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Business Cycle Association and Synchronization in Europe: a Descriptive Review

Ricardo Fernando Silva, University of Aveiro, Portugal[1]

The share of a single currency inside a continent where the social, political and economic conditions are heterogeneous provokes a new wave of research on the effects of convergence in economic policies, monetary and non-monetary. The effects of Maastricht treaty and its nominal convergence criteria, helped many European countries to achieve nominal stability and start with new and controlled monetary and fiscal policies in order to slow down inflation and decrease interest rates. According to Angeloni and Dedola (1999) the European countries seem to have engaged in a new form of synchronized policies since the Bretton-Woods era to the period of the Exchange Rate Mechanism (ERM) and the beginning of the European Monetary Union (EMU). Taking this into account, the goal of this paper is to test the hypothesis that the launch of the currency union in Europe increased the cyclical synchronization between the participating countries. This hypothesis is tested by providing a descriptive analysis of the cyclical position of 26 countries from Europe in relation to the Euro Area aggregate for the period 1983-2002.

The sample is divided in two parts to study this evolution. The first one goes from 1983 to 1990 and the second from 1991 to 2002. This division has several reasons. The first one is the interest in describing the impact of the second oil shock in the cyclical position of the countries. Some other reasons are: the interest in the effect of Germany's reunification in 1989; the beginning of the first phase of EMU in 1990, with the liberalization of capital flows in Europe and free circulation of people and trade. These last three factors, namely, liberalization of capital flows, free circulation of people and trade, have been the *"Prima Donnas "*of some economists when they try to explain increases in synchronization and cyclical association. Examples of this are Herrero and Ruiz (2005) that use trade and financial integration indicators to explain synchronization between Euro Area countries and Spain. They found positive relations between them, i.e., increases in financial and trade linkages between countries tend to increase synchronization, which is consistent with the "endogeneity" of Optimum Currency Areas hypothesis. In the same paper, they include an index for similarity in productive structure and one for exchange rate volatility. In the first case, an increase in the similarity of productive structure increases contemporaneous correlation and in the second case they find that higher differences in exchange rate volatility cause a decrease in synchronization. Bordo and Helbling (2003), investigate the effect of trade integration in contemporaneous correlations for 16 industrialized countries during 120 years. Their results are in line with Herrero and Ruiz's (2005) results for trade integration in which increases in trade integration affect correlation positively. However, synchronization depends on other factors, such as the exchange rate regime (which is connected to trade integration too) and asset markets integration. However, Bordo and Helbling (2003) couldn't take major conclusions about the effects of the exchange rate regime and assets markets integration on

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cyclical synchronization. Some results are even inconclusive. De Haan *et al.* (2002) investigated the effects of trade and exchange rate volatility in contemporaneous correlations of 18 OECD countries. As in the results mentioned above, there is a positive relation between trade and synchronization. In the case of the exchange rate, De Haan *et al.* (2002) found a positive relation, which they argue that is an expected result due to the use of the exchange rate as an adjustment tool. This can be interesting, especially if we consider different periods in history where the exchange rate was fixed or flexible and the fact that during periods of flexibility, external (and internal) imbalances were high, for example, during the Post-Bretton Woods period. It would also be expected, that countries which fix the exchange rate would converge in nominal terms, for example, towards the same level of inflation and the transparency and stability (at least theoretically) of the system would set the stage for an increase in comovements of real outputs and so, the results presented by Herrero and Ruiz (2005) would make sense. On the other hand, the connection between the exchange rate and cyclical synchronization is out of the scope of this paper thus, it is not conducted an extended discussion of these results.

The paper is organized as follows: the first section presents the theory that motivates this research; the data are described in the second section as well as its different sources; the filtering procedures and their main characteristics are analyzed in the third section; in the fourth section, contemporaneous correlations, Spearman rank correlations and estimated multiple correlations are presented to make a first assessment to synchronization with Euro Area. In the light of Artis and Zhang (1999) that compared the contemporaneous correlation of 14 European countries, Japan and Canada in relation to Germany and United States (US), in the end of the fourth section the correlations with France, Germany and Italy are compared and the contemporaneous correlations' matrixes are analyzed. In the fifth section three measures of synchronization are introduced: the Concordance Index proposed by Harding and Pagan (1999b, 2005, 2006), the intertemporal correlation coefficient and the maximum correlation coefficient. The sixth section is dedicated to explain synchronization with Euro Area, the seventh section proposes some policy recommendations and the last section presents the conclusions of this research.

I. Theory

One of the most well known debates in macroeconomic theory is whether one country should adopt a flexible or a fixed exchange rate system. Usually, the flexible exchange rate system is defended under the assumption that a currency depreciation is able to substitute an increase in unemployment while an increase in inflation can be readily corrected by a currency appreciation. Thus, this system is defended by its capacity to maintain internal as well as external equilibrium. However, the costs of exchange rate fluctuations can also be large for open economies with high levels of international trade. For countries with high trade intensity, exchange rate fluctuations are largely undesirable.

The search for the adequate regime led Mundell (1961) to propose the Theory of Optimum Currency Areas (OCA). The OCA theory defines the optimum domain for a currency union (or a fixed exchange rate system) and provides the relevant criteria for its delimitation. For instance imagine two countries A and B with two regions C and D that run across these countries. Imagine that for some reason demand flows from region D to region C, causing an increase in unemployment in the former and in inflation in the later. Since labor mobility is low and wages adjust slowly, an automatic adjustment is impossible. Also in this situation of disequilibrium, the Central Banks of both economies could act together in order to reduce unemployment in region D but always at the expense of higher inflation in region C making the adjustment inappropriate in terms of internal equilibrium in this region. In the meantime, the flexible exchange rate linking both countries will always move to correct any external imbalance between these countries but will be incapable to correct the regional disequilibrium. Hence, the flexible exchange rate system is not optimal in the sense that is unable to correct the internal imbalance, and so, the optimum currency area is defined at the regional level. This theory clearly presents relevant criteria that defines the optimality of a given exchange rate system, namely, labor mobility, wage rigidity and asymmetry of shocks. In the first case, higher labor mobility could reduce unemployment in region D since workers would be able to shift to region C where demand increased. Also, a sufficient decrease in wages in the same region would allow the necessary decrease in unemployment. At the same time, even if wage flexibility and labor mobility were low, a high symmetry of shocks would produce similar responses in both regions. Note that this last criterion can well be translated in the fact that if countries have low business cycle synchronization, it must be the case that both face persistent asymmetric shocks. Hence, business cycle synchronization can be thought as a relevant criterion for the existence of an OCA.

However, Mundell's work is ambiguous in what concerns to the definition of an optimum currency area, whether it is a fixed exchange rate agreement or on the other hand, a common currency area. McKinnon (1963) explicitly recognizes this ambiguity and defines an OCA as a common currency area in which fiscal, monetary and exchange rate policies are used to ensure three objectives: full employment, price stability and balance of payments equilibrium. His work proposes the degree of openness of an economy as another important criterion for the existence of an OCA. The underlying idea is that exchange rate fluctuations are not desirable for highly open economies since (1) introduces exchange rate uncertainty which directly affects international trade and (2) causes pressure in internal prices which violates the objective of price stability. Note that in countries with high trade intensity, imported goods represent an important portion of the basket used to compute the price index, hence, exchange rate volatility induces undesirable fluctuations in prices. Hence, the higher the bilateral trade between two countries, the higher the benefits of a currency area between them.

The benefits derived from sharing a currency are then dependent on a set of important criteria that countries must fulfill before joining a currency area. However, Frankel e Rose (1998) point the important fact these benefits are endogenous, i.e., although countries may not fulfil these criteria in the beginning, the increase in trade caused by the elimination of exchange rate fluctuations will increase business cycle synchronization. Hence, the OCA's criteria are endogenous to the adoption of the currency.

This paper is concerned with the synchronization of business cycles between countries that belong to the Euro Area. If the benefits from joining the common currency are endogenous to it's adoption then, an increase in business cycle affiliation is expected between Eurozone countries. Note for instance that two countries can only benefit from sharing a currency if, at each point in time, they are in the same phase of the business cycle. Imagine for example the hypothetical case of Germany and Portugal, where Germany is in the expansion phase while Portugal is in a recession. The pressure in inflation created by increased demand in Germany will probably lead the Central Bank to increase interest rates to eliminate inflation expectations. At the same time, it deepens the recession phase in Portugal. Thus, a "*one-size fits all*" monetary policy is not optimal. Hence, the optimality of monetary policy is endogenous to the synchronization of business cycles. This provides the necessary motivation to conduct an extensive research on the cyclical evolution of the Eurozone economies.

II. Data

The cyclical components used in the study are computed using annual GDP at constant prices from the International Monetary Fund (IMF) World Economic Outlook database (WEO-April 2006) and AMECO database covering the period 1980-2005 for the countries[2]: Spain, Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Poland, Luxembourg, the Netherlands, Norway, Romania, Sweden, Switzerland, Ireland, Portugal and UK. For the emerging economies, Lithuania, Slovenia, Czech Republic, Estonia, Croatia, the data comes from the IMF (WEO-April 2006) for the period 1992-2005. In the last section, data for unemployment rate and budget deficits are from the IMF (WEO-April 2006) and AMECO datasets.

III. Filtering Methods

In the last fifty years, many economists like Burns and Mitchell[3], Lucas (1977, 1980), Kydland and Prescott (1990, 1997), tried to formalize a definition of business cycle. The result was two different propositions for the same phenomena. Burns and Mitchell proposed a definition in which a business cycle is a sequence of expansions and contractions, paying a particular attention to the peaks, troughs, turning points and their timing. This is what we call today, the classical cycle. On the other hand, Lucas (1977,1980), Kydland and Prescott (1990), proposed a revolutionary definition. According to their view, the business cycle is simply the fluctuation of real GDP along a trend which represents the potential of the economy or, as the growth theory predicts, the steady-state of growth. In this paper the definition initially proposed by Lucas (1977,1980) and then refined by Kydland and Prescott (1990) is applied, i.e., the growth cycle.

A. The Hodrick-Prescott Filter

One of the methods used to compute the cyclical components is the Hodrick-Prescott (HP) filter. As Azevedo (2002) points out, the HP filter can be seen as a high-pass filter and puts in practice the hypothesis that the potential growth is not constant along the period. Following Hodrick and Prescott (1997) and Kim (2004), this statistical method is not difficult to employ because it simply solves the following problem:

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[2] The isocodes used are: Euro Area (EA); Spain (SP); Austria (AUS); Belgium (BGM); Bulgaria (BUL); Cyprus (CY); Denmark (DEN); Finland (FINL); Portugal (PT); France (FR); Germany (GER); Greece (ATH); Luxembourg (LX); The Netherlands (NL); Norway (NRW); Poland (PL); Romania (ROM); Sweden (SE); Switzerland (SW); United Kingdom (UK); Ireland (IE); Lithuania (LT); Slovenia (SL); Czech Republic (CZ); Estonia (ES); Croatia (CRO); Italy (IT).

[3] Cited in Harding and Pagan (1999b).

(1) $$\min_{y^*_t} \sum_{t=1}^{T} (y_t - y_t^*)^2 + \lambda \sum_{t=2}^{T-1} \left[(y_{t+1}^* - y_t^*) - (y_t^* - y_{t-1}^*) \right]^2$$

Where y_t is the log of GDP at constant prices at time t, y^*_t is the potential output at time t, which is the solution of the problem, and λ is the smoothness parameter. For this investigation λ=100, since it is the recommended value for annual data. The solutions of the minimization problem can be easily demonstrated. Following Kim (2004) in matrix notation, the solution is:

(2) $$Y^* = (\lambda F + I_T)^{-1} Y$$

Where Y is a Tx1 matrix of the observed series that we want to filter, Y* is a Tx1 matrix with the unobserved trend that we want to compute, λ is a constant that represents the smoothness parameter, I_T is the TxT identity matrix and F is a TxT matrix of the form:

(3) $$F_{TxT} = \begin{vmatrix} 1 & -2 & 1 & 0 & \cdots & & & & & & & \cdots & 0 \\ -2 & 5 & -4 & 1 & 0 & \cdots & & & & & & \cdots & 0 \\ 1 & -4 & 6 & -4 & 1 & 0 & \cdots & & & & & \cdots & 0 \\ 0 & 1 & -4 & 6 & -4 & 1 & 0 & \cdots & & & & & \vdots \\ \vdots & & & & & & & \ddots & & & & & \vdots \\ \vdots & & & & & & & \cdots & 0 & 1 & -4 & 6 & -4 & 1 & 0 \\ \vdots & & & & & & & & \cdots & 0 & 1 & -4 & 6 & -4 & 1 \\ 0 & \cdots & & & & & & & & \cdots & 0 & 1 & -4 & 5 & -2 \\ 0 & \cdots & & & & & & & & & \cdots & 0 & 1 & -2 & 1 \end{vmatrix}$$

After computing the trend vector Y*, it is easy to compute the cyclical component. The HP filter decomposes the time-series y_t into a non-stationary series y^*_t and a stationary series C_t , which represents the residual of the following equation and the cyclical component:

(4) $$y_t = y_t^* + c_t \qquad \text{For } t=1,2,\ldots,T$$

The major advantage of the HP filter is its simplicity, but other advantages can be identified such as its ability to compute a good approximation of the cyclical component and the capacity to deal well with the high and low frequencies of the series. Some literature such as St Amant and Van Norden (1997), analyze these properties of the filter making a comparison to the properties of an optimal filter and found that the Hodrick-Prescott has some problems, especially the behavior at the end of the samples. Another problem of the procedure is that we need to choose the value of the smoothing parameter λ[4], which can create biased cycles. These issues have been widely discussed in related literature where mechanical filters such as the Hodrick-Prescott are subject of intensive scrutiny and criticism. One of the alternatives that is commonly used is the well known Kalman filter, but the procedure loses the simplicity provided by the Hodrick-Prescott and similar filters which can be a drawback in its usage.

[4] See Giorno et al. (1995) for more on this subject.

B. The Baxter-King Filter

The Baxter-King (BK) filter can be seen as an approximation of an ideal band-pass filter and an alternative to the Hodrick-Prescott filter which by definition removes both high and low frequencies. The filter is a symmetric moving-average of finite order *h* which ensures that there is no phase shift, i.e., the filter doesn't change the timing of the turning points in the series[5] and on the other hand, ensures stationary series. Following Baxter and King (1995) and Woitek (1998), analytically it takes the form:

(5)
$$\hat{y} = \sum_{j=-h}^{h} a_j L^j y_t$$

Where L^j is the lag operator such that $LY_t=Y_{t-1}$. The weights a_j take the form:

(6)
$$a_j = b_j + \theta \qquad j = 0, \pm 1, \pm 2, \ldots, \pm h$$

(7)
$$b_j = \begin{cases} \dfrac{w_2 - w_1}{\pi}, & if \quad j = 0 \\ \dfrac{1}{\pi}\left(\sin w_2 j - \sin w_1 j\right), & if \quad j = \pm 1, \pm 2, \ldots, \pm h \end{cases}$$

(8)
$$\theta = \frac{-\sum_{j=-h}^{h} b_j}{2h+1}$$

Since the data are in annual frequency, the parameters take the values h=3, $w_1 = 2\pi\frac{1}{8}$ and $w_2 = \pi$, which are the ones assumed by Woitek (1998). Natural logarithms were applied to all series before computing the cyclical components. One of the consequences of this filter is the reduction in the length of the series in six years so, the period in analysis goes from 1983 to 2002.

C. Results

The descriptive statistics of the output gaps are presented in tables 1 and 2. In relation to the HP cycles, if we measure cyclical volatility by the standard deviation, the Bulgarian cycle is the most volatile and the Slovenian cycle is the less volatile. Note however that the Slovenian cycle has only

[5] Since this filter is symmetric ($a_j = a_{-j}$), it reduces the sample in $2h$ observations.

eight observations and the differences in the number of observations may cause biased results. Thus, accounting for this feature, the Austrian cycle now replaces the Slovenian in the lowest volatility place.

Table 1. Descriptive Statistics for Hodrick-Prescott (HP) Cycles (1983-2002)[6]

	N	Min	Max	Mean	St.Dev.	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Std. Error
EA	20	-1,515	2,710	-0,011	1,484	0,645	0,512	-1,155	0,992
ATH	20	-2,983	2,655	-0,350	1,579	0,370	0,512	-0,635	0,992
AUS	20	-1,887	2,197	0,023	1,182	0,509	0,512	-0,723	0,992
BGM	20	-2,244	2,318	-0,057	1,416	0,078	0,512	-1,278	0,992
BUL	20	-12,390	17,326	0,237	8,126	0,639	0,512	-0,227	0,992
CRO	8	-2,228	4,206	0,279	2,328	0,812	0,752	-0,731	1,481
CY	20	-2,650	3,597	0,210	1,796	0,421	0,512	-0,673	0,992
CZ	8	-2,633	4,707	0,109	2,634	0,864	0,752	-0,661	1,481
DEN	20	-3,903	3,998	0,405	1,855	-0,311	0,512	0,352	0,992
EE	8	-4,156	1,676	-1,542	2,320	0,130	0,752	-1,646	1,481
FINL	20	-8,075	8,947	0,313	4,328	-0,004	0,512	0,000	0,992
FR	20	-2,093	2,618	0,015	1,512	0,350	0,512	-1,404	0,992
GER	20	-2,820	3,896	-0,017	1,767	0,757	0,512	0,299	0,992
IE	20	-5,508	5,821	-0,015	3,101	0,149	0,512	-0,519	0,992
IT	20	-2,174	1,984	-0,064	1,372	0,060	0,512	-1,257	0,992
LT	8	-7,811	1,834	-3,054	2,907	-0,001	0,752	0,572	1,481
LX	20	-5,171	5,959	-0,086	3,386	0,143	0,512	-0,878	0,992
NL	20	-2,202	3,540	0,117	1,730	0,538	0,512	-1,002	0,992
NRW	20	-2,693	3,552	0,297	2,106	-0,024	0,512	-1,411	0,992

[6] Descriptive statistics were computed using SPSS version 13. Business Cycles computed using both filters were multiplied by 100 for the rest of the investigation. This transformation produces percent deviations from estimated trend.

PL	20	-8,238	9,175	0,201	4,739	-0,245	0,512	-0,420	0,992
PT	20	-5,668	5,174	0,014	3,199	-0,114	0,512	-0,826	0,992
ROM	20	-13,003	11,114	0,368	6,901	-0,216	0,512	-0,961	0,992
SE	20	-4,400	3,718	0,100	2,135	-0,139	0,512	-0,438	0,992
SP	20	-3,121	4,258	-0,142	2,405	0,461	0,512	-1,115	0,992
SW	20	-2,843	4,704	0,000	1,860	0,835	0,512	0,684	0,992
SL	8	-0,547	1,559	0,373	0,728	0,859	0,752	-0,293	1,481
UK	20	-3,121	4,306	0,080	1,998	0,595	0,512	0,174	0,992

Table 2. Descriptive Statistics for Baxter-King (BK) Cycles (1983-2002)

	N	**Min**	**Max**	**Mean**	**St. Dev.**	**Skewness**		**Kurtosis**	
	Stat.	Stat.	Stat.	Stat.	Stat.	Stat.	Std. Error	Stat.	Std. Error
EA	20	-1,259	1,307	0,021	0,742	0,408	0,512	-0,715	0,992
ATH	20	-2,980	1,504	-0,281	1,118	-0,449	0,512	0,641	0,992
AUS	20	-1,214	1,494	0,028	0,749	0,426	0,512	-0,600	0,992
BGM	20	-2,004	1,304	-0,032	0,873	-0,364	0,512	-0,222	0,992
BUL	20	-6,070	6,730	-0,069	2,942	0,269	0,512	0,930	0,992
CRO	8	-1,785	2,995	0,189	1,713	0,509	0,752	-0,782	1,481
CY	20	-2,017	3,242	0,208	1,571	0,245	0,512	-0,934	0,992
CZ	8	-1,824	3,320	0,214	1,754	0,539	0,752	-0,178	1,481
DEN	20	-2,391	2,049	0,171	0,873	-0,649	0,512	3,909	0,992
EE	8	-2,984	2,976	-0,581	2,197	0,568	0,752	-0,867	1,481
FINL	20	-4,019	4,454	0,024	2,013	0,488	0,512	1,409	0,992
FR	20	-1,135	1,214	0,017	0,735	0,268	0,512	-1,050	0,992
GER	20	-1,298	2,256	0,060	0,967	0,714	0,512	0,140	0,992
IE	20	-2,763	2,641	-0,241	1,469	0,107	0,512	-0,450	0,992
IT	20	-1,566	1,059	0,056	0,717	-0,510	0,512	-0,269	0,992
LTH	8	-4,925	3,701	-1,241	2,562	0,896	0,752	1,533	1,481
LX	20	-2,985	3,887	-0,045	1,759	0,457	0,512	0,043	0,992
NL	20	-1,425	1,709	0,057	0,884	0,208	0,512	-0,770	0,992
NRW	20	-1,895	1,776	0,099	1,012	-0,034	0,512	-0,520	0,992
PL	20	-5,825	6,294	-0,116	2,404	0,148	0,512	2,975	0,992
PT	20	-2,630	2,570	0,064	1,486	-0,132	0,512	-0,797	0,992
ROM	20	-8,076	6,372	-0,042	3,608	-0,356	0,512	-0,235	0,992
SE	20	-2,744	1,784	-0,001	1,117	-0,440	0,512	0,614	0,992
SP	20	-1,989	1,718	-0,085	1,062	-0,003	0,512	-0,835	0,992
SW	20	-1,875	2,764	0,024	1,049	0,707	0,512	1,236	0,992
SL	8	-0,427	0,951	0,152	0,494	0,615	0,752	-0,516	1,481
UK	20	-1,985	2,013	0,018	0,992	0,283	0,512	0,483	0,992

The BK cycles produce different results. The Romanian cycle has now the highest volatility and the Slovenian cycle still has the lowest variation. Taking into account the differences in the length of the samples, there are now several cycles with almost the same variability, for example: Euro Area, Austria, France and Italy.

In order to compare the results produced by the two filtering methods, in Table 3 are presented the correlations between the same cycles computed with the two filters.

Table 3. Correlation between Filters HP-BK

EA	ATH	AUS	BGM	BUL	CRO	CY	CZ	DEN	EE	FINL	FR	GER	IE
0.92	0.88	0.93	0.92	0.89	0.98	0.96	0.94	0.87	0.98	0.92	0.94	0.89	0.91

IT	LT	LX	NL	NRW	PL	PT	ROM	SE	SP	SW	SL	UK
0.91	0.90	0.92	0.93	0.91	0.91	0.97	0.92	0.88	0.94	0.89	0.93	0.92

The cycles produced by the two methods are in all cases similar and positively correlated, thus, if the two procedures are analyzed in the same periods should display considerably similar results. Guay and St-Amant (1997) analyzed the properties of these two filters through spectral analysis and argued that in terms of extracting the cyclical component, the Baxter-King filter has better performance than the one proposed by Hodrick and Prescott (1997).

IV. A First Approach to Synchronization

A. Synchronization with Euro Area

In this section three main statistics are presented to analyze synchronization with the Euro Area cycle: the correlation coefficient or as it will be called, the contemporaneous correlation coefficient, the Spearman rank correlation and multiple correlations estimated through linear regressions.

The contemporaneous correlation coefficient gives the degree of linear association between two series and its value lies between [-1; 1]. It can be seen as a measure of comovements between two cycles and its absolute value gives the strength of association between the two series. Computing these statistics for the period 1983-2002 and for the two sub-periods 1983-1990 and 1991-2002 in relation to the Euro Area cycle produces the results presented in Table 4.

Looking to the results obtained with the HP filter, as expected, it is possible to see that the Euro Area countries have in general high synchronization with the Euro Area cycle. For the period 1983-2002, the countries with highest synchronization ($|\rho_{i\ j}| \geq 0{,}80$) are Belgium, France, Italy, Luxembourg, the Netherlands, Portugal, Spain and Switzerland. Another country that demonstrates a good synchronization is Germany. In summary, the European countries that form the core of the monetary union display high levels of synchronization. Another conclusion that can be taken from the table 4 is that there are six countries that move in the opposite direction of the Euro Area cycle, i.e., are countercyclical in relation to Euro Area: Croatia, Czech-Republic, Denmark, Norway, Poland and

Romania. Note the case of Finland (where the correlation is not statistically significant) and Ireland that are the Euro area countries that have the lowest degree of association with the Euro Area cycle.

For the same period, the results produced by the BK filter are not very different. Establishing the same rule for highest levels of synchronization, $|\rho_{ij}| \geq 0{,}80$, there are six countries that meet this requirement: Belgium, France, Germany, Italy, the Netherlands and Spain. Finland continues to have a correlation that isn't statistically significant. Eyeballing the results provides the impression that they are robust when we compare the two filters. Note that, what matters in terms of evolution is the strength of the relation, not the sign of the correlation. A country can be synchronized even if displays a countercyclical behavior in relation to Euro Area (Dolado *et al.* (1993)).

Table 4. Contemporaneous Correlation with Euro Area[7]

	Correlation (HP)			**Correlation (BK)**		
	1983-2002	**1983-1990**	**1991-2002**	**1983-2002**	**1983-1990**	**1991-2002**
ATH	0.76 º	0.66	0.92 º	0.62 º	0.54	0.85 º
AUS	0.71 º	0.38	0.90 º	0.65 º	0.13	0.86 º
BGM	0,89 º	0,99 º	0,80 º	0,87 º	0,96 º	0,83 º
BUL	0.36	0.66	0.86 º	0.32	0.44	0.66
CRO	-0.72	-	-	-0.69	-	-
CY	0.54 º	0.88 º	0.24	0.50 º	0.82	0.38
CZ	-0.68	-	-	-0.14	-	-
DEN	-0.36	-0.83	0.04	0.24	-0.30	0.57
EE	0.07	-	-	-0.15	-	-
FINL	0.36	0.88 º	0.36	0.37	0.87 º	0.31
FR	0.94 º	0.96 º	0.97 º	0.89 º	0.87 º	0.93 º
GER	0.79 º	0.82	0.86 º	0.85 º	0.65	0.95 º
IE	0.49 º	0.63	0.49	0.67 º	0.76	0.63
IT	0.86 º	0.89 º	0.85 º	0.84 º	0.80	0.88 º
LT	0.17	-	-	-0.34	-	-
LX	0.88 º	0.88 º	0.86 º	0.61 º	0.57	0.60
NL	0.81 º	0.91 º	0.75 º	0.84 º	0.82	0.85 º
NRW	-0.47 º	-0.70	-0.29	-0.11	-0.42	0.14
PL	-0.10	0.37	-0.25	-0.15	0.33	-0.32
PT	0.89 º	0.86	0.94 º	0.67 º	0.47	0.82 º
ROM	-0.42	-0.03	-0.55	-0.24	0.50	-0.30
SE	0.46	0.75	0.57	0.55 º	0.78	0.61
SP	0.92 º	0.93 º	0.97 º	0.84 º	0.69	0.95 º
SW	0.89 º	0.94 º	0.95º	0.73 º	0.91 º	0.78 º
SL	0.69	-	-	0.59	-	-
UK	0.26	0.66	0.14	0.14	0.53	0.05

Note: *º Correlation Coefficient is significant for at 5 percent level (2-tailed); - The sample is too short to compute the correlation.*

[7] The significance test for the correlation coefficient was computed using the formula (see Belo (2001)): $\pm t_{\alpha/2}^{df} / \sqrt{T}$ with *df* = (n-2) degrees of freedom.

Analyzing the evolution of correlation of the HP cycles, there are 9 cycles that increased synchronization: Greece, Austria, Bulgaria, France, Germany, Portugal, Romania, Spain and Switzerland; and eleven cycles that decreased synchronization: Belgium, Cyprus, Denmark, Finland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Sweden and UK. Only six Euro zone countries increased synchronization: Greece, Austria, France, Germany, Portugal and Spain.

For the BK cycles, there are eleven cycles that increased synchronization: Greece, Austria, Bulgaria, Denmark, France, Germany, Italy, Luxembourg, the Netherlands, Portugal and Spain; and nine cycles that decreased synchronization: Belgium, Cyprus, Finland, Ireland, Norway, Romania, Sweden, Switzerland and UK. Nine Euro zone countries increased association: Greece, Austria, France, Germany, Italy, Luxembourg, the Netherlands, Portugal and Spain. The results for Poland are confusing, displaying an uncertain evolution for both filters.

In order to compare the results and take into account the possibility of nonlinear relations between the cycles, it was computed the Spearman rank correlation. The Spearman rank correlation as the name suggest, take the correlation between the rank of the observations. The results are presented in Table 5.

The Spearman rank correlation reinforces the conclusions presented for contemporaneous correlation. The Euro Area countries still have high synchronization with the Euro cycle. For the HP cycles, the countries that display the highest degree of association (≥0,80) in the period 1983-2002 are: Belgium, France, Italy, Luxembourg, Portugal, Spain, and Switzerland. For the same period the BK cycles produce almost the same results. Belgium, France, Germany, Italy, the Netherlands and Spain are the countries with higher synchronization.

Regarding the evolution of synchronization, for the HP cycles, almost all countries increased the association with the Euro cycle. The exceptions were: Cyprus, Denmark, Finland, France, Norway, Poland, Sweden and UK. The correlations computed with the BK cycles are once again similar. Belgium, Cyprus, Denmark, Finland, Italy, Norway, Poland, Romania, Sweden, Switzerland and UK decreased association. The results are in line with the ones presented for the contemporaneous correlation. An interesting result is the one for Slovenia that display a high degree of association with Euro Area.

Table 5. Spearman rank correlation with Euro Area[8]

	Correlation (HP)			Correlation (BK)		
	1983-2002	1983-1990	1991-2002	1983-2002	1983-1990	1991-2002
ATH	0.71 ºº	0.67	0.92 ºº	0.68 ºº	0.67	0.83 ºº
AUS	0.65 ºº	0.19	0.86 ºº	0.49 º	-0.26	0.73 ºº
BGM	0.88 ºº	0.83 º	0.85 ºº	0.89 ºº	1 ºº	0.83 ºº
BUL	0.28	0.57	0.87 ºº	0.37	0.55	0.79 ºº
CRO	-0.79 ºº	-	-	-0.76 º	-	-
CY	0.55 º	0.81 º	0.34	0.54 º	0.76 ºº	0.41
CZ	-0.60	-	-	-0.29	-	-
DEN	-0.46 º	-0.71 º	-0.01	-0.06	-0.45	0.15
EE	0.17	-	-	-0.12	-	-
FINL	0.29	0.57	0.35	0.36	0.90 ºº	0.24
FR	0.89 ºº	0.93 ºº	0.92 ºº	0.88 ºº	0.69	0.95 ºº
GER	0.77 ºº	0.69	0.80 ºº	0.81 ºº	0.62	0.96 ºº
IE	0.43	0.36	0.49	0.65 ºº	0.43	0.57
IT	0.82 ºº	0.62	0.87 ºº	0.82 ºº	0.86 ºº	0.82 ºº
LT	0.26	-	-	-0.38	-	-
LX	0.88 ºº	0.67	0.85 ºº	0.54 º	0.52	0.57
NL	0.73 ºº	0.69	0.70 º	0.83 ºº	0.64	0.86 ºº
NRW	-0.48 º	-0.62	-0.32	-0.13	-0.31	0.01
PL	-0.02	0.26	-0.15	0.00	0.43	-0.20
PT	0.87 ºº	0.62	0.90 ºº	0.61 ºº	0.29	0.78 ºº
ROM	-0.53 º	-0.07	-0.55	-0.16	0.55	-0.24
SE	0.37	0.62	0.57	0.56 ºº	0.81 º	0.56
SP	0.83 ºº	0.69	0.95 ºº	0.83 ºº	0.60	0.95 ºº
SW	0.84 ºº	0.69	0.94 ºº	0.74 ºº	0.81 º	0.78 ºº
SL	0.76 º	-	-	0.62	-	-
UK	0.21	0.50	0.11	0.18	0.45	0.08

Note: *ººCorrelation is significant at 1 percent level (2-tailed). º Correlation is significant at 5 percent level (2-tailed).*

The last method used in this first section is the estimation of a regression with the objective of obtaining a multiple correlation coefficient with the Euro Area cycle. The regression used was presented by Belo (2001) and is as follows:

(9) $$C_t^i = \beta_1 C_t^{EA} + \beta_2 C_{t-2}^{EA} + \beta_3 C_{t-1}^{EA} + \beta_4 C_{t+1}^{EA} + \beta_5 C_{t+2}^{EA} + \varepsilon_{it}$$

[8] Correlations and significance tests computed with SPSS version 13.

Where C_t^i is the cycle in country *i* at time t and C_t^{EA} is the Euro Area cycle at time *t* and β_i are parameters. From this simple regression, we can obtain a good and accurate estimation of the multiple correlation coefficient which can give another measure of linear association between the cycle of country *i* and the Euro Area cycle. The multiple correlation coefficients can be computed by taking the square root of the determination coefficient.

These results must be interpreted carefully, first once again, because of the small size of the samples that can induce measuring and over-estimation problems; second because of the inexistence of an intercept in the regression (see for example Gujarati (2004) pp. 164-169). The results are presented in Table 6.

Table 6. Multiple Correlations with Euro Area (1983-2002)

	ATH	AUS	BGM	BUL	CY	DEN	FINL	FR	GER	IE	IT
HP	0.76	0.84	0.94	0.61	0.64	0.87	0.95	0.97	0.95	0.71	0.96
BK	0.64	0.81	0.94	0.66	0.74	0.82	0.91	0.96	0.96	0.69	0.93

	LX	NL	NRW	PL	PT	ROM	SE	SP	SW	UK
HP	0.91	0.85	0.84	0.95	0.95	0.76	0.92	0.97	0.90	0.92
BK	0.73	0.85	0.64	0.86	0.90	0.68	0.93	0.91	0.73	0.89

The estimates refer only to the period 1983-2002 because of the small samples in the sub-periods that disable the possibility of estimation. The conclusion taken from this table is that the Euro Area countries still have the highest levels of synchronization. It's not easy to obtain clear conclusions because the results are confusing and the estimates appear to be inflated.

B. Germany, France or Italy?

In this section, the correlations with France, Germany and Italy are analyzed. Artis and Zhang (1999) compared the correlations of 17 countries in relation to Germany and the US. They found that in the pre-ERM era, countries had higher association with the US cycles but during the ERM period they found the opposite result. This is quite expected since the nominal anchor in Exchange Rate Mechanism was the German currency. Following their strategy, a comparison is made here between the cycles of France, Germany and Italy.

In Figures 1, 2 and 3 are presented the correlations with France, Germany and Italy. The figures also present a 45º line equally separating the correlations for both countries. The results are rather interesting since Germany, which is normally pointed as the European "engine" loses this position for the other two economies in cyclical terms.

If we look at Figure 1, it is possible to see that almost all countries have higher correlations with France, with only a few exceptions. Figure 2 brings a similar conclusion with almost all countries having higher correlations with Italy. Figure 3 shows the corollary of the last two in which Germany loses the position of cyclical attractor for France and Italy.

Figure 1. Correlations with Germany and France (HP,BK)

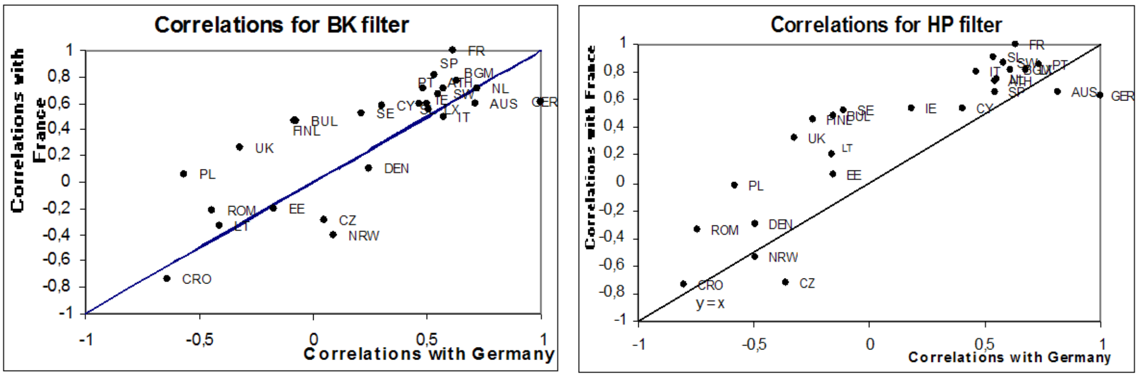


Figure 2. Correlations with Germany and Italy (HP,BK)

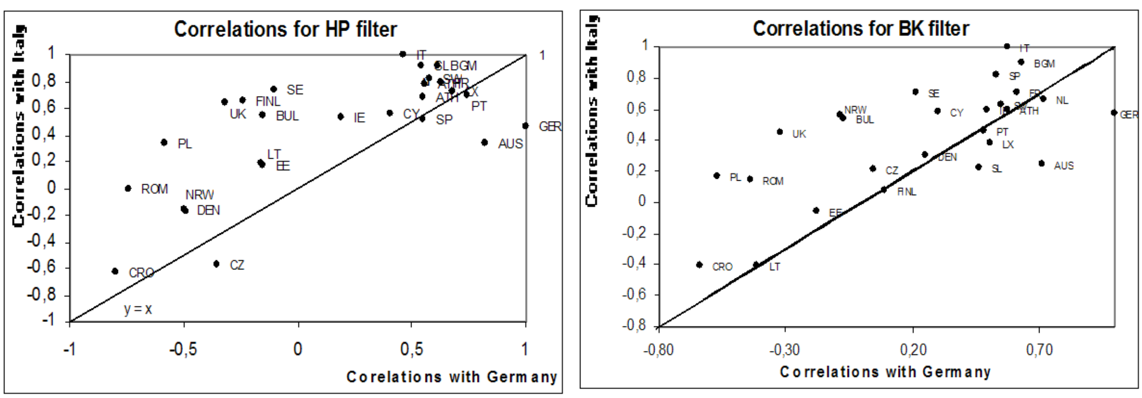
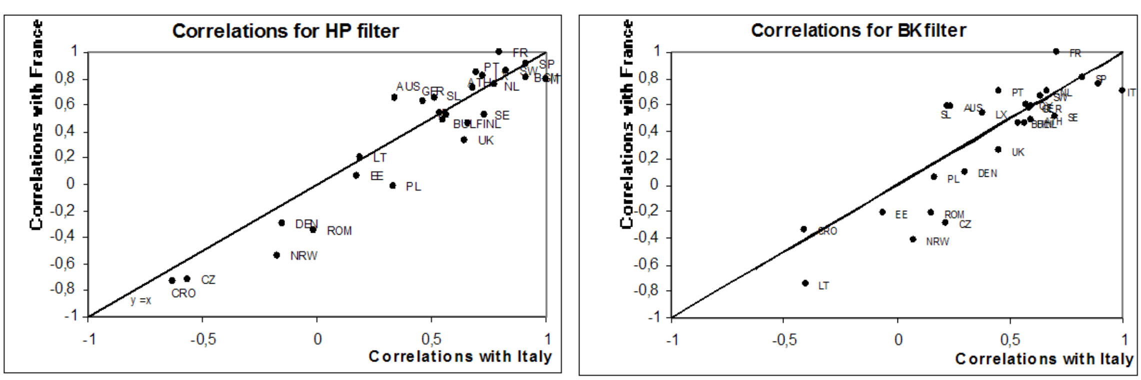


Figure 3. Correlations with France and Italy (HP,BK)



Looking more closely at the contemporaneous correlations obtained with the HP cycles, it is possible to see that almost all countries have higher correlations with Italy. If we compare these results with those obtained with the BK cycles we will get almost the same conclusions. The most flagrant results are for the Euro Area countries that tend to for a cluster in the higher levels of the correlations. For example, the correlations with Greece are higher with France for the HP cycles and with Italy for the BK cycles. Other interesting results are the ones from Spain, Finland, Ireland, Luxembourg and Sweden, which seems to display higher correlations with Italy than with the other two countries.

C. From Particular to General

In this section it is provided a full panel analysis. This analysis is made by presenting the contemporaneous correlations matrices for the three periods, which will provide accurate conclusions regarding the cyclical evolution in Europe. In this section are also pointed some countries that in general have good synchronization with the rest of the countries in study.

In Table A.1 and A.2 (Appendix), are presented the matrices for the period 1983-2002. In first place, Spain has good cyclical affiliation with the other Euro Area countries as expected. These results do not vary too much when the filters are compared, the differences are quite small. Analyzing its evolution in Tables A.3 and A.4, it is possible to observe great variations.

For example, increases in association are observed with Germany, Austria, Greece, France, but for example, the correlations with Italy, Luxembourg and Portugal aren't conclusive. A similar analysis can be made for the Portuguese and Greek case.

Other interesting results appear for the emerging economies. For example, Slovenia displays high correlations with almost all countries such has Austria, Belgium, France, Ireland, Luxembourg, the Netherlands, Sweden, Spain and UK, but we cannot make the same analysis for the other emerging economies. Countries like Lithuania, Czech Republic, Estonia, Croatia and Romania have in general poor results. Considering the significance test applied, it stresses the fact that almost all correlations are insignificant from a statistical point of view, even for the correlations with Slovenia that are pointed above. Even in relation to each other, these countries still have low degrees of association, which is quite interesting. In the last section, a set of standard regressions, test the common border effect, which is related to this case.

Another case that is interesting to detach here is the case of UK. The results show a low association not only with the Euro Area core countries but with almost all countries. The results from the BK series reinforce this conclusion, so, the influence of the filtering method is small. Although in this paper it is given more attention to the exposition of the facts, here can be interesting to show some attention and try to link the facts to its possible causes. Recent literature like Massmann and Mitchell (2002) also noted these results for the UK cycle and presented an explanation based on the increase in the exchange rate volatility in the 1980's. Based on De Haan et al. (2002) argument, these results are questionable because in periods of more volatility, synchronization and association increases. If one thinks about the exchange rate as an adjustment tool, flexibility would reduce asymmetries between countries insulating the economy from external shocks. On the other hand, historical data shows that during these periods of flexibility the imbalances were high and economic cooperation was low. Exchange rate speculation is another characteristic of flexible exchange rates which in a (fully) stable fixed exchange rate system wouldn't be a problem. If for instances we look at the evolution of contemporaneous correlation for UK in tables A.3 and A.4 it is confirmed a continuous decrease in association, especially with Euro Area cycle and the main Euro Area countries such has Spain, France and Portugal, which induces the possible explanation that the monetary integration in Europe has affected the UK cycle. Some important events are the creation of the ERM, which the UK was a member, the adoption of controlled fiscal policies imposed by Maastricht and the adoption of common monetary policies with the creation of EMU which the UK didn't ratified. It is possible that the synergies caused by the convergence in policies did not spread to the UK economy. In the end, the main conclusion asserts the need of more research on the theoretical and empirical link between the exchange rate system and the synchronization of national business cycles.

V. A Second Approach to Synchronization

Two approaches are considered in this section for the analysis of synchronization. The first is a non-parametric statistic proposed by Harding and Pagan (1999b, 2005, 2006) known has the Concordance Index. Let S_{xt} be a series which takes the value 1 when the economy is in expansion and the value 0 when the economy is in recession. In this case since the data are in annual frequency, let S_{xt} take the value 1 when the cycle in country x is positive and take the value 0 when the cycle is negative. The index takes the form:

(10)

$$C_{xy} = \frac{1}{T}\left\{\sum_{t=1}^{T} S_{xt}S_{yt} + \sum_{t=1}^{T}(1-S_{xt})(1-S_{yt})\right\}$$

Note now that after the transformation, binary reference cycles are used which will allow the computation of a measure of synchronization between country ***x*** and ***y***, scaled to range between 0 and 1. If there is perfect synchronization then C_{xy}=1. The concordance index was computed taking the Eurozone cycle as reference and the results are in Table 7. This statistic typically implies a dating process of the turning points of the series and as a consequence, it is usually used in classical cycle analysis, see Harding and Pagan (1999b, 2005, 2006) and Pagan (2005) for more on the subject. The problem is that since annual data are used, this procedure cannot be employed.

The results suggest that once again, the Eurozone countries have the highest degree of synchronization with the Euro Area cycle. Looking at the period 1983-2002 for the HP cycles, the countries with higher synchronization (≥0,80) are Greece, Spain, Austria, Belgium, Portugal, France, Luxembourg, the Netherlands, Switzerland, Italy and Sweden. In general, the results from the index computed with the BK filtered series confirm the previous ones.

The evolution of synchronization is also presented in Table 7 by the two sub-periods. For the HP cycles the countries that increased the synchronization with Eurozone are Spain, Austria, Bulgaria, Denmark, Finland, Greece, Portugal, France, Norway, Sweden, UK, Ireland and Italy. It's interesting to note that in the first sub-period Luxembourg, the Netherlands and Switzerland have perfect synchronization with Euro Area as well as France and Spain in the second sub-period.

For the BK cycles, the results are almost the same. The countries that increased their synchronization are: Greece, Austria, Bulgaria, Cyprus, Denmark, France, Germany, Ireland, Italy, Norway, Romania, Spain and Sweden. France has perfect synchronization in the second sub-period.

Table 7. Concordance with Euro Area

	Concordance (HP)			Concordance (BK)		
	1983-2002	1983-1990	1991-2002	1983-2002	1983-1990	1991-2002
ATH	0.80	0.75	0.83	0.70	0.63	0.75
AUS	0.80	0.75	0.83	0.70	0.63	0.75
BGM	0.85	0.88	0.83	0.85	0.88	0.83
BUL	0.65	0.50	0.75	0.60	0.50	0.67
CRO	0.13	-	-	0.10	-	-
CY	0.75	0.75	0.75	0.70	0.63	0.75
CZ	0.13	-	-	0.25	-	-
DEN	0.35	0.13	0.50	0.35	0.25	0.42
EE	0.25	-	-	0.10	-	-
FINL	0.60	0.50	0.67	0.50	0.75	0.33
FR	0.95	0.88	1.00	0.95	0.88	1.00
GER	0.75	0.88	0.67	0.80	0.63	0.92
IE	0.65	0.63	0.67	0.65	0.63	0.67
IT	0.90	0.88	0.92	0.95	0.88	1.00
LT	0.38	-	-	0.10	-	-
LX	0.95	1.00	0.92	0.70	0.88	0.58
NL	0.95	1.00	0.92	0.80	0.88	0.75
NRW	0.40	0.25	0.50	0.35	0.25	0.42
PL	0.55	0.63	0.50	0.40	0.63	0.25
PT	0.90	0.88	0.92	0.80	0.88	0.75
ROM	0.25	0.25	0.25	0.35	0.25	0.42
SE	0.80	0.63	0.92	0.70	0.63	0.75
SP	0.95	0.88	1.00	0.90	0.88	0.92
SW	0.95	1.00	0.92	0.70	0.75	0.67
SL	0.75	-	-	0.30	-	-
UK	0.70	0.63	0.75	0.70	0.75	0.67

One way to confirm these results is through the intertemporal correlation, which is simply the correlation obtained in the presence of lagged and leading relationships. It is also possible to analyze the behavior of one cycle in relation to the others, i.e., if one leads or lags the others, through the maximum correlation coefficient. The cycle of one country lags (leads) the Euro Area cycle if the maximum correlation coefficient $|\rho_{EA,X}|$ is obtained at t+i (t-i) with i=1,2,3. Two cycles are synchronized if the maximum correlation is obtained at $t = 0$. The results are in Tables A.4, A.5 and A.6. The correlations were computed using a three year lag (lead).

Analyzing the results, they confirm the main conclusions presented above for the concordance index. Once again the Euro Area countries in general have a good synchronization.

Looking at the Table A.5, for 1983-2002, there are ten cycles that lead the Euro Area cycle: Bulgaria, Czech-Republic, Estonia, Finland, Lithuania, Norway (only for BK filter), Poland (only for BK filter), Sweden, Slovenia and the United Kingdom. The countries that display good levels of synchronization (maximum at t=0) are Greece, Austria, Belgium, Croatia, Cyprus, France, Germany (only for BK filter), Ireland (only for BK filter), Italy, Luxembourg, the Netherlands, Portugal, Spain and Switzerland. Denmark, Germany (for HP filter), Ireland (for HP filter), Norway (for HP filter), Poland (for HP filter) and Romania lag behind Euro Area.

Analyzing the evolution of correlations implicit in Tables A.6 and A.7, we can see that Austria, Bulgaria Cyprus and Denmark (for BK filter) increased synchronization with the Eurozone cycle. Denmark (for HP filter), Finland, Ireland (for HP filter), Norway, Poland and Romania (for HP filter) decreased synchronization and in general the rest of the countries maintained the levels of synchronization with Euro Area.

The Table A.8 presents a summary of the evolution of synchronization for all measures analyzed so far. There are some interesting results. For example, there is a very good consistency in the results for Greece (increase), Austria (increase), Belgium (decrease), Bulgaria (increase), Finland (decrease), France (increase), Norway (decrease), Poland (decrease), Portugal (increase), Spain (increase) and the UK (decrease).

VI. Explaining Synchronization in Europe

In this section it is proposed a simple exercise for explaining the synchronization with the Euro Area cycle. As discussed in the introduction, much of the literature, focused on the role of trade and exchange rates to explain cyclical synchronization. Let's now take another step further and look at the effects of some indicators like fiscal divergence, fiscal synchronization, labor market flexibility (measured by the NAIRU) and business cycle volatility, on business cycle synchronization.

A. Econometric Framework

The models used in the rest of the research are simple cross-country regressions of the form:

(11) $$\rho_{ij,t} = \alpha + \beta SD_{ij,t} + \delta EA_i + \gamma CB_{ij} + \varepsilon_{ij,t}$$

(12) $$\rho_{ij,t} = \alpha + \beta NAIRU_{ij,t} + \delta EA_i + \gamma CB_{ij} + \varepsilon_{ij,t}$$

(13) $$\rho_{ij,t} = \alpha + \beta FD_{ij,t} + \psi Corr(BD)_{ij,t} + \delta EA_i + \gamma CB_{ij} + \varepsilon_{ij,t}$$

Where $\rho_{ij,t}$ is the correlation coefficient between the cycles from countries *i* and *j* in the period *t*. The bilateral variables are defined as follows:

(14) $$SD_{ij,t} = \left| \frac{SD_{i,t} - SD_{j,t}}{SD_{j,t}} \right|$$

Which is defined as the percentual deviation between the standard deviations of the cycles from countries *i* and *j*, i.e., the differences in the volatility of business cycles in period *t*. The variable NAIRU is expressed as:

(15)
$$NAIRU_{ij,t} = \left| \frac{NAIRU_{i,t} - NAIRU_{j,t}}{NAIRU_{j,t}} \right|$$

Where NAIRU stands for the *Non-Accelerating Inflation Rate of Unemployment* which measures labor market flexibility. The index captures the differences in the flexibility of labor markets of countries *i* and *j*. Finding an index of labor market flexibility is not straightforward so, in this study and following Artis (2003) the NAIRU is used to do this task. The index of Fiscal Divergence is presented by Darvas, Rose and Szapáry (2005):

(16)
$$FD_{ij,t} = T^{-1} \sum_{t=1}^{T} \left(\left| Budget_{i,t} - Budget_{j,t} \right| \right)$$

The last measure used $Corr(BD)_{ij,t}$ is the contemporaneous correlation between budget balances of countries i and j in the period t, which is used to measure synchronization in fiscal policy. EA_{ij} is a dummy variable that equals 1 when countries i and j belong to Euro Area and equals 0 otherwise. CB_{ij} is a dummy for common border that equals 1 if countries i and j have a common border. The parameters to be estimated are α, β , δ, ψ and γ and εij,t is the conventional error term which is assumed to follow the classical assumptions.

For the two Dummies are expected positive signs. The reason for the positive sign in the Euro Area dummy comes (partly) from the optimum currency areas theory. If two countries share the same currency and converge in fiscal and monetary policies, it is expected that the two cycles follow the same path. In the case of the common border effect, particularly inside Europe, where the integration of goods, services and financial markets is quite deep, it is expected that countries do synchronize in cyclical terms. In another form, differences in business cycle volatility can induce a lack of synchronization between cycles, thus it is expected a negative sign for the volatility coefficient. In an analogous form, divergence in fiscal policies may mean divergence in the timing of expansions and recessions and so reduced synchronization in cyclical positions. In the same line of thought, synchronization in budget balances may induce stronger relationships between business cycles.

B. The NAIRU estimation

For the NAIRU estimation, it is used a model based on Okun's Law $u_t = u^* - \beta(y_t - y_t^*) + \varepsilon_t$. Using this contemporaneous relationship, the NAIRU can be estimated as being the constant term of the equation. The only problem with this specification is that it only describes the long-run relation between the variables, so the solution, is to transform the model into a dynamic model that makes the unemployment be determined not only by the long-run but also by the short-run dynamics. The objective consists in the estimation of a constant NAIRU, for the computation of the index, so, the model here employed was proposed by Dias, Esteves and Félix (2004). Following their work, departing from an Autoregressive Distributed Lag model (ADL), which introduces the idea that unemployment can also be determined by its own past values, we can specify this relation into an Error Correction Model (ECM). The idea behind the ECM is that, although there is in the long-run an equilibrium between unemployment and the output gap, in the short-run, there is a constant disequilibrium between them, so, the equation is transformed in order to ensure that the transition dynamics from the short to the long-run is guided to an equilibrium. The final model takes the form:

(17) $$\Delta u_t = \delta_0 + \beta_1 \Delta u_{t-1} + \beta_2 \Delta u_{t-2} + \alpha_0 \Delta(y_t - y_t^*) + \alpha_1 \Delta(y_{t-1} - y_{t-1}^*) + \theta_1 u_{t-1} + \omega_1 (y_{t-1} - y_{t-1}^*) + \varepsilon_t$$

Now, the evolution of the unemployment rate is previously determined by the short-run relation with the output gap and its own past values and also, the long-run relation specified by the original Okun equation. In this paper, the number of lags and the specification are the same as the ones specified by Dias *et al.* (2004). The NAIRU can be estimated by the long-run equilibrium value: $NAIRU = \delta_0 / \theta_1$. The results from the estimation are in Table 8[9].

Table 8. NAIRU Estimates for Selected Countries (1983-2002) [10]

	EA	**ATH**	**AUS**	**BGM**	**BUL**	**CY**	**DEN**	**FINL**	**FR**	**GER**	**IE**
HP	9.36	10.81	3.70	8.53	15.51	3.05	4.69	11.04	10.37	7.25	17.88
BK	8.91	11.26	3.68	8.54	12.80	3.00	7.97	9.95	10.20	6.97	17.10

	IT	**LX**	**NL**	**NRW**	**PL**	**PT**	**ROM**	**SE**	**SP**	**SW**	**UK**
HP	11.04	2.51	0.11	4.58	14.18	5.90	9.31	5.31	14.63	3.11	0.90
BK	11.04	2.50	2.07	4.58	13.59	5.92	5.59	4.93	14.93	2.77	5.58

Analyzing the final results from the NAIRU estimation, it is observable that the estimates for the Netherlands and the UK are very inconsistent for the HP output gaps. This may cause serious estimation problems in the cross country regressions, so, in order to test this possibility the regressions will be estimated first, using all countries, and then, excluding the Netherlands and the UK. The rest of the results are consistent, not only comparing the results obtained with the two filters (HP and BK), but

[9] To conserve space only the estimated NAIRU's are presented, however, the full set of results can be made available upon request.
[10] Periods of Estimation: Bulgaria (1991-2002); Poland (1992-2002); Romania (1992-2002)

also compared with estimations from Turner *et al.* (2001) or Denis *et al.* (2006). It is also possible to note that Croatia, Czech-Republic, Estonia, Lithuania and Slovenia were excluded from estimation due to problems with data.

C. Cross-Country Estimation Results

The results from the estimation of the cross-country regressions proposed above are presented in this section in Tables A.9 and A.10.

In each estimation two White Heteroskedasticity tests were employed, one using crossed terms and another one without crossed terms in order to account for the lost of degrees of freedom and the presence of the two dummies. Heteroskedasticity is present in the regression if the null hypothesis of the White test is rejected (for more on this subject see Gujarati (2004) pp. 413-414). Note also that to account for the possible existence of multicollinearity and endogeneity problems, each variable is considered first with other control variables and then alone as explanatory variable. The tables also present a test for the presence of autocorrelation in the residuals of the estimated regressions though the baseline Durbin-Watson test. Whenever autocorrelation and heteroskedasticity were present in the regressions, robust t-ratios were computed through the Newey-West method, in order to avoid losses in efficiency.

In general, the assumptions made in the beginning are confirmed. For both HP and BK output gaps, the same conclusions can be taken. Looking at both tables, it is possible to see that higher differences in the volatility of business cycles significantly decrease its synchronization. This result is important since differences in volatility can arise from the existence of asymmetric shocks or the predominance of idiosyncratic policies among Eurozone members. A connection can then be made to the monetary and fiscal stabilization policies inside Europe during the nominal convergence phase previous to the launch of the Euro. If policies became more homogeneous across Eurozone members then one should expect an increase in business cycle synchronization at least due to the decrease in idiosyncratic shocks stemming from fiscal and monetary policies and also from the decrease in volatility differentials. In fact, Angeloni and Dedola (1999) document the existence of convergence in European monetary policies during the ERM phase, presenting evidence of an increase in business cycle comovements.

Regarding fiscal policy, it is well known that the Maastricht treaty and the Stability Pact impose great restrictions on policies, especially for those countries that systematically violate the pact. These restrictions induce asymmetric capacities to use non-monetary stabilization policies among countries and as a consequence induce asymmetric paths in business cycles. However, the persistent violation of the pact by several countries indicates that fiscal policy is divergent and increases the volatility differential leading to a decrease in the optimality of monetary policy through a decrease in synchronization. These ideas shed light into the conclusion that the optimality of a currency area should be endogenous to the harmonization of economic policies. Also, despite the utilization of different extraction methods, the results are statistically significant, although appropriate correction of the variance-covariance matrix had to be made due to the existence of autocorrelation. Note however that the presence of autocorrelation may arise from the misspecification of the model which is highly possible in this case. Judging from the low explanatory power of the regressions, it is probable that important regressors are being omitted.

The NAIRU regressions (*iii*, *iv*, *v*, *vi*) presented in the same tables don't produce the expected results. In all estimations the NAIRU variable suffers from a lack of significance, thus, no major conclusion can be taken from these estimations. Note that, the fact that the NAIRU is insignificant doesn't mean that it is not a determinant of business cycle synchronization. The variable probably suffers from a bad specification of the index, so, it is preferable to assume that no conclusion can be taken. In estimations *v* e *vi*, again presented in the Tables A.9 and A.10, the data from the Netherlands and the UK were excluded, but the lack of significance in the NAIRU coefficient remains. Note that (at least theoretically) high differences in labor market flexibility between countries should be a determinant of business cycle synchronization. Note that a country with a rigid labor market tends to be characterized by a lower adjustment capacity when facing adverse shocks, which is directly translated in a different motion in its business cycle when compared to a country with higher flexibility in the labor market and facing the same shock. Hence, higher differences in labor market flexibility may be consistent with lower business cycle synchronization.

In regressions *vii* and *viii* the fiscal divergence index produces the expected results. In fact, higher divergence in budget balances causes a decrease in synchronization. This result is directly linked to the conclusion presented above for the standard deviation. When countries diverge in the timing of usage of fiscal policies for expansions or recovering from recessions, it is possible that the turning points occur in different points in time, so it's normal to verify a lower synchronization of the cyclical components. Adding the correlation between budgets in the regression, once again, the expectations are confirmed since higher synchronization between budgets leads to higher synchronization in the cyclical positions of countries. The interesting fact of these estimations is that, they are very consistent, judging from the difference in the estimation of the cyclical components of real output. This points to the possibility that synchronization would increase through an increase in fiscal integration inside Eurozone.

Moreover, as pointed in Sala-i-Martin and Sachs (1991) the implementation of fiscal federalism could increase the benefits derived from the introduction of the common currency. Fiscal federalism would constitute a method of risk sharing between the Eurozone members. However, one should remember that Eurozone countries naturally belong to the European Union with other member states that didn't adopt the common currency. Hence, should the federalist system be only considered for Eurozone members or also to the remaining countries of the European Union? This is probably one of the challenges that European countries will face in the medium-run.

At last, in the previous analysis, any particular attention was addressed to the results from the coefficients of the two dummy variables. As expected, the participation in Euro Area increases synchronization between the cycles. The theory of Optimum Currency Areas predicts that countries which belong to the union increase their welfare, if shocks affect the participating economies symmetrically. Thus, higher synchronization of business cycles between countries means that monetary integration is appropriate. A national and independent monetary system is appropriate for those countries that in each year face adjustment problems and have higher probability of facing asymmetric shocks. Also, this is a direct test to the endogeneity of Optimum Currency Areas, in a sense that business cycle synchronization should increase after the adoption of the common monetary policy. Although theoretically this can be true, we can put the Portuguese case into the discussion table. The Portuguese business cycle is highly correlated with almost all countries that are members of the monetary union, but on the other hand, after a decade of integration, the Portuguese economy seems to have real difficulties to benefit from the share of the Euro and recover from recessions. The other side of the coin is the share of a common border. As expected a common border is a significant determinant for higher association of business cycles. This result stems from the fact that countries that are close geographically trade more with each other. From the endogeneity of the Optimum Currency Areas theory, one can extrapolate the hypothesis that the higher is the trade in goods and services between two economies the higher will be the synchronization between the business cycles and the optimality of the common currency. However, since the regressions include countries that do not belong to the currency area, this result shows that geographic proximity increases trade through the existence of lower transaction costs. Hence, business cycle synchronization should increase for the same reason mentioned above.

Note however that autocorrelation affects all the regressions presented in the tables. This is clearly the symptom that important determinants of business cycle synchronization are being excluded from the analysis. However, all the inference performed and the conclusions presented remain robust since the variance-covariance matrix was appropriately corrected by the Newey-West method.

VII. Policy Implications

The results presented in this paper point towards several policy implications. First, although cyclical synchronization is apparently the result of an increase in monetary integration, several countries still have difficulties in benefiting from the common monetary policy and hence the common currency. For example, as pointed in Martins (2008), the low interest rate policy conducted by the ECB since the launch of the Euro was not optimal for Portugal. Using a simple dynamic structure for the Portuguese economy and monetary preferences *a la* Rudebusch-Svensson, he points the fact that if the preferences of the ECB were applied to the Portuguese macroeconomic reality, the resulting short-run interest rate would be 1.6 percent higher on average over the period 1999-2007. Although this may be a good symptom that a "*one-size fits all*" monetary policy is not adequate for all member states, it may be also the result of the persistence in the asymmetry of economic shocks. Bayoumi and Eichengreen (1993) provide evidence on this matter by recovering supply and demand disturbances through a bivariate structural vector autoregression with long-run restrictions. Their results suggest that the correlation of supply and demand shocks in Europe is lower than that for U.S. states, pointing for higher incidence of asymmetric shocks in the former than in the later.

One of these shocks may simply result from idiosyncratic fiscal policies that still exist across member states. Hence, a clear way to increase the benefits of the Euro across members would be to increase the homogeneity of fiscal policy and the clear definition of fiscal rules. The implementation of a federalist system as argued by Sala-i-Martin and Sachs (1991) can be considered a possibility. However, these transformations would clearly imply an increase in political centralization which seems to create difficulties in several European countries (the rejection of the European treaty is the prominent example). Moreover, political barriers could arise since member states would lose the most important tool available to national policymakers. Interestingly, at the theoretical level, the reduction in idiosyncratic fiscal shocks would contribute (*ceteris paribus*) to an increase in business cycle synchronization first through the reduction in idiosyncratic shocks and second through the reduction in the differences in the volatility of business cycles.

VII. Concluding Remarks

In this study, synchronization is analyzed across 26 European countries, focusing the attention in the relations between Euro Area members. It's now a fact that a shared currency between countries has the effect of increasing the links between the participant economies. Common currency areas tend to adopt not only a common currency but also to adopt common policies that are important to the synchronization of cycles. So, there is a multiple relation between these facts, i.e., currency areas can only be considered as optimum, if cyclical synchronization is high, or in another form, if countries can benefit from the common currency. On the other hand, the share of a currency increases the association of outputs. That's the case of Euro Area that is analyzed in this paper, so, the fact that UK economy decreased its association with the main Euro Area countries and the Euro Area cycle doesn't seem a big surprise.

Two main conclusions can be taken from this investigation. In first place, a compromise to achieve nominal standards imposed by Maastricht in Euro Area caused real negative consequences for economies with little capacity to resist to adverse shocks, which by itself imposed new restrictions on policies and a bigger restriction to a comovement in European cycles. If structural differences affect synchronization and facts like the imposition of nominal criteria affect the smoothness of the cycle by imposing restrictions on stabilization policies (which by consequence affect the capacity of readjustment of the economy in the long-run), we are creating a snowball effect with negative consequences for small economies. But for instances, if we think that a country do not have to follow rules, this will lead simply to a big lack of responsibility from each member state. These are the two sides of the same coin. In another level, if nominal stability is achieved, it will induce a higher synchronization between cycles, which by instance necessarily needs the imposition of rules. In second place, the 90's initiated a new wave of transformations in European economies. The creation of a common market and a common currency, improved economic conditions for some economies but affected others negatively. Looking into the spectrum of the analysis, the creation of a common currency area, as expected, affected the cyclical position of some countries in a negative form. The continuous decrease in the contemporaneous correlation in those countries (UK for example), suggests that those economies have been entering in cyclical isolation. This stems from the fact that common policies are determinant for higher synchronization of cycles. Synchronization in macroeconomic policies, in this case fiscal policy, seems to reinforce the cyclical connections between countries by reducing the probability of idiosyncratic fiscal shocks and by reducing as a consequence the differences in volatility of business cycles.

In this paper, simple methods are used to expose a most complex phenomenon in economic theory. After the introduction of the euro, maybe this is the time to study the evolution of European economies with the particular attention to the future. Is this the time to initiate new enlargements and political integration with a European treaty (recently rejected)? Should we wait for more stability on the real side of the economy, especially considering the recent financial crisis? The increased degree of cooperation between countries worldwide in order to face the new challenges posed to policymakers during this period of turbulence, should be seen as a unique opportunity to set the stage for an increase in the degree of integration between the member states of the Euro Area, although this doesn't necessarily mean that new enlargements should take place.

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IX. Appendix

Table A.1.Contemporaneous Correlation Matrix for the Period 1983-2002 (BK Business Cycles)

	EA	ATH	AUS	BGM	BUL	CRO	CY	CZ	DEN	EE	FINL	FR	GER	IE	IT	LT	LX	NL	NRW	PL	PT	ROM	SE	SP	SW	SL	UK
EA	**1**	0.62º	0.65º	0.87º	0.32	-0.69	0.50º	-0.14	0.24	-0.15	0.37	0.89º	0.85º	0.67º	0.84º	-0.34	0.61º	0.84º	-0.11	-0.15	0.67º	-0.24	0.55º	0.84º	0.73º	0.59	0.14
ATH		**1**	0.19	0.56º	0.16	0.04	0.26	-0.32	0.25	0.29	0.24	0.49º	0.58º	0.32	0.59º	0.34	0.44	0.56º	0.14	0.00	0.05	-0.18	0.25	0.35	0.59º	0.05	-0.04
AUS			**1**	0.37	-0.07	-0.79	0.10	-0.16	0.22	-0.40	-0.03	0.59º	0.71º	0.42	0.24	-0.27	0.48º	0.61º	-0.13	-0.39	0.61º	-0.48º	0.17	0.48º	0.33	0.68	-0.27
BGM				**1**	0.42	-0.51	0.64º	0.04	0.34	-0.16	0.58º	0.76º	0.63º	0.69º	0.90º	-0.56	0.42	0.70º	-0.08	0.13	0.48º	0.05	0.72º	0.81º	0.62º	0.70	0.38
BUL					**1**	-0.69	0.47	-0.02	0.08	-0.62	0.59º	0.47	-0.07	0.07	0.53º	-0.64	0.10	0.14	-0.30	0.42	0.12	0.44	0.71º	0.55º	0.27	0.28	0.66º
CRO						**1**	-0.60	0.11	-0.44	0.77	-0.12	-0.74	-0.64	-0.43	-0.41	0.71	-0.54	-0.68º	0.67	-0.05	-0.43	0.26	-0.88º	-0.80	-0.45	-0.74	-0.57
CY							**1**	0.39	0.29	-0.69	0.39	0.58º	0.30	0.45	0.58º	-0.80	-0.14	0.34	-0.21	0.20	0.21	0.25	0.56º	0.47º	0.41	0.19	0.28
CZ								**1**	0.28	-0.28	-0.48	-0.28	0.05	-0.56	0.22	-0.41	-0.49	-0.48	0.13	-0.09	-0.59	0.91º	0.01	-0.27	-0.35	-0.31	0.10
DEN									**1**	-0.06	0.26	0.10	0.25	0.40	0.30	-0.29	-0.07	0.32	0.57º	0.13	-0.23	0.21	0.47	0.03	0.20	0.58	0.12
EE										**1**	0.42	-0.21	-0.18	0.18	-0.06	0.83	0.09	-0.09	0.79	0.18	0.17	-0.29	-0.62	-0.27	0.16	-0.35	-0.14
FINL											**1**	0.47º	-0.09	0.55º	0.57º	0.39	0.19	0.43	-0.13	0.69º	0.25	0.47	0.78º	0.55º	0.55º	0.54	0.81º
FR												**1**	0.61º	0.59º	0.71º	-0.34	0.55º	0.71º	-0.41	0.06	0.71º	-0.22	0.52º	0.81º	0.67º	0.59	0.26
GER													**1**	0.50º	0.58º	-0.41	0.51º	0.72º	0.01	-0.57º	0.48º	-0.44	0.21	0.53º	0.55º	0.47	-0.32
IE														**1**	0.60º	0.00	0.30	0.80º	0.14	0.07	0.56º	-0.06	0.55º	0.61º	0.63º	0.72	0.16
IT															**1**	-0.41	0.38	0.66º	0.07	0.17	0.46	0.15	0.70º	0.82º	0.63º	0.22	0.45
LT																**1**	0.00	-0.06	0.67	0.28	0.17	-0.37	-0.69	-0.40	0.03	-0.47	-0.32
LX																	**1**	0.70º	-0.06	0.01	0.40	-0.50º	0.30	0.44	0.58º	0.78	0.12
NL																		**1**	0.16	0.01	0.52º	-0.28	0.57º	0.63º	0.80º	0.67	0.12

NRW	**1**	0.00	-0.40	0.06	0.00	-0.30	-0.01	-0.38	-0.16
PL		**1**	-0.17	0.46	0.43	0.05	0.11	0.43	0.78º
PT			**1**	-0.39	0.18	0.80º	0.36	0.42	0.06
ROM				**1**	0.43	-0.05	-0.08	-0.53	0.59º
SE					**1**	0.63º	0.55º	0.78	0.70º
SP						**1**	0.50º	0.68	0.36
SW							**1**	0.41	0.30
SL								**1**	0.58
UK									**1**

Note: º Correlation is Significant at 5 percent level (2-tailed).

Table A.2.Contemporaneous Correlation Matrix for the Period 1983-2002 (HP Business Cycles)

	EA	**ATH**	**AUS**	**BGM**	**BUL**	**CRO**	**CY**	**CZ**	**DEN**	**EE**	**FINL**	**FR**	**GER**	**IE**	**IT**	**LT**	**LX**	**NL**	**NRW**	**PL**	**PT**	**ROM**	**SE**	**SP**	**SW**	**SL**	**UK**
EA	**1**																										
ATH	0.76º	**1**																									
AUS	0.71º	0.37	**1**																								
BGM	0.89º	0.64º	0.53º	**1**																							
BUL	0.36	0.50º	-0.20	0.31	**1**																						
CRO	-0.72	-0.41	-0.70	-0.64	-0.74	**1**																					
CY	0.54	0.34	0.24	0.67º	0.22	-0.68	**1**																				

CZ	-0.68	-0.71	-0.60	-0.54	-0.50	0.31	0.29	**1**																			
DEN	-0.36	-0.19	-0.22	-0.17	-0.05	-0.22	-0.13	-0.36	**1**																		
EE	0.07	0.40	-0.16	0.07	-0.11	0.62	-0.69	-0.36	0.17	**1**																	
FINL	0.36	0.37	-0.09	0.54º	0.68º	-0.19	0.26	-0.84	0.33	0.47	**1**																
FR	0.94º	0.74º	0.65º	0.81º	0.49º	-0.73	0.53º	-0.72	-0.30	0.06	0.46	**1**															
GER	0.79º	0.55º	0.82º	0.61º	-0.15	-0.80	0.41	-0.36	-0.50º	-0.15	-0.24	0.63º	**1**														
IE	0.49º	0.28	0.45	0.60º	0.05	-0.39	0.28	-0.86	0.43	0.34	0.60º	0.54º	0.19	**1**													
IT	0.86º	0.68º	0.34	0.91º	0.55º	-0.63	0.56º	-0.57	-0.15	0.17	0.66º	0.80º	0.46	0.54º	**1**												
LT	0.17	0.46	0.08	-0.02	0.00	0.47	-0.75	-0.62	0.20	0.85	0.65	0.20	-0.16	0.51	0.19	**1**											
LX	0.88º	0.65º	0.65º	0.72º	0.31	-0.59	0.21	-0.79	-0.40	0.17	0.30	0.82º	0.68º	0.38	0.72º	0.30	**1**										
NL	0.81º	0.55º	0.66º	0.80º	0.15	-0.52	0.37	-0.81	0.06	0.16	0.52º	0.75º	0.55º	0.82º	0.77º	0.39	0.79º	**1**									
NRW	-0.47º	-0.31	-0.36	-0.28	-0.22	0.65	-0.34	-0.02	0.81º	0.54	0.16	-0.53º	-0.49º	0.25	-0.18	0.52	-0.38	0.02	**1**								
PL	-0.10	-0.06	-0.40	0.20	0.36	0.16	0.06	-0.44	0.49º	0.33	0.79º	-0.01	-0.58º	0.39	0.33	0.47	-0.01	0.25	0.51º	**1**							
PT	0.89º	0.48º	0.77º	0.78º	0.13	-0.51	0.42	-0.85	-0.50º	0.26	0.24	0.85º	0.74º	0.50º	0.70º	0.47	0.79º	0.73º	-0.55º	-0.14	**1**						
ROM	-0.42	-0.17	-0.76º	-0.20	0.51º	0.36	-0.01	0.92º	0.43	-0.29	0.49º	-0.34	-0.74º	-0.13	-0.01	-0.49	-0.51º	-0.37	0.36	0.58º	-0.58º	**1**					
SE	0.46	0.42	-0.01	0.60º	0.76º	-0.80	0.36	-0.68	0.33	-0.13	0.92º	0.52º	-0.11	0.55º	0.73º	0.04	0.40	0.57º	0.15	0.68º	0.24	0.47º	**1**				
SP	0.92º	0.69º	0.50º	0.87º	0.60º	-0.68	0.49º	-0.78	-0.36	0.12	0.59º	0.91º	0.54º	0.47º	0.91º	0.28	0.80º	0.72º	-0.46	0.13	0.85º	-0.16	0.64º	**1**			
SW	0.89º	0.79º	0.58º	0.78º	0.54º	-0.60	0.49º	-0.75	-0.28	0.22	0.54º	0.86º	0.58º	0.44	0.83º	0.35	0.82º	0.76º	-0.37	0.08	0.70º	-0.19	0.60º	0.85º	**1**		
SL	0.69	0.37	0.85	0.81	0.27	-0.58	0.00	-0.65	0.77	-0.08	0.75	0.65	0.54	0.79	0.51	0.03	0.87º	0.84	0.09	0.63	0.72	-0.83	0.86º	0.69	0.64	**1**	
UK	0.26	0.21	-0.27	0.46	0.71º	-0.52	0.24	-0.71	0.20	0.23	0.90º	0.33	-0.32	0.34	0.65º	0.36	0.28	0.36	0.15	0.83º	0.14	0.58º	0.88º	0.52 º	0.44	0.77	**1**

Note: º Correlation is Significant at 5 percent level (2-tailed).

Table A.3. Contemporaneous Correlations Matrix for the Period 1983-1990

	EA	ATH	AUS	BGM	BUL	CY	DEN	FINL	FR	GER	IE	IT	LX	NL	NRW	PL	PT	ROM	SE	SP	SW	UK
EA	1	0.54	0.13	0.96 º	0.44	0.82	-0.30	0.87 º	0.87 º	0.65	0.76	0.80	0.57	0.82	-0.42	0.33	0.47	0.50	0.78	0.69	0.91 º	0.53
ATH	0.66	1	-0.22	0.55	0.14	0.39	0.24	0.37	0.40	0.47	0.20	0.53	0.59	0.58	0.09	0.43	-0.39	-0.04	0.34	-0.02	0.63	0.13
AUS	0.38	0.03	1	-0.12	-0.49	-0.12	-0.03	-0.04	0.27	0.37	0.35	-0.38	-0.06	0.23	-0.23	-0.40	0.40	-0.49	-0.33	-0.05	0.18	-0.39
BGM	0.99 º	0.67	0.27	1	0.60	0.86	-0.35	0.92 º	0.85	0.48	0.64	0.89 º	0.53	0.68	-0.48	0.48	0.45	0.61	0.83	0.76	0.81	0.69
BUL	0.66	0.46	-0.34	0.70	1	0.35	-0.74	0.74	0.49	-0.31	-0.01	0.76	0.58	0.18	-0.41	0.84	0.44	0.74	0.74	0.81	0.24	0.93 º
CY	0.88 º	0.61	0.30	0.89 º	0.44	1	-0.06	0.76	0.70	0.52	0.78	0.64	0.14	0.57	-0.46	0.17	0.39	0.55	0.74	0.61	0.69	0.39
DEN	-0.83	-0.28	-0.36	-0.84	-0.65	-0.61	1	-0.52	-0.54	0.32	0.13	-0.37	-0.45	0.02	0.65	-0.53	-0.70	-0.58	-0.34	-0.74	0.00	-0.76
FINL	0.88 º	0.64	-0.03	0.92 º	0.92 º	0.72	-0.78	1	0.88 º	0.22	0.58	0.85	0.54	0.59	-0.60	0.65	0.65	0.56	0.83	0.90 º	0.72	0.78
FR	0.96 º	0.60	0.49	0.96 º	0.55	0.85	-0.88 º	0.81	1	0.35	0.54	0.60	0.49	0.55	-0.78	0.47	0.65	0.37	0.56	0.76	0.65	0.57
GER	0.82	0.56	0.68	0.74	0.15	0.80	-0.51	0.47	0.78	1	0.77	0.26	0.25	0.80	0.15	-0.37	-0.04	0.05	0.33	-0.02	0.77	-0.22
IE	0.63	0.31	0.70	0.56	-0.09	0.79	-0.32	0.28	0.62	0.88 º	1	0.43	0.09	0.76	-0.17	-0.18	0.44	0.23	0.60	0.43	0.81	0.07
IT	0.89 º	0.63	-0.03	0.92 º	0.92 º	0.71	-0.76	0.99 º	0.80	0.51	0.28	1	0.63	0.60	-0.21	0.64	0.32	0.67	0.89 º	0.73	0.73	0.82
LX	0.88 º	0.68	0.14	0.87 º	0.84	0.61	-0.79	0.92 º	0.82	0.56	0.24	0.92 º	1	0.67	-0.01	0.66	0.06	0.30	0.57	0.36	0.59	0.49
NL	0.91 º	0.73	0.34	0.86	0.62	0.77	-0.61	0.81	0.81	0.82	0.60	0.83	0.88 º	1	0.07	0.15	0.15	0.21	0.69	0.32	0.95 º	0.15
NRW	-0.70	-0.25	-0.58	-0.72	-0.22	-0.69	0.82	-0.50	-0.86	-0.58	-0.58	-0.45	-0.46	-0.41	1	-0.35	-0.75	-0.31	-0.17	-0.69	-0.07	-0.50
PL	0.37	0.44	-0.52	0.44	0.89 º	0.13	-0.43	0.74	0.30	-0.19	-0.42	0.71	0.68	0.35	-0.02	1	0.20	0.30	0.49	0.56	0.24	0.76

PT	0.86 º	0.24	0.57	0.84	0.47	0.73	-0.92 º	0.71	0.91 º	0.67	0.61	0.69	0.67	0.65	-0.89 º	0.18	1	0.41	0.39	0.85	0.25	0.56
ROM	-0.03	0.07	-0.85	0.04	0.67	-0.13	0.02	0.35	-0.21	-0.40	-0.58	0.39	0.27	0.06	0.48	0.69	-0.26	1	0.76	0.71	0.24	0.74
SE	0.75	0.55	-0.26	0.77	0.96 º	0.60	-0.60	0.93 º	0.60	0.35	0.14	0.94 º	0.86	0.77	-0.20	0.77	0.49	0.61	1	0.75	0.73	0.68
SP	0.93 º	0.47	0.21	0.95 º	0.81	0.76	-0.92	0.94 º	0.91 º	0.57	0.41	0.93 º	0.88 º	0.78	-0.70	0.55	0.89 º	0.15	0.82	1	0.45	0.87 º
SW	0.94 º	0.76	0.30	0.90 º	0.65	0.81	-0.62	0.85	0.83	0.81	0.61	0.87	0.87 º	0.98 º	-0.44	0.38	0.67	0.07	0.79	0.82	1	0.30
UK	0.66	0.43	-0.31	0.72	0.98 º	0.43	-0.70	0.91 º	0.57	0.14	-0.10	0.92 º	0.82	0.57	-0.29	0.87 º	0.52	0.63	0.91 º	0.83	0.62	1

Note: º Correlation is significant at 5 percent level (2-tailed). Correlations above the diagonal computed with BK cyclical components and below the diagonal computed with HP Business Cycles.

Table A.4. Contemporaneous Correlations Matrix for the Period 1991-2002

	EA	ATH	AUS	BGM	BUL	CY	DEN	FINL	FR	GER	IE	IT	LX	NL	NRW	PL	PT	ROM	SE	SP	SW	UK
EA	1	0.85 º	0.86 º	0.83 º	0.66 º	0.38	0.57	0.31	0.93 º	0.95 º	0.63	0.88 º	0.60	0.85 º	0.14	-0.32	0.82 º	-0.30	0.61	0.95 º	0.78 º	0.05
ATH	0.92 º	1	0.67 º	0.66 º	0.38	0.15	0.34	0.13	0.67 º	0.90 º	0.49	0.75 º	0.39	0.62	0.25	-0.55	0.80 º	-0.35	0.25	0.87 º	0.49	-0.30
AUS	0.90 º	0.74 º	1	0.60	0.53	0.24	0.45	0.20	0.81 º	0.83 º	0.45	0.58	0.68 º	0.80 º	-0.08	-0.29	0.75 º	-0.43	0.55	0.81 º	0.65 º	-0.04
BGM	0.80 º	0.67 º	0.68 º	1	0.65 º	0.54	0.76 º	0.57	0.72 º	0.72 º	0.72 º	0.90 º	0.35	0.70 º	0.33	0.00	0.50	0.05	0.80 º	0.85 º	0.55	0.31
BUL	0.86 º	0.83 º	0.65 º	0.62	1	0.69 º	0.43	0.19	0.71 º	0.61	0.27	0.67 º	0.17	0.48	-0.24	-0.20	0.33	0.04	0.70 º	0.63	0.50	0.22
CY	0.24	0.09	0.20	0.42	0.31	1	0.49	0.14	0.51	0.29	0.26	0.55	-0.27	0.23	0.06	0.21	0.11	0.23	0.48	0.38	0.12	0.19
DEN	0.04	-0.18	0.07	0.50	-0.14	0.29	1	0.75 º	0.49	0.41	0.59	0.71 º	0.19	0.59	0.62	0.43	0.23	0.29	0.80 º	0.51	0.49	0.70 º
FINL	0.36	0.21	0.31	0.69 º	0.18	0.05	0.83 º	1	0.25	0.07	0.73 º	0.50	0.21	0.60	0.68 º	0.64 º	0.18	0.31	0.74 º	0.38	0.44	0.78 º
FR	0.97 º	0.85 º	0.86 º	0.73 º	0.87 º	0.27	0.06	0.38	1	0.83 º	0.63	0.78 º	0.60	0.83 º	0.00	-0.20	0.83 º	-0.41	0.56	0.85 º	0.81 º	0.06
GER	0.86 º	0.87 º	0.80 º	0.54	0.75 º	0.22	-0.35	-0.11	0.77 º	1	0.40	0.79 º	0.54	0.67 º	0.01	-0.57	0.76 º	-0.34	0.43	0.89 º	0.65 º	-0.18
IE	0.49	0.32	0.42	0.72 º	0.31	0.14	0.74 º	0.95 º	0.55	0.00	1	0.69 º	0.38	0.83 º	0.51	0.29	0.68 º	-0.07	0.61	0.72 º	0.54	0.33
IT	0.85 º	0.76 º	0.66 º	0.93 º	0.74 º	0.38	0.44	0.68 º	0.83 º	0.56	0.75 º	1	0.26	0.72 º	0.42	-0.09	0.61	0.12	0.69 º	0.88 º	0.63	0.26
LX	0.86 º	0.72 º	0.87 º	0.58	0.66 º	-0.12	-0.06	0.30	0.86 º	0.72 º	0.43	0.59	1	0.69 º	-0.16	-0.20	0.61	-0.63	0.33	0.50	0.78 º	0.08
NL	0.75 º	0.55	0.75 º	0.80 º	0.50	0.14	0.56	0.83 º	0.78 º	0.35	0.90 º	0.82 º	0.72 º	1	0.27	0.05	0.82 º	-0.31	0.69 º	0.85 º	0.81 º	0.29
NRW	-0.29	-0.38	-0.26	0.19	-0.48	0.04	0.88 º	0.72 º	-0.28	-0.62	0.59	0.15	-0.34	0.31	1	0.51	0.12	0.36	0.22	0.18	0.13	0.45
PL	-0.25	-0.43	-0.18	0.21	-0.40	0.07	0.90 º	0.77 º	-0.18	-0.65 º	0.68 º	0.16	-0.22	0.42	0.94 º	1	-0.35	0.40	0.31	-0.30	-0.05	0.74 º
PT	0.94 º	0.89 º	0.88 º	0.68 º	0.74 º	0.05	0.00	0.41	0.94 º	0.75 º	0.57	0.76 º	0.88 º	0.80 º	-0.22	-0.17	1	-0.58	0.24	0.82 º	0.67 º	-0.24

ROM	-0.55	-0.51	-0.65 º	-0.13	-0.36	0.16	0.43	0.17	-0.58	-0.62	-0.01	-0.10	-0.75 º	-0.32	0.54	0.45	-0.67 º	1	0.28	-0.23	-0.35	0.53
SE	0.57	0.35	0.52	0.84 º	0.48	0.31	0.75 º	0.88 º	0.59	0.16	0.87	0.82 º	0.46	0.86 º	0.44	0.55	0.50	0.10	1	0.63	0.53	0.69 º
SP	0.97 º	0.93 º	0.85 º	0.83 º	0.84 º	0.19	0.08	0.47	0.93 º	0.78 º	0.58	0.89 º	0.81 º	0.79 º	-0.19	-0.16	0.94 º	-0.46	0.63	1	0.64 º	-0.01
SW	0.95 º	0.85 º	0.85 º	0.69 º	0.83 º	0.06	0.01	0.39	0.96 º	0.77 º	0.50	0.78 º	0.93 º	0.77 º	-0.29	-0.21	0.93 º	-0.62	0.55	0.91 º	1	0.35
UK	0.14	-0.08	0.09	0.51	0.07	0.12	0.91 º	0.89 º	0.19	-0.32	0.81 º	0.52	0.11	0.64	0.75 º	0.84 º	0.10	0.40	0.85 º	0.20	0.20	1

Note: º Correlation is significant at 5 percent level (2-tailed). Correlations above the diagonal computed with BK cyclical components and below the diagonal computed with HP Business Cycles.

Table A.5. Intertemporal and Maximum Correlation Coefficient between Euro Area and X(t ± i) for the Period 1983-2002

Lag	X	ATH	AUS	BGM	BUL	CRO	CY	CZ	DEN	EE	FINL	FR	GER	IE	IT	LTH	LX	NL	NRW	PL	PT	ROM	SE	SP	SL	SW	UK
-3	**HP**	-0.02	-0.46	0.06	0.33	0.56	-0.17	-0.10	0.29	**0.50**	0.52	-0.16	-0.47	0.10	0.28	0.48	-0.02	0.08	0.53	0.74	-0.18	0.47	0.45	0.10	-0.05	-0.03	0.63
	BK	0.02	-0.39	-0.05	0.12	0.62	-0.27	-0.28	0.00	**0.74**	0.16	-0.24	-0.38	-0.16	0.14	**0.72**	0.01	-0.17	**0.39**	0.50	-0.11	0.07	-0.01	0.02	-0.22	-0.28	0.31
-2	**HP**	0.18	-0.13	0.44	0.50	0.11	0.20	-0.60	-0.01	0.31	0.52	0.32	-0.19	0.35	0.58	**0.58**	0.36	0.45	0.10	0.74	0.30	0.28	0.68	0.52	0.41	0.43	**0.80**
	BK	-0.14	-0.26	0.08	**0.39**	0.00	0.16	**-0.77**	-0.30	0.22	0.58	0.17	-0.43	0.16	0.14	0.56	0.10	0.11	-0.21	**0.69**	0.23	0.16	0.29	0.25	0.08	0.16	**0.62**
-1	**HP**	0.50	0.35	0.77	**0.49**	-0.46	0.32	**-0.79**	-0.20	0.08	**0.71**	0.71	0.31	0.52	0.80	0.33	0.75	0.74	-0.25	0.39	0.69	-0.06	**0.71**	0.84	**0.87**	0.77	0.66
	BK	0.12	0.21	0.47	0.35	-0.68	0.10	-0.61	-0.04	-0.24	**0.68**	0.46	0.11	0.50	0.40	-0.10	0.51	0.52	-0.34	0.31	0.47	0.06	**0.62**	0.59	**0.81**	0.50	0.57
0	**HP**	**0.76**	**0.71**	**0.89**	0.36	**-0.72**	**0.54**	-0.68	-0.36	0.07	0.36	**0.94**	0.79	0.49	**0.86**	0.17	**0.88**	**0.81**	-0.47	-0.10	**0.89**	-0.42	0.46	**0.92**	0.69	**0.89**	0.26
	BK	**0.62**	**0.65**	**0.87**	0.32	**-0.69**	**0.50**	-0.14	0.24	-0.15	0.37	**0.89**	**0.85**	**0.67**	**0.84**	-0.34	**0.61**	**0.84**	-0.11	-0.15	**0.67**	-0.24	0.55	**0.84**	0.59	**0.73**	0.14
1	**HP**	0.53	0.68	0.44	0.06	-0.65	0.27	-0.35	-0.64	-0.09	-0.19	0.71	**0.79**	0.17	0.42	-0.04	0.64	0.43	**-0.65**	-0.56	0.77	-0.65	-0.12	0.59	0.10	0.56	-0.27
	BK	0.24	0.45	0.13	-0.14	-0.34	0.07	0.06	-0.36	-0.22	-0.29	0.44	0.53	0.28	0.22	-0.37	0.26	0.35	-0.19	-0.50	0.59	-0.46	-0.26	0.37	-0.11	0.24	-0.48
2	**HP**	0.15	0.40	-0.03	-0.23	-0.24	-0.02	0.06	**-0.65**	-0.07	-0.60	0.25	0.60	-0.24	-0.10	-0.15	0.30	-0.05	-0.61	**-0.79**	0.38	**-0.67**	-0.54	0.09	-0.27	0.13	-0.58
	BK	-0.13	0.10	-0.34	-0.43	0.13	-0.36	0.12	**-0.44**	0.01	-0.58	-0.05	0.18	-0.19	-0.34	-0.23	0.14	-0.15	-0.19	-0.60	0.24	**-0.53**	-0.60	-0.19	-0.19	-0.12	-0.51
3	**HP**	-0.17	0.06	-0.30	-0.39	0.21	-0.02	0.32	-0.44	0.06	-0.76	-0.18	0.29	**-0.54**	-0.41	-0.10	-0.10	-0.41	-0.40	-0.68	-0.09	-0.46	-0.68	-0.33	-0.42	-0.23	-0.64
	BK	-0.15	-0.17	-0.22	-0.16	0.35	-0.08	0.21	-0.22	0.15	-0.46	-0.17	-0.04	-0.45	-0.32	0.11	-0.03	-0.35	-0.23	-0.28	-0.19	-0.36	-0.37	-0.32	-0.35	-0.20	-0.26

Note: Maximum Correlation detached.

Table A.6. Intertemporal and Maximum Correlation Coefficient between Euro Area and X(t ± i) for the Period 1983-1990

Lag	X	ATH	AUS	BGM	BUL	CY	DEN	FINL	FR	GER	IE	IT	LX	NL	NRW	PL	PT	ROM	SE	SP	SW	UK
-3	HP	-0.21	-0.31	-0.25	0.27	-0.42	0.18	0.03	-0.35	-0.33	-0.40	0.06	0.08	0.03	0.59	0.33	-0.26	0.51	0.25	-0.08	-0.02	0.21
	BK	-0.34	0.03	-0.36	0.11	-0.57	-0.11	-0.19	-0.43	-0.30	-0.24	-0.03	0.18	-0.05	0.47	0.09	0.02	-0.12	-0.03	-0.04	-0.12	0.06
-2	HP	-0.10	**-0.53**	0.17	0.65	-0.09	-0.30	0.39	0.00	-0.28	-0.48	0.45	0.33	0.05	0.14	0.60	0.08	**0.78**	0.54	0.34	0.08	0.69
	BK	-0.38	-0.43	0.03	0.55	-0.18	**-0.64**	0.06	-0.08	-0.46	-0.40	0.24	0.10	-0.36	-0.13	0.25	0.24	**0.62**	0.17	0.37	-0.33	0.60
-1	HP	0.43	-0.35	0.64	**0.87**	0.43	-0.62	0.83	0.54	0.00	-0.12	0.78	0.68	0.41	-0.37	**0.87**	0.46	0.49	**0.77**	0.73	0.46	**0.87**
	BK	0.19	**-0.50**	0.52	**0.80**	0.44	-0.45	0.67	0.46	-0.40	0.00	0.59	0.24	-0.02	**-0.52**	**0.78**	0.36	0.49	0.54	0.67	0.13	**0.75**
0	HP	**0.66**	0.38	**0.99**	0.66	**0.88**	**-0.83**	**0.88**	**0.96**	**0.82**	**0.63**	**0.89**	**0.88**	**0.91**	**-0.70**	0.37	**0.86**	-0.03	0.75	**0.93**	**0.94**	0.66
	BK	**0.54**	0.13	**0.96**	0.44	**0.82**	-0.30	**0.87**	**0.87**	**0.65**	**0.76**	**0.80**	**0.57**	**0.82**	-0.42	0.33	**0.47**	0.50	**0.78**	**0.69**	**0.91**	0.53
1	HP	0.26	0.51	0.51	0.17	0.48	-0.48	0.38	0.58	0.56	0.51	0.37	0.42	0.50	-0.51	-0.01	0.58	-0.32	0.23	0.48	0.49	0.18
	BK	0.06	0.50	0.19	-0.04	0.13	-0.08	0.28	0.33	0.28	0.39	0.09	0.21	0.40	-0.14	0.03	0.33	-0.16	0.13	0.20	0.39	-0.01
2	HP	-0.06	0.31	0.09	-0.16	0.17	-0.12	-0.05	0.15	0.25	0.29	-0.04	-0.02	0.07	-0.23	-0.28	0.20	-0.28	-0.11	0.06	0.06	-0.15
	BK	-0.33	0.21	-0.17	-0.19	-0.10	-0.06	-0.21	-0.11	0.07	0.02	-0.24	-0.18	-0.10	0.00	-0.36	0.10	0.05	-0.15	-0.08	-0.16	-0.16
3	HP	-0.11	0.05	-0.19	-0.29	-0.08	0.21	-0.25	-0.15	-0.07	0.04	-0.27	-0.28	-0.22	0.02	-0.24	-0.14	-0.21	-0.28	-0.23	-0.21	-0.29
	BK	-0.10	-0.23	-0.23	-0.09	-0.11	0.18	-0.21	-0.24	-0.31	-0.25	-0.21	-0.33	-0.38	0.02	-0.02	-0.18	-0.12	-0.23	-0.18	-0.34	-0.11

Note: Maximum Correlation detached.

Table A.7. Intertemporal and Maximum Correlation Coefficient between Euro Area and X(t ± i) for the Period 1991-2002

Lag	X	ATH	AUS	BGM	BUL	CY	DEN	FINL	FR	GER	IE	IT	LX	NL	NRW	PL	PT	ROM	SE	SP	SW	UK
-3	HP	-0.12	-0.16	0.18	-0.27	-0.06	0.54	0.53	-0.14	-0.37	0.45	0.16	-0.19	0.25	**0.67**	0.60	-0.04	0.29	0.28	-0.03	-0.14	0.46
	BK	0.10	-0.13	0.11	-0.25	-0.03	0.21	0.38	-0.06	-0.12	0.33	0.10	-0.10	0.10	**0.55**	0.34	0.09	0.03	-0.02	0.04	0.00	0.13
-2	HP	-0.06	0.08	0.19	-0.12	-0.07	0.48	0.59	0.09	-0.30	0.58	0.19	0.08	0.47	0.53	0.59	0.18	-0.01	0.39	0.11	0.08	0.47
	BK	-0.31	-0.17	-0.20	-0.17	0.02	-0.01	0.32	-0.08	-0.43	0.23	-0.22	-0.09	0.11	0.19	**0.56**	0.01	-0.11	-0.02	-0.18	-0.01	0.22
-1	HP	0.42	0.57	0.55	0.38	-0.19	0.31	**0.62**	0.54	0.26	**0.63**	0.54	0.64	0.74	0.14	0.24	0.60	-0.27	**0.65**	0.60	0.60	**0.47**
	BK	0.08	0.38	0.24	0.13	-0.30	0.23	**0.51**	0.22	0.14	0.45	0.14	0.59	0.57	0.02	0.12	0.28	-0.10	0.52	0.32	0.42	0.39
0	HP	**0.92**	**0.90**	**0.80**	**0.86**	**0.24**	0.04	0.36	**0.97**	**0.86**	0.49	**0.85**	**0.86**	**0.75**	-0.29	-0.25	**0.94**	-0.55	0.57	**0.97**	**0.95**	0.14
	BK	**0.85**	**0.86**	**0.83**	**0.66**	**0.38**	**0.57**	0.31	**0.93**	**0.95**	**0.63**	**0.88**	**0.60**	**0.85**	0.14	-0.32	**0.82**	-0.30	**0.61**	**0.95**	**0.78**	0.05
1	HP	0.57	0.40	0.09	0.63	0.21	-0.46	-0.23	0.65	0.55	0.05	0.30	0.46	0.19	-0.58	-0.51	0.60	**-0.56**	-0.09	0.49	0.55	-0.36
	BK	0.29	0.15	-0.04	0.12	0.22	-0.36	-0.44	0.42	0.29	0.18	0.20	0.03	0.16	-0.23	-0.40	0.55	-0.32	-0.31	0.28	0.15	**-0.55**
2	HP	0.10	-0.09	-0.44	0.25	-0.37	**-0.66**	-0.54	0.10	0.17	-0.41	-0.29	0.20	-0.33	-0.67	**-0.60**	0.04	-0.35	-0.45	-0.08	0.15	-0.44
	BK	-0.17	-0.26	-0.54	-0.38	-0.57	-0.53	-0.51	-0.19	-0.17	-0.32	-0.46	0.16	-0.32	-0.35	-0.38	0.01	**-0.33**	-0.58	-0.39	-0.03	-0.33
3	HP	-0.08	-0.22	-0.26	0.11	0.08	-0.43	-0.58	-0.16	0.16	-0.62	-0.30	-0.14	-0.53	-0.51	-0.53	-0.32	-0.04	-0.38	-0.25	-0.12	-0.38
	BK	-0.05	-0.12	0.00	0.25	0.02	-0.10	-0.25	-0.01	0.07	-0.41	-0.10	0.09	-0.24	-0.36	-0.26	-0.25	-0.19	-0.05	-0.15	0.08	-0.02

Note: Maximum Correlation detached.

Table A.8. Evolution of Synchronization for all Measures Used

		ATH	AUS	BGM	BUL	CY	DEN	FIN	FR	GER	IE	IT	LX	NL	NRW	PL	PT	ROM	SE	SP	SW	UK
Cont. Correlation	**HP**	↑	↑	↓	↑	↓	↓	↓	↑	↑	↓	↓	↓	↓	↓	?	↑	↑	↓	↑	↑	↓
	BK	↑	↑	↓	↑	↓	↑	↓	↑	↑	↓	↑	↑	↑	↓	?	↑	↓	↓	↑	↓	↓
Spearman	**HP**	↑	↑	↑	↑	↓	↓	↓	↓	↑	↑	↑	↑	↑	↓	↓	↑	↑	↓	↑	↑	↓
	BK	↑	↑	↓	↑	↓	↓	↓	↑	↑	↑	↓	↑	↑	↓	↓	↑	↓	↓	↑	↓	↓
Concordance	**HP**	↑	↑	↓	↑	=	↑	↑	↑	↓	↑	↑	↓	↓	↑	↓	↑	=	↑	↑	↓	↑
	BK	↑	↑	↓	↑	↑	↑	↓	↑	↑	↑	↑	↓	↓	↑	↓	↓	↑	↑	↑	↓	↓
Inter. Correlation	**HP**	=	↑	=	↑	↑	↓	↓	=	=	↓	=	=	=	↓	↓	=	↓	=	=	=	=
	BK	=	↑	=	↑	↑	↑	↓	=	=	=	=	=	=	↓	↓	=	?	=	=	=	=

Note: *The sign ? means an insignificant or uncertain evolution.*

Table A.9. Estimation Results using HP Business Cycles

Dependent Variable: Correlation between Cycles (ρ_{ij})

	i	*ii*	*iii*	*iv*	*v*	*vi*	*vii*	*viii*	*ix*	*x*	*xi*
Constant	0.326	0.449	0.223	0.383	0.207	0.378	0.218	0.416	0.221	0.402	0.291
	(8.269 *)	(15.204 *)	(6.013 *)	(12.590 *)	(5.019 *)	(10.579 *)	(3.251 *)	(6.721 *)	(3.421 *)	(7.076 *)	(9.199 *)
$SD_{ij,t}$	-0.080	-0.110									
	(-3.743 *)	(-5.088 *)									
$NAIRU_{ij,t}$			0.015	0.004	0.014	-0.006					
			(2.117 *)	(0.595)	(0.641)	(-0.284)					
$FD_{ij,t}$							-0.019	-0.023	-0.019	-0.022	
							(-1.634)	(-2.138 *)	(-1.721 *)	(-2.099 *)	
Corr $(BD)_{ij,t}$									-0.004	0.024	0.078
									(-0.047)	(0.356)	(1.077)
EA_{ij}	0.120		0.365		0.367		0.238		0.238		
	(2.247 *)		(9.087 *)		(8.513 *)		(2.828 *)		(3.785 *)		
CB_{ij}	0.284		0.216		0.235		0.329		0.329		
	(5.474 *)		(4.058 *)		(4.126 *)		(4.676 *)		(4.421 *)		
R-squared	0.12	0.05	0.19	0.00	0.19	0.00	0.12	0.01	0.12	0.01	0.00

F	22.624*	25.884*	38.162*	0.188	30.485*	0.059	20.759*	6.274*	15.534*	3.183*	1.208
Standard Error	0.403	0.419	0.404	0.448	0.423	0.468	0.486	0.514	0.486	0.515	0.517
N	484	484	484	484	400	400	441	441	441	441	441
DW	1.522 [a]	1.522 [a]	1.605 [a]	1.527 [a]	1.652 [a]	1.576 [a]	1.459 [a]	1.466 [a]	1.458 [a]	1.468 [a]	1.480 [a]
White (cross-terms)	4.147	-	84.275 [a]	-	73.482 [a]	-	34.950 [a]	-	60.170 [a]	48.024 [a]	-
White	1.822	0.710	79.439 [a]	11.534	69.764 [a]	5.667	31.545 [a]	30.623 [a]	45.033 [a]	46.003 [a]	32.707 [a]

Note: OLS estimation. t-ratios in parentheses**.**

***** Significant at 5 percent level.

[a] Null Hypotheses is Rejected for 5 percent level of Significance. Robust t-ratios were computed using the Newey-West Method.

Table A.10. Cross-Country Estimation Results using BK Business Cycles

Dependent Variable: Correlation between Cycles (ρ_{ij})

	i	*ii*	*iii*	*iv*	*v*	*vi*	*vii*	*viii*	*ix*	*x*	*xi*
Constant	0.368	0.452	0.268	0.377	0.271	0.379	0.294	0.439	0.235	0.366	0.250
	(11.788 *)	(18.815 *)	(9.274 *)	(14.432 *)	(8.877*)	(13.991 *)	(5.738 *)	(9.137 *)	(4.387 *)	(7.596 *)	(1.983 *)
$SD_{ij.t}$	-0.129	-0.159									
	(-5.279 *)	(-6.754 *)									
$NAIRU_{ij.t}$			0.005	0.004	-0.007	-0.016					
			(0.343)	(0.313)	(-0.358)	(-1.065)					
$FD_{ij.t}$							-0.024	-0.028	-0.020	-0.023	
							(-3.046 *)	(-3.805 *)	(-2.686 *)	(-3.261 *)	
Corr $(BD)_{ij.t}$									0.099	0.121	0.178
									(1.605)	(2.055 *)	(2.880 *)
EA_{ij}	0.069		0.260		0.248		0.166		0.169		
	(1.743)		(8.177 *)		(7.567 *)		(3.387 *)		(3.438 *)		
CB_{ij}	0.217		0.189		0.195		0.264		0.252		
	(4.766 *)		(4.430 *)		(4.360 *)		(4.520 *)		(4.227 *)		
R-squared	0.15	0.09	0.18	0.00	0.17	0.00	0.13	0.03	0.14	0.04	0.02

F	28.225*	49.676*	35.878*	0.081	28.916*	0.769	22.246*	15.289*	17.549*	9.850*	10.160*
Standard Error	0.321	0.331	0.313	0.346	0.320	0.349	0.383	0.403	0.382	0.402	0.405
N	484	484	484	484	441	441	441	441	441	441	441
DW	1.499 [a]	1.488 [a]	1.667 [a]	1.571 [a]	1.617 [a]	1.557 [a]	1.489 [a]	1.473 [a]	1.496 [a]	1.473 [a]	1.486 [a]
White (cross-terms)	12.260	-	45.745 [a]	-	37.904 [a]	-	33.600 [a]	-	39.882 [a]	37.670 [a]	-
White	2.652	0.803	42.753 [a]	20.025 [a]	35.837 [a]	17.762 [a]	28.080 [a]	39.595 [a]	28.020 [a]	35.184 [a]	19.623 [a]

Note: OLS estimation. t-ratios in parentheses.

***** Significant at 5 percent level.

[a] Null Hypotheses is Rejected for 5 percent level of Significance. Robust t-ratios were computed using the Newey-West Method.

Figure A.1. Estimated Impacts of Variables on Business Cycles Synchronization

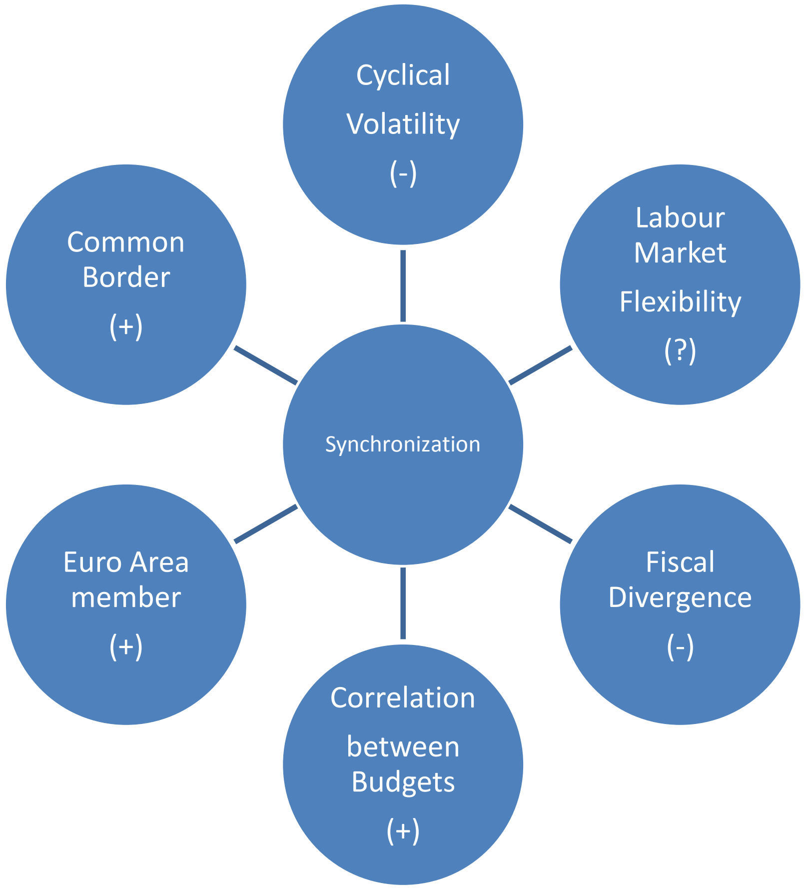


Figure A.2. Association between Correlation and Differences in Volatility (HP-left; BK-right)

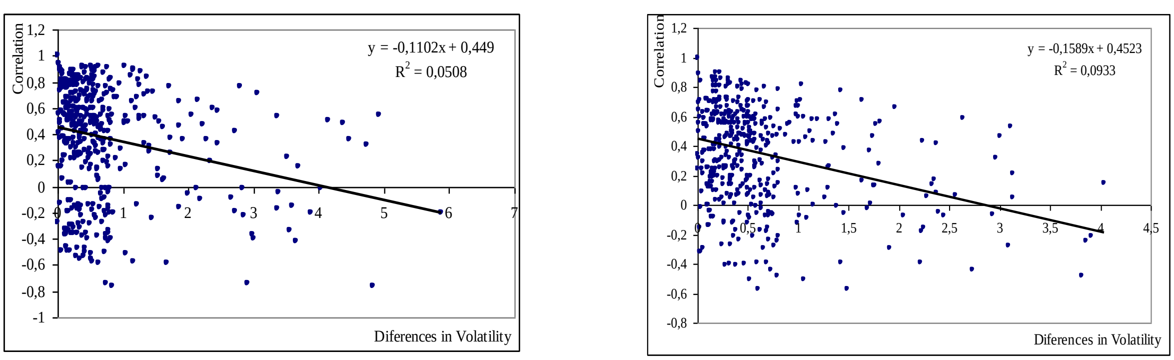


Figure A.3. Association between Correlation and Differences in NAIRU's (HP-left; BK-right)

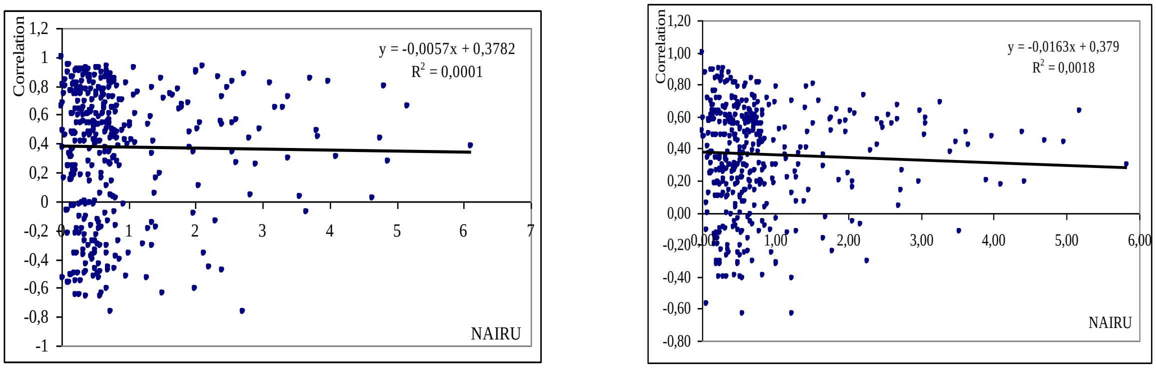


Figure A.4. Association between Correlation and Fiscal Divergence (HP-left; BK-right)

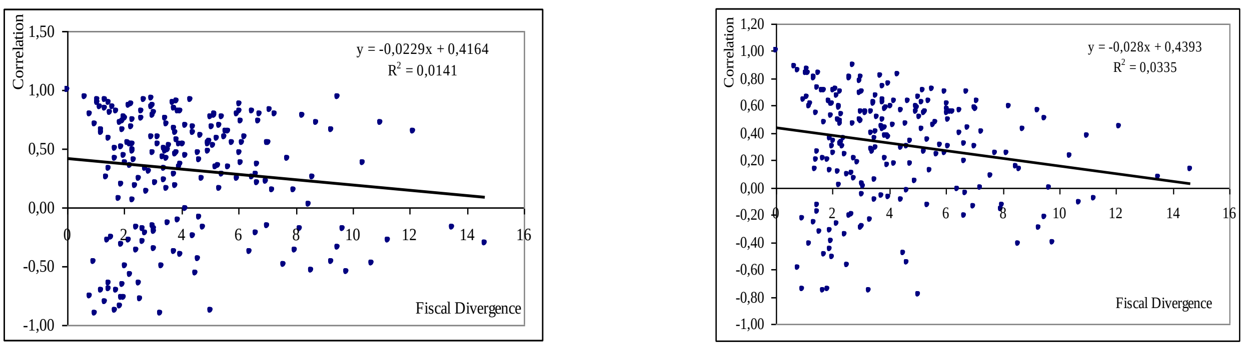


Figure A.5. Association between Business Cycles Correlation and Correlation between Budgets (HP-left; BK-right)

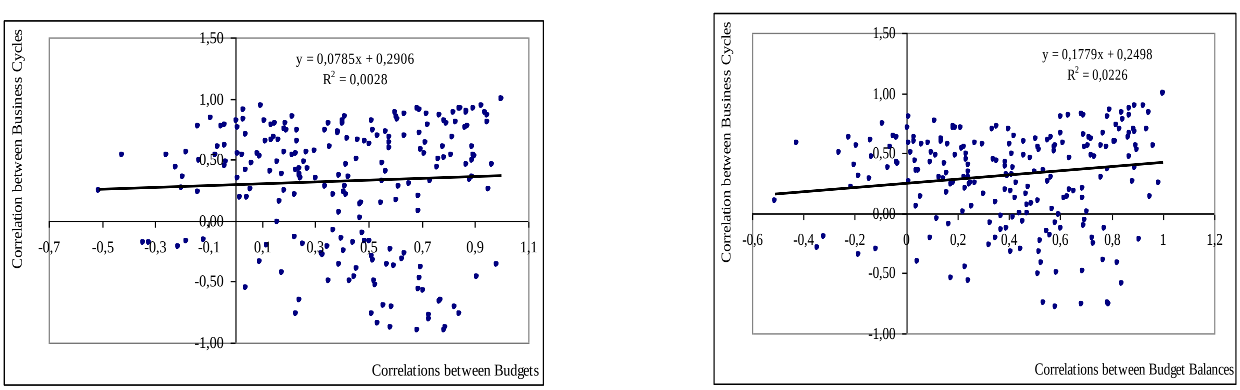
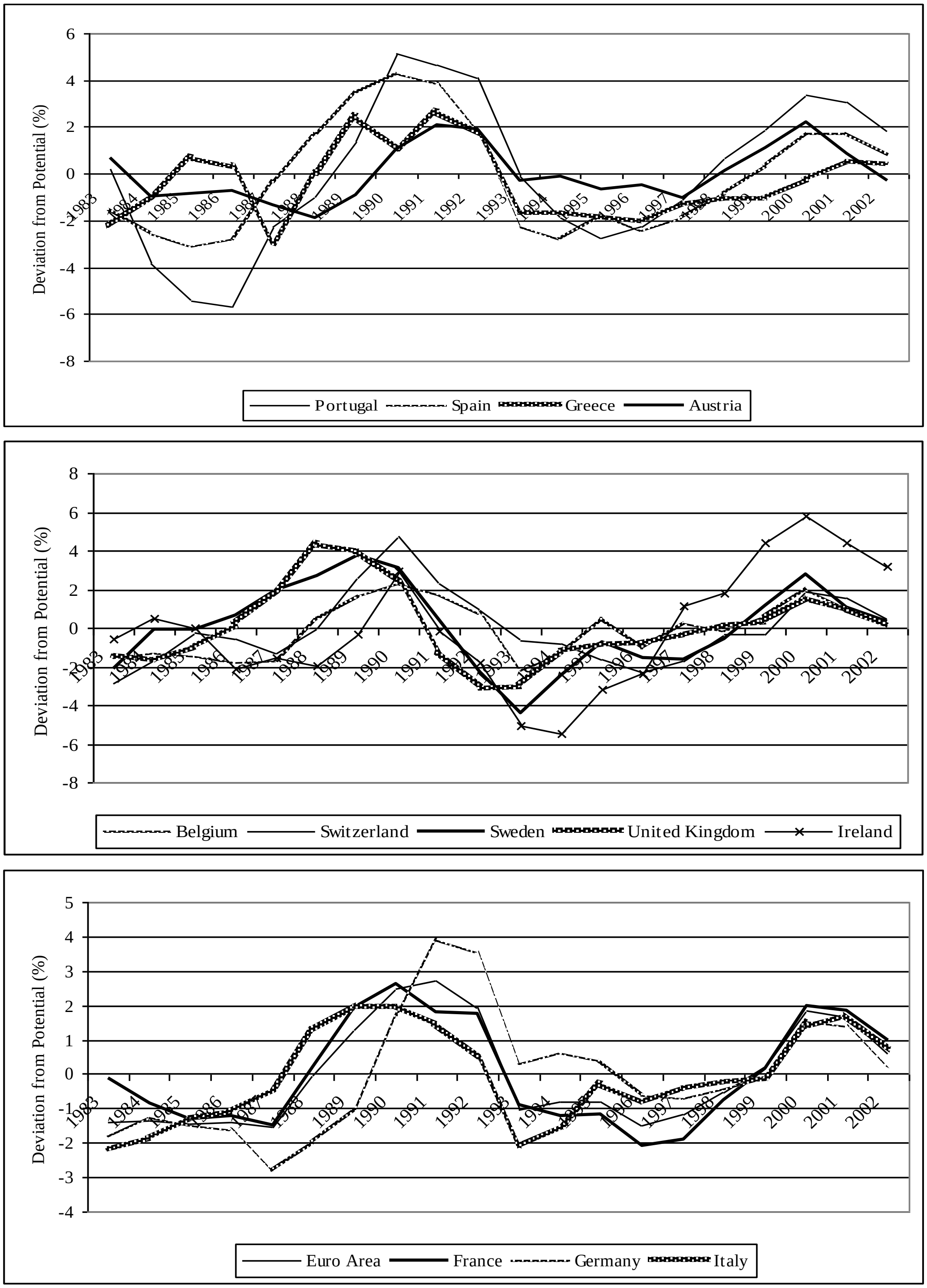
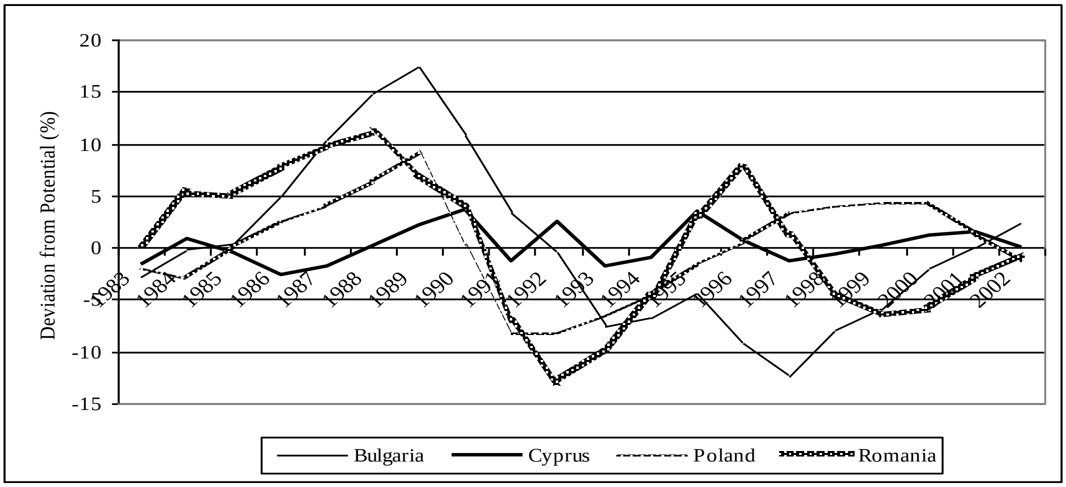


Figure A.6. Business Cycles computed using HP Filter (λ=100)




Deviation from Potential (%)
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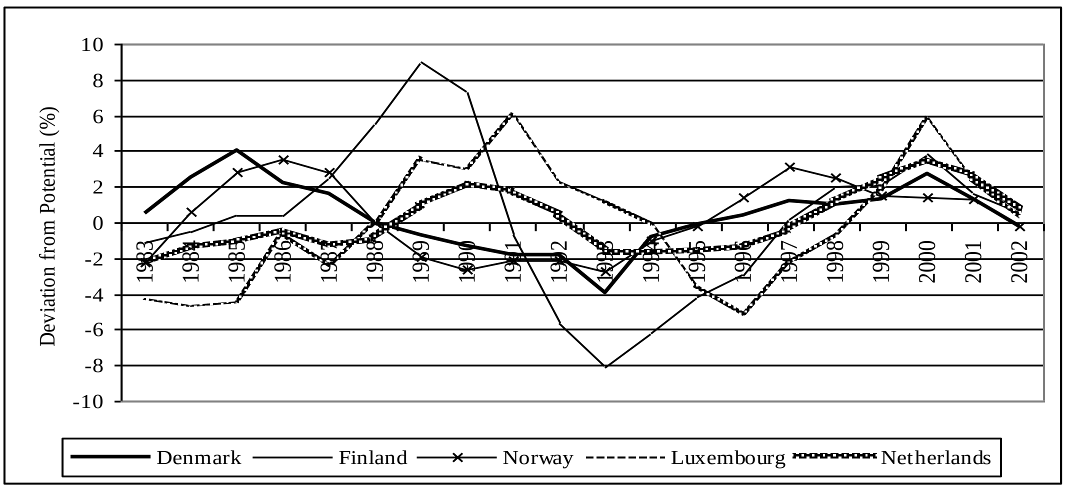
Cyprus
Poland
Romania


Deviation from Potential (%)
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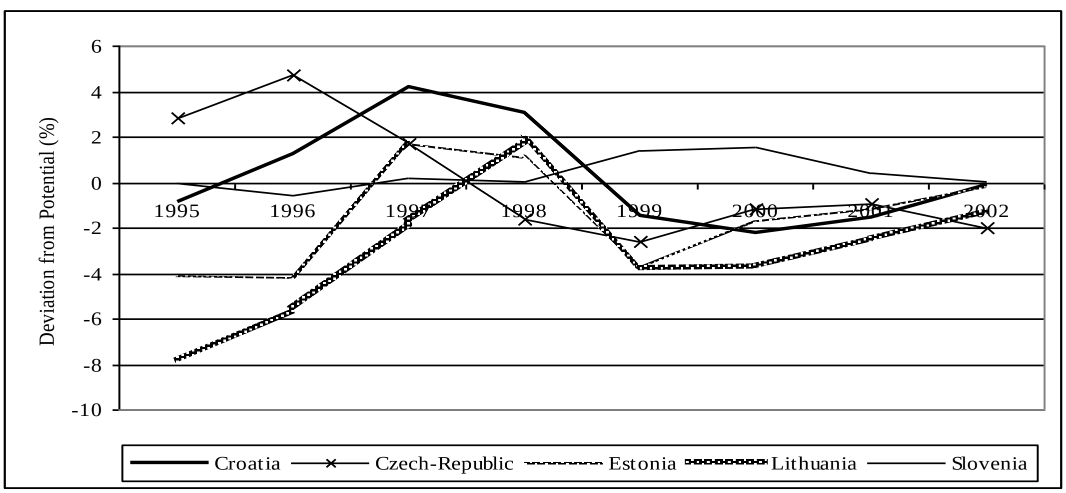
Finland
Norway
Luxembourg
Netherlands


Deviation from Potential (%)
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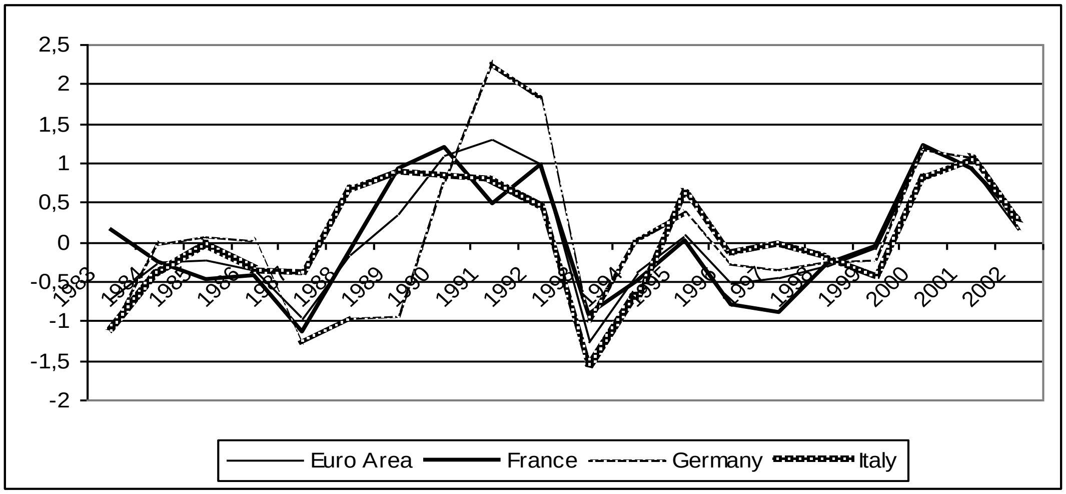
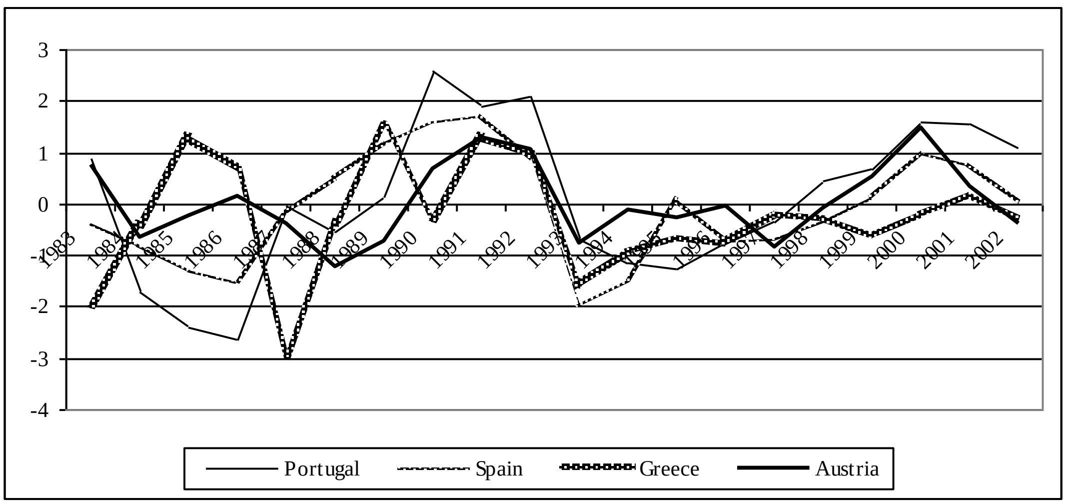
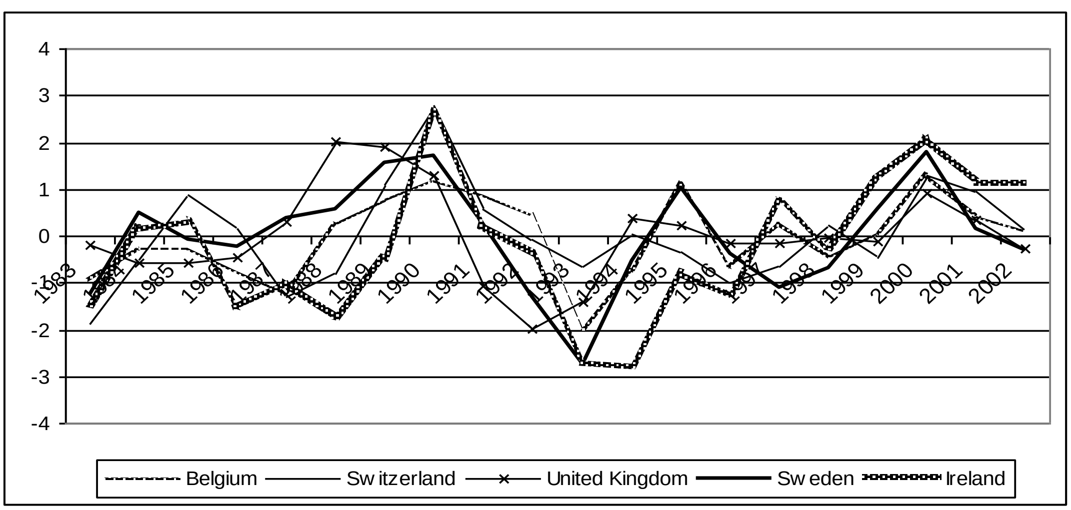
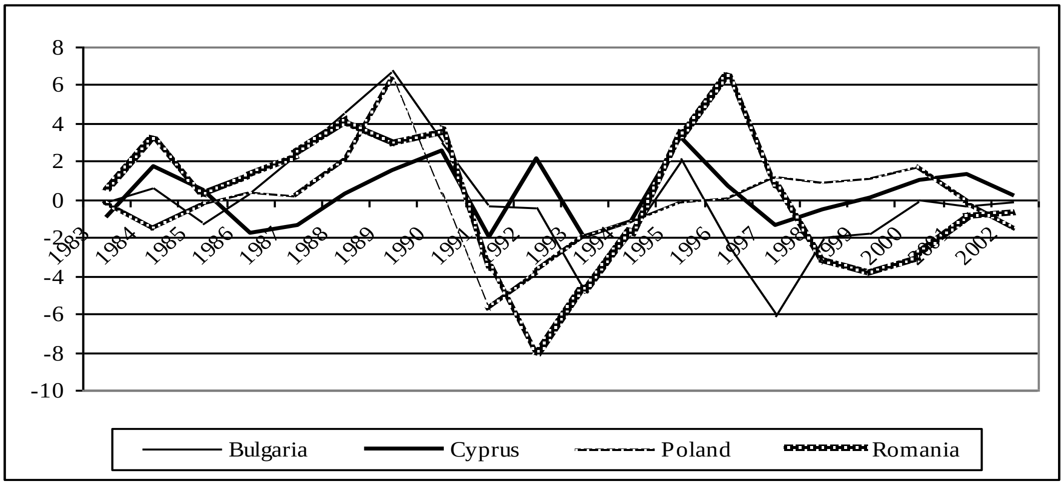
Czech-Republic
Estonia
Lithuania
Slovenia

Figure A.7. Business Cycles computed using Baxter-King Filter





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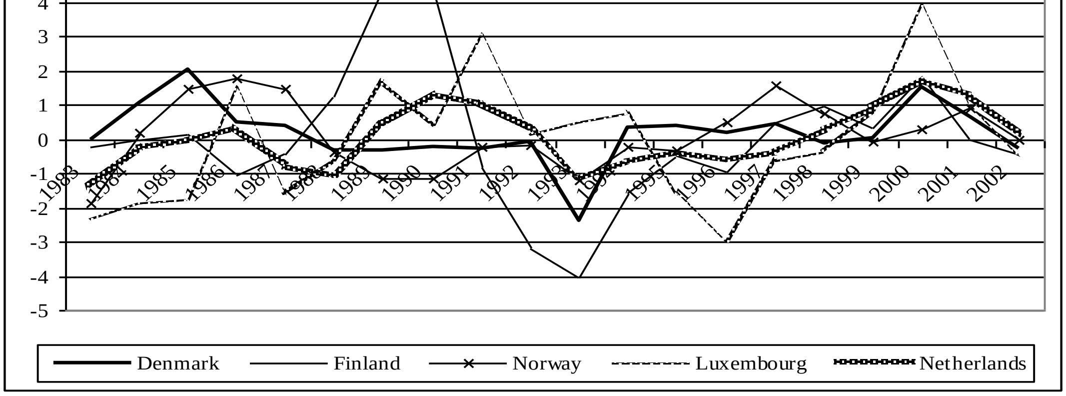
Poland
Romania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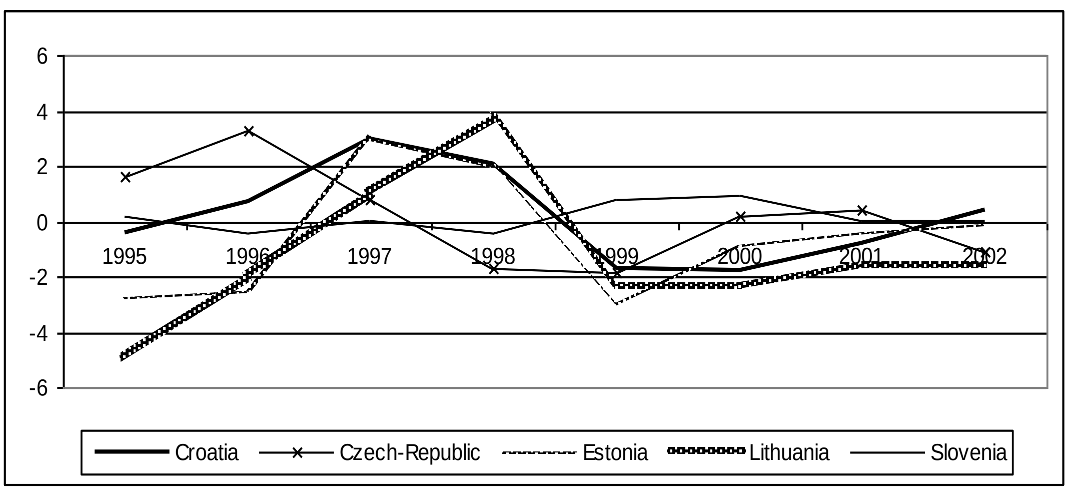
Norway
Luxembourg
Netherlands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Lithuania
Slovenia