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Abstract

In this paper, we focus on how European economic integration has affected the synchronization and the magnitude of business cycles among participating countries. We measure, based on bandpass filtered data, the characteristics of European business cycles analyzing to what extent they have become more similar over time. We also consider the role of other factors such as differences in fiscal and monetary policy, border effects, and trade intensity. Our main finding is that European business cycles are highly synchronized, although we also find that synchronization was higher during periods with highly flexible exchange rates. In addition we find a positive tradeoff between timing and magnitude such that more synchronization coincides with larger relative magnitude. These results raise concern about the consequences of a common monetary policy within EMU.
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1 Introduction

Linkages between European countries have become more prevalent in the postwar period as a result of the efforts of integrating national markets within Europe. These efforts include the removal of trade barriers, the implementation of the Single European Act in 1986, the Maastricht Treaty in 1992, the introduction of the Single European Market in 1993, the Stability and Growth Pact in 1997, and the creation of the European Monetary Union with a common currency and common monetary policy. An important question is

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whether these efforts of economic and monetary integration have lead to a higher degree of similarity of European business cycles in recent years.

Such a development is also desirable since the loss of the option of following an independent monetary policy and giving up the value of changing the exchange rate when desired would otherwise constitute a major cost for the EMU countries. These options are especially important if countries are facing asymmetric shocks, in which case exchange rate adjustments and separate monetary policies could help to stabilize nation–specific aggregate fluctuations. A common monetary policy therefore requires that the timing of business cycles is similar among the members of the monetary union. However, even if the timing of business cycles is similar, the magnitude may differ, in which case the intensity of policies may have to be different.

There are theoretical reasons for both the view that economic integration will lead to more synchronized business cycles and the opposite view that increased economic integration will lead to less synchronized business cycles. Kalemli–Ozcan, Sørensen and Yosha (2001) argue that increased economic integration leads to better income insurance through greater capital integration which in turn will lead to a more specialized production structure and an increase in trade and therefore less synchronized business cycles. A similar argument has also been proposed by Krugman (1993). Alternatively, it could be argued, as Coe and Helpman (1995) and Frankel and Rose (1998) suggest, that the removal of trade barriers will lead to more trade such that demand shocks are more easily transmitted across national borders. Economic and monetary integration, will according to this view, lead to more symmetry of structural shocks and knowledge and technology spillovers which will lead to a higher degree of synchronization of national business cycles.

Given these theoretical ambiguities over the effects of economic and monetary integration on the behavior of business cycles, empirical evidence must be brought to bear on the issue. Indeed, there are several papers suggesting that business cycles are more synchronized when exchange rate variability is low, see for example Fatás (1997), Artis and Zhang (1997, 1999), Dickerson, Gibson and Tsakalotos (1998) and Rose and Engel (2002). However, there are also papers suggesting the opposite, that business cycles are more synchronized during periods with higher exchange rate volatility, see for example Gerlach (1988), Inklaar and De Haan (2001) and De Haan, Inklaar and Sleijpen (2002). A few authors report evidence suggesting no relationship between exchange rate regime and business cycle synchronization, see Baxter and Stockman (1989) and Sopraseuth (2003).[1] In addition, there seems to be at most only weak evidence supporting the view that increased economic integration leads to a higher degree of synchronization. Indeed, Doyle and Faust (2002) and Kose, Prasad and Terrones (2003) find no strong evidence supporting this idea.

[1] Baxter and Stockman (1989) found that synchronization and monetary regimes were unrelated for linear trend adjusted data but not for first log difference data where synchronization was higher when exchange rate volatility was low. Sopraseuth (2003) also found that even though membership of the EMS did not result in a higher degree of synchronization, business cycles in EMS countries became more synchronized to the German cycle and less synchronized to the US cycle.

With few exceptions, earlier papers focus on the relationship between exchange rate regimes and the timing of European business cycles disregarding any effects of the magnitude of cycles.[2] This is in part surprising since there is a direct relationship between the correlation and the variance. For example, holding everything else constant, a lower variance would imply a higher correlation coefficient. Dickerson, Gibson and Tsakalotos (1998) find that the magnitude of business cycles in general is lower for core EU countries but they provide no analysis of the relationship between magnitude and exchange rate regimes. Sopraseuth (2003), however, found that the magnitude of European business cycles was unrelated to membership of the EMS.

The purpose of this paper is to shed light on the question whether European business cycles have become more similar as a result of economic and monetary integration. We measure, based on bandpass filtered data, the characteristics of European business cycles analyzing to what extent they have become more synchronized over time and test whether, for example, EU membership and the Single Market program can account for a higher degree of synchronization. We then consider the role of other factors that have received considerable attention in the literature such as differences in fiscal and monetary policy, border effects, and trade intensity. Can these factors explain the lack of full synchronization among European business cycles?

The paper is organized in the following manner. In section 2 we provide a selected overview of the earlier literature focusing on studies of European business cycle behavior and exchange rate regimes. In section 3 we describe the method used to extract the business cycle component from the data and perform a first preliminary analysis of the data. Section 4 contains the empirical analysis. Section 5 summarizes the main findings.

2 Overview of the earlier literature

In this section we provide a selected overview of the earlier literature on the relationship between exchange rate regimes and business cycle fluctuations in Europe. One of the first papers that examined the relationship between exchange rate regimes and business cycles, Baxter and Stockman (1989), found that business cycles (measured using the first log difference filter) have become more country–specific during the postwar period. This result suggests that business cycles are more synchronized during fixed exchange rate regimes. However, as was mentioned in the introduction, this result was not robust to other ways to compute the business cycle. Using linear trend adjusted data, they found no relationship between co–movements of business cycles and the exchange rate regime.

One approach in the literature is to distinguish between core and periphery European

[2]The literature usually focuses on the G–7 countries documenting shifts in the volatility and in the synchronization of cycles, see e.g. Doyle and Faust (2002), van Dijk, Osborn and Sensier (2002) and Stock and Watson (2003). The consensus from this body of literature is that the business cycle has been dampened recently but there is disagreement on the number of shifts, the dates of the breaks and the magnitude of these breaks. There are also large differences between different macroeconomic time series but a general result is that there are only few structural breaks in the amplitude of business cycles.

countries, where the core countries have highly synchronized business cycles. Countries with less synchronized cycles are, thus, categorized as the periphery. Artis and Zhang (1997) find that world business cycles became more group specific after 1979, with the German business cycle linking countries participating in the ERM system whereas countries outside had weaker cyclical ties to Germany. In a later paper, (Artis and Zhang (1999)) they show that business cycles in ERM countries have become more synchronized to the German business cycle and less synchronized with the US business cycle. Artis, Kontolemis and Osborn (1997) show, using the Bry and Boschan (1971) method to emulate the NBER chronology, that there is a strong association between US and Canadian business cycles and they also identify a group of core European countries with highly synchronized business cycles using measures of business cycle turning points. Christodoulakis, Dimelis and Kollintzas (1995) also present evidence supporting the core/periphery distinction where core countries tend to have highly synchronized business cycles. Dickerson, Gibson and Tsakalotos (1998) who study both the timing and the magnitude of European business cycles find that the long–standing members of the EU, Austria and which is quite surprising Portugal and Greece have highly synchronized cycles. The magnitude of national business cycles differs, however, considerably even though business cycles in core countries tend to have lower amplitude. Rose and Engel (2002) find that members of currency unions tend to have more highly synchronized business cycles compared to countries with national monies. They argue that this reflects increased trade among members of currency unions.

Another approach to the study of business cycle synchronization is to compare cross–correlations between regions within a certain country and compare to correlations between countries. De Haan, Inklaar and Sleijpen (2002) present evidence from US and German states showing that higher exchange rate stability is related to less synchronized business cycles, thus questioning earlier results. They also find that higher trade intensity is associated with a higher degree of synchronization. Also comparing cross–correlation within and between European countries, Fatás (1997) finds evidence suggesting that borders become less important over time as the correlations between European states are increasing whereas the correlation between regions within a European country is decreasing over time. In particular, it is argued that the EMS with considerably lower exchange rate volatility has increased the degree of synchronization. Wynne and Koo (2000) study all 15 EU countries and the 12 Federal Reserve districts in the US. They find much higher correlations between the US districts than between the European countries. However, they also find that the long–standing members of the EU have highly synchronized cycles and that there is both a border and a trade effect such that bordering countries that are likely to trade more with each other also tend to have highly synchronized cycles. Business cycles in large EU countries tend to be more correlated to the US, in particular the business cycle in the UK.

Clark and van Wincoop (2001) study the border effect on the synchronization of business cycle. In their empirical work, they compare results for 14 European countries, the 9 US Census regions and regions within France and Germany. They find a very strong border effect on synchronization. As in earlier literature they find that business cycles within the US Census regions are more correlated than the European countries and that these differences can be related to the border effect. The border effect can be explained by the lower trade among European countries compared to the trade between US Census regions. Their conclusion with regard to future developments in Europe is that business cycle synchronization is not likely to increase unless the volume of trade increases as a result of the elimination of exchange rate related uncertainty.

Examining the historical record of international business cycles, Bergman, Bordo and Jonung (1998) find that business cycles have become more synchronized as measured by the contemporaneous correlation of business cycles in a large set of countries.[3] Their evidence suggests that interrelationships between countries under different monetary regimes reflect the growth and interdependence of markets and changing patterns of economic performance. They also find that business cycles in core EU countries are very high correlated during the post–Bretton Woods period that most likely demonstrates the establishment of the common European market.

Massmann and Mitchell (2003) show that the synchronization of European business cycles has switched between periods of convergence and periods of divergence over the last 40 years. These changes are not completely related to the exchange rate regime as has been found in the literature discussed above. Using monthly data on industrial production, they find an upward trend in synchronization until the mid 1970s, a period of divergence until the mid to late 1980s, a short–lived period of convergence until the German unification in the early 1990s where synchronization fell sharply and finally a period of convergence. Similar changes in synchronization has also been documented by Doyle and Faust (2002). These results suggest that the degree of synchronization is not constant over time and that the particular sub–periods used in the analysis can affect the results.

There is also empirical evidence supporting the opposite view that business cycles are less synchronized during periods with low exchange rate volatility. For example, Gerlach (1988) finds that business cycles were more strongly linked during the flexible exchange rate period compared to the Bretton–Woods period. This result is also supported by Inklaar and De Haan (2001) and De Haan, Inklaar and Sleijpen (2002) in their re–examination of the evidence provided by Artis and Zhang (1997, 1999). Bowden and Martin (1995) and Sopraseuth (2003) present additional empirical evidence supporting a positive relationship between exchange rate volatility and business cycle synchronization, thus, questioning earlier findings.

Another strand of the literature estimates common components of national business cycles interpreting the implied common component as a world or a European business cycle. Gerlach (1988) found that business cycle synchronized was higher during the flexible exchange rate regime than during the 1960's and argued that there existed evidence in favor of an international or world business cycle.[4] In a similar way, Gergory, Head and

[3]See Backus and Kehoe (1992) and Basu and Taylor (1999) for similar studies.

[4]Building on this paper, Gerlach and Klock (1988) and Bergman, Gerlach and Jonung (1992) estimated

Raynauld (1997), also use a dynamic factor model with common and nation–specific components to test for international business cycles. They find, for the G–7 countries, evidence of a common world business cycle but they also suggest that the nation–specific component is important. More recently, Lumsdaine and Prasad (2003) find that business cycles fluctuations become more synchronized during the post–Bretton Woods period. They estimate common business cycle components by decomposing domestic economic fluctuations into a common "world" and a country–specific business cycle. Using this method, they find evidence of both a "world" and a "European" common business cycle and they find that the correlation between these common cycles and domestic business cycles is stronger during the post–Bretton Woods period compared to the earlier Bretton Woods era. Similar results are obtained by Dueker and Wesche (2003) who construct a cyclical indicator for Europe (the European business cycle). The correlation between the estimated European business cycle and business cycles in France, Germany and Italy tends to increase over time. However, compared to the method used by Lumsdaine and Prasad, Dueker and Wesche only base their estimate of the European business cycle on the three countries mentioned before. Lumsdaine and Prasad use information from all countries when they construct their indicator.

Bowden and Martin (1995) use a latent factor model to estimate the international business cycle. In their empirical analysis they find a slight increase in the coherence between national business cycles and between national business cycles and the latent international business cycle in the period with flexible exchange rates, thus supporting the earlier results provided by Gerlach (1988). In other respects, there is no uniform relationship between exchange rate regimes and business cycle behavior.

Mansour (2003) also estimates a common component using a dynamic factor model using real GDP per capita growth for 113 countries. It is argued that there exists a world business cycle which is generated by world or common shocks. The model is then extended to also allow for a common European factor such that the output per capita growth can be decomposed into a world, a European and an idiosyncratic component. Estimates of the variance decomposition of European output suggest that Greece and Ireland (two small countries in the periphery), are more influenced by the world business cycle than by the European cycle. Core European countries, on the other hand, are approximately equally influenced by the two common international components. These results again suggest that there are not only a common world business cycle but also a common European business cycle.

Using a Bayesian panel VAR model, Canova, Ciccarelli and Ortega (2003) question these results. They show that there is very weak evidence in support of a distinct European business cycle. The difference between this study and most earlier papers is that they consider a broader set of data for the G–7 countries instead of only relying on one indicator

common components of GDP and interpreted these components as international business cycles. They estimate a latent common component using the Kalman filter. However, they do not address the question whether the influence from the international business cycle has changed over time and whether it is related to the exchange rate regime.

of the business cycle as is typically done in this literature. However, their results strongly suggest the existence of a world business cycle. This common business cycle explains about 30 percent of the fluctuations in each country.

There is also a large body of research on changes in the amplitude of business cycles. The general consensus in this literature is that business cycle fluctuations in the US but also in some other G–7 countries have been dampened significantly but there is a disagreement about the date of the breaks, how many breaks there are and in the magnitude of the breaks. Doyle and Faust (2002) test whether there has been a structural break in both the synchronization and in the amplitude of country–specific business cycles in the G–7 countries. They find that there is no significant increase in the co–movements of growth rates among the Euro–zone members, thus questioning findings in the earlier literature. When looking at the amplitude, they find that there has been a structural break for most of these countries in the early 1980s. The only exceptions are France where they only find weak evidence supporting a structural break and Japan where the amplitude has increased in recent years. However, their estimates suggest relatively large differences in the relative magnitude and that there also are large shifts in these over time.

In a similar study, van Dijk, Osborn and Sensier (2002) study a larger set of macroeconomic time series for the G–7 countries and focus on structural breaks in the volatility. Using monthly data on industrial production, they find one significant structural break in the amplitude for the four European countries in the late 1980s and in the early 1990s. There is no evidence of multiple structural breaks in industrial production as opposed to in some of the other time series under study. An interesting finding is that these breaks documented for European countries are almost synchronous with the structural breaks in the US, Canada and Japan.

Stock and Watson (2003) extends the analysis by also considering alternative explanations to why the volatility has changed. They first test for structural breaks in both the co–movement and in the volatility between two periods 1960–83 and 1984–2002 using data for the G–7 countries. As in Doyle and Faust (2002) they find no overall evidence of increased synchronization among the G–7 countries. However, looking more closely at groups of countries, the evidence seems to support a higher degree of synchronization among the Euro–zone countries and among the English–speaking countries. This evidence is consistent with much of the findings in the literature that European countries have highly synchronized cycles and the assumption that there is a distinct European business cycle. They attribute the decline of the amplitude to a decline in the amplitude of structural shocks affecting the economies. In particular, they find evidence of a reduction in the size of international common shocks but very small effects from smaller idiosyncratic shocks. This suggest that the relative importance of country–specific shocks and spillover effects tend to increase as an explanation to the volatility of business cycles.

The only paper in the literature explicitly studying the relative magnitude of European business cycles is Dickerson, Gibson and Tsakalotos (1998). For Hodrick–Prescott filtered annual GDP data they compute the mean absolute deviation from the implied trend and then rank the 23 countries. The results are not very distinct but there seems to be the case that core EU countries (except Luxembourg) have somewhat smaller amplitudes. They all are ranked among the top half of the countries with smallest amplitude. However, Norway and Australia for example also ranks very high and in between the EU core. However, when looking at sub–samples, the evidence is stronger supporting the view that EU core can be distinguished from other countries. There are also quite large differences in the amplitude even for the core EU countries raising concern about the effects of the common monetary policy in Europe.

In the context of the European integration since the World War II, the empirical evidence often suggests that business cycle synchronization was higher when exchange rate volatility was low. The contradicting evidence discussed in this section also suggest that both synchronization and the relative magnitude of business cycles in Europe tend to change over time, sometimes as a result of changes in the monetary regime and exchange rate system.

3 Methodology

3.1 Data

The data set consists of quarterly observations on industrial production for the EU–14 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden and the United Kingdom) and five non–EU countries (Canada, Japan, Norway, Switzerland and the US) for the sample 1961:1 to 2001:4.[5] The data are taken from IFS CD–Rom except industrial production for Ireland and Portugal taken from OECD Main Economic Indicators, see Appendix A.

3.2 Measuring domestic business cycles

Prior to our empirical analysis we must extract the cyclical component from the macroeconomic time series, i.e., the natural logarithm of industrial production. Recently, Baxter and King (1999) have developed a bandpass filter that isolates cyclical components of economic time series. This filter can be designed to isolate cyclical components of economic time series conforming to a certain definition of business cycles.[6] In particular, we isolate cyclical components of the data with durations conforming to the Burns–Mitchell definition of the business cycle.[7] We use a 12–order two–sided filter following Baxter and King (1999) to extract all fluctuations at frequencies between 6 and 32 quarters (1.5 year and

[5] We use industrial production as our business cycle indicator rather than GDP since quarterly GDP data for all these countries is only available for a shorter sample period making it difficult to study changes in business cycle behavior over time.

[6] Baxter and King (1995) compare the properties of cyclical components of US GNP generated by different detrending techniques and find that the bandpass filter usually is superior to other filters in isolating cyclical variation within certain frequency bands.

[7] They define business cycles as recurrent, but not strictly periodic, fluctuations in economic activity with a duration usually between one and ten years, the average length varying over time.

eight years) from the logarithm of industrial production in each country.[8] When applying this filter, we lose observations at both ends of our sample. We use forecasts and backcasts based on a twelfth order univariate autoregressive model to add these observations to the sample prior to applying the bandpass filter. This same method is used by Stock and Watson (1999) and Bergman, Bordo and Jonung (1998) amongst others.

In Appendix B, we show plots of the extracted business cycles in all countries. A striking feature of these graphs is the regularity of national business cycles and the co–movements of downturns and upturns, in particular between the EU–14 countries. The overall impression is that cyclical fluctuations in industrial production in this sample of countries display a relatively high degree of synchronization. It is also interesting to note that the severity of business cycles has declined in the latter part of our sample for some countries (Denmark, France and Greece) while the amplitude seems to be relatively unchanged over time for other countries. The effects of the oil price shock during the second half of the 1970's and in the beginning of the 1980's are also evident for most countries as are the banking and currency crises in Finland and Sweden in the early 1990's.

4 Empirical work

4.1 Country–specific co–movements

In Figure 1 we study the co–movements between EU–14 and non–EU countries and the co–movements between EU–14 countries before and after the particular country became a member of the EU. To construct the graph in the upper panel we use the full sample and compute the average of bilateral contemporaneous cross–correlation between EU–14 and non–EU countries for each country in our sample. On the vertical axis we measure cross–correlations with non–EU countries whereas we measure cross–correlations with EU–14 countries on the horizontal axis. As can be seen in this graph, there is a tendency that business cycles in non–EU countries are more correlated to business cycles in non–EU countries than to business cycles in the EU–14 countries with the exception of Austria and Switzerland. The EU–14 countries seem to be more correlated to other EU–14 countries. However, the differences are not substantial according to this plot.

The lower graph in Figure 1 shows the average of contemporaneous cross–correlations between EU member states excluding the six original members prior to (vertical axis) and after (horizontal axis) the particular country became a member of the EU. There is no clear–cut pattern evident in this graph. Some countries have become more correlated to other EU–countries after entering the EU (Ireland and the UK) while business cycles in other countries were more synchronized prior to their EU–membership (Austria, Greece and Portugal). Again there is no uniform evidence pointing in any particular direction for these nine countries. The graphs in Figure 1 suggest that business cycles in the EU–14

[8] The results below are essentially unaffected when using the Hodrick–Prescott filter to extract the business cycle component of industrial production instead of the Baxter–King filter.

countries are somewhat more synchronized to business cycles in other EU–14 countries than with non–EU countries whereas EU membership seems to have had only marginal effects on the degree of synchronization for most European countries.

4.2 Has the degree of synchronization changed over time?

It may well be the case that the degree of synchronization has changed over time and that these changes are related to other developments than the timing of EU–membership, for example, the exchange rate regime. Therefore we now divide our sample into five sub–samples reflecting different monetary regimes and different degrees of economic integration: the Bretton–Woods period 1961:1–1973:1, the flexible exchange rate regime 1973:2–1978:4, the EMS period 1979:1–1987:2, the implementation of the Single European Act period 1987:3–1992:4, and the implementation of the common market and preparations for monetary union 1993:1–2001:4.[9] In addition, we will from now on focus on the general pattern, i.e., we distinguish between groups of countries instead of differences between countries. This allows us to distinguish between EU member states, non–EU member states and the role played by the monetary regime and the degree of economic integration.

In Table 1 we present the average cross–correlations between all countries, between EU–14 countries, between non–EU countries and finally between EU–14 and non–EU countries for the full sample and the five sub–samples. To measure these averages, we first compute the bilateral cross–correlations between country i and j (ρ_{ij}) for each sub–sample and stack the unique cross–correlations in the vector ρ. This leads to a vector with 855 unique cross–correlations for the 19 countries (for each sample we have $19(19-1)/2$ unique cross–correlations). The average of cross–correlations between, say, the EU–14 countries over the full sample is then a linear combination of these unique cross–correlations of the form $\rho = \delta'\rho$. To measure the variance of these averages we use the Newey–West heteroscedastic and autocorrelated corrected variance estimator (HAC).[10]

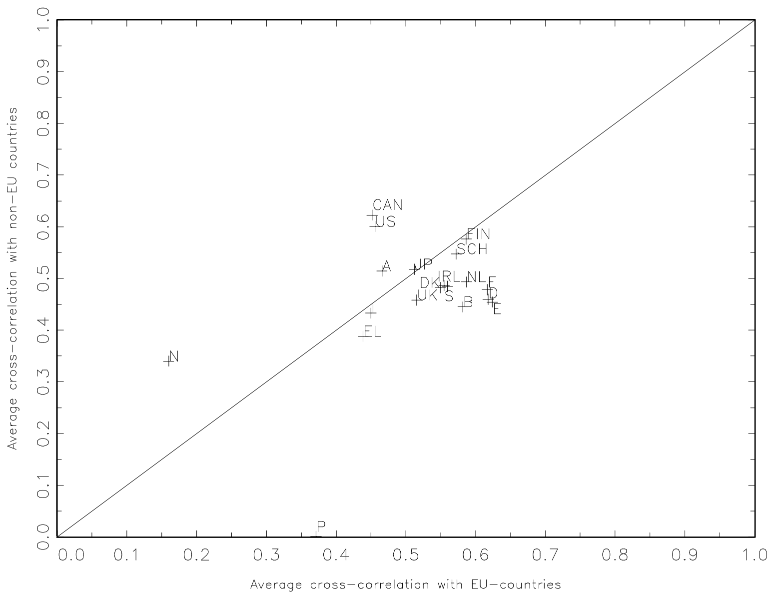
Looking first at the first row of Table 1 where we report estimates of the average cross–correlations (ρ) for all countries. As can be seen from this row, the point estimates of the degree of synchronization change over time, it is highest during the flexible exchange rate period and lowest during the Bretton–Woods period. There is also a clear cycle in the degree of synchronization. It is increasing between the first two sub–samples, decreasing during the next two and then finally increasing again.

[9]It would have been interesting to divide the last period into two sub–periods allowing us to also study the effects of EMU. This is, unfortunately, not possible since our estimates of co–movements would be highly uncertain given the few available observations on industrial production and other variables used in the analysis below for the EMU–period. The sub–samples we use roughly correspond to the ones used in the earlier literature.

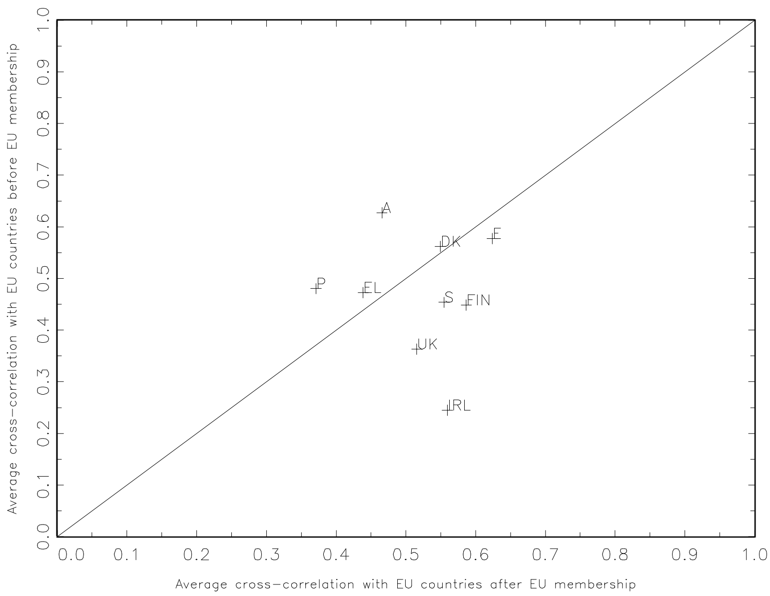
[10]It may be the case that the cross–correlations in ρ are correlated, the cross–correlation between Sweden and Belgium and between Sweden and Denmark is correlated to the cross–correlation between Denmark and Belgium. This potential problem gives rise to autocorrelated residuals. Following the practice in the related literature we estimate the parameters using OLS and the variance using a robust estimator.

Figure 1: Cross–correlations.

(a) Average cross–correlation with EU and non–EU countries.



(b) Average cross–correlation with EU countries before and after EU membership.



Note: The average cross–correlations for non–EU countries shown in subfigure 1(a) are computed using the full sample whereas the cross–correlations for EU countries are computed using data when they are members of the EU. In subfigure 1(b) we show the average cross–correlation between a EU country and other EU member states before and after the particular country entered the EU.

This pattern is also evident in the next row reporting the average cross–correlations between EU member states, ($\rho^{\mathrm{EUM}}_{\mathrm{EUM}}$). These averages are based on the sample of countries that were members of the EU during the particular sub–sample, Denmark and Ireland joined in 1973, Greece in 1981, Portugal and Spain joined in 1986 whereas Austria, Finland and Sweden joined in 1995.[11] The synchronization of business cycles between EU–member states are highest during the flexible exchange rate period and higher during the most recent period compared to the earlier two sub–samples.

A different pattern is evident for the sample of non–EU member states. Note that these cross–correlations ($\rho^{\mathrm{NEU}}_{\mathrm{NEU}}$) are computed for all countries that were not members of the EU during the particular sub–sample. For these countries we observe a downward trend (according to the point estimates) in the degree of synchronization over time. As for the earlier two groups of countries, business cycles were strongly synchronized during the flexible exchange rate period.

In the last row of the upper part of Table 1 we show the estimates of the average degree of synchronization between EU–member states and non–EU member states ($\rho^{\mathrm{NEU}}_{\mathrm{EUM}}$). The pattern is similar, but not as strong, as for the EU–member states. The degree of synchronization seems to increase somewhat in the last sub–period 1993–2001 compared to the earlier period.

Comparing the degrees of synchronization across groups of countries and across time, we find an interesting pattern. In Panel B in Table 1 we report Wald tests of the null hypothesis that the average cross–correlations across EU–members and across non–EU members are equal during each sample. These tests reveal that the degree of synchronization differs only during the flexible exchange rate period. This suggests again that the degree of synchronization has changed in a similar way for these two groups of countries over time. In the second row of Panel B, we test the null hypothesis that EU–member states synchronization with other EU–members and non–EU members are equal for each sample. These tests show that business cycles in EU–member states were more synchronized business during the flexible exchange rate period and the most recent period of deepening European integration.

The analysis above only shows the main tendencies of the data and cannot be used to argue that the attempts to bring European countries closer to each other by the implementation of the common market and the establishment of the monetary union have made business cycles more synchronized in Europe. To answer such questions, we from now on focus on the sample of EU–countries, that is we focus only on bilateral cross–correlations between EU–14 countries during each sub–sample testing for an additional EU membership effect and the role played by the monetary regime.

In Table 2 we report tests of the null hypothesis that sub–sample averages of cross–correlations between EU–member states are equal. A striking feature of these results is

[11] Our five sub–samples do not fully correspond to the dates when these countries joined the EU. In our empirical work we, therefore, include Greece in our sample of EU countries in the sub–sample 1978–87, Portugal and Spain in the sub–sample 1987–1992 and Austria, Finland and Sweden in the last sub–sample 1993–2011. Our empirical results are essentially unaffected by these assumptions.

Table 1: Average cross–correlations in EU and non–EU countries.

	1961–2001	1961–1973	1973–1978	1979–1987	1987–1992	1993–2001
Panel A: Average cross–correlations.						
ρ	0.455	0.327	0.646	0.493	0.333	0.478
	(0.018)	(0.031)	(0.037)	(0.033)	(0.029)	(0.038)
$\rho^{\mathrm{EUM}}_{\mathrm{EUM}}$	0.543	0.300	0.824	0.517	0.345	0.567
	(0.028)	(0.174)	(0.026)	(0.040)	(0.064)	(0.030)
$\rho^{\mathrm{NEU}}_{\mathrm{NEU}}$	0.409	0.333	0.552	0.464	0.322	0.319
	(0.031)	(0.029)	(0.061)	(0.081)	(0.084)	(0.192)
$\rho^{\mathrm{EUM}}_{\mathrm{NEU}}$	0.440	0.323	0.647	0.498	0.332	0.386
	(0.024)	(0.044)	(0.051)	(0.039)	(0.036)	(0.069)
Panel B: Wald tests.						
H_0: $\rho^{\mathrm{EUM}}_{\mathrm{EUM}} = \rho^{\mathrm{NEU}}_{\mathrm{NEU}}$	10.373	0.035	16.559	0.353	0.052	1.620
	0.001	0.852	0.000	0.553	0.820	0.203
H_0: $\rho^{\mathrm{EUM}}_{\mathrm{EUM}} = \rho^{\mathrm{EUM}}_{\mathrm{NEU}}$	8.801	0.022	10.438	0.138	0.028	5.790
	0.003	0.882	0.001	0.710	0.868	0.016

Note: In Panel A we report the average of bilateral contemporaneous cross–correlations for all countries (ρ), the average of contemporaneous cross–correlation between EU member states ($\rho^{\mathrm{EUM}}_{\mathrm{EUM}}$), the average of contemporaneous cross–correlations between non–EU member states ($\rho^{\mathrm{NEU}}_{\mathrm{NEU}}$), and the average of contemporaneous cross–correlations between EU member states and non–EU members ($\rho^{\mathrm{EUM}}_{\mathrm{NEU}}$). Newey–West HAC standard errors are shown in parentheses below each cross–correlation. In Panel B we report Wald tests of the null hypothesis that the cross–correlation between EU and non–EU countries is equal (H_0: $\rho^{\mathrm{EUM}}_{\mathrm{EUM}} = \rho^{\mathrm{NEU}}_{\mathrm{NEU}}$) and Wald tests of the null hypothesis that the cross–correlation between EU member states is equal to the cross–correlations between EU member states and non–EU member states (H_0: $\rho^{\mathrm{EUM}}_{\mathrm{EUM}} = \rho^{\mathrm{EUM}}_{\mathrm{NEU}}$). These tests are χ^2 distributed with 1 degree of freedom.

that the second sub–sample, the flexible exchange rate regime, stands out as different. We strongly reject the null hypothesis that business cycle synchronization during this sample is equal to the synchronization during all other sub–samples. These results support our earlier finding that business cycles were more synchronized during this sub–sample compared to the other four regimes. It is also noteworthy that it is commonly argued in the literature that flexible exchange rates tend to insulate the national economy from demand type shocks, i.e., shocks affecting the business cycle.[12] Our calculations lend support to this idea. Monetary regimes with less flexible exchange rates tend to be associated to a lower degree of synchronization. The results in Table 2 also suggest that the degree of synchronization during the most recent sub–sample is significantly different from the co–movements during the period when the Single European Act was implemented. In this regard, it may be argued that a deepening of European integration has led to a higher degree of synchronization although business cycles were even more synchronized during the earlier flexible exchange rate period. A Wald test of the null hypothesis that cross–correlations are equal across all five subperiods strongly rejects the null, $\chi^2 = 91.978$ with p–value = 0.000 further supporting the conclusion that the degree of synchronization has changed over time. This result is consistent with the results provided by Massmann and Mitchell (2003) in particular but also the large body of the literature suggesting changes in the degree of synchronization across time.

Our analysis above suggests that the synchronization of business cycles among EU member states is higher than among non–EU member states. In the next subsection we turn to the question why we observe these changes in the degree of synchronization. What could explain the apparent changes in synchronization? In particular, we are interested in explaining why the degree of synchronization was so high during the period when the European countries had flexible exchange rates. It is also interesting to test whether the significantly higher degree of synchronization during the last period is explained by the increased economic integration or if other factors explain this increase.

4.3 What accounts for the EU membership effect?

In this section we examine whether the EU membership effects identified above can be explained by other factors affecting the European economies or if other developments have led to an increase in the degree of synchronization. Following Clark and van Wincoop (2001) who study the border effect on the synchronization of business cycles, we consider in addition to a border effect, the role played by trade intensity, distance between countries, the size of countries, differences in monetary and fiscal policy, and exchange rate volatility.

We define trade intensity (following Frankel and Rose (1998)) as the natural logarithm of the value of bilateral trade between two countries divided by sum of the value of total

[12]Within a Mundell–Fleming model it is possible to show that flexible exchange rates insulate the economy to aggregate demand shocks but not to money demand shocks. For a large open economy with an inflation target, a fixed exchange rate regime is optimal.

Table 2: Wald tests of EU membership effects across different monetary regimes.

		1973–1978	1978–1987	1987–1992	1993–2001
1961–73	Wald	9.045	1.512	0.061	2.336
	p–value	0.003	0.219	0.805	0.126
1973–78	Wald		43.222	48.604	44.027
	p–value		0.000	0.000	0.000
1978–87	Wald			5.303	1.052
	p–value			0.021	0.305
1987–92	Wald				10.280
	p–value				0.001

Notes: Wald tests are based on regressions with a constant and sub–sample dependent EU dummy variables and the HAC covariance matrix estimator. The degree of freedom is 2 for all tests.

trade in both countries, i.e.,

$$w_{ijt} = \ln\left(\frac{X_{ijt} + M_{ijt}}{X_{it} + M_{it} + X_{jt} + M_{jt}}\right).$$

We then take the average of these trade intensities over the five sub–samples. The distance (D) between countries is measured as the great circle between largest cities in each country according to Fitzpatrick and Modlin (1986).[13] The size is measured as the natural logarithm of the product of real GDP per capita measured in current US$.[14] To account for differences in monetary and fiscal policy, we use the standard deviation of the money market (or equivalent measures) interest rate differential (σ_{r-r^*}) and the standard deviation of the budget deficit (as a percentage of GDP) differential (σ_{D-D^*}), respectively. Finally, the exchange rate volatility is measured as the standard deviation of the first log difference of bilateral exchange rates ($\sigma_{\Delta s}$). Data sources and sample ranges are presented in Appendix A.

In Table 3 we show the role of these factors in explaining the synchronization of business cycles within the EU–14 countries. All results are based on running the following regression

$$\rho = \alpha_0 + \alpha_1 \mathrm{EUM} + X\beta + \varepsilon$$

where EUM is a dummy variable taking the value 1 if both countries are members of the EU, X includes the various variables discussed above. Initially, we focus on the

[13] We have also considered alternative measures of distance such as the distance in radians of the unit circle between country centroids. The empirical results below are essentially unaffected when using this measure.

[14] Another approach to measure size is to use the natural logarithm of the sum of population. In general, the significance of the parameters associated to this measure of size was lower (although statistically significant at conventional levels) compared to the significance of the log of the product of real GDP. All other results were essentially unaffected.

Table 3: Testing the border effect, the role of distance, size, trade and economic policy. EU–14 countries.

	OLS	OLS	IV	IV	IV	IV
EUM	0.090	0.062	0.033	0.027	0.034	0.046
	(0.036)	(0.037)	(0.040)	(0.042)	(0.041)	(0.041)
Border		0.170				
		(0.052)				
Distance		0.019				
		(0.037)				
Size		0.142	0.093	0.162	0.036	0.105
		(0.065)	(0.063)	(0.064)	(0.082)	(0.060)
w_{ij}			0.032	0.041	0.048	0.047
			(0.011)	(0.012)	(0.016)	(0.012)
σ_{r-r^*}				0.062		
				(0.027)		
σ_{D-D^*}					0.079	
					(0.059)	
$\sigma_{\Delta s}$						0.158
						(0.049)

Notes: Estimates are based on regressions of the average bilateral cross–correlations on a constant and the various variables shown in the table where w_{ij} is trade intensity, σ_{r-r^*} denotes differences in monetary policy, σ_{D-D^*} is a measure of differences in fiscal policy and $\sigma_{\Delta s}$ is the standard deviation of bilateral exchange rates. Instruments for trade are border, distance, language and an interaction term of distance and size. The policy variables are instrumented using the absolute inflation differential, the sum of interest rates, the absolute difference between the ratios of government spending to GDP and the sum of the ratios of government spending to GDP. HAC standard errors using 4 lags are shown in parentheses below each parameter estimate.

full sample, i.e., we do not distinguish between sub–periods. When including trade and the policy variables, we estimate the regression using instrumental variables as discussed below.

In the first column of Table 3 we report the estimated effect of EU membership. As we already know from our earlier analysis, this parameter is significant and positive suggesting that EU member states tend to have more synchronized business cycles compared to EU–14 countries that were not members of the EU at the point in time we computed the cross–correlation. The question now is whether this positive effect disappears when including other variables in the regression. In other words, is this EU member effect robust or are there other explanations to the increasing synchronization that we have observed above.

The second column in Table 3 reports the results when including border, distance and size as additional explanatory variables besides the constant and the EU membership dummy. As is evident, there is a very strong border effect. Bordering EU countries tend to have more synchronized business cycles compared to non–bordering countries. This result is consistent with evidence provided by Clark and van Wincoop (2001) who report very strong border effects between France, Germany, Italy and the UK. The distance between the countries seems to play no role in explaining synchronization, the parameter is not significantly different from zero. The size effect is highly significant suggesting that the size of the countries play an important role for explaining the degree of business cycle synchronization. The cross–correlation between large countries tends to be higher compared to between two small countries. However, controlling for border, distance and size has some effect on the importance of EU membership. The coefficient drops from 0.090 to 0.062 and it is only statistically significant at the 10 percent level suggesting that border, distance and size explain parts of the co–movements of business cycles in EU member states. The conclusion is that controlling for a border, in particular, but also for size reduces the EU membership effect somewhat.

Next, we add trade intensity to the regression. To avoid multicolinearity between the regressors, we now exclude both border and distance from our regression.[15] Since trade may be endogenous (as argued by Frankel and Rose (1998)) we estimate the regression using instrumental variables. Countries that border usually trade more and therefore have more synchronized business cycles. A similar argument holds for distance, the longer the distance is between two countries, the more likely it is that the volume of trade is smaller. At the same time, as argued by both Frankel and Rose (1998) and Clark and van Wincoop (2001), countries with highly synchronized business cycles are better candidates for currency unions, which in turn could increase trade. We use instruments that often are used in gravity models: border, distance, linguistic distance, and an interaction term equal to the product of size and distance.[16]

The results when including trade as an explanatory variable are shown in the third column of Table 3. The parameter associated with the EU dummy is further reduced and is not statistically different from zero when adding the policy variables. Trade, on the other hand, is positively related to the synchronization of business cycles. The reason why the business cycle is more synchronized between EU member states is, according to these estimates, that they trade more not that they are members of the EU.

In the last three columns of Table 3 we also include the three policy variables, differences in monetary and fiscal policy and exchange rate volatility. We still use instrumental variables when estimating the parameters. Trade is instrumented using the same set of instruments as indicated above. To instrument the policy variables, we use the absolute inflation differential, the sum of interest rates, the absolute difference between the ratios of government spending to GDP and the sum of the ratios of government spending to GDP. These same instruments were used in a similar context by Clark and van Wincoop (2001). From these columns we observe that trade intensity is always significantly different from one and positive. As the parameter associated to the EU membership dummy is not statistically significant at conventional levels, our results suggest that trade and

[15] Trade, border and distance are highly correlated, the correlation coefficients are above 0.6 between trade and the other two variables.

[16] The explanatory power for trade in the first stage regression using these instruments is 0.68.

the policy variables explain the co–movements of business cycles in these countries, trade intensity is still significant and the point estimates increase somewhat compared to the case when we only add trade to the regression. A surprising result, however, is that the three policy variables all exert a positive influence on the degree of synchronization. It is often assumed that more similar economic policy, a lower value of the policy variables, should to lead to a higher degree of business cycle synchronization. Looking at the particular estimates, we find that larger differences in monetary policy and a higher bilateral exchange rate volatility implies a higher degree of synchronization. Differences in fiscal policy is not statistically different from zero. These results are different from the evidence presented by Clark and van Winccop (2001). In their empirical application, policy variables were often found to be positively related to the degree of synchronization but very seldom statistically significant. The positive relationship between synchronization and exchange rate volatility in Table 3 is, however, consistent with results provided by, for example, De Haan, Inklaar and Sleijpen (2002). Note also that our results shown in Table 3 is consistent with the findings in Table 1 where we show that the degree of synchronization among EU member states was highest during the period with flexible exchange rates.

The results shown in Table 3 cannot be used to draw inference about the importance of economic integration as the parameters are not allowed to vary across different sub–samples. It may well be the case that EU membership is important during, say, the last sub–period where the European countries have become more integrated. To examine whether this is the case, we now allow the EU membership dummy to vary across the five sub–samples. We still assume, however, that the influence from other explanatory variables is time invariant. The results from these estimates are shown in Table 4.

For comparison we have included in the first column estimates of sample dependent EU membership effects taken from Table 1. What is immediately evident in this table is that the parameter associated to EU membership tends to change very little for some sub–samples whereas it changes considerably for other sub–samples. The effect of the EU membership dummy variable changes considerably for the first two sub–samples but much less for the last sub–sample. Controlling for trade and policy variables, in general, leads to a drop in the EM membership dummy suggesting that synchronization is explained by trade in particular but also differences in monetary policy and exchange rate volatility, see the last four columns of Table 4.

Similarly to our earlier results presented earlier in Table 3, the policy variables exert a positive influence on synchronization. There is a strong border effect and trade is always significant. This suggests that bordering countries that also trade more, will have more synchronized business cycles compared to countries located far away. The size of the countries plays a minor role, however. The parameter associated with size is never significantly different from zero when we add trade to the regression except when we add differences in monetary policy. Differences in monetary policy and exchange rate volatility are both significant and have parameters of approximately the same size regardless of whether we allow the EU membership dummy to vary across subsamples or not. It is still surprising that business cycles are not more synchronized in countries with similar monetary policy (low standard deviation of the interest rate differential).

Looking more closely at the results for the flexible exchange rate regime, we find that the effect of EU membership drops when adding the control variables. This suggests that the control variables explain parts of the very high synchronization of business cycles for this sub–sample. For the more recent sub–samples, the parameter changes very little. Looking at the results for the most recent period, we can conclude that the various control variables cannot explain the increased synchronization during this period. In this respect, the increased economic integration have had a positive influence on business cycle synchronization. Differences in monetary policy and increases in exchange rate volatility also contributes to the co–movements of business cycles but the effect from economic integration is still significant.

Our results on the timing of business cycles within Europe suggest that business cycles were more synchronized during the flexible exchange rate period 1973–1978 compared to the other four periods we study in this paper. However, after a relatively sharp fall in business cycle correlations, the degree of synchronization has increased somewhat in recent years. Since our measure of economic policy, trade and exchange rate volatility cannot explain the recent development, our results suggest that economic and monetary integration may have played an important role. This conclusion is, however, not fully consistent with the empirical evidence in Doyle and Faust (2002) and Kose, Prasad and Terrones (2003). Even though there is an upward trend in synchronization, we cannot draw any strong conclusions about the future of European business cycle behavior. The reason is that synchronization depends also on trade, exchange rate volatility and differences in monetary policy. The empirical evidence on the relationship between exchange rate volatility and trade suggest that trade possibly will increase in the future as a result of monetary union.[17] At the same time, our evidence support the view that flexible exchange rates tend to insulate the economy such that business cycles in Europe then move more uniformly. A lower exchange rate volatility would then tend to reduce business cycle synchronization. Looking at the average bilateral exchange rate volatility during our five sub–samples, we find that it moves in the same direction as the average cross–correlations.[18] We also found a positive and significant effect between differences in monetary policy and synchronization. If this result is robust, then the common monetary policy in Europe runs the risk of increasing the divergence in business cycles counteracting the positive effects from economic integration. It is, of course, an open question whether the trade effect is stronger or weaker than the effect from differences in monetary policy

[17]Running a regression of trade on exchange rate volatility, we find a very strong and significant effect implying that lower exchange rate volatility will tend to increase trade. This positive relationship has also been found by, e.g., Rose and Engel (2002).

[18]The average exchange rate volatility for EU member states during the five sub–samples is 1.032, 1.823, 1.487, 0.997 and 1.482, respectively. Note, however, that exchange rate volatility for all EU–14 countries was higher during all sub–samples. Trade intensity, on the other hand, is always higher for EU member states compared to the EU–14 countries. There is no clear–cut pattern for the two indicators of similarities of economic policy.

Table 4: Testing the border effect, the role of distance, size, trade and economic policy. EU–14 countries. Sample dependent EU membership effects.

	OLS	OLS	IV	IV	IV	IV
EUM 1961–73	−0.152	−0.256	−0.363	−0.336	−0.390	−0.341
	(0.167)	(0.155)	(0.158)	(0.152)	(0.163)	(0.155)
EUM 1973–78	0.372	0.314	0.267	0.251	0.249	0.216
	(0.037)	(0.041)	(0.041)	(0.043)	(0.046)	(0.047)
EUM 1979–87	0.065	0.024	−0.024	−0.049	−0.031	−0.028
	(0.047)	(0.047)	(0.048)	(0.050)	(0.048)	(0.048)
EUM 1987–92	−0.107	−0.152	−0.202	−0.216	−0.212	−0.143
	(0.071)	(0.066)	(0.071)	(0.071)	(0.072)	(0.075)
EUM 1993–2001	0.115	0.098	0.079	0.081	0.087	0.091
	(0.040)	(0.038)	(0.039)	(0.038)	(0.039)	(0.037)
Border		0.178				
		(0.045)				
Distance		0.004				
		(0.035)				
Size		0.123	0.067	0.124	0.030	0.078
		(0.062)	(0.061)	(0.061)	(0.078)	(0.058)
w_{ij}			0.046	0.055	0.058	0.059
			(0.013)	(0.014)	(0.018)	(0.014)
σ_{r-r^*}				0.052		
				(0.023)		
σ_{D-D^*}					0.047	
					(0.052)	
$\sigma_{\Delta s}$						0.129
						(0.048)

Notes: Estimates are based on regressions of the average bilateral cross–correlations on a constant and the various variables shown in the table where w_{ij} is trade intensity, σ_{r-r^*} denotes differences in monetary policy, σ_{D-D^*} is a measure of differences in fiscal policy and $\sigma_{\Delta s}$ is the standard deviation of bilateral exchange rates. Instruments for trade are border, distance, language and an interaction term of distance and size. The policy variables are instrumented using the absolute inflation differential, the sum of interest rates, the absolute difference between the ratios of government spending to GDP and the sum of the ratios of government spending to GDP. HAC standard errors using 4 lags are shown in parentheses below each parameter estimate.

and from exchange rate volatility. The common monetary policy and lower exchange rate volatility in EU member states will tend to decrease synchronization whereas increased trade intensity will tend to increase synchronization. If the former effect dominates, the common monetary policy would be too expansive in some countries and too restrictive in others. These potential problems will not occur to the same extent if the latter effect dominates.

4.4 The magnitude of business cycles

The analysis above shed some light on the timing of business cycles in the EU where the main argument was that the implementation of a common monetary policy and the synchronization of fiscal policy within the EU–area is a concern if the timing of business cycles differs considerably. A similar argument holds for the magnitude of business cycles as a common economic policy could lead to too small effects in countries with highly variable cycles and too large effects in countries with less variable cycles. For countries with similar amplitudes, a common economic policy raises no such concerns. In other words, the intensity of economic policies has to differ among countries with different amplitudes of its business cycles.

An analysis and comparison of the amplitude of business cycles and its consequences for the common economic policy in Europe require a thorough analysis of each national business cycle and its relation to business cycles in all other EU countries. In this subsection, however, we continue to study the average behavior in all EU countries. There are, of course, many aspects that such analysis cannot capture, but it is nevertheless interesting to study the main tendencies, in particular to establish whether the business cycle amplitude has changed over time and if so, if these changes are related to the monetary regime.

In the upper panel of Table 5 we report estimates of the absolute difference of the standard deviation of national business cycles both for all EU–14 countries and for the EU member states.[19] According to these estimates, the amplitude for all EU–14 countries have increased considerably over the sample from 0.6 to 0.95. This suggests that the magnitude of business cycles were more similar during the Bretton–Woods period compared to all other sub–samples we examine. This result does not fully carry over to EU member states. According to the results shown in Panel A, differences in the amplitude for these countries fell somewhat during the implementation of the Single European Act period compared to the earlier EMS period.

In Panel B, we report formal tests of the hypothesis that the relative magnitude of business cycles is equal across sub–samples.[20] These results show that we can always

[19]There are other ways to measure the amplitude of business cycles, for example by using the mean absolute deviation as suggested by Dickerson, Gibson and Tsakalotos (1998). They report, however, that their results were unchanged when they used the standard deviation as the measure of business cycle amplitude as we use here.

[20]We only report results for EU member states in the table. We obtain similar results for the sample of all EU–14 countries and these results are available upon request from the author.

Table 5: Absolute difference between the standard deviation of the business cycle. EU–14 countries.

Panel A: Mean of absolute difference of standard deviations.						
	1961–2001	1961–1972	1973–78	1979–1987	1987–1992	1993–2001
EU–14	0.749	0.595	0.759	0.678	0.767	0.948
	(0.031)	(0.056)	(0.091)	(0.062)	(0.043)	(0.055)
EU members	0.792	0.682	0.717	0.682	0.575	0.948
	(0.043)	(0.132)	(0.118)	(0.074)	(0.077)	(0.055)

Panel B: Wald tests of equal differences in magnitude for EU–members across monetary regimes.					
		1973–1978	1978–1987	1987–1992	1993–2001
1961–73	Wald	0.040	0.000	0.488	3.484
	p–value	0.842	0.999	0.485	0.062
1973–78	Wald		0.065	1.014	3.160
	p–value		0.799	0.314	0.075
1978–87	Wald			0.997	8.465
	p–value			0.318	0.004
1987–92	Wald				15.325
	p–value				0.000

Note: EUM denotes a EU membership dummy variable, D_i denotes a dummy variable for sub–sample i, and $\mid \sigma_i - \sigma_j \mid$ is the absolute difference between the standard deviation of the business cycle in country i and j. HAC standard errors using 4 lags are shown in parentheses below each parameter estimate. Wald tests are based on regressions with a constant and a EU dummy variable where all parameters are allowed to vary across the sub–samples and the HAC covariance matrix estimator. Degrees of freedom is 2 for all tests. A Wald test of the null hypothesis that cross–correlations are equal across all five subperiods strongly reject the null, $\chi^2 = 18.852$ with p–value = 0.001.

reject the null hypothesis of equal magnitudes when comparing the last sub–sample with all other sub–samples at the 10% level. Based on this evidence, we conclude that the bilateral differences of the magnitude are larger during the most recent sub–sample. A test of the hypothesis that the average amplitude is constant over all samples is strongly rejected, $\chi^2_4 = 18.852$ with p–value = 0.001 suggesting that the magnitude is not constant.

It is surprising that the relative magnitude of European business cycles tends to increase, in particular, towards the end of our sample. Our result is, however, consistent with earlier empirical findings in the literature. There is a general consensus that the volatility of business cycle in the US and in the G–7 countries has been dampened even though there is a debate on the date of the structural break in the amplitude and, of course, whether there has been more than one structural break, see e.g. van Dijk, Osborn and Sensier (2002), Doyle and Faust (2002) and Stock and Watson (2003). Indeed, looking at the underlying data we use to compute the relative magnitudes, we find that the volatility of the bandpass filtered data tend to be lower for the more recent sub–samples for some countries compared to earlier periods. This can also be seen in the plots of the bandpass filtered data in Appendix B.

How should we interpret our results that both the cross–correlations and the relative magnitude have increased during the most recent period. First, we recognize that these changes are related. Holding everything else constant, an increase in the volatility implies a reduction in the co–movement of the two time series we examine. But how do increases in economic integration or a higher degree of asymmetry of nation–specific shocks affect these measures? To answer these questions it is informative to use the following model that is also used by Doyle and Faust (2002). Assume for simplicity that we only study two countries, home and foreign, and that the business cycle in each country is driven by idiosyncratic shocks and common shocks. We also allow for a direct linkage between the countries such that, say, the nation–specific foreign shocks are transmitted to the home country. Let y be the measure of the business cycle, ε_h and ε_f are the idiosyncratic shocks (they are assumed to be independent white noise sequences with variance σ_h^2 and σ_f^2 respectively), ε_c is the common shock (also white noise with variance σ_c^2) and $0 < \gamma < 1$ is a parameter determining the linkages between the two countries. We can now write the model in the following way

$$\begin{aligned} y_h &= \varepsilon_h + \varepsilon_c + \gamma y_f \\ y_f &= \varepsilon_f + \varepsilon_c + \gamma y_h. \end{aligned}$$

We have used the simple correlation coefficient to measure co–movements and the absolute value of the difference between the standard deviations of the cycles. Using the model above to compute the variance of the business cycles in the two countries and the covariance between the cycles, we obtain

$$\begin{aligned} \mathrm{Var}\left(y_h\right) &= \left(-\tfrac{1}{\gamma^2-1}\right)^2 \left(\sigma_h^2 + \gamma^2\sigma_f^2 + (1+\gamma)^2\sigma_c^2\right) \\ \mathrm{Var}\left(y_f\right) &= \left(-\tfrac{1}{\gamma^2-1}\right)^2 \left(\gamma^2\sigma_h^2 + \sigma_f^2 + (1+\gamma)^2\sigma_c^2\right) \\ \mathrm{Cov}\left(y_h, y_f\right) &= \left(-\tfrac{1}{\gamma^2-1}\right)^2 \left(\gamma\left(\sigma_h^2 + \sigma_f^2\right) + (1+\gamma)^2\sigma_c^2\right). \end{aligned}$$

The correlation coefficient is therefore

$$\rho_{hf} = \frac{\gamma\left(\sigma_h^2 + \sigma_f^2\right) + (1+\gamma)^2\sigma_c^2}{\sqrt{\left(\sigma_h^2 + \gamma^2\sigma_f^2 + (1+\gamma)^2\sigma_c^2\right)\left(\gamma^2\sigma_h^2 + \sigma_f^2 + (1+\gamma)^2\sigma_c^2\right)}}$$

and the relative magnitude is

$$\mid \sigma_h - \sigma_f \mid = \mid \frac{\sigma_f^2 - \sigma_h^2}{\gamma^2 - 1} \mid .$$

From these relationships we find that the correlation coefficient is increasing in γ the parameter describing the spillover effect from one country to the other and the variance of the common shock ε_c. Higher variance of the idiosyncratic shocks tends to reduce the correlation between the cycles holding everything else constant. It is also evident that the relative standard deviation of the two cycles is independent of the variance of the common shock. Unless the idiosyncratic shocks are equal across the two countries, a higher value of γ reduces the difference. If the spillover effect is stronger, the variance of the two business cycles tends to be more equal. The only case when both the correlation and the relative standard deviation increase is when the variance of the foreign idiosyncratic shock (σ_f^2) is falling. This argument is consistent with recent empirical results provided by Stock and Watson (2003) who showed that the increases in synchronization observed for G–7 countries could be explained by lower volatility in idiosyncratic shocks.

Our empirical analysis raises the question whether there is a tradeoff between co–movements and the relative magnitude and also if there are differences between EU–member states and European countries that were not members at the time we measure these indicators. To shed some light on these questions, we run a regression with the contemporaneous cross–correlations ρ as a function of a constant, the absolute difference between standard deviations of national business cycles and the corresponding measure for EU member states. It is important to notice that we are not discussing any causal relationship between these variables, we are only interested in whether synchronization and the relative magnitudes are correlated and if there is a difference between all EU countries and EU member states. These regression results are shown in Panel A of Table 6. As can be seen from these estimates, we find a negative point estimate (although not statistically significant) of the parameter associated to the absolute difference in the magnitude. What is indeed surprising is that we also obtain a positive and significant point estimate for EU members. According to this regression result, a lower absolute difference in the magnitude is associated with a lower degree of business cycle synchronization for EU members only.[21]

This result tends to be robust to changes in the specification of the regressions. The results do not change when we allow the tradeoff to be sample dependent or when we include other explanatory variables. In Panel B, we allow the tradeoff to be sample dependent. In the first two columns we report the results when allowing the tradeoff for all EU–14 countries to vary across sub–samples. In the second column, we also distinguish between EU–14 and EU members. From these estimates, we find that the overall negative and significant relationship holds for two sub–samples, the Bretton–Woods period and during the implementation of the Single European Act 1987–1992. For one sub–sample (the flexible exchange rate period 1973–1978) we find a positive and significant relationship. This result is not dependent on a distinction between EU–14 and EU members as can be seen in the second column where we add the relative magnitude for EU member states. The parameter associated to the relative magnitude between EU members is significant at the 10% level and positive supporting our earlier result.

In the last two columns of Panel B in Table 6 we allow the tradeoff for EU members to vary across sub–samples. In the first of these two columns we find that there is a

[21]Running a regression with cross–correlations on a constant and the relative magnitude, we find no significant relationship. But as soon as we distinguish between EU–14 countries and EU members, we obtain a positive and significant parameter.

Table 6: Tradeoff between synchronization and magnitude.

Panel A: Tradeoff between synchronization and magnitude.			
Dep.var.	const	$\mid \sigma_i - \sigma_j \mid$	$\mid \sigma_i - \sigma_j \mid .*$ EUM
ρ	0.489	-0.043	0.103
	(0.032)	(0.033)	(0.032)

Panel B: Tradeoff between synchronization and magnitude. Dependent variable: ρ.					
const	0.509	0.506	const	0.468	0.496
	(0.030)	(0.030)		(0.024)	(0.030)
$\mid \sigma_i - \sigma_j \mid .* D_1$	-0.175	-0.182	$\mid \sigma_i - \sigma_j \mid .* D_1 .* EUM$	-0.150	-0.130
	(0.068)	(0.066)		(0.196)	(0.199)
$\mid \sigma_i - \sigma_j \mid .* D_2$	0.097	0.080	$\mid \sigma_i - \sigma_j \mid .* D_2 .* EUM$	0.299	0.324
	(0.047)	(0.048)		(0.042)	(0.045)
$\mid \sigma_i - \sigma_j \mid .* D_3$	-0.032	-0.055	$\mid \sigma_i - \sigma_j \mid .* D_3 .* EUM$	0.054	0.076
	(0.034)	(0.041)		(0.043)	(0.045)
$\mid \sigma_i - \sigma_j \mid .* D_4$	-0.110	-0.124	$\mid \sigma_i - \sigma_j \mid .* D_4 .* EUM$	-0.112	-0.094
	(0.041)	(0.043)		(0.074)	(0.078)
$\mid \sigma_i - \sigma_j \mid .* D_5$	0.048	-0.026	$\mid \sigma_i - \sigma_j \mid .* D_5 .* EUM$	0.079	0.107
	(0.030)	(0.053)		(0.028)	(0.034)
$\mid \sigma_i - \sigma_j \mid .* EUM$		0.076	$\mid \sigma_i - \sigma_j \mid$		-0.050
		(0.043)			(0.032)

Panel C: Can policy variables explain the tradeoff? Dependent variable: ρ.					
const	$\mid \sigma_i - \sigma_j \mid$	$\mid \sigma_i - \sigma_j \mid .*$ EUM	σ_{r-r^*}	σ_{D-D^*}	$\sigma_{\Delta s}$
0.489	-0.050	0.115	0.040		
(0.031)	(0.032)	(0.030)	(0.026)		
0.488	-0.042	0.101		-0.007	
(0.032)	(0.034)	(0.033)		(0.065)	
0.490	-0.055	0.126			0.099
(0.031)	(0.032)	(0.031)			(0.056)

Note: EUM denotes a EU membership dummy variable, D_i denotes a dummy variable for sub–sample i and $\mid \sigma_i - \sigma_j \mid$ is the absolute difference between the standard deviation of the business cycle in country i and j. The policy variables are instrumented using the absolute inflation differential, the sum of interest rates, the absolute difference between the ratios of government spending to GDP and the sum of the ratios of government spending to GDP. HAC standard errors using 4 lags are shown in parentheses below each parameter estimate.

strong positive relationship during the flexible exchange rate period and the most recent sub–sample. There is no significant tradeoff during the other three sub–samples according to these estimates. This conclusion does not change if we include the magnitude for all EU–14 countries in the regression with one exception. The parameter associated to the tradeoff between EU members during the EMS period is positive and significant at the 10% level.

Our conclusion from these estimates is that there seems to be a positive tradeoff between synchronization and the relative magnitude of business cycles for the EU member states. A higher degree of synchronization is associated with larger differences in the relative magnitude as the volatility of country–specific business cycles tends to be lower in recent years for some EU member states and higher for other. A similar tradeoff is not evident for European countries that are not members of the EU at the time of measurement except for the second sub–sample with flexible exchange rates where the parameter is positive and statistically significant at the 10% level, see the two first columns of Table 6. This raises concern over the attempts of using a common monetary policy to stabilize the European economies since it suggests that it is important to vary the intensity of the policy. It is possible, of course, that national fiscal policies can be used to compensate for differences in the intensity of the common monetary policy.

To answer the question whether similarities in economic policy and whether the exchange rate regime can explain the significant EU–membership effect, we run additional regression of the cross–correlations on a constant, the magnitude and the magnitude for EU members adding one policy variable at a time. These results are shown in Panel C in Table 6. We use the same instruments for the policy variables as in our earlier regressions. The overall impression from these tests is that the policy variables cannot explain the positive tradeoff. Neither differences in monetary policy nor differences in fiscal policy is statistically significant in these regressions and the parameter associated to the magnitude for EU members does not change much. It is still significant and positive. We also reach the same conclusion when adding exchange rate volatility. Our results suggest that a higher degree of exchange rate volatility is associated with a higher degree of synchronization, the same result as we obtained earlier. In this last regression, we also find a negative and significant tradeoff between synchronization and the magnitude for the EU–14 countries that are not members of the EU. This further highlights the differences between EU members and nonmembers.

To interpret these empirical results and to be able to speculate about future developments and the consequences of the common monetary policy in Europe, we have to look more closely at the exchange rate volatility we have measured for the five sub–samples. For the EU member states, exchange rate volatility was highest during the flexible exchange rate period and the most recent period. It is also for these two sub–samples we obtain a positive tradeoff between the relative magnitude and synchronization. This implies that a higher degree of exchange rate volatility is associated with more synchronization and larger differences in the magnitude of the business cycle. This would imply, if these relations are stable over time and over different monetary regimes, that business cycles in

EU member states will become less synchronized but also display less differences in the magnitude which would constitute a potential problem when implementing a common monetary policy and the common currency.

When the magnitude is similar, the common monetary policy will suit all member countries equally well. The less synchronized cycles, on the other hand, imply that the timing of the common policy will not be optimal for some member states. In addition to these implications, the common currency leading to lower exchange rate volatility (by definition) will lead to a lower degree of synchronization. These effects are counteracted by the tendency of increases in trade intensity among the EU members leading to more synchronized cycles. However, a higher degree of synchronization is according to our estimates correlated to larger differences in the magnitude. If this turns out to be the case in the future, then the common policy has the correct timing but will be too intense or too weak for some member states. Either way, our results raise concern about the implementation of a common monetary policy within the EMU area.

5 Conclusions

It is widely argued that the success of the common currency area in Europe rests on the uniformity of business cycle fluctuations. The main question, from an empirical point of view, is whether European integration also leads to a higher degree of similarity of business cycles.

Such development is desirably for the design of the monetary policy to be optimal within the EMU area. If business cycles are similar across the member states, then there will be fewer asymmetries in the timing and in the intensity of the common policy. This paper examines the effects of designing common institutions and policies on the co–movements and on the relative magnitudes of business cycles. The underlying argument is that a higher degree of symmetry between the European economies will lead to a more similar propagation mechanism such that the effects of structural shocks become more similar. As a result, business cycle fluctuations will be more similar across member states.

Our results suggest that European business cycles are synchronized to a high degree but we also find that the degree of synchronization has changed considerably since the early 1960s. In particular, we find that synchronization is higher during periods with more flexible exchange rates and lower when exchange rate volatility is low. These results question earlier findings that European business cycles became more synchronized during the EMS period. However, we also find that economic and monetary integration during the last 10 years have affected business cycle behavior and lead to increases in the degree of synchronization. Our evidence further suggests that there are several contradicting forces affecting the degree of synchronization, a lower exchange rate volatility and smaller differences in monetary policy leading to less synchronized cycles and increases in trade leading to more synchronization. As a major objective of the EU is economic and monetary integration, one would anticipate that the linkages should strengthen over time, maybe also offset the negative effects from the common monetary policy and lower exchange rate volatility.

When adding the analysis of the magnitude of European business cycles, the picture becomes more complex. Our estimates suggest that differences in the magnitude of European business cycles have risen over time and have never been so large for EU members. This piece of evidence raises concern about the common monetary policy as it is likely that the policy will be too expansive for some member states and too restrictive for others. This conclusion is supported by empirical evidence suggesting that differences in magnitude is significantly higher for EU member states after they entered the EU. The tradeoff between synchronization and differences in magnitude is positive such that larger differences coincide with a higher degree of synchronization. These empirical results highlight the potential problem when implementing a common policy in Europe. If business cycles become less synchronized and the relative magnitude more similar, then the intensity of the common policy tends to be optimal but the timing tends to be wrong for some member states. Similarly, if cycles become more synchronized as a result of economic integration and increased trade and there are large differences in the magnitude, then the timing of the policy will be more optimal but the policy too intense or too weak for some members. Our results, therefore, raises concern about the implementation of a common monetary policy in the EMU area.

A major objective of the EU is to foster stronger economic ties between members and this process will tend to increase the degree of compatibility between the member states. If this also leads to more synchronization and convergence of the amplitude of the business cycle in member countries is an open question and cannot be answered by looking at historical relationships. The analysis in this paper supports this view. We find that business cycle behavior change over time in response to new economic environments. This point, which is a version of the Lucas critique, implies that it is not possible to draw too strong policy conclusions from our empirical analysis. It may well be the case that economic integration leads to more similar business cycles within the EMU area even though our empirical analysis of historical data suggests the opposite.

Appendix A: Data sources

Industrial production To measure business cycles we use quarterly observations of industrial production taken from IFS for all countries except for Ireland and Portugal where the data is extracted from OECD Main Economic Indicators. All data are seasonally adjusted. Sample range is 1961:1–2001:4 for all countries except Belgium 1961:4–2000:4, Denmark 1968:1–2001:4 and Switzerland 1965:1–2001:4. Estimates of bilateral cross–correlations use all data available for each pair of countries.

Trade Annual bilateral trade statistics are obtained from IMF Direction of Trade Statistics. Sample range is 1961–2001.

Interest rates The following interest rates are used to measure differences in monetary policy over the sample 1980–2001: Austria – money market rate; Belgium – call money rate; Canada – overnight money market rate; Denmark – call money rate; Finland – average cost of CB debt; France – call money rate; Germany – call money rate; Greece – central bank rate; Ireland – exchequer bills; Italy – money market rate; Japan – call money rate; Netherlands – call money rate; Norway – call money rate; Portugal – up to 5 days interbank deposit; Spain – call money rate; Sweden – call money rate; Switzerland – money market rate; United Kingdom – overnight interbank rate; United States – Federal funds rate. For the period 1961–1979 we use discount rates taken from IFS except for Greece where we use central bank rate. All data are quarterly.

Consumer price index We use quarterly observations of the consumer price index taken from IFS to compute annual inflation.

Budget deficit as a fraction of GDP Annual data on net lending as a fraction of GDP for the European countries, Japan and the US during the period 1970–2001 are obtained from European Economy Tables 78A linked to data from Table 78B. Data for the period 1960–69 are obtained from IFS. Data for other non–European countries are taken from IFS. The sample range is 1961–2001 except Japan and Portugal 1970–2001.

Exchange rate volatility Monthly nominal exchange rates are obtained from IFS. Sample range is 1961:1–2001:4. Exchange rate volatility is measured as the average of log first difference of bilateral exchange rates.

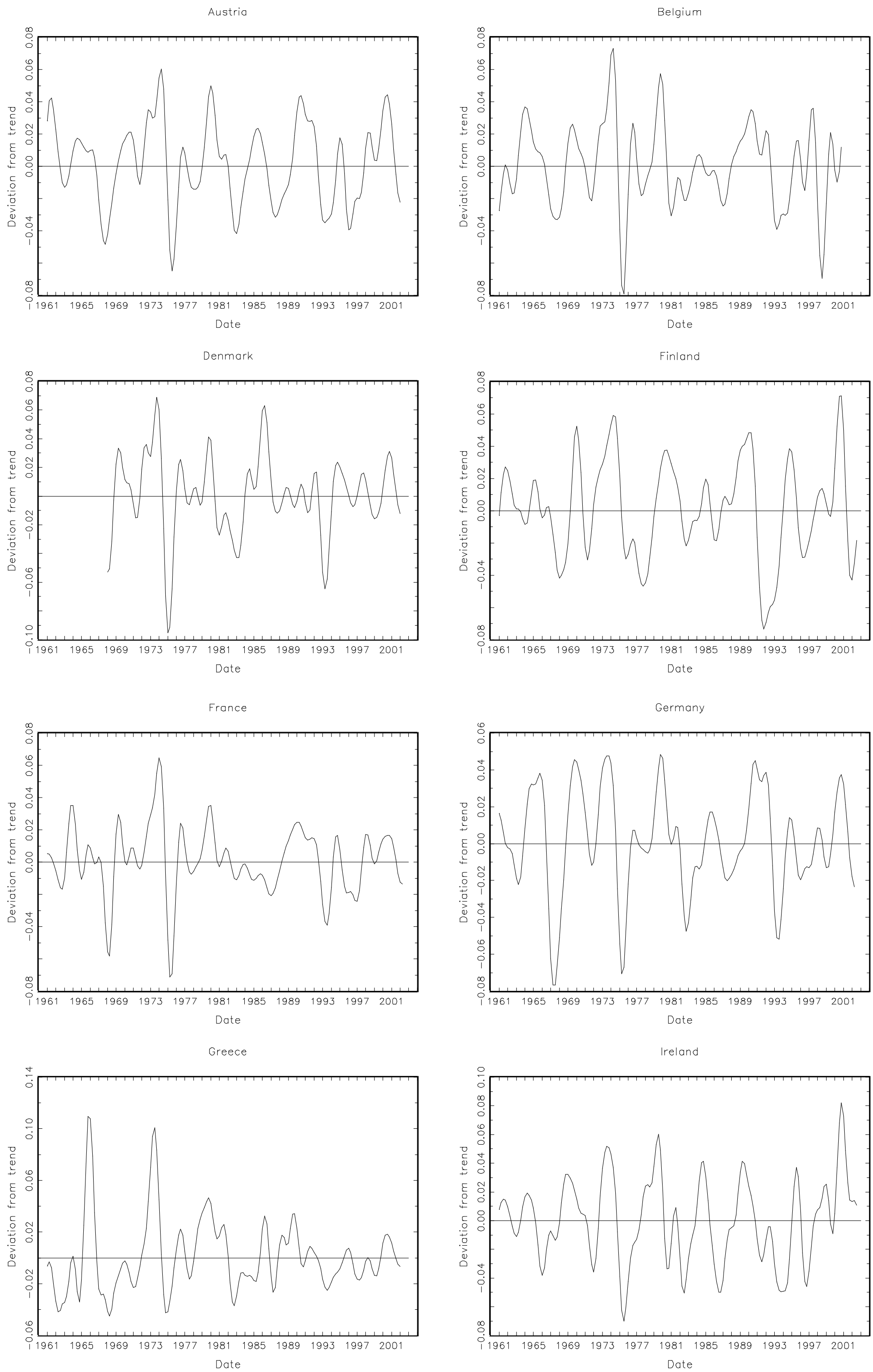
Government expenditure as a fraction of GDP Annual observations of government expenditure and nominal GDP are obtained from IFS. The sample ranges are: Austria and Belgium 1961–98, Canada 1961–2000, Denmark 1961–1999, Finland 1961–1998, France 1972–1997, Germany 1961–1998, Greece 1961–1999, Ireland 1961–1999, Italy 1961–98, Netherlands 1961–98, Norway 1961–98, Portugal 1970–98, Spain 1962–99, Sweden 1961–2000, Switzerland 1961–2001, United Kingdom 1961–99, United States 1961–2001.

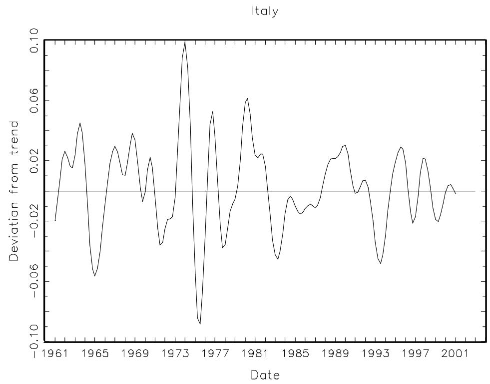
GDP per capita Real Gross Domestic Product per Capita measured in current US$ taken from Penn World Table 6.1 (CGDP). The sample range is 1960–2000.

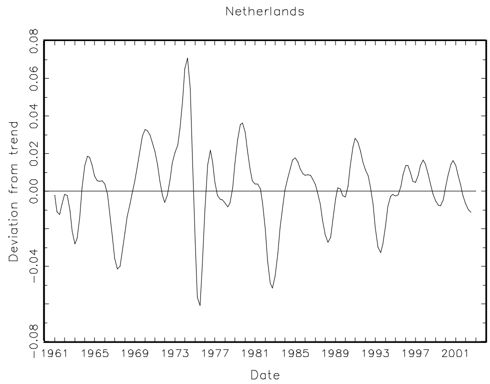
Distance Distance between two locations is measured as the great circle between largest cities in each country according to Fitzpatrick and Modlin (1986).

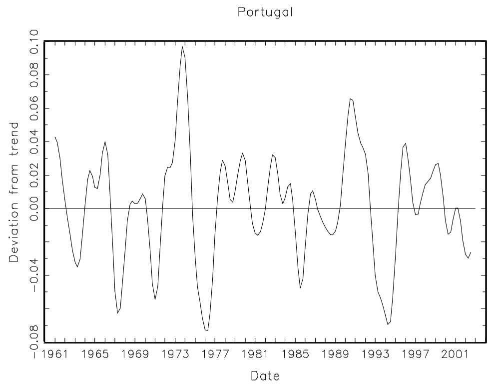
Linguistic distance This measure ranges from 0 (nobody speaks the same primary language in the two countries) to 10000 (everybody speaks the same primary language) taken from Boisso and Ferrantino (1997). Note that we have updated this series such that the primary language in the three Nordic countries Denmark, Norway and Sweden is identical (the language variable is 10000). The reason for this is that the language spoken in the three Nordic countries essentially is the same. In addition we let the language variable between Finland and the three Nordic countries be equal to the measure of identical primary language between Finland and Sweden (600).

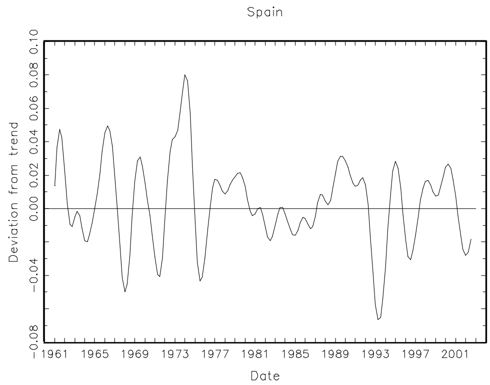
Appendix B: Bandpass filtered industrial production

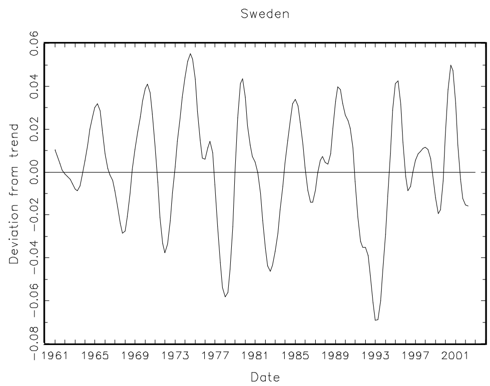


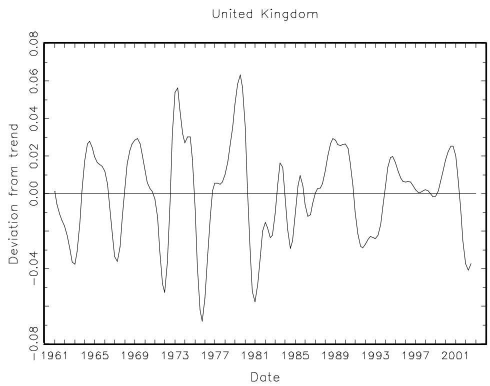

Italy
Deviation from trend
Date

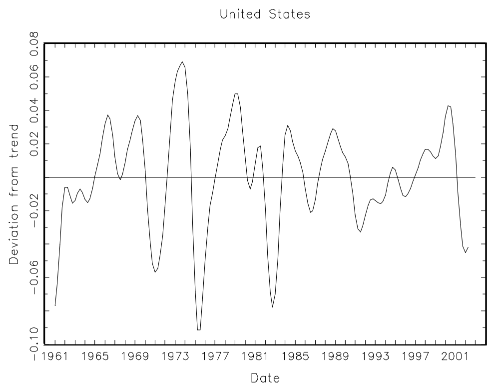

Netherlands
Deviation from trend
Date


Portugal
Deviation from trend
Date


Spain
Deviation from trend
Date


Sweden
Deviation from trend
Date


United Kingdom
Deviation from trend
Date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Deviation from trend
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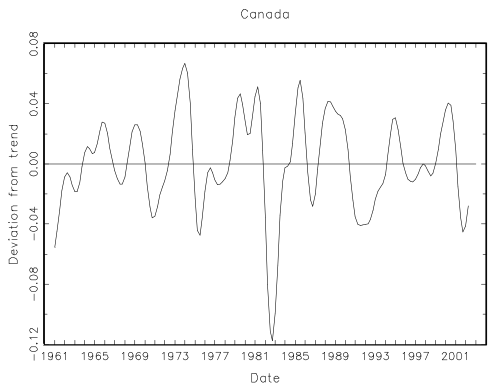
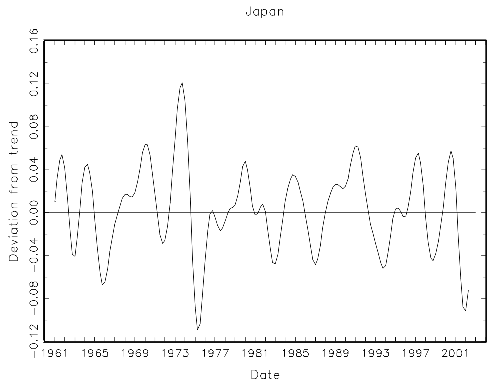
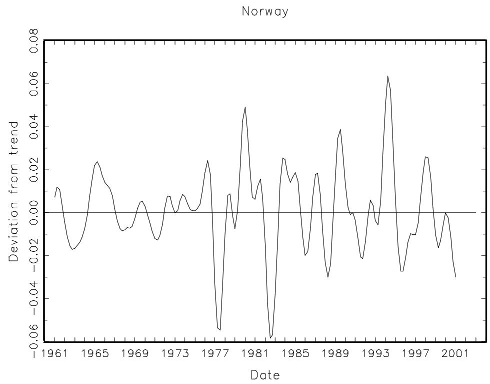
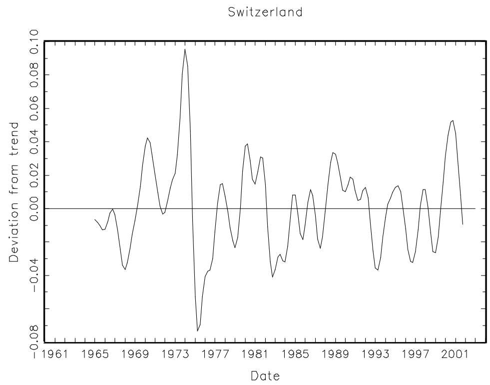

Canada
Deviation from trend
Date


Japan
Deviation from trend
Date


Norway
Deviation from trend
Date


Switzerland
Deviation from trend
Date

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