ECONOMIC COMOVEMENTS IN EUROPEAN COUNTRIES*

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A B S T R A C T

This paper examines the existence of common movements in production, prices and interest rates in three countries: France, Germany and the United Kingdom. To analyse this issue, the usual approach of studying cross-correlations is extended. Though these European countries are closely linked to each other, the results obtained vary substantially over time, with the economic variables and in the countries under consideration.

Keywords: Business cycle; comovements
JEL classification: E32

R E S U M E N

Este trabajo examina la existencia de movimientos comunes en la producción, en los precios y en los tipos de interés en tres países: Francia, Alemania y el Reino Unido. Para analizar este tema, se extiende el enfoque habitual del estudio de las correlaciones cruzadas. A pesar de que estos países europeos están estrechamente relacionados, los resultados varían apreciablemente a lo largo del tiempo, con las variables económicas y en los países en consideración.

Palabras clave: Ciclo económico; comovimientos.
Clasificación JEL: E32

1. INTRODUCTION

The study of common or similar economic movements occurring at the same time in different countries (comovements) has received the attention of economic research for many years. The usual belief assumes the existence of positive comovements between developed countries. Traditionally, it has been thought that these comovements may be due to different reasons or transmitted through different channels. A first source of comovements would be global shocks with world-wide influences. Clear examples of this kind of shocks were the oil price increases in the 70's, which affected developed economies in a similar way. Another source (or channel) would be international trade via changes, for example, in the demand for imports or in relative prices. Finally, capital mobility and the evolution of financial markets could also be the origin of comovements. Over time, several facts have stressed the presumption of positive comovements: i) the higher degree of openness of most economies; ii) the integration of different economies with the building of economic unions; and iii) the deregulation of financial markets and the relaxation of controls on international capital movements, which have increased the importance of these markets and strengthened their relationships all over the world. In spite of all these facts, the different performance of the U.S., Japanese, and European economies in the last years has questioned this conviction. In the light of recent behaviour, they seem to be in very distinct phases in the business cycle, and the existence of positive comovements is not at all clear. On the contrary, in some cases, they seem to be negative.

This issue of the existence of comovements has been tackled both from a theoretical and from a purely empirical perspective. Several theoretical models imply the existence of certain relationships between the same economic variables in different countries. Thus, for example, the Fleming-Mundell model implies a negative transmission of shocks, depending on the exchange-rate regime. As a negative relationship is difficult to accept, given the empirical evidence, extensions, modifications and alternative models have been proposed. Thus, Cantor and Mark (1988) present a two-country model, each with an infinitely-lived representative agent that describes the behaviour of firms, consumers and workers with the same wealth and tastes. In this model, although exchange rate considerations are not taken into account, securities markets transmit business cycles and originate positive cross-correlations in output. Analogously, Greenwood and Williamson (1989) build a two-country overlapping generations model with perfect capital mobility in which, both under flexible and fixed exchange rate systems, output, interest rates and inflation are positively correlated across countries.

Economic comovements are also important from a policy point of view. This is especially true with regard to European countries. If European economies are fairly

synchronized, then little is lost with a common economic policy. On the contrary, if there are strong divergences, then different or asymmetric economic policies would be needed by the different countries. In particular, independent monetary policies or independent exchange rate policies could be necessary to stabilize domestic economies.

Empirically, the relationship between the fluctuations in economic activity in different countries, especially in developed ones, has been considered over many years. A variety of methodologies have been used in the research on this topic. Two classifications of these methodologies are particularly relevant. The first classification allows to distinguish the studies that are based on the timings and phases of the business cycles in the countries under examination (mainly, those established by the National Bureau of Economic Research, NBER) from those that do not rely on any established chronology of the business cycles. The second classification distinguishes between the approaches that are merely interested in the comovements in different countries from those that pursue the confirmation (or denial) of the existence of a common international cycle.

The results obtained in empirical research support mostly the existence of positive relationships. By using chronologies similar to that of the NBER, Moore and Zarnowitz (1986, p. 776) conclude that 'The international connections among growth cycles since World War II seem to be about as pervasive as those among business cycles before the war'. In the same way, Artis, Kontolemis and Osborn (1997) detect a strong association between the business cycles regimes (expansions or contractions) in several European countries. Without relying on any business cycle chronology, Stulz and Wasserfallen (1985) find a positive international connection between developed countries, and Gerlach (1988) and Lumsdaine and Prasad (1997) yield evidence in favour of a world business cycle. While virtually all these contributions focus on output, Bowden and Martin (1995), when examining up to eighteen series, find statistically significant coherences despite the fact that evidence for an international business cycle is not very strong.

A point that has received special attention in empirical research has been the evolution of the strength of the relationships over time. Backus and Kehoe (1992) present cross-country correlations generally higher between World War I and World War II than before World War I and after World War II. In turn, the correlations are typically larger after World War II than before World War I. Nevertheless, Zarnowitz (1992) finds a high conformity between the business cycles in the European countries before World War I that decreased in the following two decades. More specifically, many authors have addressed the question of a possibly distinct intensity with flexible and fixed exchange rates with very different answers. Gerlach (1988) finds higher coherence under the flexible exchange period, Lumsdaine and Prasad (1997) do not find

systematic differences between the Bretton Woods and the post Bretton Woods periods, and Baxter and Stockman (1989, p. 399) find that 'the international correlation of output fluctuations generally decreased in the post-1973 period compared with the earlier (Bretton Woods) period.'

Consequently, the contributions of empirical literature can be summarised as follows: i) consensus on the existence of positive comovements in output, ii) very different conclusions on the evolution of its intensity over time, and iii) not definite conclusions on comovements in other variables. The aim of this paper is to examine these points (that is, to verify or reject i), and to cast some light on ii) and iii)) with regard to three European countries: France, Germany and the United Kingdom. With that purpose, section 2 presents the data used: production, prices and interest rates from these countries. Section 3 explains in detail the method followed, and presents empirical evidence and its implications. Finally, section 4 summarises the main results and conclusions.

2. DATA

When studying the issue of common movements, the question arises of which variables to consider. Most research has considered output (industrial production or GDP) or has built a representative variable of the domestic business cycles. However, as there could exist comovements in economic variables different from production, it would be interesting to examine this possibility in other variables and not restrict the analysis to a single variable. Therefore, to obtain a deeper analysis on the existence of comovements, four variables will be considered. Annual data on industrial production, consumer price indexes, short-term interest rates and long-term interest rates from France, Germany and the United Kingdom have been used. All these observations were collected from *International Financial Statistics*, International Monetary Fund (series xxx66..IZF…, xxx64…ZF…, xxx60B..ZF… and xxx61…ZF…, respectively). They cover the period 1950-1997, excepting long-term interest rates for Germany that begins in 1956.[1]

The use of annual data requires an explanation. Though most contributions do not discuss the frequency election, many of them use higher frequency data (i.e. monthly or quarterly data). This practice has the advantage of having a greater number of observations at

[1] In what follows, the results that involve German long-term interest rates have been obtained with this sample period, although not explicitly stated.

one's disposal. However, it has two drawbacks. The first, and less important, is the shorter span of observations. Many economic series are not available on a monthly basis, or have begun to be built on a quarterly basis more recently. The second drawback is more critical, and concerns the concept of comovement itself. This concept entails common or similar movements in economic variables *over a certain period of time*, but the duration of this period is somewhat arbitrary. Obviously, nobody would accept the premise that similar economic movements occur in the same brief instant (second, minute, hour, …), with the exception of some movements in financial markets. With regard to macroeconomic variables, to establish this period as one month, or even one quarter, seems to be a too brief election, as the transmission of movements may take unavoidable delays. On a monthly or quarterly basis, some comovements could be seen as sequential or causal, rather than contemporaneous, when they are due to a common exogenous cause but the effect takes a few weeks more in one country than in others. An annual basis seems a reasonable election for examining the existence of relevant comovements.

In order to induce stationarity in these four variables, they must be detrended. The selection of a detrending procedure is a complex task because there are several possible ways of doing so, and each of them is pertinent in certain circumstances and has its own implications. The two most habitual methods are the Hodrick and Prescott (1980 and 1997) filter, HP, and first differencing. The first method has been widely used, specially in those contributions interested in the coherence of business cycles, but recently several authors have warned of the consequences of applying this filter (see King and Rebelo, 1993, Jaeger, 1994 and Cogley and Nason, 1995). In particular, when studying comovements in HP-filtered series, there exists one potential problem, which may be important. A common tool in the analysis of comovements is the estimation of cross-correlations, but the standard errors of these estimates may be large. For HP-filtered independent random walks, Harvey and Jaeger (1993) report asymptotic standard deviations of the sample cross-correlations much higher than those obtained when at least one of the filtered series is white noise. Hence, the danger of finding spurious comovements if correct standard errors are not used.

Given all these warnings and the potential problems, the data will be first differenced. This practice has been used in Gerlach (1988), Baxter and Stockman (1989), Bowden and Martin (1995), Lumsdaine and Prasad (1997) and many others. (Augmented) Dickey-Fuller and Phillips-Perron unit root tests, whose results are available on request, confirmed that the series cited above (or their logarithms) are non-stationary. Therefore, first differences were taken to induce stationarity and, thus, new series were obtained that extend from 1951 to 1997. These series are composed of the changes in the logarithms (rates of growth) of

industrial production, changes in the logarithms of consumer prices indexes (inflation rates), and changes in short- and long-term interest rates.

3. METHODS AND RESULTS

Three main methodologies have been used in analysing economic comovements: i) spectral analysis, ii) vector autoregressive (VAR) models, and iii) cross-correlations. Each of these methods is pertinent in certain circumstances and has its own implications. Spectral analysis is an important tool in this context and cross-spectral density functions may be helpful in detecting and measuring comovements. In fact, it has been used in Gerlach (1988) and Bowden and Martin (1995). Nevertheless, spectral techniques require much more data than other techniques, as they are not used so efficiently. With macroeconomic series, the number of observations is relatively low, specially when the interest lies in the comovements over short periods of time, which is a serious limitation in the application of spectral methods. VAR models have also been repeatedly used in order to examine the dynamics between economic variables. Impulse response functions may reflect the response over time of an economic variable to innovations in another economic variable. However, the model must be identified in the sense that restrictions must be imposed to allow that the innovations be properly interpreted. Ordinary VAR models introduce arbitrary restrictions. Structural ones impose theoretical restrictions but, even in the case that this approach could be followed with different variables and different countries, the robustness of the conclusions is questionable (see Cooley and Dwyer, 1998). Finally, the study of cross-correlations is probably the most widely used method. In what follows, this will be the approach undertaken, but with important qualifications. Firstly, as cross-correlations do not allow the analysis of comovements between more than two countries, they will be extended to a multivariate framework, where any number of countries, n, could be considered, $n > 1$. Secondly, in order to analyse the dynamics of comovements, moving cross-correlations and moving correlation matrices will be used.

3.1. Bivariate framework

In order to examine the degree of coherence between economic movements in two countries, cross-country correlations will be estimated. Given two independent series, X_{1t} and X_{2t}, the asymptotic distribution of their contemporaneous cross-correlation is given by

$$r_{12} \Rightarrow AN\left(0,\ T^{-1}\left(1+2\sum_{k=1}^{\infty}\rho_{11}(k)\rho_{22}(k)\right)\right), \qquad (1)$$

where r_{12} is the sample cross-correlation between X_{1t} and X_{2t}, *AN* stands for asymptotically normal, *T* is the sample size and $\rho_{ii}(k)$ is the autocorrelation of order *k* of X_{it}, *i* = 1, 2 (see Brockwell and Davis, 1991). This means that the asymptotic distribution of sample cross-correlation depends on the autocorrelation functions of both series, which makes the analysis of cross-correlations a problematic task. However, when one (or both) of the series is white noise, the asymptotic distribution simplifies and (1) becomes

$$r_{12} \Rightarrow AN\left(0,\ T^{-1}\right). \qquad (2)$$

Therefore, before computing the cross-correlations, the variables were filtered using its own past by selecting the AR model with the lower Schwartz statistic (up to AR(4)) and using its non-autocorrelated residuals. Table 1 displays the cross-country correlations. They clearly indicate a strong positive correlation with negligible *P*-values. The conclusion is, then, evident: in the period 1951-1997 the movements in the four variables have been similar in the three European countries.

Nevertheless, though these results indicate a strong conformity, they do not allow the observation of some interesting facts of how they evolve over time. With that purpose, now these correlations will not be computed for the whole period, nor for only two periods (the fixed and the flexible exchange rates periods, for example). Instead, they will be computed initially for the very first years of the sample, then a new correlation will be computed by dropping the first observation and adding a new one in the end, and so on. In this way, a picture is obtained of their evolution over time. The number of observations used in each correlation is 12, but similar results are obtained when using a different number of observations (10 or 15, for example). Again, the series were filtered recursively using their own past. AR models with the lower Schwartz statistic (up to AR(4)) were selected for the sample period that begins in 1951 and ends in the last year to be included in the correlation estimation, and using its non-autocorrelated

residuals. The first correlation was computed for the period 1955-1966. As an example to illustrate this method, in studying the coherence between industrial production in France and Germany these two series were filtered and the cross-correlations for the periods 1955-1966, 1956-1967, …, 1986-1997 have been calculated. A plot of these correlations will show the evolution of the strength of the comovements in the rates of growth in industrial production in France and Germany over the lasts decades. It is important to bear in mind that the cross-country correlations thus obtained are not independent, unless they are at least twelve years apart, but they provide a meaningful image of the evolution of the intensity of the comovements over time.

As the sample size is very small, $T = 12$, one could suspect that the asymptotic distribution in (2) may be misleading. Simulations of cross-correlations between two independent N(0, 1) random variables with sample size $T = 12$ were computed. The sample distribution thus obtained is very close to the asymptotic distribution reflected in (2), meaning that the asymptotic distribution is a good approximation even for sample sizes as low as $T = 12$. Figures 1, 2, 3 and 4 show the evolution of the correlations between these countries. In each graph, 95% confidence bands are also shown. As the asymptotic standard error is equal to $T^{-1/2}$, these bands have been drawn at $\pm 1.96 \cdot T^{-1/2} = \pm 1.96 \cdot 12^{-1/2} = \pm 0.566$. When examining the different figures, the most interesting conclusion is that the intensity of the comovements varies clearly over time. In spite of the results shown in Table 1 for the period 1951-1997, in many sub-periods the comovements are not very strong. Even in some case (for example, the comovements between short-term interest rates in Germany and the U.K.) significant correlations are not detected in, practically, any of the different sub-periods, though a significant correlation is obtained in the whole period. Looking more deeply, these figures can be studied from several points of view as attention is paid to the evolution over time, to the specific countries or to the different economic variables. Thus, in the first place, each of the panels can be examined in a temporal perspective. This perspective clarifies whether the degree of cohesion has increased over time, and, in particular, whether the cohesion has been higher with flexible exchange rates. In the second place, for each pair of countries, the comparison of the corresponding panels may show a distinct degree of coherence in the different economic variables. In the third place, the different panels in each figure may cast some light on the degree of cohesion between the different pairs of countries.

Table 1. Cross-country correlations.

Variable	Countries	Correlation	*P*-value
Industrial Production	France-Germany	0.653	0.000
Industrial Production	France-U.K.	0.496	0.001
Industrial Production	Germany-U.K.	0.667	0.000
Consumer Prices	France-Germany	0.283	0.052
Consumer Prices	France-U.K.	0.375	0.010
Consumer Prices	Germany-U.K.	0.458	0.002
Short-term Interest	France-Germany	0.509	0.000
Short-term Interest	France-U.K.	0.362	0.013
Short-term Interest	Germany-U.K.	0.378	0.010
Long-term Interest	France-Germany	0.653	0.000
Long-term Interest	France-U.K.	0.627	0.000
Long-term Interest	Germany-U.K.	0.676	0.000

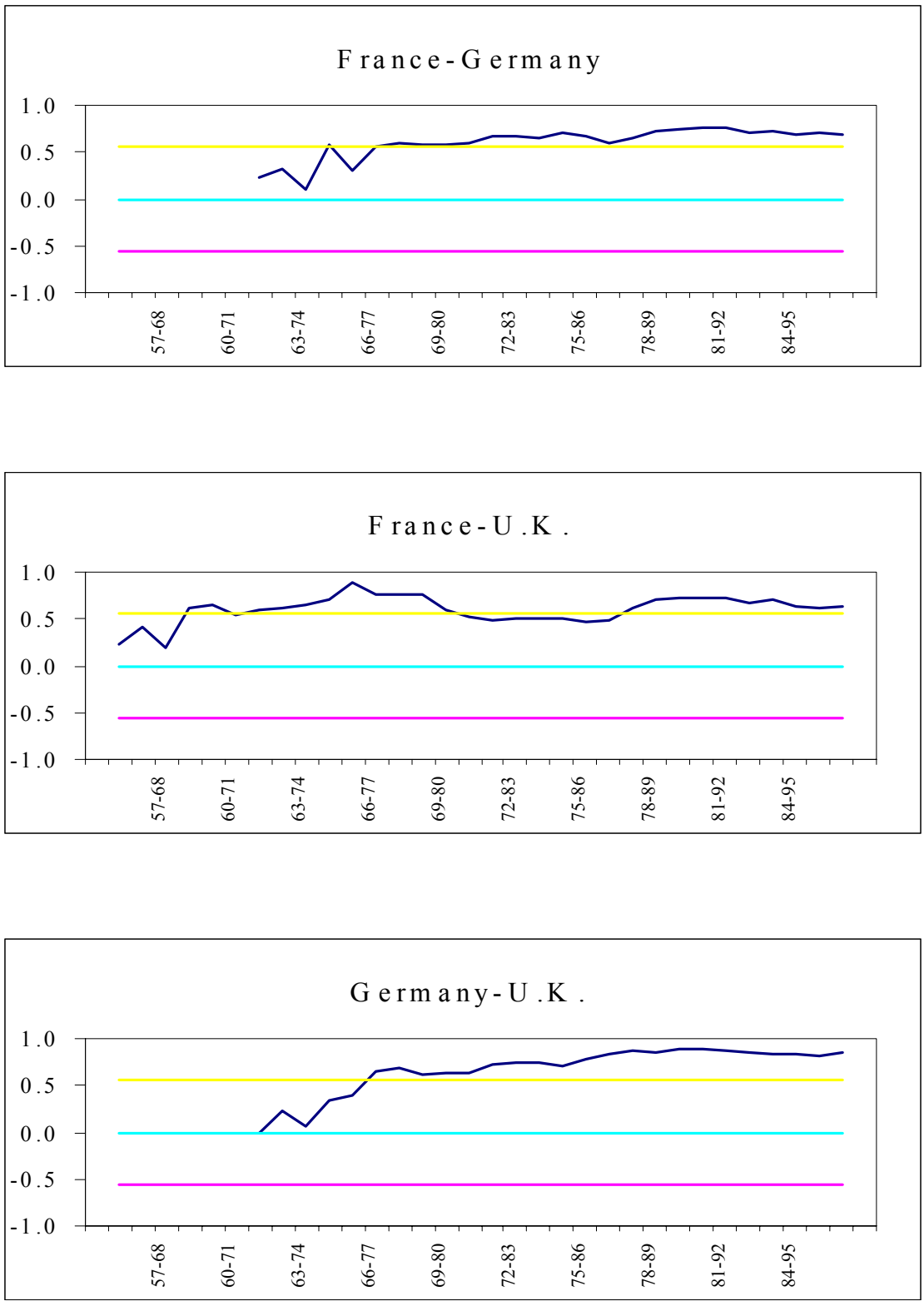
Cross-country correlations for the period 1951-1997. The *P*-values have been computed under the hypothesis that the correlations follow a N(0, 1/*T*) distribution, *T* being the sample size.

Figure 1. Cross-correlations in rates of growth in industrial production

Figure 2. Cross-correlations in inflation

Figure 3. Cross-correlations in changes in short-term interest rates

Figure 4. Cross-correlations in changes in long-term interest rates



With respect to the first approach, some graphs show an increase in the coherence over time, but for some variables and combinations of countries it has not increased at all. Thus, the correlation in production (as well as in the other variables) between France and Germany has clearly increased over time, but the correlation in prices between Germany and the United Kingdom seems to have decreased. Coherence in short-term interest rates between these same countries has remained roughly at the same level. Therefore, although there seems to be, in general, a higher coherence in recent years, not all the variables and all the countries behave in the same way.

With regard to the second approach, some differences are observed in the four variables. The comovements in long-term interest rates are the highest; as expected, they are clearly higher than in short-term interest rates. It is somewhat surprising that the coherence in prices is not so high as in production or in interest rates. This is especially true for the U.K., with non-significant correlations with the other two countries most of the time. These divergent results also suggest that it is much more interesting to study the comovements in the different variables than simply to restrict the analysis to output or to a single variable that intends to represent the whole business cycle.

Finally, when examining the correlations of the different pairs of countries in the last years, France and Germany display significant correlations in the four variables examined. They are higher than in the other two cases (France-U.K. or Germany-U.K.) except in long-term interest rates, where, in spite of being fairly high, they are a little lower than for Germany and the United Kingdom. On the other hand, in recent years, the correlations of the United Kingdom with France or Germany, though positive, are not significant in production, prices and short-term interest rates. Only movements in long-term interest rates are significantly correlated with those of France or Germany. In agreement with Artis and Zhang (1999), these results confirm the common belief of a higher integration of the French and German economies and a lower economic integration of the United Kingdom with the other two European countries in recent years.

3.2.. Multivariate framework

Cross-correlations provide a good measure of linear relationship between economic variables in *two* different countries. However, if we intend to analyse the comovements between more than two countries, correlation matrices must be used. In what follows, the case of n countries will be tackled, for any integer $n > 1$.

Let **R** be a square matrix of order *n*, whose *ij*-element is the (sample) correlation of a certain filtered economic variable in countries *i* and *j*. That is, **R** is a correlation matrix. The determinant of this matrix, $|\mathbf{R}|$, will lie between 0 and 1: $0 \leq |\mathbf{R}| \leq 1$, and will be a measure of the conformity of the movements in the considered economic variable in all the countries. A value of $|\mathbf{R}|$ close to 1 denotes the absence of comovements in the countries taken together, while a value close to 0 denotes strong comovements.

Under the null hypothesis that all cross-correlations are zero, $\rho_{ij} = 0$, for *i*, *j* = 1, 2, …, *n* and $i \neq j$, $-(T-1)\log|\mathbf{R}|$ follows asymptotically a χ^2 distribution with $n(n-1)/2$ degrees of freedom (see Kendall, Stuart and Ord, 1983). This property could be used to analyse formally the existence of comovements between the three countries under study. Table 2 shows these statistics and their *P*-values. In agreement with previous results, the null hypotheses of absence of comovements are clearly rejected.

Table 2. Tests of comovements in France, Germany and the United Kingdom.

Variable	**Countries**	$-(T-1)\log\|\mathbf{R}\|$	***P*-value**
Industrial Production	France-Germany-U.K.	53.17	0.000
Consumer Prices	France-Germany-U.K.	18.64	0.000
Short-term Interest	France-Germany-U.K.	23.04	0.000
Long-term Interest	France-Germany-U.K.	59.05	0.000

T denotes the sample size and **R** is the correlation matrix whose *ij*-element is the sample correlation of the (filtered) variable in countries *i* and *j* in the period 1951-1997. The *P*-values have been computed under the hypothesis that the statistics follow a χ^2_3 distribution.

As before, these results may conceal the evolution of the comovements over time. Therefore, rolling determinants and their corresponding tests statistics will be computed following an analogous way to that used in sub-section 3.1. Once again, as the sample size is small (12 annual data), one may wonder whether or not the asymptotic distribution is misleading. Consequently, 50,000 simulations were generated for $-(T-1)\log|\mathbf{R}|$, for different sample sizes, *T* = 12, 20 and 50, and **R** being a matrix of sample correlations of three independent N(0, 1) random variables. Table 3 shows the quantiles of the sample distribution

of $-(T-1)\log|\mathbf{R}|$ and the quantiles of the asymptotic distribution χ^2_3. It may be seen that for sample sizes moderately high, T = 50, for example, the asymptotic distribution provides a good approximation. But for low sample sizes, as T = 12, using the asymptotic distribution would incorrectly yield too many rejections of the null; that is, too many detections of comovements.

Table 3. Sample distribution of $-(T-1)\log|\mathbf{R}|$.

Quantil	***T* = 12**	***T* = 20**	***T* = 50**	χ^2_3
0.90	7.48	6.96	6.46	6.25
0.95	9.36	8.50	8.03	7.81
0.99	13.6	12.2	11.8	11.3

T denotes the sample size and **R** is the correlation matrix of three independent N(0, 1) random variables.

For a significance level equal to 0.05, the critical value for T = 12 obtained in the simulations is 9.36. Therefore, when testing for absence of comovements, $H_0: |\mathbf{R}| = 1$ against $H_1: |\mathbf{R}| < 1$, the null is rejected if $-(T-1)\log|\mathbf{R}| > 9.36$, or, equivalently, if $|\mathbf{R}| < 0.427$. As it seems to be much more intuitive, the measure $\Lambda = 1 - |\mathbf{R}|$ will be used instead of $|\mathbf{R}|$. Λ will also be comprised between 0 and 1: $0 \le \Lambda \le 1$. High values of Λ imply strong comovements while low values imply the absence of comovements. Therefore, the null hypothesis of absence of comovements will be rejected if $\Lambda > 1 - 0.427 = 0.573$. Figure 5 shows the evolution of the rolling values of Λ. A horizontal line has been drawn for Λ = 0.573. Values above this line indicate the rejection of the null hypothesis of absence of comovements at the 0.05 significance level.

Figure 5 shows that the comovements in the first sub-periods in the sample are mostly non-significant. Focussing in the second half of the sample, a distinct pattern is observed for the different variables. The evolution of conformity in long-term interest rates in France, Germany and the U.K. presents a definite pattern with an almost monotonously increasing conformity. Industrial production and short-term interest rates are also integrated in many of the 12-year sub-periods but not so strongly as long-term interest rates and with different time

patterns. While industrial production reached the highest coherence from the mid sixties to the mid eighties, the coherence in short-term interest rates became highest from the mid seventies to the mid nineties. With regard to consumer prices, the pattern is not definite, though a slight increase in conformity is observed over time. As the approach followed in sub-section 3.1 may be seen as a particular case ($n = 2$) of the general approach introduced in this sub-section, these general patterns are in accordance with those of Figures 1, 2, 3 and 4. In particular, under the increasing conformity in long-term interest rates in the three countries lies the increasing conformity between each pair of countries, as reflected in Figure 4.

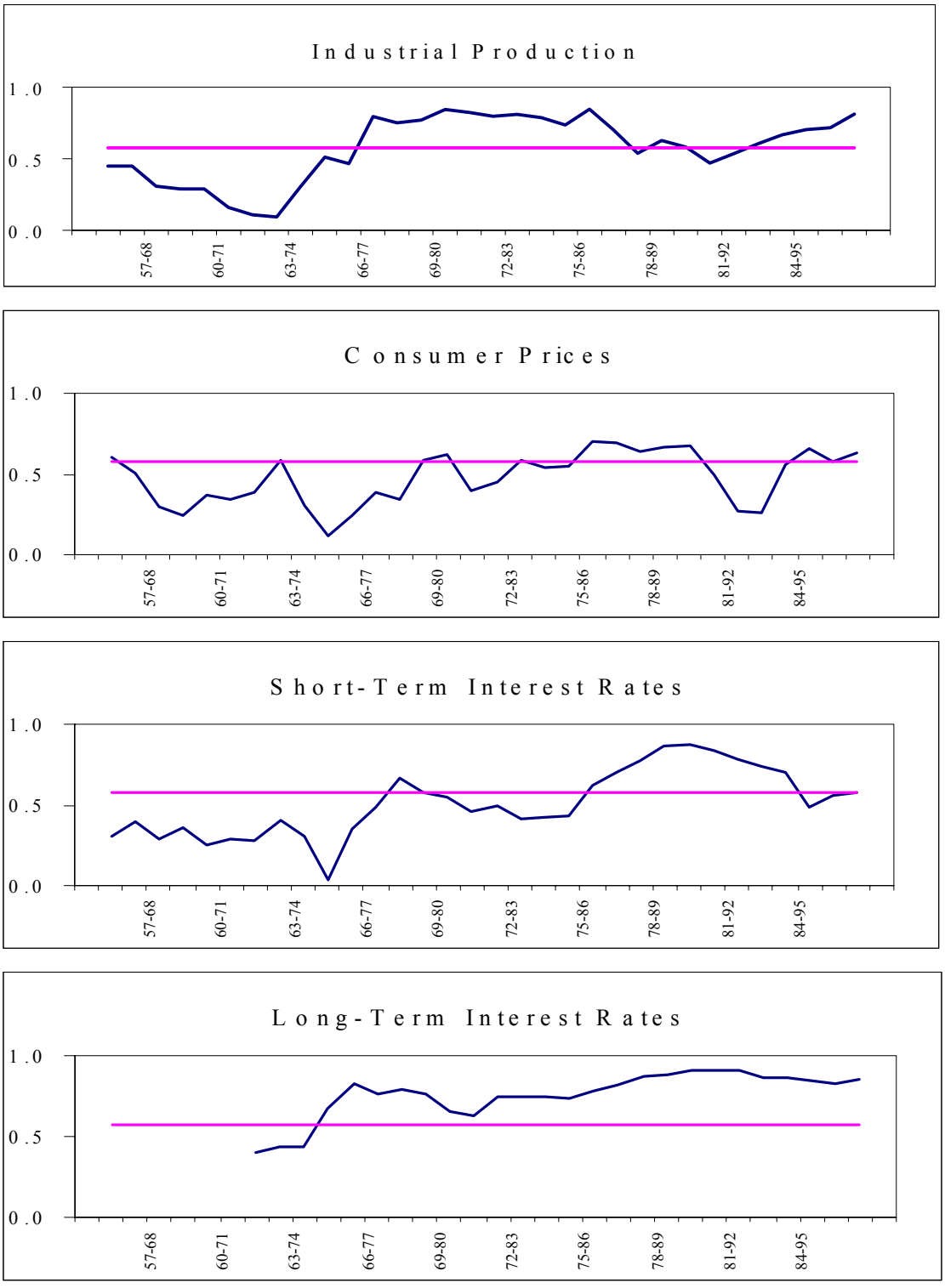
Finally, it is worth mentioning that all the results obtained in this sub-section, as well as those in sub-section 3.1, are fairly robust to different practices. For three of the four variables, filtering does not induce appreciable modifications in the results obtained with regard to considering the original (relative) changes without filtering. Only inflation presents some differences that are relatively small. Doubtless, this robustness is due to the weak dynamics that present changes in industrial production and in interest rates, which in many cases are (nearly) white noise. Nor do the results depend on the election of twelve years as the 'window length'. Obviously, as the length increases, the evolution of cross-correlations becomes flatter, and, conversely, when it decreases the evolution is more irregular. But the features pointed out in this paper are also observed with different lengths, and other reasonable elections, as 10 or 15 years, yielded similar results.

4. SUMMARY AND CONCLUSIONS

In order to analyse the existence of common movements or a common business cycle in France, Germany and the United Kingdom, moving cross-country correlations and correlation matrices in (filtered) annual changes in industrial production, consumer prices, short-term interest rates and long-term interest rates have been examined.

Undoubtedly, economic comovements do exist between these European countries, which are closely linked to each other. Nevertheless, important differences are observed over time, in the different pairs of countries and in the different economic variables. Generally, the comovements are stronger in the last years, though there are striking exceptions. France and Germany are strongly related to each other, while the comovements of the United Kingdom with each of the other two countries are usually lower, especially in recent years.

Figure 5. Conformity of comovements in France, Germany and the United Kingdom.



When taking the three countries together, there is a significant conformity in all the variables, but the comovements in long-term interest rates and industrial production are much stronger than in consumer prices and short-term interest rates. These results suggest the existence of a common business cycle in these three European countries, as well as the convenience of analysing different economic variables separately. With respect to its evolution over time, the conformity in the 80's and 90's is clearly higher than in the 50's and 60's.

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