Time-varying business cycles synchronisation in Europe

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Abstract

The paper investigates the time-varying correlation between the EU12-wide business cycle and the initial EU14 member-countries (Luxembourg is not included in our sample), using the multivariate scalar-BEKK and RiskMetrics approaches, for the period 1980-2009. The contemporaneous correlation results show that the business cycle synchronisation has moved in a direction positive for the operation of a single currency and a common monetary policy and that the Maastricht Treaty and the establishment of the European Monetary Union appear to have reinforced the process of convergence in business cycle synchronisation. However, the last economic crisis has halted and in some cases reversed the process of convergence of the business cycle synchronisation in Europe. Overall, our results indicate that the formation of a common currency is endogenous factor to business cycle synchronisation.

Keywords: EU, business cycle, business cycle synchronisation

JEL: C32, E32, F44, O52

1. Introduction and a brief review of the literature

This paper investigates the time-varying business cycles synchronisation between the initial EMU12 member-countries and the EMU12-wide business cycle[1], using quarterly data from 1980 until 2009. In addition, we investigate this relation for Denmark, Sweden and the UK, the non-EMU members, but originally EU15 members. The concern with the extent of business cycle synchronisation was high at the time of entry to the European Monetary Union (EMU). In the UK, for instance, one of Gordon Brown famous 5 tests for joining the Euro was the assurance that UK and the European-wide business cycles would be synchronised. In addition, the last economic crisis signified the importance for business cycle synchronisation in EU. Thus this study explores a current topic using recent data and considers the recent economic developments.

We need to make clear that business cycle synchronisation does not necessarily mean economic convergence. The term convergence is related to the catch-up effect between countries' growth rates, whereas synchronisation has the meaning of similar movements of the countries' growth rates over time (Crowley and Schultz, 2010). Synchronisation, however, if exists, it can lead to economic convergence between the member-countries of a monetary union.

The analysis of business cycles, for Europe or elsewhere, is not new to the literature. Pioneers in this area of research are, inter alia, Mitchell (1946), Burns and Mitchell (1946) and Kuznets (1958). Since then, a significant amount of literature has been involved in the study of business cycle synchronisation. Papageorgiou, Michaelides and Milios (2010) and de Haan, Inklaar and Jong-A-Pin (2008b) provide an extensive review of the literature. Recent studies on business cycle synchronisation in Europe can be found in Crowley and Schultz, 2010; Bergman and Jonung, 2010; Canova, Ciccarelli and Ortega, 2009; Gogas and Kothroulas, 2009; Kalemli-Ozcan, Papaioannou and Peydro, 2009; Concaria and Soares, 2009; Ferreira-Lopes and Pina, 2009; Furceri and Karras, 2008).

[1] Luxemburg was omitted due to data unavailability. Our results are not sensitive to the exclusion of Luxemburg data due to its small size. We estimate the European Union-wide business cycle in the same spirit with de Haan, Jacobs and Mink (2007) and Artis, Krolzig and Toro (2004). Artis, et al. (2004) provides some stylized facts for the European business cycle.

Business cycle synchronisation is an important pre-requisite to forming a common currency area (see, inter alia, Kennen, 1969; McKinnon, 1963; Mundell, 1961 (for Optimum Currency Area theory - OCA); Furceri and Karras, 2008; Alesina and Barro, 2002). In addition, some authors argue that business cycle synchronisation is not only a pre-requisite to the formation of a monetary union but they go further suggesting that the survival of a common currency area depends on the commonality of business cycle fluctuations (see, for example, Bergman, 2006).

The formation of a single currency area explicitly involves the synchronisation of monetary policy and this common monetary policy will be influenced by the union-wide business cycle. In order for a one size fits all monetary policy to be efficient there must be a high degree of synchronisation of business cycles. Consequently, if the member-countries' business cycles are closely related to the union-wide business cycle, then their individual monetary policies will be perfectly substituted by the common monetary policy, which will be imposed by the central bank. Conversely, if countries' business cycles diverge from the union-wide business cycle, then they are more sensitive to asymmetric shocks and thus the common monetary policy will result to the destabilization of the individual economies, which will aggravate the cost of joining the monetary union (Savva, Neanidis and Osborn, 2010; Sebastien, 2009; Furceri and Karras, 2008; Fidrmuc and Korhonen, 2006). Hence, it is clear that business cycle synchronisation has an implication to the policies of the central bank. If synchronised business cycles exist, it will be easier for the central bank to impose its stabilising interventions in order to counterbalance the asymmetric shocks (Savva, et al., 2010; Crowley and Schultz, 2010; Furceri and Karras, 2008; Clarida, Gali and Getler, 1999; Rogoff, 1985).

Apart from the fact that business cycles synchronisation impacts on the central bank and its monetary policy decisions; the level of synchronisation has implication on the fiscal policy of each member-country, as well. Unless the monetary policy response from the central bank to an asymmetric shock is suitable for every member-country, the members will only be able to use their independent fiscal policy to counterbalance the negative effects of the common monetary policy (Crowley and Schultz, 2010). The problem that European countries face, though, is that in the case of the European Union, where the Stability and

Growth Pact (SGP) exists, the use of fiscal policy, as a protection against the adverse effects of the common monetary policy, becomes very limited (Crowley and Schultz, 2010; Furceri and Karras, 2008; Furceri, 2005; Gali and Perotti, 2003).All the aforementioned authors, implicitly or explicitly, suggest that business cycle synchronisation should be considered as an exogenous criterion for the formation of an OCA, such as the EMU.

However, for over the last 15 years now several authors have challenged the exogenous character of business cycle synchronisation for monetary unions. Bower and Guillemineau (2006), Fidrmuc (2004), Maurel (2002) and Frankel and Rose (1998), for example, argued that business cycle synchronisation is actually an endogenous OCA criterion in the sense that the formation of a monetary union will lead to the higher synchronisation of the members' business cycles. Thus, many authors argue that one of the main determinants of business cycle synchronisation is the formation of a monetary union itself (see, inter alia, Bergman and Jonung, 2010; Rose and Stanley, 2005; López-Córdova and Meissner, 2003; Rose and Engel, 2002; Fatas, 1997).

Mounting evidence suggest that another major determinant of business cycle synchronisation is the bilateral trade intensification (which can also be assisted by a monetary union, see for example Rose and Stanley, 2005) as documented by, inter alia, de Haan, Inklaar and Jong-A-Pin (2008a), Baxter and Kapouritsas (2005), Sharma and Chua (2000), Canova and Dellas (1993) and Frankel and Rose (1988).

In addition, several other authors have concluded that financial integration, industrial specialisation, similarity in industrial structure, fiscal policy, factor endowments, distance between countries, language and adjacency can also determine the level of business cycle synchronisation (see, for example, Inklaar, et al., 2008a,b; Imbs, 2006, 2004; Morgan, Rime and Strahan, 2004; Fidrmuc, 2004; Kose, Otrok and Whiteman, 2003a; Kose, Prasad and Terrones, 2003b; Claessens, Dornbusch and Park, 2001; Clark and Van Wincoop, 2001; Imbs, 1999, 1998; Calvo and Reinhart, 1996).

There are few authors though who voice a completely different opinion. Krugman (1993), for example, argues that as countries become more integrated, the level of specialisation

increases and thus countries face different threats and thus they are influenced by different shocks. This tends to create asynchronous business cycles, rather than the opposite. At the same line of argument we can find other authors as well, such as, inter alia, Artis, Fidrmuc, and Scharler (2008), Batorova, Fidrmuc and Korhonen, (2008), Fidrmuc (2004), Kalemli-Ozcan, Sorensen and Yosha (2003), Baxter and Crucini (1995), Obstfeld, (1994) and Backus, Kehoe and Kydland (1992).

It is clear that the literature of business cycle synchronisation (see all aforementioned studies) does not provide any consistent evidence on the level of European Union business cycle synchronisation and how this level has changed over time. Different studies paint somehow different pictures[2]. Several of these studies have reached the conclusion that there is a greater level of synchronisation in European Union after 1992, (i.e. at the time when the Maastricht treaty was signed); whereas other studies concluded that there is a higher level of synchronisation in the post-European Monetary System (EMS) period. Furthermore, there are those studies which demonstrated that there is an increase in business cycle synchronisation after the adoption of the common currency – euro (i.e. after 1999). Some studies pointed out that there are two clusters in European business cycle synchronisation. These clusters are the core member-countries and the periphery. Finally, there are those studies that argue that synchronisation existed prior to the EMU and the Exchange Rate Mechanism (ERM). All that said, Canova, et al. (2009) argued that changes in the European business cycles synchronisation cannot be attributed to institutional changes.

Furthermore, past studies have used a wide range of methods, models and data to study the level of synchronisation in European business cycles or any other bilateral business cycles synchronisation between various countries. These various methods or models that have been applied to this research question range from constant contemporaneous and/or lagged correlations for entire periods or sub-periods (see, inter alia, Gogas and Kothroulas, 2009; Ferreira-Lopes and Pina, 2009; Furceri and Karras, 2008; and Artis and Zhang, 1999; Fatas, 1997; Inklaar and de Haan, 2001 – as these cited in de Haan, et al., 2008b) to VAR models (see, for example, Bergman and Jonung, 2010) and from frequency-domain dynamic

[2] A review of these studies along with their findings can be found in Papageorgiou, et al. (2010) and de Haan, et al. (2008b).

correlations (see, for example, Concaria and Soares, 2009; and Azevedo, 2002; Croux, et al., 2001 – as these cited in de Haan, et al., 2008b) to rolling windows correlations (see, for example, Dopke, 1999 - as this cited in de Haan, et al., 2008b). Although these methods provide a sufficient understanding of the business cycle synchronisation in Europe, they have some limitations. To start with, a uniform correlation figure is not able to capture any fluctuations of the correlation level between the business cycles in the inter-period of a study. In addition, the robustness of the results obtained for rolling windows correlations is subject to the length of the rolling window (see Savva, et al. (2010) for additional explanation). Furthermore, choosing sub-periods exogenously in an effort to produce a quasi time-varying correlation could have several drawbacks, as well (see Sebastien (2009) for additional explanation of these drawbacks).

The present study directly addresses all the above issues by employing two robust quantitative techniques, namely the scalar-BEKK and RiskMetrics models, as these were suggested by Baba, Engle, Kraft and Kroner (1990) and J.P. Morgan (1996), respectively. These techniques have not been applied before to investigate the time-varying correlation between the individual European member-countries and the European Union-wide business cycle. To the best of our knowledge there is only one paper in the current literature that applies a time-varying correlation method in time-domain (Savva, et al., 2010 – they use a switch-regime time-varying correlation, using a regime-switch DSTCC-VAR-GARCH approach[3]). In addition, for robustness purposes we use two different filtering methods for the extraction of the cyclical components, namely the Hodrick-Prescott filter (Hodrick and Prescott, 1997) and the band-pass filter proposed by Baxter and King (1999).

The main contribution of this paper to the existing literature can be described succinctly. First, we apply two robust quantitative methods which enable us to examine the evolution of the business cycle synchronisation in EU, and limit the shortcomings of the methods that have been used so far. Second, we use two filtering methods for robustness purposes and

[3] The paper by Savva, et al., (2010) presents a regime-switch time-varying correlation between the EU member-countries and the EU-wide business cycles, whereas our technique captures all the fluctuations that have been taken place during the whole period of the study.

third we are using recent data, which enables us to identify the impact of the 2008 economic crisis in the business cycle synchronisation in the EU.

The rest of the paper proceeds as follows: section 2 presents the data, section 3 describes the models used, section 4 presents the empirical findings of the research and, finally, section 5 concludes the study.

2. Data description

In this study we use quarterly GDP data from 14 EU member-countries and the aggregate EMU12 GDP (EMU members: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain; non-EMU members: Denmark, Sweden and UK). The data cover the period from 1980:Q1 to 2009:Q4. All GDP prices are converted in logarithms; they are seasonally adjusted and refer to constant levels. We use GDP, as according to de Haan, et al. (2008b) studies on business cycle synchronisation should focus on GDP (rather than industrial production, for example), as this represents the broadest measure of output.

Still, according to de Haan, et al. (2008b), there are very few studies that examine the robustness of their results using different filtering methods for their cyclical components. This study will use two different filtering methods for the extraction of the cyclical components. These methods are the Hodrick-Prescott filter (Hodrick and Prescott, 1997) and the band-pass filter proposed by Baxter and King (1999).

The methods that we use are the scalar-BEKK and the RiskMetrics, which were proposed by Baba et al. (1990) and J.P. Morgan (1996), respectively. For illustration purposes and the analysis of the empirical results we only show the output of one filtering method, namely the Hodrick-Prescott (1997).

3. Models description

3.1. Scalar-BEKK

It should be mentioned that the present study focuses on investigating the undeviating time-varying correlation between business cycles of EU14 and the aggregate EMU12.

In the paragraphs follow, the scalar-BEKK framework of our study is presented. Let the $(n\times 1)$ vector $\{\mathbf{y}_t\}$ refer to the multivariate stochastic process to be estimated. In the present model framework, $n=15$ and $\mathbf{y}_t=\begin{pmatrix} y_{1,t} & y_{2,t} & \dots & y_{14,t} & y_{15,t}\end{pmatrix}'$, where $y_{1,t}$ denotes the business cycles of 14 countries and $y_{15,t}$ denotes the business cycle of EMU12. The innovation process for the conditional mean $\boldsymbol{\varepsilon}_t \equiv \mathbf{y}_t - \boldsymbol{\mu}_t$ has an $(n\times n)$ conditional covariance matrix $V_{t-1}(\mathbf{y}_t)\equiv \mathbf{H}_t$:

$$\begin{aligned} \mathbf{y}_t &= \boldsymbol{\mu}_t + \boldsymbol{\varepsilon}_t \\ \boldsymbol{\varepsilon}_t &= \mathbf{H}_t^{1/2}\mathbf{z}_t \\ \mathbf{z}_t &\sim N(\mathbf{z}_t;\mathbf{0},\mathbf{I}) \\ \mathbf{H}_t &= \sigma(\mathbf{H}_{t-1},\mathbf{H}_{t-2},...,\boldsymbol{\varepsilon}_{t-1},\boldsymbol{\varepsilon}_{t-2},...), \end{aligned} \tag{1}$$

where $E_{t-1}(\mathbf{y}_t)\equiv\boldsymbol{\mu}_t$ denotes the mean of $\mathbf{y}_t$ conditional the available information at time $t-1$, I_{t-1}. $\mathbf{z}_t$ is an $(n\times 1)$ vector process such that $E(\mathbf{z}_t)=\mathbf{0}$ and $E(\mathbf{z}_t\mathbf{z}_t')=\mathbf{I}$, whereas $N(\mathbf{z}_t;\mathbf{0},\mathbf{I})$ denotes the multivariate standard normal density function. $\sigma(.)$ is a positive measurable function of the lagged conditional covariance matrices and the innovation process.

Engle and Kroner (1995) and Baba et al. (1990) proposed the BEKK model, which has been successively estimated for large time-varying covariance matrices. However, the BEKK model requires the estimation of $(n(n+1)/2)+2n^2$ parameters. A less general version is commonly applied, named scalar-BEKK model. The advantage is that the scalar-BEKK model is guaranteed to be positive definite and requires the estimation of fewer parameters than the BEKK model, i.e. $(n(n+1)/2)+2$ parameters. The covariance matrix of the scalar-BEKK model is defined as:

$$\mathbf{H}_t = \mathbf{A_0}\mathbf{A_0}' + a\mathbf{i}\mathbf{i}'\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}_{t-1}' + b\mathbf{i}\mathbf{i}'\mathbf{H}_{t-1}, \tag{2}$$

where $\mathbf{A_0}$ is a lower triangular matrix with $\left(n(n+1)/2\right)$ parameters, a and b are positive scalars and $\mathbf{i}$ is an $(n\times 1)$ vector of ones. This parameterization guarantees that $\mathbf{H}_t$ is positive definite, if $\mathbf{A_0}\mathbf{A_0'}$ is a positive definite matrix. For technical details about the estimation of the model, the interested reader is referred to Xekalaki and Degiannakis (2010). The models were estimated in G@RCH 5.0 package for Ox Metrics®; for technical details about the estimation of the model in Ox Metrics®, see Laurent (2007).

The detailed presentation of scalar-BEKK model for $n=15$ dimensions follows:

$$\begin{pmatrix} y_{1,t} \\ y_{2,t} \\ . \\ . \\ . \\ y_{15,t} \end{pmatrix} = \begin{pmatrix} b_1 \\ b_2 \\ . \\ . \\ . \\ b_{15} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ . \\ . \\ . \\ \varepsilon_{15,t} \end{pmatrix}$$

$$\left(\varepsilon_{1,t} \quad \varepsilon_{2,t} \quad . \quad . \quad . \quad \varepsilon_{15,t}\right)' = \mathbf{H}_t^{1/2}\left(z_{1,t} \quad z_{2,t} \quad . \quad . \quad . \quad z_{15,t}\right)'$$

$$\left(z_{1,t} \quad z_{2,t} \quad . \quad . \quad . \quad z_{15,t}\right)' \sim N(\mathbf{0},\mathbf{I})$$

$$\mathbf{H}_t = \mathbf{A_0}\mathbf{A_0'} + a\begin{pmatrix} 1 & 1 & . & . & . & 1 \\ 1 & 1 & . & . & . & 1 \\ . & . & . & & & . \\ . & . & & . & & . \\ . & . & & & . & . \\ 1 & 1 & . & . & . & 1 \end{pmatrix}\begin{pmatrix} \varepsilon_{1,t-1} \\ \varepsilon_{2,t-1} \\ . \\ . \\ . \\ \varepsilon_{15,t-1} \end{pmatrix}\left(\varepsilon_{1,t-1} \quad \varepsilon_{2,t-1} \quad . \quad . \quad . \quad \varepsilon_{15,t-1}\right)' + b\begin{pmatrix} 1 & 1 & . & . & . & 1 \\ 1 & 1 & . & . & . & 1 \\ . & . & . & & & . \\ . & . & & . & & . \\ . & . & & & . & . \\ 1 & 1 & . & . & . & 1 \end{pmatrix}\mathbf{H}_{t-1} \qquad (3)$$

$$\mathbf{H}_t = \begin{pmatrix} \sigma_{1,t}^2 & \sigma_{1,2,t} & . & . & . & \sigma_{1,15,t} \\ \sigma_{1,2,t} & \sigma_{2,t}^2 & . & . & . & \sigma_{2,15,t} \\ . & . & . & & & . \\ . & . & & . & & . \\ . & . & & & . & . \\ \sigma_{1,15,t} & \sigma_{2,15,t} & . & . & . & \sigma_{15,t}^2 \end{pmatrix},$$

$$\mathbf{A_0} = \begin{pmatrix} a_{1,1} & a_{1,2} & . & . & . & a_{1,15} \\ 0 & a_{2,2} & . & . & . & a_{2,15} \\ . & . & . & & & . \\ . & . & & . & & . \\ . & . & & & . & . \\ 0 & 0 & . & . & . & a_{15,15} \end{pmatrix}$$

3.2. RiskMetrics

A simplified multivariate ARCH framework is the Multivariate Riskmetrics model proposed by J.P. Morgan (1996). The Multivariate Riskmetrics® model is guaranteed to be positive definite, does not require the estimation of any parameters of $\mathbf{H}_t$, is easy to work with in practice but the assumption of imposing the same dynamics on every component in a multivariate ARCH model is difficult to justify. The covariance matrix of the Multivariate Riskmetrics model is defined as:

$$\mathbf{H}_t = (1-\lambda)\boldsymbol{\varepsilon}_{t-1}\boldsymbol{\varepsilon}'_{t-1} + \lambda\mathbf{H}_{t-1}, \tag{4}$$

where $0<\lambda<1$ is a scalar, which according to Riskmetrics® equals to 0.94 for daily data and 0.97 for monthly and quarterly data. The detailed presentation of Multivariate Riskmetrics model for $n=15$ dimensions follows:

$$\begin{gathered}
\begin{pmatrix} y_{1,t} \\ y_{2,t} \\ . \\ . \\ . \\ y_{15,t} \end{pmatrix} = \begin{pmatrix} b_1 \\ b_2 \\ . \\ . \\ . \\ b_{15} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ . \\ . \\ . \\ \varepsilon_{15,t} \end{pmatrix} \\
\begin{pmatrix} \varepsilon_{1,t} & \varepsilon_{2,t} & . & . & . & \varepsilon_{15,t} \end{pmatrix}' = \mathbf{H}_t^{1/2} \begin{pmatrix} z_{1,t} & z_{2,t} & . & . & . & z_{15,t} \end{pmatrix}' \\
\begin{pmatrix} z_{1,t} & z_{2,t} & . & . & . & z_{15,t} \end{pmatrix}' \sim N(\mathbf{0},\mathbf{I}) \\
\mathbf{H}_t = \begin{pmatrix} \sigma_{1,t}^2 & \sigma_{1,2,t} & . & . & . & \sigma_{1,15,t} \\ \sigma_{1,2,t} & \sigma_{2,t}^2 & . & . & . & \sigma_{2,15,t} \\ . & . & . & & & . \\ . & . & & . & & . \\ . & . & & & . & . \\ \sigma_{1,15,t} & \sigma_{2,15,t} & . & . & . & \sigma_{15,t}^2 \end{pmatrix} = 0.03 \begin{pmatrix} \varepsilon_{1,t-1} \\ \varepsilon_{2,t-1} \\ . \\ . \\ . \\ \varepsilon_{15,t-1} \end{pmatrix} \begin{pmatrix} \varepsilon_{1,t-1} & \varepsilon_{2,t-1} & . & . & . & \varepsilon_{15,t-1} \end{pmatrix}' + 0.97\mathbf{H}_{t-1}
\end{gathered} \tag{5}$$

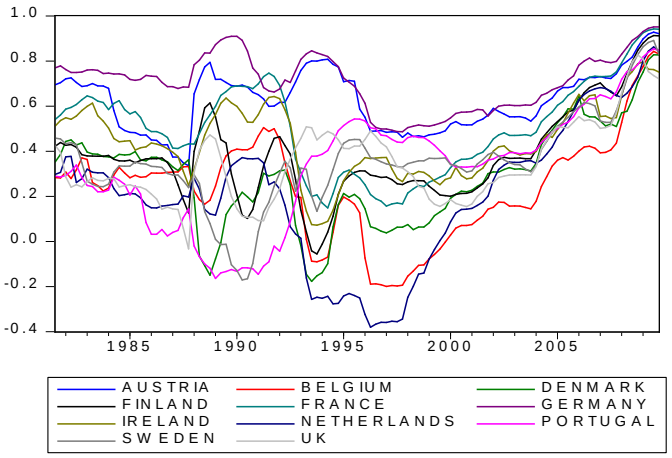
The results of the two models produced qualitatively similar results. However, due to the fact that scalar-BEKK model produced some more volatile time-varying correlation plots, we only present the plots from RiskMetrics model.

4. Empirical results

The measure of business cycle synchronisation estimated in this paper gives an interesting overview of the dynamics of business cycle synchronisation across the 14 sample countries from 1980 to 2009. An overview of the broad trends in this measure for 11 out of the 14 countries can be depicted in Figure 1 below.

We exclude Greece, Italy and Spain for now, as their time-varying correlation plots seem to tell a somewhat different story. These plots will be considered in Figure 2.

Figure 1: The time varying synchronisation for 11 EU Countries 1980-2009



Note: The sample countries Greece, Italy and Spain are excluded from this image.

Although it is difficult to identify individual countries from this image, some clear patterns of change in the measure of synchronisation are apparent from this chart. Firstly there is a consistent movement from the mid 1990s onwards towards higher levels of business cycle synchronisation across the country group. Secondly from this point onwards there is less dispersion in the measure of business cycle synchronisation among this group of countries. Given the adoption of the single currency this is the most striking and important of trends observable from our results.

The level of synchronisation in the early 1980s was reasonably stable although lower and more dispersed than the later part of the sample period. From the mid 1980s until the early 1990s the measure of synchronisation decreases whereas the variability of the degree of synchronisation increases.

Figure 2: The time varying synchronisation for Greece, Spain, and Italy 1981-2009.

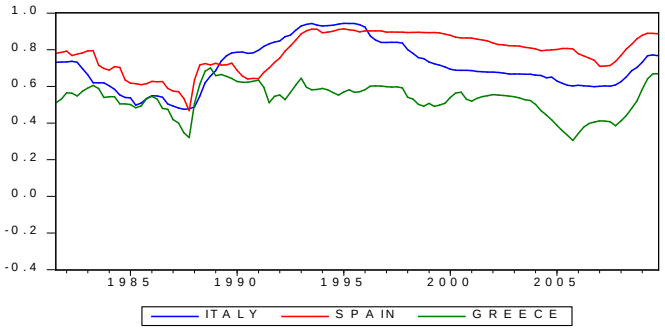


Figure 2 above illustrates that the measure of synchronisation in Greece, Spain and Italy follows a dynamic that is different to the other sample countries but similar to each other. There is a decline in the measure of synchronisation in the early part of the sample period which increases in the late 1980s and early 1990s and remains relatively high (although declining) until the later part of the sample period where the measure increases again.

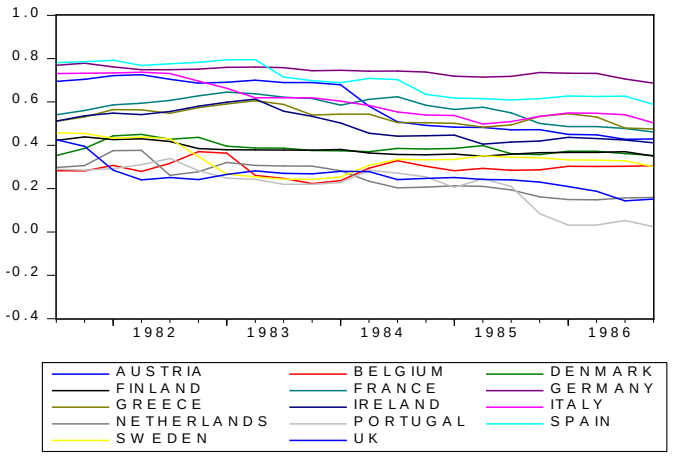
For ease of exposition and in the spirit of previous studies the following charts will examine the synchronisation of business cycles across countries for various sub-periods. The selection of these sub-periods has been chosen based upon the stylised observations outlined earlier and is in the spirit of previous studies into changes in measures of business cycle synchronisation such as Papageorgiou, et al. (2010) and earlier studies by Artis, et al. (1999) and Inklaar and De Haan (2001) – as these cited in de Haan (2008b).

The sub-periods correspond not only to the stylised observations from Figure 1 but also correspond to institutional changes that have taken place at a European level. The first period considered is from 1981-1986 which corresponds to the early period of the European Exchange Rate Mechanism (ERM) which operated from 1979-1985, the second sub-period considered is from 1987- 1995 corresponding to the later period of the ERM and its de-facto suspension in 1993. While the third period from 1994- 2007 corresponds to the period of the Maastricht Treaty of 1991and the launch of the single European currency in 1999 while the final short period from 2007-2009 provides us with an early indication of how the current crisis has affected the measure of business cycle synchronisation. For ease of exposition the sub-period graphs of the synchronisation measure are arranged into groups of countries showing similarities.

It should be noted that the sub-periods chosen do not correspond precisely to the timing of the institutional changes just outlined. Flexibility must be allowed for in our choice of sample periods to account for any lags in the effects of these institutional changes on business cycle synchronisation. Indeed in exploratory studies such as this the precise timing of a sub-period change or the inclusion or exclusion of any country from a group could be debated, the emphasis here is in outlining broad trends which require further explanation and raise questions for further studies.

The first sub-period to be considered is that from 1981-1986 shown in Figure 3 below. The business cycle synchronisation measure for this period highlights the relatively high degree of synchronisation at the time and the relatively stability of the measure across countries for this period. In all cases the degree synchronisation was positive and relatively high ranging from about 0.2 to 0.8.

Figure 3: Time varying synchronisation for all 14 EU sample countries 1981-1986



This period of relative stability in the degree of business cycle synchronisation co-insides with the roughly with first period of the ERM from 1979-1985 This first period of ERM involved countries operating different inflation rates and making frequent re-alignments of their currency pegs. This looser version of the ERM contrasts with the later period ERM from 1986 to 1993 when countries aimed to converge their inflation rates with those of the lowest member country. At the time this was Germany. This made Germany the anchor currency for the regime until its essential suspension in 1993 following the UK and Italian exit in 1992 and the speculative attacks on several other member currencies. This tighter

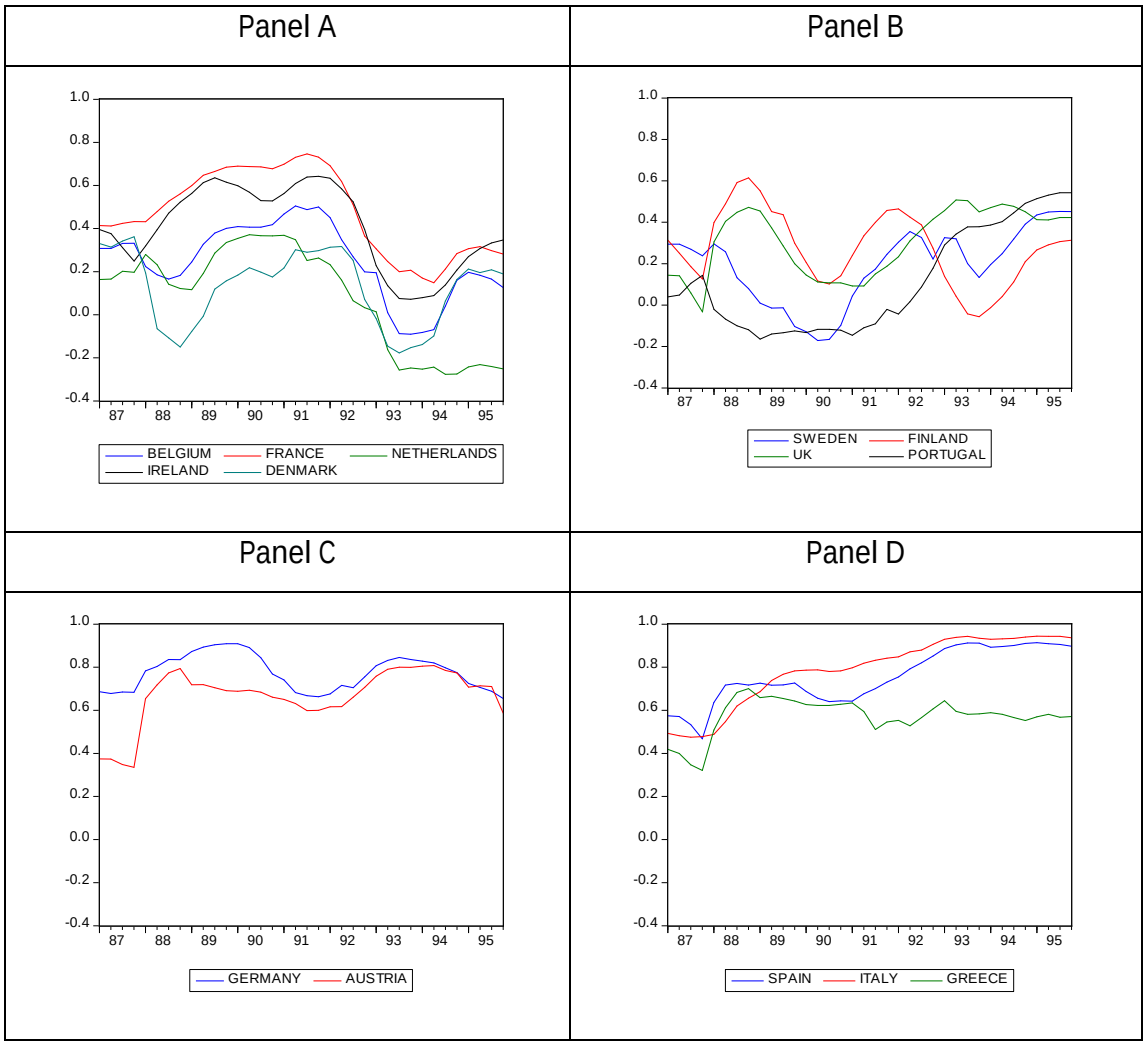
version of EMS which eventually blew up due to the evolution of economic pressures on the peg in effect involved the surrender of independent monetary policy in favour of tight German policy. There were no currency re-alignments during the period 1987- September 1992 while capital controls after being gradually phased out were banned in July 1990. These institutional changes increased inflexibility in the EU's monetary institutions were associated with a greater diversion in the degree of business cycle synchronisation across countries as shown in panels A-D in Figure 4 on the following page.

The measure of business cycle synchronisation during this sub-period is at its lowest and shows the most variation both within country and across countries. Most countries were to start the sub-period with relatively low measures of synchronisation and many were to end it ended with even lower measures. The fall off in the level of synchronisation and the degree of divergence among countries was to ebb at around 1993 co-incident with the suspension of the narrow bands of ERM and the advent closer policy co-ordination deemed necessary for Euro membership.

For exposition purposes it helps to split the countries into four groups. The first panel shows the core EU countries of France, Belgium, Denmark and the Netherlands as well as Ireland. Their level of synchronisation with the EU cycle declines dramatically during this sub-period. These were countries were to experience a mixture of diverging fundamentals and speculative currency attack at this time. The distinguishing feature for these countries is the dramatic drop in the measure of cyclical synchronisation during the early 1990s. Similar patterns of divergence are observed among the countries of Panel B. These countries were either not members of ERM or as in the case of the UK joined briefly from 1990 to 1992 or Portugal who only joined in 1992. With less experience with the straight jacket of ERM and the measure of cyclical synchronisation for these countries fluctuated to a greater extent throughout the period in line with economic fundamentals. Sweden and Finland were to have a major economic during this period while the recession in the UK was less synchronised with that of Germany than was the case with the 1970s recession. Indeed the UK was exiting the early 1990s recession as the Germany economy started to contract (Artis, et al., 2004).

The third panel shows declining synchronisation for the economies of Germany and Austria. The decline is less dramatic than is the case in other countries and may reflect Germany's weight in the European economy. The experience of Italy, Greece and Spain as shown in Panel D illustrates in the main an increasingly high level of synchronisation during the period. This is not as easily explained by the institutional changes, the periphery status or the economic fundamentals of these countries and is perhaps a surprising result.

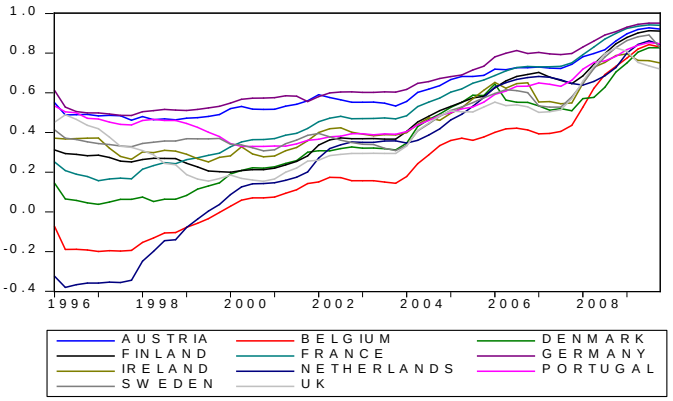
Figure 4: Time varying synchronisation for all 14 EU sample countries 1987-1995



The blow up of the ERM was not the only major institutional change taking place during the early 1990s. Denmark's failure to ratify the Maastricht Treaty in 1992 may have shook the markets confidence in Europe's ability to ratify the Treaty and proceed with Currency Union the Maastricht treaty did promote convergence paved the way to European Monetary Union (EMU) in 1999. The Maastricht Treaty and the subsequent Stability and Growth Pact

did promote a convergence in inflation rates; interest rates and fiscal policy in the run up to EMU, for an example of the effects of Maastricht on the convergence of fiscal policy outcomes see Considine and Duffy (2006). The effect of this convergence is demonstrated in the measure of business cycle synchronization for the period as shown in Figure 5 below.

Figure 5: Time varying synchronisation for 11 EU Countries 1996-2009.



Note: The sample countries Greece, Italy and Spain are excluded from this image.

Figure 5 above shows the measure of business cycle synchronisation for most sample countries from 1996 until 1999. The image here emphaisies the relatively steady and consistent move towards greater business cycle synchronisation across the group of countries during this sub-period. Also evident is the relatively steady and consistent reduction in the dispersion of the correlation coefficient across countries. This contrasts with the experience of earlier periods and the process of convergence continues up until the beginning of the current economic crisis in 2007. The economic crisis has resulted in a halt to the process of convergence and a move to divergence in the correlations across some countries. The effects of the economic crisis across this group of countries are best shown by zooming in on the later part of the sub-period as shown in Figure 6 below.

Figure 6: Time varying synchronisation for 14 EU Countries during the current economic crisis.

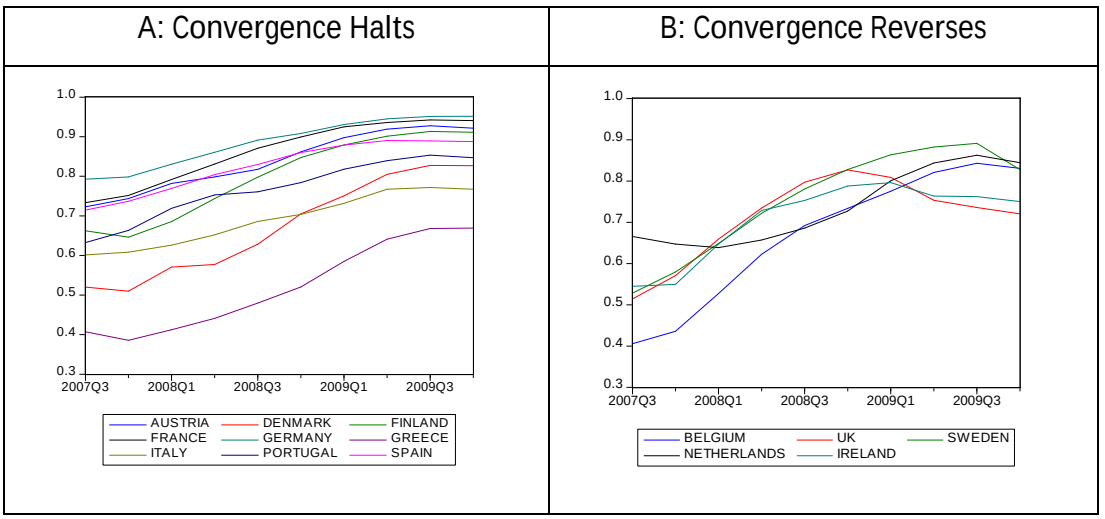


Figure 6 panels A and B above shows the effects of the economic crisis on the measure of synchronisation across all sample countreis. Panel A shows those countries for whom the convergence in the measure of synchronisation halts in its move towards convergence. In several cases this is not surprising as the measure of synchronisation is very high but for others the halt in the move towards increasing synchronisation is at levels somewhat lower. Of potentially greater concern for the operation of the single currency is the move to lower levels of synchronisation in Belgium, Ireland and the Netherlands. The UK and Sweden also reverse the process of increasing business cycle synchronisation.

4. Concluding remarks

Taken together the dynamics of the measure of business cycle synchronisation has moved in a direction positive for the operation of a single currency and a common monetary policy. The effects of the Maastricht Treaty and the establishment of the European Monetary Union appear to have reinforced the process of convergence in business cycle synchronisation. This was however the case in a benign economic environment with no major symmetric or asymmetric economic shocks. The effects of the of the 2007 economic crisis are clear. Even with the institutional environment supporting convergence in business cycle synchronisation a severe symmetric economic shock, which has had a more severe effect in some countries than others, has halted and in some cases reversed the process of convergence. Perhaps a word of caution is advisable here, these results only give us a first

glimpse at the effect of the current crisis on business cycle synchronisation. Additionally the effects of the economic crisis observed here should not be overstated. A closer examination of the evolution of the business cycle synchronisation measure over the earlier sub-period reveals that the diverging effects of the current crisis have not yet been as severe as the institutional suspension of the ERM or the asymmetric economic shocks associated with recessions of the early 1990s. However, the accumulation of data in the following years could paint a clearer picturer.

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