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A NONPARAMETRIC ANALYSIS OF THE INTERNATIONAL BUSINESS CYCLES

by

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ABSTRACT[(*)]

This paper examines the emergence of economic clubs and its coherence with the European commitments by analysing business cycle comovements in six industrialised economies, which are pooled into four different clusters. Starting from turning points chronologies, a binary measure of association for expansion and contraction regimes is used to perform a nonparametric analysis. This framework allows to address the relative groupwise dependency and not only the frequently studied pairwise correlations under very few assumptions. Studying relative dependency is important in order to establish if and how much "europeanization" is a different phenomenon with respect to globalization. Data lead to conclude that an English-speaking club is emerging in the last decades, whereas explicit and formal commitments seem to have had a relatively weaker power in determining Euro-zone business cycles comovements. Since European commitments failed to pass the "English exam", some additional problem could arise should the UK adopt the Euro.

JEL Classification: C14, C33, E32, F47.

Key words: Business Cycles, Synchronization, Turning Points.

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NON TECHNICAL SUMMARY

This paper deals with a particular and relatively recent aspect of international business cycles, the emergence of cyclically coherent groups. Essentially it compares turning points chronologies of two groups of countries, the concern being the relative performance in the synchronization. In fact, evidence of greater synchronization within a cluster over time could be partly due to a tendency of world business cycles. In other words, there could be an interest in comparing the relative degree of "globalization" and "europeanization". Within this framework I focus exclusively on *if* and not on *why* business cycles are (in)dependent, throughout several periods and across some macro area.

A nonparametric analysis is performed to address the relative groupwise dependence between international business cycles as dated by the Economic Cycle Research Institute (ECRI) and by the IMF (2002). It is worth noting that most hypotheses in this field of research have so far been tested by evaluating pairwise correlations. Also, the analysis of the recent developments in international business cycles may face a problem of data scarcity. As a matter of fact, some experiments here presented are based on limited samples and, as known, nonparametric tests are usefully and validly applied when there are few observations.

From the methodological point of view this paper complements to some extent the work of Artis *et al.* (1997), where a classical business cycle chronology is used to create a zero/one time series variable for each country according to the cyclical phase. Then, the scores are organised into 2x2 contingency tables recording pairwise expansion/contraction frequencies, which form the bases for Pearson's independence tests. Alike, I make use of the McNemar test (McNemar, 1947) to statistically analyse groupwise proportions arranged in 2x2 contingency tables.

Data suggest to conclude that the English-speaking group is much more internally congruent than the core Euro-zone one. This result holds for different chronologies and it is even enforced in the last decade, thus we can say that European commitments failed to pass the "English exam". Using the words of Helbling and Bayoumi (2003), there are emerging two different "boats", in the sense that the Anglo-Saxon countries appear to sail more often in the same direction than core Euro-zone economies. In this paper synchronization is the situation in which all countries share the same cyclical phase (recession or growth). This definition is extreme as compared to what sometimes proposed in the literature, and it is verified by nonparametric tests, which are based on very few assumptions. Taken together, it means that the reported findings are very robust.

UN'ANALISI NON PARAMETRICA DEL CICLO ECONOMICO INTERNAZIONALE

SINTESI

Questo lavoro si propone di studiare la nascita e lo sviluppo di (eventuali) interdipendenze tra i cicli economici di sei paesi e la loro coerenza con gli accordi europei. La fase ciclica è definita dicotomicamente partendo dalla cronologia dei punti di svolta, dando il valore "1" ai periodi compresi tra una gola e un picco e "0" agli altri. Da queste serie storiche binarie si costruiscono tavole di contingenza 2x2 in cui si confrontano due gruppi di paesi. Esse vengono analizzate con un test non parametrico che riesce a definire statisticamente se un gruppo di cicli nazionali è più o meno omogeneo di un altro gruppo. E' la prima volta che questo test, noto come test di omogeneità marginale di McNemar, è utilizzato con questi fini. Essendo non parametrica, la verifica empirica risulta particolarmente robusta; inoltre essa consente di definire la dipendenza tra gruppi, un concetto più generale della correlazione tra coppie che usualmente è riportata in letteratura. I dati suggeriscono che i paesi di lingua inglese (Canada, Gran Bretagna e USA) costituiscono un insieme maggiormente coerente rispetto a quello rappresentato dai tre paesi "core" dell'Euro (Francia, Germania, Italia). Visto che questo risultato vale soprattutto nel periodo più recente, è evidente che l'influenza degli accordi europei di questi ultimi decenni potrebbero non aver avuto il potere di avvicinare l'Inghilterra ai paesi dell'area dell'Euro. Ovviamente potrebbe anche darsi che l'Inghilterra abbia seguito maggiormente l'andamento ciclico nordamericano proprio a causa degli accordi comunitari. Sia come sia, pare di potersi concludere che gli accordi comunitari non hanno superato "l'esame di Inglese" e che, *ceteris paribus*, l'ingresso della Gran Bretagna nell'Europa dei 12 costituisce un problema aggiuntivo.

Classificazione JEL: C14, C33, E32, F47.

Parole chiave: Ciclo economico, sincronizzazione, punti di svolta.

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1. INTRODUCTION

There are several reasons for taking an interest in the international business cycles. Just to mention a few issues, it is important to gather information about the relative contributions of domestic and international shocks to recessions, or about how synchronized cycles need to be for countries to form a monetary union. Also, over the last years there have been a number of studies focusing on the dynamics of their comovements. Results suggest widespread reduction in volatility (Carvalho and Harvey, 2002; Stock and Watson, 2003), and little tendency towards increasing international synchronization of cyclical fluctuations (Doyle and Faust, 2002a, 2002b; Heathcoate and Perri, 2002; Kose, Prasad, and Terrones, 2003). Instead, there appears to have been an emergence of at least one cyclically coherent group, the major countries in the Euro-zone (Artis, Kontelemis, and Osborn, 1997; Artis and Zhang, 1997, 1999; Carvalho and Harvey, 2002; Helbling and Bayoumi, 2003; Dalsgaard, Elmeskov and Park, 2002; Del Negro and Otrok, 2003; Luginbuhl and Koopman, 2003), and possibly a second, English-speaking group, consisting of Canada, the UK, and the US (Helbling and Bayoumi, 2003; Stock and Watson, 2003). Given the European commitments, it is important to investigate whether the European countries business cycles have become more correlated over time. Because of its possible participation in the Euro-area, the stronger convergence of the UK with the other Anglo-Saxon countries rather than with the other European countries can be a problem should these two clusters drift apart.

I seek to contribute to this strand of the literature. Essentially I deal with turning points chronologies, and my interest is in answering a series of questions to see whether there are any robust stylised facts, such as the presence/persistence of economic clubs and their coherence with the European commitments, that come through. By comparing groups of countries, I address the problem of the relative performance in the groupwise synchronization. In fact, evidence of greater synchronization within a cluster over time could be partly due to a tendency of world business cycles. In other words, there could be an interest in comparing the relative degree of "globalization" and "europeanization". Within this framework I focus exclusively on *if* business cycles are (in)dependent, throughout several periods and across some macro area. This is an admittedly less ambitious target compared, e.g., to the "holy grail of business cycle research" (Harding and Pagan, 2002a, p. 2), i.e. understanding *why* there is (not) synchronization in the level of economic activity across countries. Hopefully, useful insights can emerge in this limited field as well.

A nonparametric analysis is performed to deal with the relative groupwise dependence between international business cycles as dated by the Economic

Cycle Research Institute (ECRI) and by the IMF (2002). It is worth noting that most hypotheses in this field of research have so far been tested by evaluating pairwise correlations. Also, the analysis of the recent developments in international business cycles may face a problem of data scarcity. As a matter of fact, some experiments here presented are based on limited samples and, as known, nonparametric tests are usefully and validly applied when there are few observations.

From the methodological point of view this paper complements to some extent the work of Artis *et al.* (1997), where a classical business cycle chronology is used to create a binary (expansion=1; contraction=0) time series variable for each country. Then, the scores are organised into 2x2 contingency tables recording pairwise expansion/contraction frequencies, which form the bases for Pearson's independence tests. Alike, I make use of the McNemar test (McNemar, 1947) to statistically analyse groupwise proportions arranged in 2x2 contingency tables.

Results show that troughs and peaks tend to take place at the same time with a greater frequency in North America than in Europe (France, Germany, Italy, UK), and in the English-speaking countries (Canada, UK, US) than in the core Euro-zone countries (France, Germany, Italy). This finding is not a constant feature in international business cycles, but it is emerging in the last decades. *Ad hoc* experiments performed using different concepts of business cycles suggest that in the aftermath of the Maastricht Treaty and of the introduction of the Euro, France, Germany and Italy formed a less coherent club than the English-speaking countries. In other words it seems that the "treatment" does not matter, at least in the expected direction, because the UK seems belonging more and more in the North American continent rather than in the Europe, despite European commitments.

The paper is organised as follows. In the next section I describe the data and their sources. The statistical framework and the empirical results are reported, respectively, in the third and in the fourth section. Concluding remarks close the paper.

2. DATA SOURCES

To test the independence in the international business cycles we need a business cycle chronology for each country. There is a large amount of literature dealing with the problem of dating business cycles (Artis *et al.*, 2002), and it can roughly be grouped into two research approaches (Harding and Pagan, 2003).

One (nonparametric) approach is the traditional way of distinguishing between different phases of the business cycle by picking peaks and troughs with the Bry and Boschan (1971) procedure. This approach is related directly to the methodology of Burns and Mitchell (1946) and the NBER Business Cycle Dating Committee. The other dominant (parametric) approach is stemming from the influential work of Hamilton (1989). It takes advance of regime switching models that assume the economy is to be found in one of a number of different states, and where the probability of moving from the current state to another is contingent on the current state. As argued by Harding and Pagan (2002c), the traditional approach is more robust and transparent. I avoid the problem of dating business cycles by using three different chronologies as computed by two "official" institutions, the IMF and the ECRI. The paper deals with the most industrialised countries[1], which are grouped into four clusters:

1. Europe (France, Germany, Italy, UK);

2. Euro-zone (France, Germany, Italy);

3. English-speaking (Canada, UK, US);

4. North America (Canada, US).

The IMF data (IMF, 2002) are annual over 1890-2000, and the turning points are determined using annual real GDP data as reference series. The years 1914–18 and 1939–49 are excluded because of the two world wars[2]. Data on GDP are not fully available for all countries: data for France are not available for 1919–22; data for Germany are not available for 1919–24. Because of these missing data, my sample period is: 1890-1913; 1925-1938; 1950-2000. According to the IMF, a year is designated as a trough if growth in the year in question is negative and growth in the following year is positive. Similarly, a year is designated as a peak if growth in the year in question is positive and growth in the following year is negative. In cases where a business cycle phase extended beyond the end of a subperiod, the phase is truncated at the end of that subperiod. As a result, troughs do not always follow peaks and vice versa.

[1] I exclude Japan because it is outside the main purpose of this work.
[2] As it will be clear later on, this is not a problem because here I analyse only different behaviours and in the wartime it is very likely to think about non divergent behaviours across countries.

The other two chronologies[3] are developed at the NBER and extended by the ECRI. Although the NBER method and dates have sometimes aroused controversy, they are widely accepted and frequently used. ECRI determines the reference cycle chronologies for several economies using the same methodology used to establish the official business cycle dates for the United States. NBER-ECRI data are based on the behaviour of a very large number of macroeconomic variables. Coincident, lagging, and leading indicators of the state of the business cycle are constructed, and peaks and troughs in the coincident index are used to date recessions for any given economy. The data are monthly, cover a shorter period than the IMF data set (from January 1956 to December 2002), and the reference aggregate variable is not the GDP. In the ECRI approach, the business cycle can not be defined by any single variable, but by the consensus of key measures of output, income, employment and sales. These indicators define "the economy" and constitute ECRI's reference series for each country. To identify business cycle recessions and expansions and the turning points (peaks and troughs) that demarcate them, ECRI uses an algorithm (Bry and Boschan, 1971) codifying the judgmental procedures used by classical business cycle analysts. Basically, in order to indicate cycle and turning points, Bry-Boschan try to delete trend and irregular components from the seasonal adjusted data. According to this procedure, each cyclical movement (peak-to-peak or trough-to-trough) should not be less than 15 months, each phase (peak-to-trough or trough-to-peak) should have a minimum of 6 months, and troughs always follow peaks and vice versa. As Watson (1994) has pointed out, the Bry-Boschan algorithm provides a good way to define turning points, since it is based on objective criteria for determining cyclical peaks and troughs.

The two NBER-ECRI chronologies are different because one deals with the classical business cycle, the other with the growth rate cycle. The dating procedure is the same except that it is applied to the levels, in the former case, and to growth rates of the same time series, in the latter case. Otherwise stated, the only difference is that classical cycles refer to alternating periods of expansion and contraction, while growth rate cycles refer to alternating periods of rising and declining growth rates.

Even if the dating rule for classical cycles uses growth rates of economic activity, it has been observed (Stock and Watson, 1999) that in a trending series: (i) classical cycle peaks come later in time than growth rate cycle peaks; (ii) classical cycles become more and more asymmetric over time: a long period of positive growth is followed by a short downturn; and (iii) classical cycles tend to vanish over time if the trend growth rises steadily from zero: in the long run the length of the classical contractions become shorter and shorter compared to the

[3] Available via the Internet http://www.businesscycle.com/research/intlcycledates.php

expansions so classical turning points will ultimately disappear. Actually, in many political circles the main focus seems to be on declines in the growth rate of aggregate economic activity as the primary way to monitor cyclical fluctuations in the economic system. On the other hand, even if many countries saw long periods of virtually uninterrupted growth, in the recent decades there have been a number of instances of absolute decline in GDP, which have renewed the conceptual appeal of classical business cycle contractions. Summing up, in this paper I use both concepts of the cycle because they can tell different stories about the economy.

3. THE STATISTICAL PROCEDURE

In this section I broadly follow the methodology suggested by Artis, *et al.* (1997) to study the synchronous nature of business cycles. The procedure is nonparametric and it ignores the magnitude of change, considering only the direction of underlying movement implied by the chronologies mentioned in the previous section. These latter are used to create a binary time series variable (S_{ti}) for each country, denoting periods such a way that:

$$\text{PEAK} \rightarrow \text{TROUGH} \Rightarrow S_{ti} = 0$$

$$\text{TROUGH} \rightarrow \text{PEAK} \Rightarrow S_{ti} = 1$$

where:

i=1,…,j;
j=number of countries;
t=1,…,N;
N=number of periods.

With j countries, we have j Nx1 binary column vectors. By pooling them an Nxj "world-matrix" is generated, and the problem of the independence in the international business cycles can be seen as the degree of "horizontal disorder" in this world-matrix. In other words, an obvious way of measuring the degree of synchronization in business cycles is to ask what fraction of time the cycles are in the same phase (expansion/recession). With respect to the world-matrix, let us define:

Dependence = all countries are in the same phase = all rows contain only zeros or ones;
Independence = at least one country is out-of-phase = no row contains only zeros or ones.

With this at hand, we can answer the questions of interest via a statistical analysis, and better qualify them. An easy way to design a useful statistical framework is to compare the number of in-phase periods throughout different samples and across macro regions. It is worth noting that even if an economic club is emerging, in the sense that its internal coherence is increasing, one must control whether there is a tendency of world business cycle. In other words, it is important to study the relative homogeneity within a group as compared to the rest of the world (or to other groups). To this end, I select a period and two groups of countries from the world-matrix; then, a 2x2 contingency table is created according to the four possible combinations:

Table 1

		Cluster 2	
		In-phase	Out-of-phase
Cluster 1	In-phase	N_{11}	N_{12}
	Out-of-phase	N_{21}	N_{22}

A useful test for comparing the proportions in table 1 is the McNemar test (McNemar, 1947). Basically, it is a very good nonparametric test when the data are nominal, and can be said that McNemar's test is a Sign-Test in disguise. It examines marginal homogeneity and consists in analysing the off-diagonal terms of table 1, because marginal homogeneity implies that row totals are equal to the corresponding column totals, or

$$(N_{11}+ N_{12}) = (N_{11} + N_{21})$$

$$(N_{21}+ N_{22}) = (N_{12}+ N_{22})$$

This implies $N_{12} = N_{21}$, which is the basis of the McNemar test. In fact, with $(N_{12}+ N_{21})>9$, McNemar offered a chi-square test with 1 degree of freedom[4]:

$$(?^2)_1 = \frac{(N_{12} - N_{21})^2}{N_{12} + N_{21}}$$

[4] When $(N_{12}+ N_{21})<10$, a two-tailed exact test, based on the cumulative binomial distribution with p=q=0.5, can be used instead.

Intuitively, when the focus is on different behaviours it seems logic to concentrate on situations in which the "subjects" behave differently. A continuity correction, reflected in the numerator as $(|N_{12} - N_{21}| - 1)^2$, could be included to improve the approximation (Sheskin, 2000). In the present context a significant result implies that the two clusters are not homogeneous, in the sense that the probability of being in the same phase (*i.e.*, of having identical business cycle turning point dates) within each cluster is different across clusters. Otherwise stated, when N_{12} is significantly larger (smaller) than N_{21}, we can conclude that countries included in cluster 1 constitute a more (less) coherent group than those in cluster 2. Since national classical business cycles will very often show $S_{ti} = 1$ (see section 2), frequencies are so heavily clustered on the upper left cell that it will be likely to reject the null of independence. A test of marginal homogeneity focusing only on the off-diagonal proportions does not suffer from this.

Admittedly, the empirical design ignores the magnitude of change and can offer only qualitative answers. However, the decreased volatility (Carvalho and Harvey, 2002; Stock and Watson, 2003) could reduce the problem of the quantification. Furthermore, in European political circles the focus is often on "relative" behaviours just to be able to claim that, putting aside the quantitative aspects, "our country is within the virtuous group". On the positive side, the Mcnemar's test allows to deal with: i) (relative) dependence, and not only with correlation; ii) groups of countries, avoiding the problems stemming from a pairwise analysis (the pairwise independence does not imply the groupwise independence); iii) the issue of analysing limited samples. Furthermore, the distribution-free nature of the test can give very robust findings and should be thought as complementing other approaches.

4. EMPIRICAL RESULTS

We are now in a position to address the questions of interest here. By comparing over the entire period the number of periods spent in the same cyclical phase within each cluster, we may test the presence of economic clubs among the most industrialised countries. To study the dynamics of convergence, I recursively replicate the experiment; whereas rolling tests are used to investigate the situation during different subsamples. The recursive analysis is led by adding five years each experiment starting from the first available decade. In the rolling analysis, the number of observations is kept constant and equal to ten years, while the starting date is shifted five years ahead each trial.

The following tables are organised according to i) the concept of cycle, ii) the sample period, and iii) the type of clusters under comparison. Tables 2-5 and tables 2a-5a report, respectively, recursive and rolling analyses results. Table 6 collects the "historical enquiry", and tables 7-8 report *ad hoc* trials about the effects of European commitments on international business cycles. Comments are gathered in the concluding section.

Table 2. Analysis of relative homogeneity in NBER-ECRI classical business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU3; 2=ES	Jan. 1956 – Dec. 1960	21	12	0.12	=
1=EU3; 2=ES	Jan. 1956 – Dec. 1965	**23**	**26**	**0.67**	**=**
1=EU3; 2=ES	Jan. 1956 – Dec. 1970	33	41	0.86	=
1=EU3; 2=ES	Jan. 1956 – Dec. 1975	**43**	**52**	**0.36**	**=**
1=EU3; 2=ES	Jan. 1956 – Dec. 1980	45	52	0.48	=
1=EU3; 2=ES	Jan. 1956 – Dec. 1985	**51**	**77**	**0.02**	**-**
1=EU3; 2=ES	Jan. 1956 – Dec. 1990	57	77	0.08	-
1=EU3; 2=ES	Jan. 1956 – Dec. 1995	**58**	**87**	**0.02**	**-**
1=EU3; 2=ES	Jan. 1956 – Dec. 2000	58	87	0.02	-
1=EU3; 2=ES	Jan. 1956 – Dec. 2002	**58**	**89**	**0.01**	**-**

* Clusters and frequencies follow the logic of table 1. For instance, here, EU3=cluster 1; ES=cluster 2. If $(N_{12}-N_{21})<0$, as e.g. in the last row, then Sign="-". This means that the number of in-phase periods in cluster 2, when cluster 1 is out-of-phase, N_{21}, is larger than the number of in-phase periods in cluster 1, when cluster 2 is out-of-phase, N_{12}. That is, cluster 2 is more homogeneous than cluster 1. A similar logic worth for Sign="+", and Sign="=" (homogeneity).
EU3=(France, Germany, Italy); ES=(Canada, UK, US).

Table 2a. A subsample analysis of relative homogeneity in NBER-ECRI classical business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU3; 2=ES	Jan. 1956 – Dec. 1966	23	26	0.67	=
1=EU3; 2=ES	Dec 1960 – Dec. 1970	**13**	**29**	**0.01**	**-**
1=EU3; 2=ES	Dec 1965 – Dec. 1975	20	26	0.38	=
1=EU3; 2=ES	Dec 1970 – Dec. 1980	**12**	**12**	**1.00**	=
1=EU3; 2=ES	Dec 1975 – Dec. 1985	8	25	0.00	-
1=EU3; 2=ES	Dec 1980 – Dec. 1990	**12**	**25**	**0.03**	**-**
1=EU3; 2=ES	Dec 1985 – Dec. 1995	7	10	0.47	=
1=EU3; 2=ES	Dec 1990 – Dec. 2002	**1**	**12**	**0.00**	**-**

* See table 2.

Table 3. Analysis of relative homogeneity in NBER-ECRI growth rate business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1960	0	35	0.00	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1965	**1**	**40**	**0.00**	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1970	8	48	0.00	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1975	**23**	**62**	**0.00**	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1980	29	80	0.00	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1985	**32**	**108**	**0.00**	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1990	33	144	0.00	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1995	**41**	**159**	**0.00**	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 2000	55	182	0.00	**-**
1=EU3 ; 2=ES	Jan. 1956 – Dec. 2002	**55**	**191**	**0.00**	**-**

* See table 2.

Table 3a. A subsample analysis of relative homogeneity in NBER-ECRI growth rate business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU3 ; 2=ES	Jan. 1956 – Dec. 1966	1	40	0.00	-
1=EU3 ; 2=ES	Dec 1960 – Dec. 1970	**8**	**14**	**0.20**	**=**
1=EU3 ; 2=ES	Dec 1965 – Dec. 1975	22	22	1.00	=
1=EU3 ; 2=ES	Dec 1970 – Dec. 1980	**22**	**32**	**0.17**	=
1=EU3 ; 2=ES	Dec 1975 – Dec. 1985	9	46	0.00	-
1=EU3 ; 2=ES	Dec 1980 – Dec. 1990	**4**	**65**	**0.00**	**-**
1=EU3 ; 2=ES	Dec 1985 – Dec. 1995	9	52	0.00	-
1=EU3 ; 2=ES	Dec 1990 – Dec. 2002	**22**	**48**	**0.00**	**-**

* See table 2.

Table 4. Analysis of relative homogeneity in NBER-ECRI classical business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU4; 2=NA	Jan. 1956 – Dec. 1960	18	15	0.60	=
1=EU4; 2=NA	Jan. 1956 – Dec. 1965	**20**	**29**	**0.20**	**=**
1=EU4; 2=NA	Jan. 1956 – Dec. 1970	30	44	0.10	=
1=EU4; 2=NA	Jan. 1956 – Dec. 1975	**34**	**59**	**0.01**	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1980	35	70	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1985	**35**	**115**	**0.00**	**-**
1=EU4; 2=NA	Jan. 1956 – Dec. 1990	37	118	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1995	**38**	**146**	**0.00**	**-**
1=EU4; 2=NA	Jan. 1956 – Dec. 2000	38	146	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 2002	**38**	**148**	**0.00**	**-**

* EU4=(France, Germany, Italy, UK); NA=(Canada, US). Other details under table 2.

Table 4a. A subsample analysis of relative homogeneity in NBER-ECRI classical business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU4; 2=NA	Jan. 1956 – Dec. 1966	20	29	0.20	=
1=EU4; 2=NA	Dec 1960 – Dec. 1970	**13**	**29**	**0.01**	**-**
1=EU4; 2=NA	Dec 1965 – Dec. 1975	14	30	0.01	-
1=EU4; 2=NA	Dec 1970 – Dec. 1980	**5**	**27**	**0.00**	-
1=EU4; 2=NA	Dec 1975 – Dec. 1985	1	56	0.00	-
1=EU4; 2=NA	Dec 1980 – Dec. 1990	**2**	**49**	**0.00**	**-**
1=EU4; 2=NA	Dec 1985 – Dec. 1995	3	31	0.00	-
1=EU4; 2=NA	Dec 1990 – Dec. 2002	**1**	**31**	**0.00**	**-**

* See table 4.

Table 5. Analysis of relative homogeneity in NBER-ECRI growth rate business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU4; 2=NA	Jan. 1956 – Dec. 1960	0	54	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1965	**0**	**95**	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1970	6	116	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1975	**18**	**132**	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1980	20	159	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1985	**20**	**217**	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1990	21	265	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 1995	**23**	**304**	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 2000	30	332	0.00	-
1=EU4; 2=NA	Jan. 1956 – Dec. 2002	**30**	**356**	0.00	-

* See table 4.

Table 5a. A subsample analysis of relative homogeneity in NBER-ECRI growth rate business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU4; 2=NA	Jan. 1956 – Dec. 1966	0	95	0.00	-
1=EU4; 2=NA	Dec 1960 – Dec. 1970	**6**	**63**	**0.00**	**-**
1=EU4; 2=NA	Dec 1965 – Dec. 1975	18	38	0.01	-
1=EU4; 2=NA	Dec 1970 – Dec. 1980	**14**	**43**	**0.00**	-
1=EU4; 2=NA	Dec 1975 – Dec. 1985	2	85	0.00	-
1=EU4; 2=NA	Dec 1980 – Dec. 1990	**1**	**107**	**0.00**	**-**
1=EU4; 2=NA	Dec 1985 – Dec. 1995	3	88	0.00	-
1=EU4; 2=NA	Dec 1990 – Dec. 2002	**9**	**82**	**0.00**	**-**

* See table 4.

Table 6. An historical analysis of relative homogeneity in IMF business cycles.

Clusters*	Sample	N_{12}	N_{21}	P-Value	Sign*
1=EU3 ; 2=ES	1890 – 1938	6	14	0.07	-
1=EU3 ; 2=ES	1950 – 2000	**7**	**1**	**0.03[a]**	**+**
1=EU3 ; 2=ES	1890 – 2000	13	15	0.71	=
1=EU4; 2=NA	1890 – 1938	**0**	**26**	**0.00**	**-**
1=EU4; 2=NA	1950 – 2000	3	7	0.21	=
1=EU4; 2=NA	1890 – 2000	**3**	**33**	**0.00**	**-**

a The cumulative binomial (see section 3) gives a similar exact probability. * See tables 1 and 4.

Table 7. Euro-zone vs. English-speaking countries Business Cycles Synchronization. Do European Agreements Matter?

Clusters*	Sample	CYCLES	N_{12}	N_{21}	P-Value	Sign*
1=EU3; 2=ES	Jan. 1992 – Dec. 2002	Classical	1	10	0.00	-
1=EU3; 2=ES	Jan 1999 – Dec. 2002	Classical	**0**	**2**	-	**?[a]**
1=EU3; 2=ES	Jan. 1992 – Dec. 2002	Growth rate	20	46	0.00	-
1=EU3; 2=ES	Jan 1999 – Dec. 2002	Growth rate	**10**	**16**	**0.24**	**=**

a When $(N_{12}+ N_{21})<10$ the McNemar test is not well approximated by the chi-squared distribution (sect. 3).* Other details under table 2.

Table 8. Euro-zone vs. North American Business Cycles Synchronization. Do European Agreements Matter?

Clusters*	Sample	CYCLES	N_{12}	N_{21}	P-Value	Sign*
1=EU4; 2=NA	Jan. 1992 – Dec. 2002	Classical	1	27	0.00	-
1=EU4; 2=NA	Jan 1999 – Dec. 2002	Classical	**0**	**2**	-	**? [a]**
1=EU4; 2=NA	Jan. 1992 – Dec. 2002	Growth rate	9	82	0.00	-
1=EU4; 2=NA	Jan 1999 – Dec. 2002	Growth rate	**7**	**32**	**0.00**	-

a When $(N_{12}+ N_{21})<10$ the McNemar test is not well approximated by the chi-squared distribution (sect. 3). * Other details under tables 2 and 4.

CONCLUDING REMARKS

The picture emerging from the empirical exercises leads to conclude that, considering a period lasting more than a century (1890-2000), the major European countries (France, Germany, Italy, UK) show a lower internal coherence as compared to that linking the North American economies (table 6, last row). This is an expected result given the well-known strong links between Canada and the US. Anyway, in the aftermath of the second world war and up to the late 60s, the probability of classical business cycles being in the same phase was not significantly different between these two groups (tables 4 and 6). This could be due to the strong and widespread economic boom following the second world war. When we contrast Euro-zone countries (France, Germany, Italy) with English-speaking economies (Canada, UK, US) from an historical point of view, data support cluster homogeneity. This seems caused by the opposite behaviour followed by the international business cycles before and after the Second World War (upper part of table 6).

By using the shorter but higher frequency NBER-ECRI data set (1956.1 – 2002.12), it emerges that Euro-zone business cycles behaviour has been less mutually consistent than that of the English-speaking club (tables 2, 3, last row). This finding holds for both concepts of cycle, classical and growth rate. Recursive experiments show that classical cycles were homogeneous until the end of the 70s, while henceforth troughs and peaks have tended to take place at the same time with a significant greater frequency in the English-speaking countries than in the core Euro-zone countries. The behaviour of growth rate cycles supports the stronger coherence of the English-speaking group, but the result is even more extreme because of the uninterrupted tendency of English-speaking countries to comove more closely than the European ones. Rolling tests point out that the greater tendency of English-speaking countries to form a more consistent club is not monotonic over time (tables 2a, 3a). A common feature of both concepts of cycles is the systematically superior Anglo-Saxon interaction as compared to the Euro-zone situation, especially in the last decades.

While the aim of this paper is to establish the facts rather than to explain them, one is strongly tempted to speculate about the influence of international agreements on business cycles synchronization. For instance, a frequently asked question is if the Maastricht Treaty and/or the introduction of the Euro, have induced a common cycle in the Euro-zone. *Ad hoc* experiments (tables 7-8) confirm that despite (or because of?) their formal commitments, Euro-zone countries constitute a less coherent club than the English-speaking countries. In other words it seems that the "treatment" does not matter, at least in the

expected direction. By moving the UK-vector into the Euro-zone matrix, it is somewhat confirmed that the UK business cycle is more mutually consistent with the North American economies than to the European countries. It is interesting to observe that after the introduction of the Euro, these two groups show marginal homogeneity. This could be due to the fact that even light recessions are now more probably widespread than booms. Looking at the specific samples (tables 2-3a), similar findings can be drawn for another important commitment signed in the last decades, the European Monetary System (1979). All in all a negative result should, *ceteris paribus*, the UK decide to enter the Euro-zone.

To sum up, this paper presented a nonparametric analysis of the international business cycles testing the relative convergence of some economic clubs, whose presence has been pointed out by recent works. Data suggest to conclude that the English-speaking group is much more internally congruent than the core Euro-zone one. This result holds for different chronologies and it is even enforced in the last decade, thus we can say that European commitments failed to pass the "English exam". Using the words of Helbling and Bayoumi (2003), there are emerging two different "boats", in the sense that Anglo-Saxon countries appear to sail more often in the same direction than core Euro-zone economies. In this paper synchronization is the situation in which all countries share the same cyclical phase (recession or growth). This definition is extreme as compared to what sometimes proposed in the literature, and it is verified by nonparametric tests, which are based on very few assumptions. Taken together, it means that the reported findings are very robust.

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