1	<i>94Q4</i>
	T	96Q1	96Q2	<i>96Q1</i>					96Q2	<i>96Q1</i>	96Q2	95Q4	96Q3	96Q1	<i>95Q3</i>	96Q2		
96-98	P									<i>97Q3</i>		96Q4			<i>97Q3</i>	97Q2		
	T				97Q2	<i>96Q3</i>	97Q1	<i>96Q4</i>				98Q1					97Q1	<i>96Q3</i>
98-00	P	98Q2	98Q2	<i>98Q1</i>	98Q3	<i>98Q1</i>	98Q1	<i>97Q4</i>			98Q1		98Q2	98Q4		99Q2	98Q4	<i>98Q4</i>
	T	99Q3	99Q2	<i>99Q2</i>	99Q3	<i>99Q1</i>	99Q1	<i>98Q4</i>		<i>99Q1</i>	99Q3		00Q1	99Q3	<i>99Q1</i>	99Q4	99Q4	<i>99Q3</i>
00-02	P	00Q3	00Q3	<i>00Q2</i>	00Q2	<i>00Q2</i>	01Q1	<i>01Q1</i>	00Q2	<i>00Q1</i>	00Q3	00Q1	00Q4	00Q2	<i>00Q1</i>	00Q4	00Q3	<i>00Q2</i>
	T	02Q1	02Q3	<i>02Q1</i>	02Q2		02Q1	<i>01Q4</i>	02Q2	<i>02Q2</i>	02Q1		02Q2	02Q1		01Q2	02Q1	<i>01Q4</i>
02-04	P	03Q1		<i>02Q3</i>	03Q1		03Q1	<i>02Q1</i>		<i>03Q4</i>	03Q1			03Q1		02Q2		<i>02Q1</i>
	T	03Q4		<i>03Q3</i>	03Q3	<i>03Q2</i>	04Q1	<i>03Q1</i>		<i>04Q3</i>	03Q4	03Q3		03Q3	<i>03Q1</i>	03Q3		<i>03Q1</i>
04-06	P	04Q3		<i>04Q2</i>	05Q1	<i>04Q2</i>	04Q3	<i>03Q2</i>			04Q3	04Q4	05Q1	04Q3	<i>04Q1</i>			<i>04Q3</i>
	T	05Q2		<i>05Q1</i>	06Q1	<i>05Q2</i>	05Q2	<i>04Q4</i>			05Q3	05Q2	05Q3	05Q3	<i>05Q2</i>			<i>05Q2</i>
06-07	P		07Q1	<i>06Q4</i>	06Q3		07Q1	<i>06Q2</i>	06Q2	<i>07Q1</i>			06Q3	07Q1	<i>07Q3</i>	06Q2		<i>06Q3</i>
	T								06Q3									
Avg. duration, Q	P	6.3	7.5		6.1		5.6		7.6		5.4	6.2	5.9	4.7		5	8.5	
	T	5.7	9.4		4.7		5.4		9		5.8	5.7	7.4	6.4		6	6.6	
TP as in ECRI	(Coin ±1Q)			13/22=59.1%		8/19=42.1%		12/30=40%		14/21=66.7%					8/22=36.4%			9/23=39.1%
	(Coin ±2Q)			14/22=63.6%		12/19=63.1%		15/30=50%		15/21=71.4%					15/22=68.2%			13/23=56.5%



### Figure 1. Common indicators and GDP growth



### Figure 2. Common cyclical indicator



### Figure 3. Country cyclical indicators

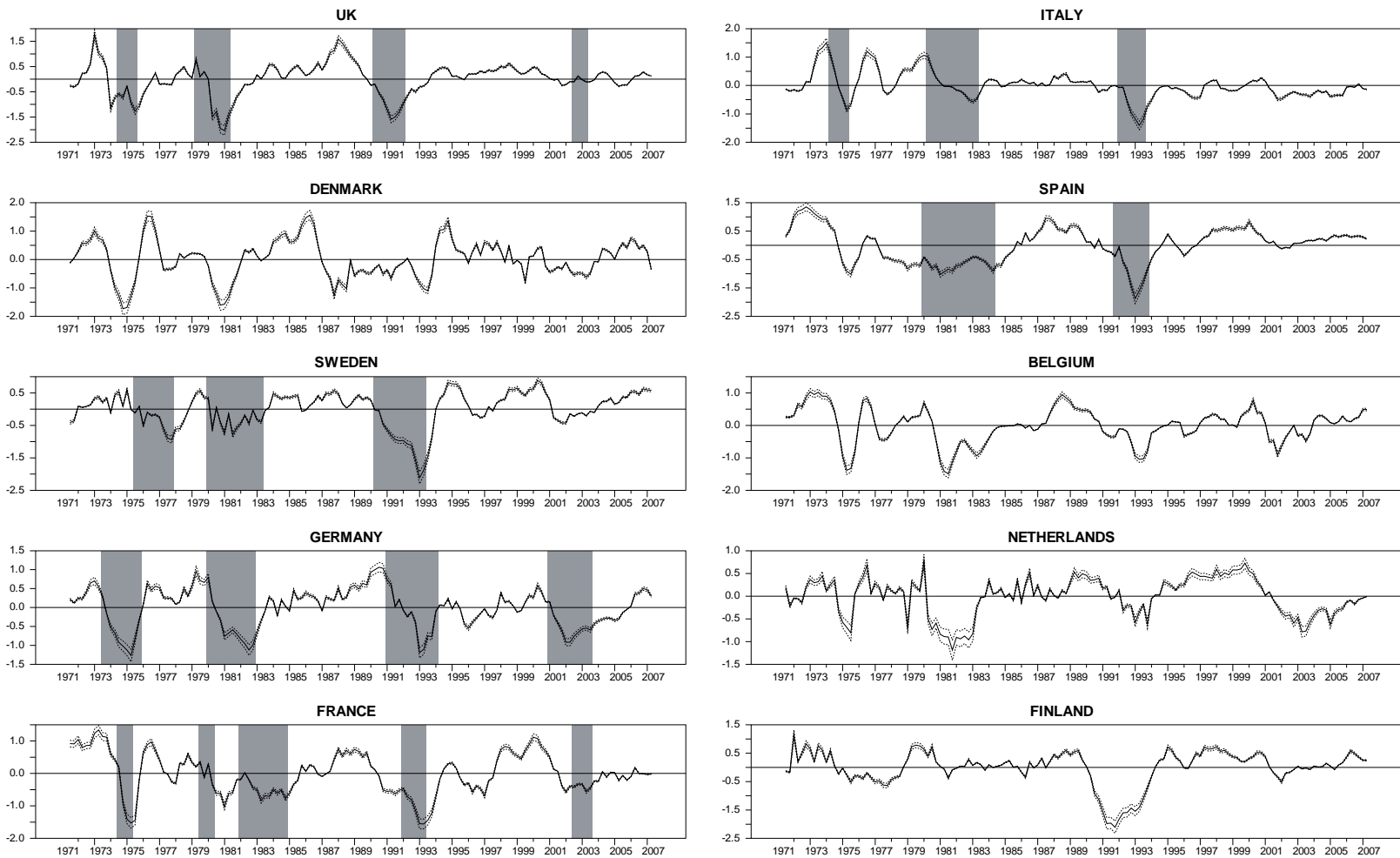
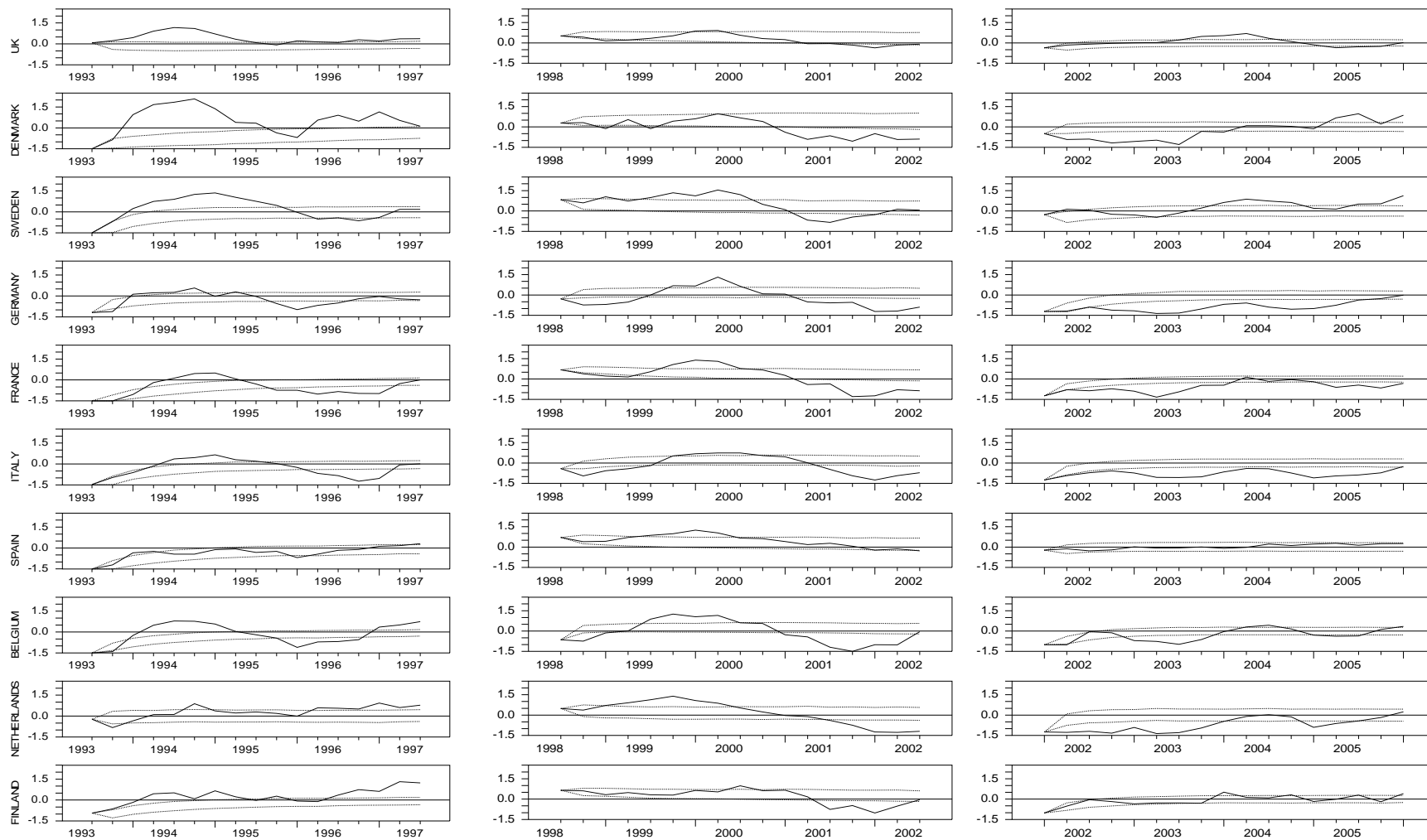


Figure 4. Forecast of GDP growth



Maastricht

ECB creation

Euro change-over

Figure 5. GDP growth responses to a German real shock

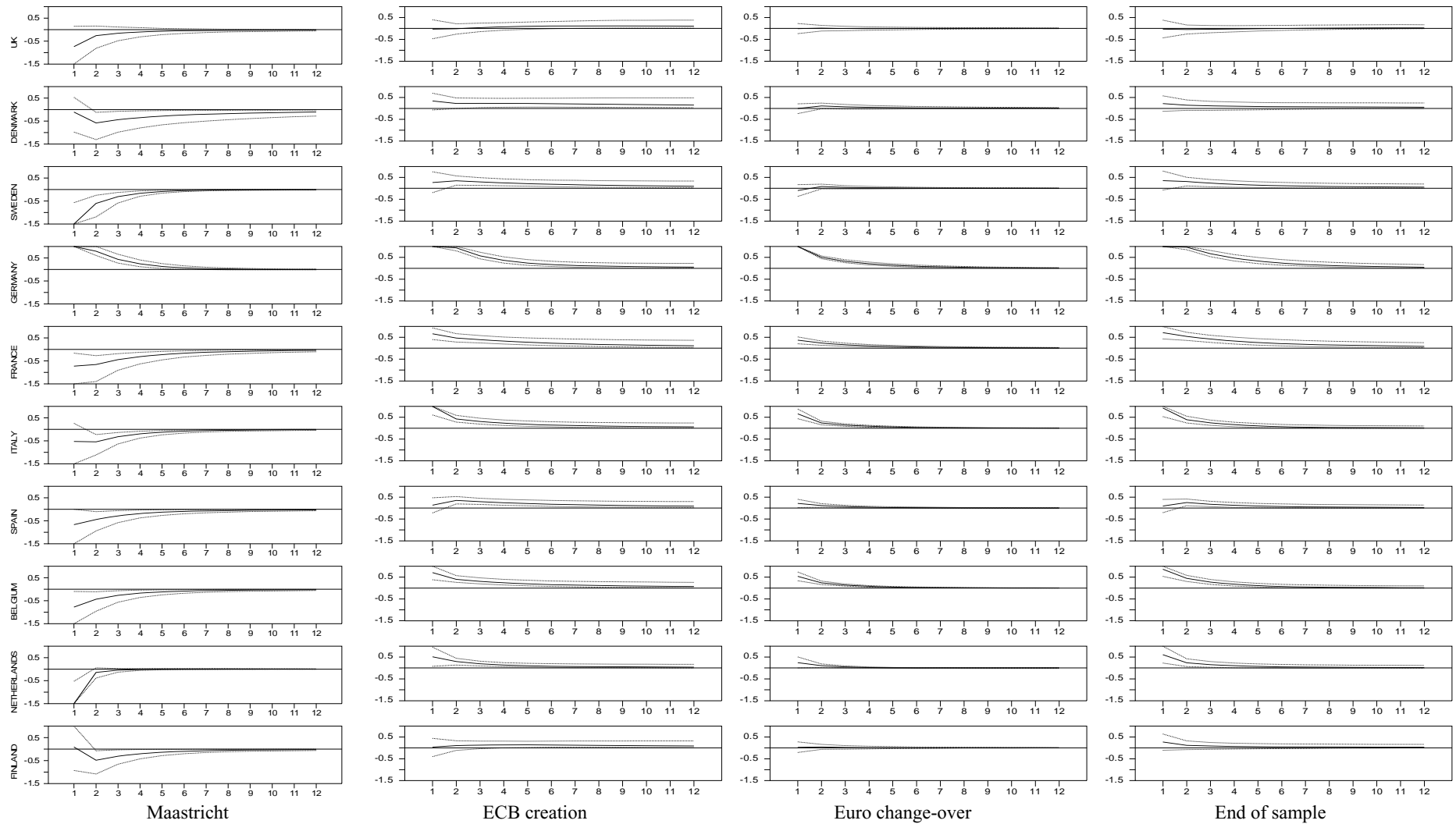
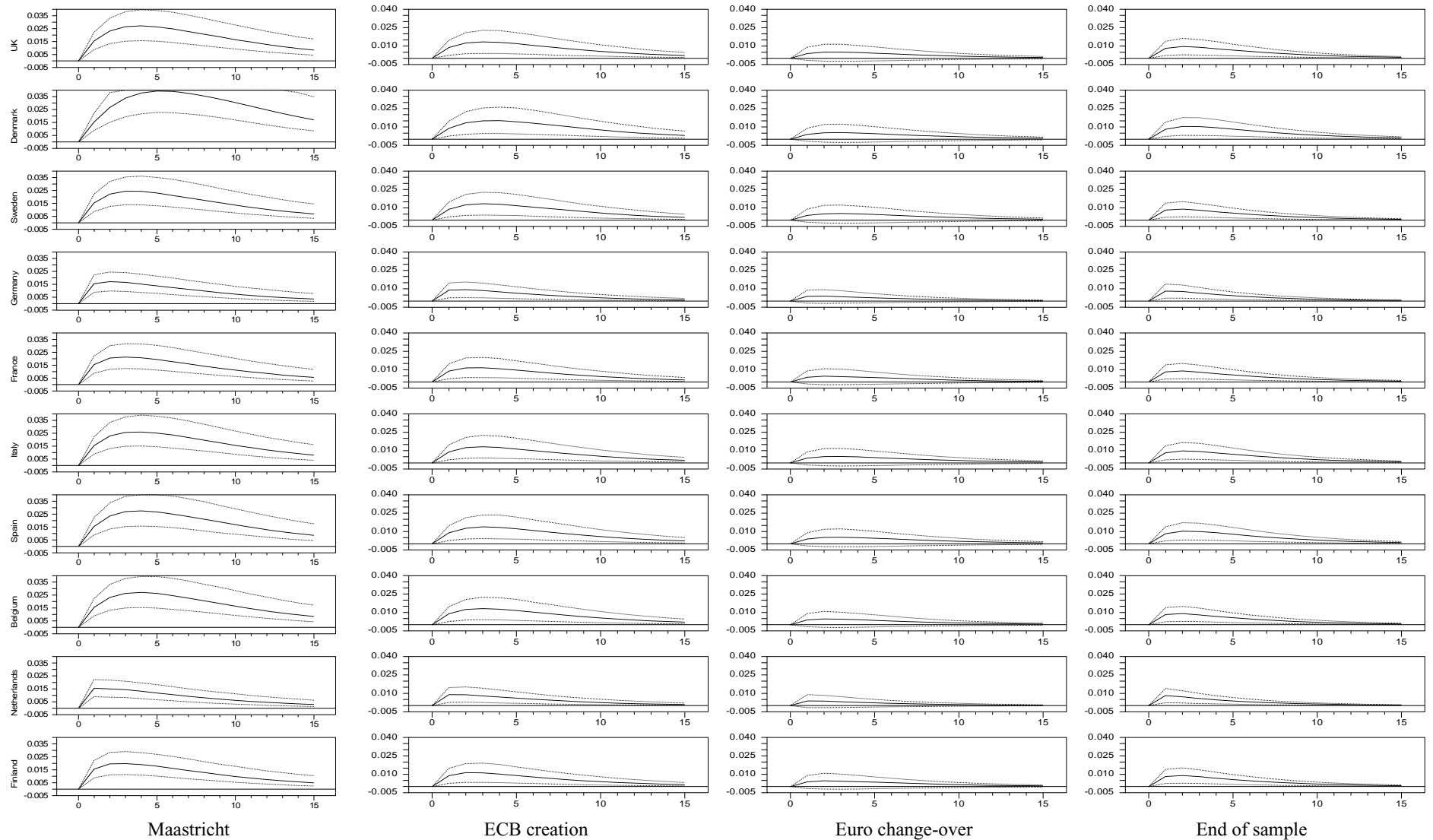


Figure 6. GDP growth responses to a US interest rate shock



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