SOME FACTS ABOUT THE CYCLICAL CONVERGENCE IN THE EURO ZONE*

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1. INTRODUCTION

One of the key elements on the ongoing debate about monetary unions is the degree of business cycle resemblance among the member states. This paper contributes to this debate by providing a descriptive analysis of the cyclical evolution of the output of the European Union countries between 1960 and 1999. As the creation of the European Monetary Union probably represents a regime shift(1) no attempt is made at forecasting cyclical fluctuations. Nonetheless, historical elements can be very useful as a benchmark in the analysis and interpretation of current results.

We resort to the association and synchronisation concepts to define cyclical convergence. Using a time domain approach, we purport the use of several parametric and non-parametric statistics to investigate whether the cycles of these countries have converged to the euro area business cycle during the sample period.

The results of this paper are much in line with those from previous studies. Some recent research provides support for the view that there was an increase in the similarity between the business cycles of the European Union countries. Arthis and Zhang (1995) studied the cyclical movements in the industrial production and focused on the role of the Exchange Rate Mechanism in inducing common business cycles among the participating countries. They have found that over time, the business cycle affiliation of most of these countries had shifted from the United States to Germany. Angeloni and Dedola (1999) studied a larger set of variables to conclude for an increase in the cyclical correlation of output, prices and stock indexes between euro countries. In our study, the results obtained suggest that Italy, Spain, Austria, The Netherlands, Portugal and Greece have cyclically converged to the euro area business cycle.

This paper is organised as follows. Section 2 briefly describes the data used and the detrending method employed. Section 3 analyses the degree of association between country and euro area cycles. Section 4 analyses the degree of synchronisation. Section 5 evaluates the existence of cyclical convergence. Finally, section 6 concludes.

2. DATA AND DETRENDING METHOD

The data used in this study is based on European Commission-Ameco database figures on annual product spanning the period from 1960 to 1999 for a sample of 17 countries plus the euro area as a whole.(2)

In this study, we follow Lucas (1977) definition of business cycle as deviations of aggregate real output from trend.(3) The decomposition of the ob...
served series into trend movement and cyclical component was made using the Hodrick-Prescott filter, the method more widely used in business cycles studies.(4) The series were all expressed in logarithms and so the cyclical component was obtained through the difference between the original series and its trend.

3. DEGREE OF CYCLICAL ASSOCIATION

In this section, we will evaluate the degree of association between the business cycles of the countries included in our sample and the euro area.

Since we are interested not only in the degree of cyclical association but also in its evolution, the sample was divided in two sub-periods, from 1960 to 1978 and from 1979 to 1999, which also coincides with the creation of the European Monetary System in 1979.

The simple correlation coefficient is the statistics normally used when we pretend to measure the degree of association between business cycles. However, since it only measures the degree of linear association, we will also compute the concordance statistics, initially proposed by Harding and Pagan (1999) and the Spearman’s rank correlation coefficient.(5)

The concordance is a non-parametric statistics that measures the proportion of time that the cycles of two series spend in the same phase.(6) As a measure of co-movement between two series, the concordance statistics main advantage in comparison with the correlation coefficient is that it can be applied to both stationary and non-stationary series, since it is not affected by single events in time series which are irrelevant for inferences of co-movement. Moreover, the concordance statistics can be used to detect both linear and non-linear type association between two series. Plotting the cycle in country \(i\) against the cycle in country \(j\), the concordance statistics will be given by the proportion of observations that are in the same quadrant, independently of the particular type of relationship between the two series (linear or non-linear).

An alternative measure of the degree of association between series that is also robust to non-linear relationships is the Spearman’s rank correlation coefficient. As its name suggests, rather than use the cycle itself, it is based on the ranks of the observations. Having ordered the values of the cycle in each country, the Spearman’s rank correlation coefficient is just the correlation coefficient calculated for the ranks of the two series.

Table 1 presents the results for the simple correlation coefficient, the concordance statistics and the Spearman’s rank correlation. The conclusions are remarkably consistent across the different methods, especially between the simple correlation coefficient and Spearman’s statistics. This also suggests that the cycle among countries exhibits in fact a linear relationship and so we can focus our analysis mainly in the correlation coefficient results.

Regarding the results for the euro zone, the most interesting feature is the high degree of contemporaneous correlation in the majority of the countries with respect to the euro area, particularly in France, Belgium, Germany, Portugal, Austria and The Netherlands. In contrast, Finland and Ireland exhibit a weak association with the euro area business cycle.

Considering the periods before and after 1979, we find that in general, there is an increase in the degree of contemporaneous association between euro zone countries and the euro area business cycle, particularly in Italy, Spain and the Netherlands. Finland and Luxembourg were the only euro zone countries where there was a significant decrease in the contemporaneous correlation with the euro zone cycle (Table 1 and Chart 1).(9) In fact,

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(4) In this study the \(\lambda\) parameter was set equal to 100, a standard value for the smoothing parameter for annual data. For a discussion of the properties of this and other filters, see Hodrick and Prescott (1997), King and Rebelo (1993), Kydland and Prescott (1990) and Baxter and King (1999).
(5) For a more detailed description of the statistics used in this study see the Working Paper no. 7 2001.
(6) As a proportion, the concordance statistics varies between 0 and 1. However, a positive relationship between the phase in two series implies a degree of concordance higher than 0.5, as this is the expected value of the concordance when we have two independent and identically distributed series, symmetrically around 0. For a detailed explanation of the concordance statistic see McDermot and Scott (1999).
(7) This discussion borrows heavily from MCDermott and Scott (1999).
(8) Country \(i\) cycle in \(x\) axis and country \(j\) in \(y\) axis.
(9) In Germany and France there also is a slight but not significant decrease in the contemporaneous correlation with the euro area.
the correlation coefficient between Finland and the euro area business cycle is not statistically significant in the late period of the sample.\(^{(10)}\)

We have also computed the contemporaneous correlation using the United States as the benchmark economy. In sharp contrast with the euro zone, the results (not shown) now exhibit a weak association between United States and euro zone countries business cycles. In fact, considering the whole sample period, the correlation coefficient is not statistically significant for the euro countries, except for The Netherlands.

In the non-euro area countries, the results for Greece suggest a relatively strong association with the euro area business cycle, especially in the late period of the sample (Table 1 and Chart 1). The Spearman’s and concordance statistics reinforce this conclusion and it is interesting to note that the concordance assumes the value unity in the late sub-period.

Note: (a) The correlation coefficient is not statistically significant with a level of significance of 10%.

Regarding the results for the United Kingdom, the evidence suggests a weak contemporaneous correlation with the euro area business cycle, particularly in the late period of the sample, where the coefficient is not statistically significant. On the contrary, the contemporaneous correlation with the United States has steadily increased, exhibiting...
in the late period of the sample, a stronger contemporaneous association with the United States than with the euro area business cycle.

Finally, Denmark and Sweden, also exhibit a weak association with the euro area business cycle.

An alternative approach to the non-parametric statistics analysed so far, will be to estimate a model where the relationship between country \( i \) and euro zone cycle is described by the following equation:

\[
X_i = \beta_1 X^{EU1} + \beta_2 X^{EU1}_{t-1} + \beta_3 X^{EU1}_{t-2} + \beta_4 X^{EU1}_{t-3} + \beta_5 X^{EU1}_{t-4} + \epsilon_i
\]

where \( X_i \) is the cycle in country \( i \) and \( X^{EU1} \) is the cycle in the euro area.

The main advantage of this approach is that it will give an accurate measure of the degree of linear association between country \( i \) and euro area business cycle in the presence of leading or lagging relationships between the cycles.

Defining \( R \) as the square root of the coefficient of determination in country \( i \) equation, the value of \( R \) is then the correlation coefficient between \( X_i \) and \( X^{EU1} \), where are the fitted values of \( X_i \). In other words, \( R \) can be seen as the multiple correlation coefficient between country \( i \) and euro area business cycle.

The results are presented in Table 2. It is clear that for the euro zone countries, there is once again a high consistency degree between these results and the previous ones. In fact, the countries that exhibit a stronger association with the euro area business cycle during the whole sample period are the same, namely France, Belgium, Germany, Austria, The Netherlands and Portugal. Finland and Ireland remain the countries with the lowest degree of association with the euro zone business cycle.

Considering the multiple correlation coefficient in both sub-periods, we find that in general, the results from the previous section also remain valid, particularly the general increase in last period association with the euro area for the euro zone countries. This increase was particularly sharp and significant in Spain and Italy, as well as in Portugal. On the opposite end, in Finland, Luxembourg and Ireland (although in the latter not observed in the previous analysis) there was a decrease in the degree of association with the euro zone business cycle.

**Table 2**

**MULTIPLE AND MAXIMUM CORRELATION WITH THE EURO AREA**

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<td>0.70</td>
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Notes:
(a) Displacement where the correlation is maximum, with \( j = -2, -1, 0, 1, 2 \). A positive value (negative) for \( j \) means that the country has a lead (lag) cycle with respect to euro area cycle.
(b) Maximum correlation is similar to contemporaneous correlation (absolute difference \( \leq 0.06 \)).
For the non-euro zone countries and in contrast to what was observed in the previous statistics, there was a sharp increase in the multiple correlation coefficient between the two sub-periods, particularly in the United Kingdom and Sweden. In the United Kingdom, it is also interesting to note that this country has the highest degree of multiple correlation with the euro zone business cycle. The contradictory results between the contemporaneous correlation and the multiple correlation suggest that these countries have in fact increased their association with the euro area business cycle but the synchronisation, which will be analysed in the next section, has changed between the two sub-periods.

At last, in Greece, the multiple correlation coefficient suggests a relatively strong association with the euro zone business cycle during the whole sample period.

4. SYNCHRONISATION

In order to determine the existence of cyclical convergence with respect to the euro zone, it is necessary not only to analyse the evolution of the degree of association between each country and the euro area business cycle, but also the degree of synchronisation.

The degree of synchronisation will be measured by the number of leading or lagging periods at which the maximum correlation is obtained so that, country $i$ will be synchronised with the euro zone business cycle if the maximum correlation is obtained contemporaneously.$^{(11)}$

According to the results presented in Table 2, we can say that for the whole sample period, the euro zone countries are highly synchronised with the euro area business cycle. This synchronisation is illustrated in Chart 2, where we confront the German, France and Belgium cycles with the euro area business cycle. In the late period, only Finland and Luxembourg seem to exhibit a lead cycle.

Considering the whole sample period, the non-euro area countries are in general not synchronised with euro area business cycle, with the exception of Greece and Japan.

Between the two sub-periods and as predicted in the previous section, we observe that the United Kingdom, United States and Denmark have become less synchronised with the euro area business cycle. As illustrated in Chart 2 for the United Kingdom, these countries exhibit a lead of about 2 years in the second period of the sample. In contrast, Greece business cycle has become more synchronised with the euro zone business cycle.

5. CYCLICAL CONVERGENCE

Evidence of cyclical convergence implies an increase in both the degree of association and synchronisation between country and euro area business cycles and so we will look at the contemporaneous correlation, concordance and maximum correlation coefficients from a dynamic perspective.

$^{(11)}$For a given pair of variables, X and Y, $\rho(\chi_{t-j}, y_t)$ denotes the correlation between X and Y at displacement $j$ ($-2 \leq j \leq 2$). The maximum correlation coefficient is then the maximum value for $\rho(\chi_{t-j}, y_t)$. 
Moreover, we will estimate and evaluate the cycli-
cal component that is specific to each country, that
is, the part in country $i$ cycle that is not explained
by the euro area business cycle.

The previous analysis suggested that in the late
period of the sample there was a high degree of as-
sociation and synchronisation in the majority of
the euro zone countries. However, in terms of cy-
clical evolution, it is possible to distinguish three
groups of countries.

A first group includes Germany, France and
Belgium, where the results suggest a high degree
of association and synchronisation with the euro
zone business cycle in the whole sample period.
However, it should be noted that, in the case of
Germany, the idiosyncratic shock caused by the
unification and the associated fiscal and monetary
policies have probably led to a slight decrease in
the degree of association and synchronisation with
the euro zone business cycle in recent years. This
fact can be observed in the correlation coefficient
for a rolling sample of 12 years (Chart 3) and in the
evolution of the displacement where the maxi-
mum correlation is obtained (not shown), which
exhibits a slight lag in the post-unification period.

A second group includes Italy, Spain, Austria,
the Netherlands and Portugal, where we observe a
sharp increase in the degree of association with the
euro zone cycle. In Chart 3 it is possible to observe
that this increase in Austria, the Netherlands and
Portugal has occurred in the beginning of the sam-
ple, earlier and sharper than in Italy and Spain.
However, in both cases, the significant increase in
the degree of association and synchronisation with
the euro zone business cycle suggests that these
countries exhibit an evolution that is compatible
with the cyclical convergence hypothesis.

A last group includes Finland, Ireland and Lux-
embourg, where the evidence does not allow us to
conclude for the existence of cyclical convergence.
This conclusion draws from the fact that during
the sample period these countries decreased their
degree of association with the euro zone business
cycle, as illustrated in Chart 3(12), and have not be-

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(12) In Ireland, although the contemporaneous correlation and concordance increase, the maximum and multiple correlation suggests a decrease in the association with the euro zone business cycle.
come more synchronized with the euro zone business cycle.

In the non-euro zone countries, although the degree of association with the euro zone business cycle has increased, particularly in the United Kingdom, the cycles have become less synchronized and so we cannot state that these countries had cyclically converged to the euro zone business cycle. The only exception seems to be Greece, where there was both an increase in association and synchronization.

An alternative approach to the cyclical convergence issue would be to analyse the specific cyclical component in each country, and so we have estimated the following equations:

\[ X_i^t = \beta_0 X_{i,t+1} + \beta_2 X_{i,t+2} + \beta_3 X_{i,t+3} + \beta_4 X_{i,t+4} + \beta_5 X_{i,t+2} + \varepsilon_{it} \]

where \( X_{i,t+j} \) is the country \( i \) cycle and \( X_{EU,t+j} \) is the euro zone cycle in the \( t+j \) period, with \( j=2,3,4 \).

The estimation residual \( \varepsilon_{it} \) can be interpreted as the part of country \( i \) cycle that is not explained by the euro zone business cycle nor by the past behaviour of the country cycle. So, the residual might be seen as the idiosyncratic component of country \( i \) fluctuations.

In Table 3 we present the results for the weight of the variability of the specific component in the total variability of the cycle. As expected, this weight decreases in the majority of the euro area countries, suggesting an increase in integration with the euro area business cycle, even for Finland and Ireland. Only in Luxembourg does the weight of the specific component increase.

In order to test if the changes in country \( i \) specific component variability are significant or not, we have applied the Goldfeld-Quandt test. If country \( i \) exhibits a higher degree of association with the euro zone business cycle one should expect a decrease in the specific component variability and so the rejection of the homoscedasticity hypothesis. If this rejection was due to a decrease in the specific component variability, then it would suggest that country \( i \) had converged to the euro zone business cycle during the sample period, since the majority of their fluctuations would be explained by those of the euro area.

According to the results presented in Table 3, we may conclude for a significant decrease in the variability of the specific component in Germany, Italy, Spain, The Netherlands, Austria and Portugal supporting the previous conclusion of cyclical convergence of these countries with respect to the euro zone business cycle.

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**Table 3**

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Notes:
* Significant at 10% level.
** Significant at 5% level.
*** Significant at 1% level.

(13) In Denmark and Japan the results for the maximum and multiple correlation suggest a different evolution, so we considered the multiple correlation coefficient to be representative of an increase in the degree of linear association.

(14) This approach is similar to a previous one by Barbosa et al. (1998) for the Portuguese business cycle. In Germany, France and Italy the equation were estimated with and without the contemporaneous cycle of the euro area in order to minimise the problem of non-exogeneity of the explanatory variable. However, as one can see in Table 3, the main conclusions remain valid.

(15) The weight is given by \( \frac{\sigma_{\varepsilon_i}}{\sigma_{X_{EU,i}}} \) where \( \sigma_{\varepsilon_i} \) is the standard deviation of the specific cyclical component and \( \sigma_{X_{EU,i}} \) the total standard deviation of the cycle in country \( i \) for the \( t \) sub-period.

(16) It should be noted that in France (with the contemporaneous euro zone cycle) and Belgium there is also an increase in the weight of the specific component, although this increase was not significant.
In the other countries, the results do not suggest a significant change in the variability of the specific component. In France and Belgium this was due to the fact that the variability of the specific component stood low during the whole sample period. In Finland, Ireland and Luxembourg the variability stood high, reinforcing the conclusion that these countries had not converged to the euro zone business cycles during the period in analysis.

6. CONCLUSIONS

This paper provided a descriptive analysis of the cyclical evolution of the European Union countries between 1960 and 1999. In particular, we investigated whether the cycle of these countries converged to the euro area business cycle.

We distinguished three groups of countries. A first group included Germany, France and Belgium, where the results suggested a high degree of association and synchronisation with the euro zone business cycle in the whole sample period. A second group included Italy, Spain, Austria, The Netherlands and Portugal, where it was observed a significant increase in both the association and synchronisation with the euro zone cycle, suggesting that these countries converged to the euro area business cycle. A last group included Finland, Ireland and Luxembourg, where no evidence of cyclical convergence with the euro area was found.

In the non-euro area countries, there was an increase in the degree of cyclical association, particularly for the United Kingdom, but not in synchronisation, so we cannot state that these countries have cyclically converged to the euro zone business cycle. The only exception seems to be Greece, where there was also an increase in synchronisation.

REFERENCES


