MEASURING INTERNATIONAL REFERENCE-CYCLES

Sonia de Lucas Santos
Inmaculada Álvarez Ayuso
Mª Jesús Delgado Rodríguez

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Abstract

Using the methodology developed in Stock and Watson (2002a), this paper offers a proposal for measuring the commom component of international economic fluctuations and for identifying the countries sharing this behavior. The proposal allows us to use the weight of the correlations of each country in relation to the factor as a criterion of belonging to the cycle. We have applied this proposal to a large sample of countries and find evidence for an international business cycle which includes a group of advanced countries in different regions of the world.

Keywords: Business fluctuations; Cycles; Factor models, Principal Components.

JEL classification:: F41, C13, E32

* University Autonoma of Madrid.
** Department of Economics, Faculty of Law and Social Sciences, University Rey Juan Carlos, Madrid, 28032 Spain. Tel.:+34-91-488 -7951; fax: +34-91-488-7777; E-mail address: mariajesus.delgado@urjc.es

1. INTRODUCTION

One of the main objectives of the analysis of business cycles is to determine the existence of similar fluctuations in macroeconomic aggregates and whether these fluctuations show substantial synchronization across countries. Recent studies provide evidence that there are many cross-country links in macroeconomic fluctuations. This is the case of Artis *et al.* (2004), Darvas and Szapáry (2004), Camacho et al. (2006), Krolzing and Toro (2005), Böwer and Guillemineau (2006) for EU countries and Cancelo and Uriz (2001), Lumsdaine and Prasad (2002), Cotis and Copel (2005) for the OECD, among others[1].

The idea of summarizing the state of the economy as a synthetic index, or reference cycle, describing the common behavior of economic variables, was introduced by Burns and Mitchell (1946), and this is the approach behind the coincident indicator of the NBER. The methodology used for such purposes is the application of multivariate techniques of factor analysis that aims to simplify a broad set of observed interdependent data and explain them in terms of a small number of unobserved and independent factors, with the lowest loss of information possible. This methodology has been improved by introducing dynamics in the traditional factor model (Sangent and Sims, 1977 and Geweke, 1977), as it is considered that the contemporary relationship between economic variables, without considering the delays, can only be interpreted as a reference cycle (Stock and Watson, 1989).

The implementation of dynamic factor analysis methodology is not always possible, especially when the number of countries under study is large. Two approaches have been developed in the literature to overcome this limitation: the first is an approximation to the dynamic factor model that is closer to multivariate statistical analysis. This approach follows the research of Stock and Watson (1998, 2002a), which has been extended in subsequent articles by Stock and Watson (1999, 2002b) for the United States, Camacho and Sancho (2003) for Spain, Artis et al. (2001) for the UK, Gosselin and Tzacz (2001) for Canada, and Angelini et al. (2001) for the euro area. The aim of all these works is to obtain predictions using diffusion indexes.

A second methodology is based on estimates from a Bayesian approach, where we can find references in Otrok and Whiteman (1998) who have subsequently sought to generalize and extend the work of Kose et al. (2003a) and Kose et al. (2003b, 2005) and Kose et al. (2008) for an international cycle. This approach resolves some of the limitations of traditional nonparametric analysis, but it raises other questions such as the fact that the factors should be estimated a priori and it is not possible to test some of the assumptions related to the dynamics between countries imposed in the model.

In this article we have proposed a procedure for investigating the international business cycle (reference-cycle) based on the first approach, which we implement using principal component methods in factor model estimation for a large sample of countries. The objetive of this paper is to estimate the common component in international economic fluctuations and identify countries sharing this behaviour. Unlike most works in this area, this article does not establish a priori the number of common factors; rather, they are selected by the model, offering criterion to determine which countries share the common international fluctuation, excluding those countries which would only introduce noise in the model. Our goal is to consider a general-enough framework to permit data-model to determine the countries participating in this common behavior. Thus, we see this research as furthering the measurement of international business cycle phenomena by implementing what it could be considered a particular case of the approach of Stock and Watson (2002a). We have applied this proposal to a large sample of countries and the estimate is carried out in terms of the economic cycle (growth rate) of GDP per capita on an annual basis from 1950 to 2006. The results show evidence for an international business cycle which includes most EU and OECD countries and other advanced countries of Asia, Latin America and the Middle East.

Finally, it is essential to evaluate the common factors in terms of their robustness and usefulness as indicators of international economic flutuations in the period 1950-2006. This is achieved by comparing the results obtained in our proposal with those reached by using an alternative application of the model of Stock and Watson (2002a). For this purpose, we focus the comparison on the cyclical dating standard proposed by Harding and Pagan (2002). This analysis will not only further explore the characteristics of the expansion and recession phases represented in each cycle, but also make comparisons between cycles, making it possible to better interpret them.

The present paper is organized as follows: Section 2 summarizes the methodology of Stock and Watson (2002a) and discusses new applications of their model for economic business cycle analysis. Section 3 describes the data, presents the results of the factor model estimation

[1] See de Haan (2008) for a revisión of this literature.

and evaluates the evidence reached. The final section offers some concluding comments and proposes some lines for further research.

2. FACTOR MODEL METHODOLOGY FOR LARGE SAMPLES

Several model specification and estimation techniques have been used in the common factor literature to investigate the comovement of economic series. In this research, we follow the methodology developed in Stock and Watson (1998, 2002a) as a main reference for the factor analysis of business cycles. The statistical method used by these authors is based on a priori assumption that finite lags in the representations of the variables under study, depending on latent factors (not observable), make it possible to use a principal component analysis in the estimation of the factors. The use of principal components facilitates the factor estimation when the number of explanatory variables is large and it can cope with irregularities in the data, using information from series with missing values.

Formally, in the model, it is assumed that a set of variables, X_t, can be represented by common latent factors, such as:

$$X_t = \Lambda_t F_t + e_t; \qquad (2.1)$$

where the idiosyncratic disturbances, $e_t = (e_{1,t}, e_{2,t}, \ldots, e_{N,t})'$, contained in a $N \times 1$ vector, are serially correlated and slightly cross-sectionally correlated with other variables in the model. In addition, the factor loadings vary over time according to:

$$\Lambda_t = \Lambda_{t-1} + h\xi_t; \qquad (2.2)$$

where h is the diagonal $N \times N$ scaling matrix, and ξ_t are $N \times r$ stochastic disturbances.

The estimation of the standard dynamic factor model, 2.1-2.2, is carried out by maximum likelihood using the Kalman filter (Kalman, 1960). Applying this filter to the dynamic factor model is justified by assuming that the factor loading matrices are constant, and with disturbances mutually independent and with a serial correlation structure. In this line, there are other representations which are equivalent to model 2.1-2.2, and they are approximations to the dynamic factor model, assuming $\Lambda_t = \Lambda$ and introducing the dynamics in a variety of ways as suggested by Sargent and Sims (1977) and Quah and Sargent (1993), among others.

However, the estimation of the model 2.1-2.2 with the Kalman filter is not feasible with a large number of series. Therefore, when *N* is large, Stock and Watson (1998, 2002a) propose an estimation approach called quasi-likelihood, since we must make very restrictive assumptions on the model, such that $\Lambda_t = \Lambda$, $h = 0$ and e_{it} is *i.i.d.* $N(0, \sigma_e^2)$ and independent across series. Under these assumptions, the maximum likelihood estimator for (Λ, F) gives consistent estimates of the factors and factor loadings, by solving a problem of nonlinear least squares:

$$V(\tilde{F}, \tilde{\Lambda}) = (NT)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} (x_{it} - \tilde{\lambda}_i \tilde{F}_t)^2 \;; \qquad (2.3)$$

So that 2.3 is the objective function of the supposed values of the factors, $\tilde{F}_t = (\tilde{F}_1, \ldots \tilde{F}_T)'$, and loadings, $\tilde{\Lambda}$, where $\hat{F}$ and $\hat{\Lambda}$ are the values resulting from the efficient minimization. In practice to solve this problem we find two cases depending on the number of variables and the number of periods: N>T (Situation A) and N<T (Situation B). These two situations are described in Stock and Watson (2002a) to offer viable solutions to solve them statistically. This article reviews the advantages and limitations of both. Then we choose the solution that allows the use of factor loadings which are interpreted as belonging to or the weight respect to common factor in order to identify countries sharing the International business cycle. So the options are:

Situation A: When sample is large and N>T:

In this case, a less computationally complex approach is required, since the determinant of the matrix $X'X$ is zero and there is therefore no single solution. To this end, Stock and Watson (2002a) propose the use of the matrix XX' ($N \times N$), which implies maximizing $tr[\tilde{F}' X X' \tilde{F}]$ subject to $\tilde{F}'\tilde{F}/T = I_r$. Therefore, from the matrix XX', in vector notation:

$$\frac{1}{T} \sum_{i=1}^{T} x_t \, x_t' \,, \qquad (2.4)$$

and, consequently, the estimate of the first k eigenvectors are directly the principal components and therefore the factors.

However, if one analyzes the content of the matrix XX':

$$XX' = \begin{pmatrix} \sum_{i=1}^{N} x_{i,1}^2 & \sum_{i=1}^{N} x_{i,1}x_{i,2} & \cdots & \sum_{i=1}^{N} x_{i,1}x_{i,T} \\ \sum_{i=1}^{N} x_{i,2}x_{i,1} & \sum_{i=1}^{N} x_{i,2}^2 & \cdots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \sum_{i=1}^{N} x_{i,T}x_{i,1} & \cdots & \cdots & \sum_{i=1}^{N} x_{i,T}^2 \end{pmatrix}; \qquad (2.5)$$

where the main diagonal of the matrix shows the variances between the data considering only one year for each country. Meanwhile, outside the main diagonal is the sum of serial correlations of each country and not include correlations between countries, which is the most important information to carry out factor analysis.

Therefore, to introduce into the analysis the correlation between countries, this paper proposes, as a solution, the introduction of variable lags and the estimation of an augmented factor model, as proposed in Stock and Watson (1998)[2]. In this case, by introducing the variables lags, the matrix is obtained:

$$X^*X^{*\prime} = \begin{pmatrix} \sum_{j=1}^{r}\sum_{t=1}^{T}(x_{1,t}^{*\,2} + x_{j,t}^{*\,2}) & \cdots & \cdots & \cdots \\ \sum_{j=1}^{r}\sum_{t=1}^{T}(x_{j,t}^{*}x_{j+1,t}^{*}) & \sum_{j=1}^{r}\sum_{t=1}^{T}(x_{2,t}^{*\,2} + x_{j+1,t}^{*\,2}) & \cdots & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ \sum_{j=1}^{r}\sum_{t=1}^{T}(x_{j+N-3,t}^{*}x_{j+1,t}^{*}) & \cdots & \cdots & \sum_{j=1}^{r}\sum_{T=1}^{T}(x_{N,t}^{*\,2} + x_{j+N-3,t}^{*\,2}) \end{pmatrix}; \ (2.6)$$

where the matrix has variances of each time series on the main diagonal and serial correlations (without contemporary correlations) between countries off-diagonal. Despite the possible solution that would lead to an approximate dynamic model, the main drawback is that in this case, we lose the interpretation of factor loading as the weight of countries in relation to the factor.

Situation B: When sample is large and N<T:

The minimization problem is equivalent to maximizing $tr[\tilde{\Lambda}' X' X \tilde{\Lambda}]$ subject to $\tilde{\Lambda}'\tilde{\Lambda}/N = I_r$; the solution of which leads to the principal component analysis, whose

[2] The use of variables lags was proposed by Stock and Watson (1998) to introduce dynamics in the standard static factor model with N<T.

detailed description can be reviewed in Peña (2002). The factors are selected using the appropriate eigenvectores of *k* largest eigenvalues of the matrix $T \times T$:

$$\frac{1}{N}\sum_{i=1}^{N} x_i x_i \text{'} ; \qquad (2.7)$$

which is the covariance matrix of X (where the matrix has variances of each series on the main diagonal and contemporary correlations between countries off-diagonal). This computing proposal is equivalent to the static factor model, since only the contemporary relationship between the countries are considered, so that we would be referring to the so-called diffusion index of Stock and Watson (1989, 1998) for the reference cycle. Therefore, the advantage of this situation respect to situation A is that it permits to obtain factor loadings, but that the sample must satisfy N<T.

For the above, when sample is large and N>*T*, one can make two methodological choices for measurig the commom component of international cycle: 1) selecting subsamples in order to apply factor analysis according to 2.7, which has the disadvantage of limiting the number of countries analyzed to fullfil (N<T) and influence the selection of a particular approach, which would not be exempt from criticism, or 2) implementing the solution of 2.5 or 2.6, losing factor loadings the information about the relevant weight in relation to the factor. Faced with this dilemma, both options have been compared in an empirical manner to reach similar results, which are presented in the following section. Consequently, given the similarity of the results of both proposals, we consider that it is more reasonable to seek a more efficient estimation, using the weight criterion of the country on a common factor analysis to exclude those that do not reach a reasonable weight in loading or communality[3], and only introduce noise in the factors.

Therefore, in this paper the methodological proposal will be to implement the static factor analysis for the sample of countries (N<T) in two stages: 1) Estimate the model with all countries in the sample, selecting the corresponding number of factors according to the model results based on the criteria of the scree test and the total variance of the model (standard criteria of the literature, see Peña (2002). 2) Exclude those countries that do not have a factor loading with an acceptable weight in any of the factors, and re-estimate the model again. This procedure is repeated until we obtain interpretable factors and factor loadings and communalities with a reasonable weight, and when the following conditions are met: a) the determinant of the covariance matrix should be sufficiently small, b) the original

variables are not correlated (Barlett's test), and c) the adequacy of the data model (Kaiser-Meyer-Olkin (KMO)) [4] test).

To sum up, this section has sought to highlight the limitations of the dynamic factor models when using a large number of countries. These situations are generally more frequent with the development of large databases, in particular, for the analysis of the global cycles in an increasingly interrelated world. It will therefore be essential not only consider the temporal and spatial information available, but also to eliminate the redundant information on countries that do not offer a significant weight in relation to the factor and that could then generate spurious factors. The latter objective is not achieved with the methodology proposed by Stock and Watson (1998, 2002a) since they lose the interpretation of factor loading as the weight of countries in relation to the factor, resulting in a less efficient estimation. Consequently, the factor analysis used in this work is a static factor analysis, being the methodology that best meets our objectives and, furthermore, it could be considered as a particular case of Stock and Watson's approach (1998, 2002a).

Finally, one of the key issues, when analysing international fluctuations, is to try to establish the *state* of the business cycle. In our research, we consider that it constitutes relevant side information for a better evaluation of the results obtained. This is achieved by the cyclical dating standard proposed by Harding and Pagan (2002). This analysis will not only further explore the characteristics of the expansion and recession phases represented in each cycle, but also make comparisons between cycles, making it possible to better interpret them.

3. EMPIRICAL RESULTS

3.1. Data description.

The data used in this study are taken from the electronic version of the *The Conference Board and Groningen Growth and Development Center (GGDC), Total Economy Database, January 2008,* http://www.conference-board.org/economics, which offers information for 106 countries, organized by world regions (Western Europe, Eastern Europe, North America, Oceania, Latin America, Middle East, Asia and Africa). In the analysis performed we used the series of

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[3] To review these concepts in the standard literature of factor analysis, see Peña (2002).
[4] To see these tests in detail, see Peña (2002) and Levi and Varela (2003).

real GDP per capita on an annual[5] basis from 1950 to 2006 that is presented at market prices based on 1990 purchasing power parities (PPP) U.S. dollars[6].

To perform this analysis we have a large sample of countries (106) and an extensive temporal coverage (1950-2006), but to perform the analysis proposed above, it is necessary to satisfy N <T. Therefore we must divide the full sample of countries to met this condition. In this search we decided to divide our sample into two groups since in this way we fulfill that condition and maintain an important dimension for each of the subsamples. Among the possible criteria, we have opted for the Human Development Index of the United Nations (UN, 2007) which brings together the countries of high, medium and low human development. Then the first group is made up of countries with a high level of development, referred to as *advanced countries* (ACs), and a second group is composed of countries with medium and low human development level, referred as *other emerging and developing economies* (53 OEADEs).

The criteria to classify countries is a contentious issue. We have chosen the recent and prominent criteria of the Human Development Index which combines an economic measure, national income, with other measures, indexes for life expentancy and education. We are aware that this issue is a key aspect in this research but we are concious that whichever measure used can be subject of criticism because some anomalies exist when determining a country status.

3.2. Measuring common international reference-cycles

This section presents the results of the factor model estimation. The original series are initially transformed into logarithms to eliminate the effect of the units and possible outliers which are not standardized since, in this case, the variability of cycles is an important aspect to consider. Figure 1 of the annex plots the evolution of the real GDP growth rate[7] for the 106

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[5] Although some works propose the use of monthly or quarterly data for cycle analysis, we consider that the temporal scope of the database employed in this research offer the possibility of capturing more economic fluctuations. In addition, quarterly real GDP data are not available for many countries on a long-term basis.

[6] In the case of Germany, per capita GDP is obtained as the sum of the data for West and East Germany. For the period 1950-1959, GDP data do not exist for East Germany. In this case data have been interpolated using the growth rate of the average weight of West Germany over the whole of Germany.

[7] In this research we use the definition of cycle as first differences (growh rate cycle) due to the fact that it offers a more direct economic interpretation than the definition of deviation cycle. However, we compare our results with those obtained from the application of other standard filters (Hodrick-Prescott, 1980, and Baxter-King, 1995) that do not show significant differences. Though not reported here, those results are available upon request.

countries (divided into ACs and OEADEs) from 1950 to 2006. With this information, we estimate the factor model in stages, according to the methodology described in section 2.

First, we have made preliminary estimates for the two subsamples and selected the number of factors according to the scree test (Figures 2 y 3 in Annex) and the criterion of the percentage of total variance explained by the model that is close to 50%. In the case of ACs, the results (Table 1) show several factors. From them we can highlight a first common cycle, which incorporates a number of countries with loadings with reasonable weight in the factor. This first factor is interpreted as a common factor for most EU and OECD countries, together with the countries of Eastern Europe and other advanced countries of Asia, Latin America and the Middle East. The second factor is less intuitive since it again includes countries of Eastern Europe with similar charges to those of the first factor but with an opposite sign, along with Luxembourg, Cuba, Malasia and Hong Kong, countries that were not included in the first factor. The rest of the factors do not present a reasonable explanation and they are formed by a wide disparity of countries not classified in the first two factors

The results for the group of OEADESs (Table 2) do not reflect a common cycle, but a number of factors that are difficult to interpret, reflecting the greater instability in the behavior of these countries, with sudden changes in their trends in the period analyzed. This result would support the decision to split the sample as it seems sensible that these countries are examined separately.

Table 1. Preliminar Factor Model for ACs: Growth Rate Cycle.

COUNTRIES	LOADINGS							COMMUNALITIES
	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	
Austria	0.6625	0.1743	-0.3776	0.0783	-0.1329	0.1546	-0.0917	0.6680
Belgium	0.7466	0.3712	-0.1653	-0.0166	0.1628	0.0008	0.1672	0.7771
Cyprus	0.1188	0.3573	0.2976	-0.2516	0.1518	-0.1242	-0.2773	0.4090
Denmark	0.4361	0.1434	0.1181	-0.4266	-0.1297	-0.0082	0.0620	0.4274
Finland	0.6996	-0.2289	-0.1757	-0.1014	0.3005	0.0376	0.2157	0.7213
France	0.8286	0.2385	-0.3044	-0.1016	0.0362	0.0153	-0.1351	0.8662
All Germany	0.5883	0.2279	-0.0951	-0.1411	-0.2307	-0.0134	-0.2056	0.5227
Greece	0.6474	0.0373	-0.0371	-0.0498	-0.2855	-0.0514	-0.0630	0.5125
Iceland	0.2890	-0.0241	0.3053	0.1669	0.2385	0.4609	-0.2027	0.5156
Ireland	0.1243	0.0168	0.1608	0.0947	0.3903	-0.6247	0.3600	0.7227
Italy	0.6081	0.2851	-0.2697	-0.1689	-0.1139	-0.1024	-0.2376	0.6321
Luxembourg	0.1842	0.4145	0.3419	-0.2240	0.2543	-0.0425	-0.1378	0.4583
Malta	0.0024	0.1933	-0.0247	0.1116	-0.2998	0.3066	0.3890	0.3856
Netherlands	0.6035	0.3819	0.0485	-0.1169	-0.0647	-0.2147	0.1637	0.6032
Norway	0.2940	0.0867	0.0016	0.0960	-0.0908	0.2080	0.4722	0.3776
Portugal	0.5711	0.5256	-0.1327	-0.1632	0.1199	-0.0925	-0.1110	0.6819
Spain	0.4984	0.1521	-0.3250	0.0310	0.1767	0.1485	-0.0393	0.4329
Sweden	0.7081	-0.2054	-0.1550	-0.1383	0.1473	-0.0406	0.2586	0.6770
Switzerland	0.7109	0.2095	-0.2492	-0.0047	0.1930	-0.1707	-0.0896	0.6858
United Kingdom	0.5158	-0.0221	0.2937	-0.4302	-0.0059	-0.1143	0.2602	0.6186
Canada	0.5527	0.0032	0.3623	-0.1204	0.0738	-0.0698	0.1185	0.4756
United States	0.4346	0.1519	0.4056	-0.2395	-0.0086	-0.2984	0.1266	0.5389
Australia	0.3773	-0.0116	0.2412	-0.0145	0.0103	-0.2955	0.3419	0.4052
New Zealand	0.0973	-0.0390	0.3234	-0.1326	0.3466	0.3717	-0.0632	0.3954
Albania	0.4329	-0.5901	0.2384	-0.1498	0.1573	-0.1255	-0.0148	0.6556
Bulgaria	0.5020	-0.5093	-0.0533	-0.0418	-0.3411	-0.0483	-0.1335	0.6525
Czechoslovakia	0.5173	-0.6138	0.1551	0.0173	0.0475	0.0613	-0.0132	0.6749
Hungary	0.5410	-0.6239	0.1311	-0.0276	0.0151	-0.0943	-0.1504	0.7317
Poland	0.4854	-0.4049	0.4099	0.0658	-0.2357	0.0409	0.1842	0.6631
Romania	0.5619	-0.5249	0.2303	-0.0112	-0.0956	0.2858	-0.1537	0.7588
Yugoslavia	0.6146	-0.3993	0.0253	-0.0797	0.0813	0.0990	0.0232	0.5611
USSR	0.4578	-0.2369	-0.0945	-0.1109	0.1171	0.1814	-0.2982	0.4225
Hong Kong	0.257971	0.428406	0.279054	-0.098701	0.189010	0.404631	-0.094114	0.5460
Japan	0.612934	0.276095	-0.389103	-0.177875	-0.209966	-0.030778	-0.110391	0.6922
Malaysia	-0.072885	0.469064	0.358242	0.081103	0.486551	0.228511	0.183899	0.6830
Singapore	0.153284	0.383031	0.266252	0.089884	0.156561	0.170134	0.314676	0.4017
South Korea	-0.043628	0.360756	0.421403	-0.401800	-0.101601	0.207884	0.054120	0.5275
Argentina	0.234932	0.216005	0.108196	0.412343	-0.377038	0.237612	0.132874	0.4999
Barbados	0.802468	-0.138663	0.079905	0.031169	-0.171308	0.110117	0.053332	0.7149
Brazil	0.513985	-0.021711	0.164735	0.071497	-0.255528	0.330185	0.135325	0.4895
Chile	0.038812	0.317507	0.398888	0.363725	-0.055147	-0.264164	-0.215730	0.5131
Costa Rica	0.305786	0.153518	0.538226	0.201023	-0.404911	-0.207055	-0.158847	0.6792
Cuba	0.250487	-0.479224	-0.040303	0.141701	0.406096	0.155149	0.035469	0.5043
Mexico	0.382363	0.128128	-0.257766	0.563274	0.189748	0.024648	0.181838	0.6160
Trinidad and Tobago	0.310327	-0.192835	0.131938	0.639332	0.077202	-0.209182	-0.100884	0.6195
Uruguay	0.061360	0.160186	0.113309	0.513539	-0.268394	0.255220	0.349620	0.5654
Bahrain	0.331472	0.103918	0.313532	0.168351	0.018681	-0.002940	-0.536874	0.5359
Israel	0.495227	0.011781	-0.358124	0.074618	0.057585	0.073514	0.246234	0.4486
Kuwait	0.072447	0.246984	0.292549	0.088413	-0.459716	-0.043348	-0.125958	0.3887
Oman	0.029288	0.001916	-0.277982	-0.146724	-0.296752	-0.282275	0.239031	0.3245
Qatar	0.413609	-0.014178	0.258866	0.518476	-0.006922	-0.269674	0.000005	0.5799
Saudi Arabia	0.479334	0.322018	-0.240262	0.441888	0.093929	0.095972	-0.247496	0.6657
Arab Emirates	0.318230	0.086773	-0.012447	0.633552	0.238034	-0.248256	-0.133392	0.6464

Explained variance by the model: 57.12%

Sampling adequacy tests of Kaiser-Meyer-Olkin: 0.207

Correlation Matrix Determinant: 2.06E-34

Bartlett's Test

Approximate Chi-square	**2831.124**
d.f.	**1378**
Sig.	**0.00**

Note: Loadings with sufficient correlation with the factor are in black and those that are not in red. Communalities with enough percentage of variance explained by the factor are in black and those without in red.

Table 2. Preliminar Factor Model for OEADESs: Growth Rate Cycle.

COUNTRIES	LOADINGS					COMMUNALITIES
	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	
Turkey	0.2170	0.0375	-0.1521	0.1753	-0.2519	0.1658
Bangladesh	0.0258	0.0249	0.2481	0.2616	0.3251	0.2369
Cambodia	0.1571	-0.0287	-0.0432	0.4082	0.4227	0.3727
China	-0.0163	-0.0763	-0.0146	0.4926	0.1206	0.2635
India	-0.0547	-0.1592	0.2224	0.4788	0.1789	0.3391
Indonesia	0.2525	-0.2587	-0.5567	0.1919	0.1213	0.4922
Myanmar	0.0805	0.2863	0.2874	0.5207	0.1406	0.4619
Pakistan	-0.0375	-0.1716	-0.1107	0.1664	0.4431	0.2671
Philippines	0.5370	0.1913	0.0402	0.1109	-0.1913	0.3755
Sri Lanka	-0.2236	-0.0575	-0.0702	0.4799	0.3042	0.3811
Taiwan	0.1851	0.0600	-0.5539	-0.0664	0.0941	0.3579
Thailand	0.0260	-0.3984	-0.3622	0.2955	0.0145	0.3781
Vietnam	0.0990	-0.0059	-0.1019	0.5252	0.0558	0.2991
Bolivia	0.3156	0.2233	-0.3402	0.2911	-0.2660	0.4207
Colombia	0.4644	-0.0617	-0.4942	-0.0891	0.2924	0.5572
Dominican Republic	0.2714	0.1340	-0.2189	0.3205	-0.2418	0.3008
Ecuador	0.3866	0.1983	-0.2828	-0.0969	0.3168	0.3785
Guatemala	0.5052	0.3159	-0.3285	-0.1184	-0.0052	0.4770
Jamaica	0.4250	-0.5314	0.0908	-0.2134	-0.2813	0.5960
Peru	0.3428	0.2038	0.0490	-0.0375	0.2063	0.2054
Puerto_Rico	0.5928	-0.3398	-0.1656	-0.3582	0.1361	0.6411
St Lucia	0.1436	-0.5205	0.0717	-0.1524	0.0126	0.3201
Venezuela	0.4773	0.0371	-0.0789	0.0495	0.0638	0.2419
Iran	0.1536	0.2042	-0.0644	0.0698	-0.5132	0.3377
Iraq	0.2532	0.3070	0.0839	-0.0816	0.1651	0.1993
Jordan	0.0050	0.4322	0.0958	-0.1182	0.5756	0.5413
Syria	0.0114	0.2444	-0.0097	-0.3084	0.1167	0.1687
Yemen	0.2328	0.3574	-0.6395	-0.0694	-0.0919	0.6042
Algeria	0.1501	0.2433	0.0265	-0.0608	0.0616	0.0899
Angola	0.5008	-0.3630	0.2056	0.1561	0.1567	0.4737
Burkina Faso	0.1754	-0.1387	0.4032	-0.1781	0.3252	0.3500
Cameroon	-0.0264	0.3404	0.2966	-0.1944	0.3322	0.3527
DR Congo	0.4814	-0.1240	0.2187	-0.0231	-0.0360	0.2968
Cote d'Ivoire	0.4518	0.3045	-0.0380	-0.1723	0.2329	0.3822
Egypt	-0.1481	0.6580	-0.0670	0.1191	0.2287	0.5259
Ethiopia	0.4726	0.1592	0.1585	0.0914	-0.0110	0.2823
Ghana	0.4799	-0.3497	0.1277	0.0265	0.3267	0.4764
Kenya	0.4022	-0.0299	0.0636	0.1353	-0.1031	0.1956
Madagascar	0.3526	0.0330	0.3040	-0.1359	-0.2108	0.2808
Malawi	0.2480	0.0871	-0.1082	-0.1867	-0.0650	0.1199
Mali	0.0498	0.2888	-0.0538	-0.0512	-0.3034	0.1835
Morocco	0.0248	0.2820	0.0139	0.0350	0.1051	0.0926
Mozambique	0.5141	-0.3457	0.2818	0.1774	-0.1042	0.5055
Niger	0.2418	0.2641	0.5182	-0.2120	0.0958	0.4509
Nigeria	0.5125	0.0742	-0.1641	0.0498	-0.1078	0.3092
Senegal	-0.0376	0.3513	0.3680	-0.0530	-0.4019	0.4246
South Africa	0.7084	0.1199	0.2688	0.0906	0.1621	0.6229
Sudan	0.0996	0.4340	0.2969	0.2629	-0.1944	0.3933
Tanzania	0.5255	0.2148	0.0760	0.3605	-0.3356	0.5707
Tunisia	-0.0003	0.3712	-0.1151	-0.1587	-0.0266	0.1769
Uganda	0.1787	-0.1586	0.2912	0.3339	-0.3185	0.3548
Zambia	0.4314	-0.0451	0.3167	-0.1773	0.0427	0.3217
Zimbabwe	0.2398	-0.1975	-0.0262	-0.5650	-0.0398	0.4180
Explained variance by the model: 42.38%						
Sampling adequacy tests of Kaiser-Meyer-Olkin:			**0.107**			
Correlation Matrix Determinant:			**1.18E-24**			
Bartlett's Test						
	Approximate Chi-square		**2010.892**			
		d.f.	**1378**			
		Sig.	**0.00**			

Note: Loadings with sufficient correlation with the factor are in black and those that are not in red. Communalities with enough percentage of variance explained by the factor are in black and those without in red.

Analysis of factor loadings and communalities in factor models of both groups of countries (Tables 1 and 2) show it would be desirable to exclude from the model these countries that are not part of or whose behaviour is not explained by the two main common factors. Our results were also confirmed by the criterion of variance and tests the adequacy of the sample. This is the case of 17 countries in the AC group and 13 in the OEAD group.

After excluding the countries that we consider that are not relevant for the factorial model, we obtained the final results, whose suitability is confirmed by the different tests that are presented in the tables of results for ACs (Table 3) and for OEADEs (Table 4). Results show two factors in ACs and four in OEADESs. For the ACs group, results in Table 3 show a first common cycle consisting of most EU and OECD countries along with the rest of the countries of Eastern Europe, Barbados (with great economic dependence on the U.S. and Europe), Brazil and Mexico (leadings economies in Latin America and MERCOSUR), Israel (possible new member of the OECD), Japan (traditional Asian potency), Qatar (has the highest GDP per capita in the developing world due to exports of oil and natural gas) and Saudi Arabia (OPEC leader). Results show France as the reference country (the country with the highest factor loading or correlation in the first common factor), therefore it could be interpreted as the country that represents the average economic behavior of all country considered in the model and during the period analyzed.

The second factor could be interpreted as a specific cycle that reflects the behavior of countries have shown a higher growth (when the sign of the charge is positive) or less growth (the sign of its charge is negative)[8] than the countries belonging to the first factor. In this first group are, in general, countries that increased growth during the crisis of 1991 compared to the decline experienced by most industrialized countries (such as Luxembourg, Malaysia and Hong Kong) and in the second group are Eastern European countries with Cuba. The case of Eastern European countries, with relevant factor loadings in both factors, may be interpreted as during a part of period analyzed these countries have belonged to the second factor (socialist planning system until the nineties) to joint part of the first in another (market system since the nineties to the present). This leads us to raise the interest of the study the stability of factor loadings in these situations.

[8] Due to the difficulty of interpreting the second factor, we considered the possibility of excluiding Luxembourg, Hong Kong, Malaysia and Cuba from the estimation with the aim to assess a single factor in the model. The estimation without these countries does not explain a sufficient proportion of the variance in order to consider the model adequate, so the estimate has been maintained with the two above factors.

Table 3. Factor Model for ACs: Growth Rate Cycle.

COUNTRIES	LOADINGS factor 1	LOADINGS factor 2	COMMUNALITIES
Austria	0.6696	0.2694	0.5210
Belgium	0.7446	0.4133	0.7252
Denmark	0.4473	0.1132	0.2129
Finland	0.7231	-0.1493	0.5452
France	0.8439	0.3174	0.8129
All Germany	0.5933	0.2815	0.4312
Greece	0.6516	0.0280	0.4254
Italy	0.6225	0.3435	0.5054
Luxembourg	0.1710	0.3627	0.1608
Netherlands	0.5934	0.3813	0.4974
Portugal	0.5755	0.5368	0.6193
Spain	0.5079	0.2384	0.3147
Sweden	0.7311	-0.1267	0.5505
Switzerland	0.7121	0.2990	0.5965
United Kingdom	0.5376	-0.0965	0.2983
Canada	0.5402	-0.0788	0.2980
United States	0.4248	0.0445	0.1825
Australia	0.3683	-0.0505	0.1382
Albania	0.4428	-0.6241	0.5855
Bulgaria	0.5240	-0.4886	0.5133
Czechoslovakia	0.5194	-0.6333	0.6709
Hungary	0.5512	-0.6245	0.6939
Poland	0.4653	-0.5288	0.4961
Romania	0.5573	-0.5877	0.6559
Yugoslavia	0.6265	-0.3787	0.5358
USSR	0.4756	-0.1665	0.2539
Hong Kong	0.2344	0.3275	0.1622
Japan	0.6405	0.3519	0.5341
Malaysia	-0.1127	0.3535	0.1377
Barbados	0.7967	-0.1676	0.6629
Brazil	0.4995	-0.0882	0.2573
Cuba	0.2565	-0.4496	0.2679
Mexico	0.3566	0.2335	0.1817
Israel	0.5081	0.1158	0.2716
Qatar	0.3616	-0.0849	0.1380
Saudi Arabia	0.4444	0.3884	0.3483
Explained variance by the model: 42.23%			
Sampling adequacy tests of Kaiser-Meyer-Olkin:			**0.625**
Correlation Matrix Determinant:			**2.35E-15**
Bartlett's Test			
	Approximate Chi-square		**1420.403733**
		d.f.	**630**
		Sig.	**0.00**

Note: Loadings with sufficient correlation with the factor are in black and those with not in red. Communalities with enough percentage of variance explained by the factor are in black and those without are in red.

Regarding the OEADE countries, the results in Table 4 show a first common factor which share South Africa (first African economy) along with other African economies, most countries in Latin America and the Philippines. In the second factor we find countries whose fundamental resources are derived from tourism. This cycle includes Egypt and Jordan, along with other countries like Sudan and Myanmar (although in this case its resources are not related to tourism). Furthermore, this group also includes countries with different behaviors, as is the case of Jamaica, Puerto Rico, St. Lucia and Zimbabwe. The third factor reflects a common cycle that is difficult to interpret, represented by Yemen, followed by Colombia, Guatemala, Taiwan and the Ivory Coast. The fourth factor represents the cycle of most Asian countries considered in the model.

Table 4. Factor Model for OEADESs: Growth Rate Cycle.

COUNTRIES	LOADINGS				COMMUNALITIES
	factor 1	factor 2	factor 3	factor 4	
Cambodia	0.1465	0.3033	-0.1058	0.4995	0.3741
China	-0.0364	0.1658	-0.2652	0.5006	0.3498
Indonesia	0.2818	-0.0410	0.2676	0.5236	0.4268
Myanmar	0.0151	0.5614	-0.3936	0.1847	0.5044
Philippines	0.5165	0.3476	0.0008	-0.1960	0.4260
Sri Lanka	-0.2652	0.1571	-0.1559	0.4418	0.3145
Taiwan	0.1550	0.0384	0.6030	0.3597	0.5186
Vietnam	0.0939	0.2906	-0.1038	0.5973	0.4608
Colombia	0.4337	-0.0035	0.4089	0.2728	0.4297
Guatemala	0.4438	0.2801	0.4550	-0.1306	0.4995
Jamaica	0.5232	-0.5120	-0.0989	0.0036	0.5457
Puerto Rico	0.6525	-0.3170	0.3200	0.0272	0.6294
St Lucia	0.2129	-0.5695	-0.0890	0.0977	0.3871
Venezuela	0.4230	0.0856	0.0490	0.2269	0.2401
Jordan	-0.0344	0.4530	0.1519	-0.1273	0.2457
Yemen	0.1656	0.2623	0.7015	0.1042	0.5992
Angola	0.5714	-0.1076	-0.2898	0.1666	0.4498
DR Congo	0.4994	-0.0812	-0.2856	-0.0202	0.3380
Cote d'Ivoire	0.4113	0.2356	0.4003	-0.2489	0.4468
Egypt	-0.2239	0.6598	0.2803	-0.1241	0.5795
Ethiopia	0.4448	0.2730	-0.0134	-0.1855	0.3070
Ghana	0.5533	-0.1158	-0.1246	0.1861	0.3697
Kenya	0.4128	0.1013	-0.0967	-0.0223	0.1905
Mozambique	0.5728	-0.0949	-0.3813	0.0653	0.4868
Niger	0.2363	0.2570	-0.1725	-0.5623	0.4679
Nigeria	0.4906	0.0991	0.1533	0.1364	0.2927
South Africa	0.6871	0.2669	-0.2456	-0.1998	0.6436
Sudan	0.0306	0.5720	-0.2248	-0.2506	0.4415
Tanzania	0.4532	0.3131	-0.2837	0.0558	0.3871
Zambia	0.4591	-0.0423	-0.2597	-0.1543	0.3038
Zimbabwe	0.3116	-0.3913	0.2899	-0.3843	0.4819
Explained variance by the model: 42.38%					
Sampling adequacy tests of Kaiser-Meyer-Olkin:			**0.450**		
Correlation Matrix Determinant:			**7.27E-08**		
Bartlett's Test					
		Approximate Chi-square	**720.4946523**		
		d.f.	**465**		
		Sig.	**0.00**		

Note: Loadings with sufficient correlation with the factor are in black and those without are in red. Communalities with enough percentage of variance explained by the factor are in black and those without are in red.

Finally, the analysis of the results (Tables 3-4 and graphs of Figure 1) show that in the subsample of ACs, there is a group of countries which includes many OECD and EU countries along with some of the most developed countries in Latin America, Asia and the Middle East, that follow a common cycle. We can include in this group the rest of Eastern Europe countries, which may have become part of the first factor from a specific date. With regard to the behavior of the countries in the subsample of the OEADESs, it is more heterogeneous, making it more difficult to find clear common cycles. The methodology proposed has allowed us to identify countries that do not provide information to the model. This is the case of countries like Ireland, Iceland and Malta in the AC group and India and Turkey in the OEADE group. Furthermore, a comparison of the cycles of the two subsamples of countries also reflects a large gap between them. This would confirm the idea, discussed in many papers, that an international common factor is the determinant of business cycles in advanced countries (Kose et al, 2003, 2005, 2008).

3.3. Model evaluation

In this subsection we will compare the results reached implementing our proposal with those obtained by using the methodolgy of Stock and Watson (1998, 2002a) for large sample with N>T and the augmented model with variable lags (equation 2.5 and 2.6). An initial comparison of the results shows that using both applications we achieved an international common factor and a less relevant second factor[9]. For a better assessment of this comparison, we have considered looking at a wide set of business cycle features[10]. First, we evaluate the results through the dating of the common cyclical factors identified. These fluctuations determine the basic chronology of the cycle[11] and would confirm the relevance of estimated cycles as international cycles. The results are also compared with the chronology of the National Bureau of Economic Research (NBER) for the United States[12] as the main benchmark. Furthermore, we will undertake the analysis of cycle properties: duration, amplitude, asymmetry and intensity.

3.3.1. The cronology of common factors.

Before the characteristics of common factors can be examined, the first step is to identify the expansions and contractions. Plots of Figures 4 and 5 of Annex show the turning points of both models, which confirm, from a historical perspective, the identification of the last two stages of the twentieth century outlined in literature and match the phases of expansion and contraction of the NBER chronology for the United States. First, we encounter a period covering the post-war era until the oil crisis, which has reflected an era of economic stability and smoother and shorter cycles. By contrast, cyclical fluctuations are more prolonged in the final third of the twentieth century and the early years of the current century due to several recessions (1974-1975, 1981-82, 1991 and 2001) and global contraction (1986 and 1995).

Dating for the ACs, in Figure 4 of the annex, we identify for the first common factor two small decelerations in the period 1950-1973, occurring in the United States in 1954 and 1961. Our findings also show a clear classification of the recessions of 1974-75, 1981, 1991 and

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9 Though not reported here, any details of the estimation of equations 2.5 and 2.6 (Situation A) are available upon request.

10 Even though for the comparison of the two methods would be sufficient the comparison of the ACs with the full sample of countries, a cyclical dating analysis has been also carried out for the OEADEs.

11 To identify the turning points we have used the method of Harding and Pagan (2002). This procedure has been implemented using the free program available at: http://www.scilab.org/.

12 The NBER chronology is available from 1850 to present in http://www.nber.org/cycles.html

2001 in the first factor, while the second factor demonstrates astonishing growth in 1991, showing a lagged connection with the first factor. The results of dating for the OEADEs in their first common contractions in 1950-1973 are less obvious. Furthermore, international recessions in 1974-75, 1981, 1991, 2001 are identified, although they are lagged respect to AC factors. This would reflect a lack of spillover transmission from AC countries to the rest of the countries. The rest of OEADEs factors are difficult to label and, for this reason, we have not commented on their dating. Finally, the Stock and Watson estimation with the full sample of countries (N>T), in plots of Figure 5 of Annex, show similar turning points with our estimation for AC countries in the two identified common factors, which confirm the similarities with our results.

3.3.2. Basic characteristics of common factors.

Tables 5-6 summarize the values of four relevant business cycle features: duration, amplitude, asymmetry and intensity computed for the two sub-samples of countries and common factors raised in our analysis. In Table 7, business cycle features for common factors with the full sample (106 countries) are presented.

The results of dating for AC growth cycles (table 5) find the average durations of the cycles in the first factor are very similar, with asymmetries in the durations - longer expansions than contractions -. These results have also been noted in studies by Razzak (2001) and Psaradakis and Sola (2003) and Boyan (2004), among others. The contractions are generally more intense than the expansions, with minor differences in the expansions in recent years. On the other hand, the second factor is more asymmetric with respect to the duration than with respect to amplitude. Futhermore, expansions are also longer than contractions, but more intense.

Table 5: Dating ACs Growth Cycles (53): Summary Statistics.

FACTOR 1										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
1955	1958	-	3	-	-	4.7	-	-	-	-
1960	1967	2	7	9	4.9	2.7	0.29	1.84	2.47	0.38
1973	1981	6	8	14	2.1	8.3	0.75	0.26	0.36	1.03
1988	1991	7	3	10	4.4	10.2	2.33	0.44	0.64	3.40
2000	2002	9	2	11	11.9	3.6	4.50	3.29	1.32	1.81
MEDIAN		**6.50**	**3.00**	**10.50**	**4.69**	**4.70**	**1.54**	**1.14**	**0.98**	**1.42**
FACTOR 2										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
1956	1957	-	1	-	-	6.9	-	-	-	-
1962	1966	5	4	9	6.7	5.0	1.25	1.36	1.35	1.24
1968	1975	2	7	9	5.6	8.7	0.29	0.64	2.81	1.25
1976	1984	1	8	9	8.1	3.9	0.13	2.06	8.11	0.49
1991	1995	7	4	11	20.3	23.5	1.75	0.87	2.90	5.87
1997	-	2	-	-	6.7	-	-	-	3.36	-
MEDIAN		**2.00**	**4.00**	**9.00**	**6.73**	**6.87**	**0.77**	**1.11**	**2.90**	**1.24**

Note: **Duration** of an expansion is the interval from the date of the initial trough to the date of the peak. The duration of a contraction is the interval from the date of the peak to the date of the final trough. **Amplitude**: the peak-trough amplitude is the difference between the level of the time series at adjacent peaks and troughs. **Asymmetry**: Currently two types of asymmetries are analyzed in duration and amplitude of cycles, discussing the distintion between sharp versus deep cycles. Sharpness occurs when contractions are steeper than expansions (dividing duration of expansions by duration of contactions), deepness occurs when troughs are more pronounced than peaks (dividing expansions amplitude by contractions amplitude). **Intensity:** Dividing expansions (contractions) amplitude by expansions (contractions) duration gives a measure of intensity in expansion (contractions). See Harding and Pagan (2001) for more details.

The results of dating for OEADEs growth cycles (Table 6) show a first common factor with expansions that are longer and more intense than contractions, which generate asymmetric behaviors opposite to those observed in ACs. This reflects the lack of connections and similarities in these countries respect to ACs. Characteristics of the other factors were not analyzed due to their lack of importance.

Table 6: Dating OEADEs (53) Growth Cycles: Summary Statistics.

FACTOR 1										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
-	1958	-	-	-	-	-	-	-	-	-
1959	1967	1	8	9	8.00	5.09	0.13	1.57	8.00	0.64
1970	1975	3	5	8	8.34	23.73	0.60	0.35	2.78	4.75
1978	1983	3	5	8	15.79	9.33	0.60	1.69	5.26	1.87
1988	1992	5	4	9	13.01	10.48	1.25	1.24	2.60	2.62
1996	1998	4	2	6	11.04	6.87	2.00	1.61	2.76	3.44
MEDIAN		**3.00**	**5.00**	**8.00**	**11.04**	**9.33**	**0.60**	**1.57**	**2.78**	**2.62**

Note: See footnote to Table 5.

Characteristics of the phases of the estimated cycles of Stock and Watson (2002a) are presented in table 7. With respect to the first factor or international cycle, results are very similar to our ACs international cyle. However, the amplitudes are much lower in this last estimation, which leads to less asymmetry and intensity in expansions and recessions that do not seem consistent with the results of the literature. These results are more evident when variable lags are introduced in the factor model (which considers the correlation between countries as in our proposal). Therefore, these results confirm the robustness of our estimation only with those countries which share a common behavior with the international cycle.

Table 7: Dating Growth Cycles (106 countries) Stock & Watson (2002a): Summary Statistics.

FACTOR 1										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
-	1958	-	-	-	-	-	-	-	-	-
1964	1967	6	3	9	2.0	1.1	2.00	1.90	0.34	0.35
1973	1982	6	9	15	1.0	3.6	0.67	0.29	0.17	0.40
1988	1991	6	3	9	2.1	2.4	2.00	0.89	0.35	0.79
2000	2002	9	2	11	2.8	1.2	4.50	2.28	0.31	0.61
MEDIAN		**6.00**	**3.00**	**10.00**	**2.07**	**1.80**	**2.00**	**1.40**	**0.32**	**0.51**
FACTOR 2										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
1961	1967	-	6	-	-	0.3	-	-	-	0.05
1973	1975	6	2	8	1.9	4.1	3.00	0.47	0.32	2.07
1991	1998	16	7	23	5.4	4.7	2.29	1.16	0.34	0.67
MEDIAN		**11.00**	**6.00**	**15.50**	**3.69**	**4.14**	**2.64**	**0.81**	**0.33**	**0.67**
FACTOR 1 lagged one period										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
1955	1959	-	4	-	-	1.0	-	-	-	-
1964	1968	5	4	9	1.2	0.6	1.25	2.09	0.24	0.14
1970	1983	2	13	15	0.7	3.5	0.15	0.20	0.34	0.27
1988	1992	5	4	9	1.9	2.3	1.25	0.83	0.37	0.56
1997	2002	5	5	10	2.6	0.9	1.00	3.05	0.52	0.17
MEDIAN		**5.00**	**4.00**	**9.50**	**1.53**	**1.04**	**1.13**	**1.46**	**0.36**	**0.22**
FACTOR 2 lagged one period										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
-	1959	-	-	-	-	-	-	-	-	-
1962	1964	3	2	5	1.2	0.4	1.50	3.05	0.39	0.19
1970	1975	6	5	11	1.6	2.9	1.20	0.54	0.26	0.58
1979	1982	4	3	7	1.7	1.4	1.33	1.17	0.42	0.48
1991	2002	9	11	20	3.8	4.5	0.82	0.86	0.43	0.41
MEDIAN		**5.00**	**4.00**	**9.00**	**1.62**	**2.17**	**1.27**	**1.02**	**0.41**	**0.44**

Table 7: Continued

FACTOR 1 lagged two periods										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
-	1959	-	-	-	-	0.8	-	-	-	-
1965	1967	6	2	8	0.4	0.5	3.00	0.77	0.06	0.25
1971	1976	4	5	9	1.9	0.6	0.80	3.34	0.49	0.12
1978	1983	2	5	7	2.0	1.7	0.40	1.17	1.00	0.34
1988	1993	5	5	10	2.1	2.5	1.00	0.83	0.42	0.50
1998	2003	5	5	10	0.7	-	1.00	-	0.15	-
MEDIAN		**5.00**	**5.00**	**9.00**	**1.95**	**0.82**	**1.00**	**1.00**	**0.42**	**0.29**
FACTOR 2 lagged two periods										
TURNING POINTS		DURATIONS			AMPLITUDES		ASYMMETRIES		INTENSITY	
PEAKS	TROUGHS	EXP.	CONT.	CYCLE	EXP.	CONT.	DURATION	AMPLITUDE	EXP.	CONT.
-	1960	-	-	-	-	-	-	-	-	-
1962	1964	2	2	4	1.2	0.6	1.00	2.18	0.61	0.28
1970	1977	6	7	13	1.4	2.4	0.86	0.59	0.24	0.34
1981	1984	4	3	7	1.6	1.6	1.33	1.00	0.41	0.54
1991	-	7	-	-	3.9	-	-	-	0.56	-
MEDIAN		**5.00**	**3.00**	**7.00**	**1.53**	**1.63**	**1.00**	**1.00**	**0.48**	**0.34**

Note: See footnote to Table 5.

4. CONCLUSIONS

In this article we have proposed a useful way of approaching the international reference-cycle by offering the possibility of estimating it only with countries that share economic fluctuations. This goal is achieved by estimating a factor model that allows the factor loadings to contain the meaning of the relevant weight in relation to the factor. The implementation of what we have called a particular case of Stock and Watson's (2002a) to large sample of countries makes it possible to refine previous measurements of the business cycle by estimating it only with countries that share or provide information to the common factor and excluding those which do not provide information to the model.

The application of this proposal allow us to offer evidence that capture, without imposing a priori restrictions, an international business cycle which includes a group of advanced countries in different regions of the world. This research contributes to the empirical literature by identifying countries which do not share the international business cycle and, hence, their inclusion in the estimation only introduces noise in the factors (this is the case of Ireland and Malta, among others). These criteria should be helpful in applications in which the sample of countries has traditionally been assumed rather than determined by the data, such as analysis of the economic cycle in the European Union. The comparison between the results obtained implementing our proposal (N<T) and those obtained using the methodology of Stock and Watson in the case of N>T, also allows us to conclude that results are robust to the exclusion of the countries that do not reach a reasonable weight in loading or communality

We consider that our results seem to be promising enough to warrant further research, provide the utility of factor loadings in the factor analysis of international business cycle. A future line of research in which we are concerned is whether exists stability in the relation between countries and the international common factor (stability analysis of model parameters or factor loadings) along the full time period or if this relation has emerged after a specific date.

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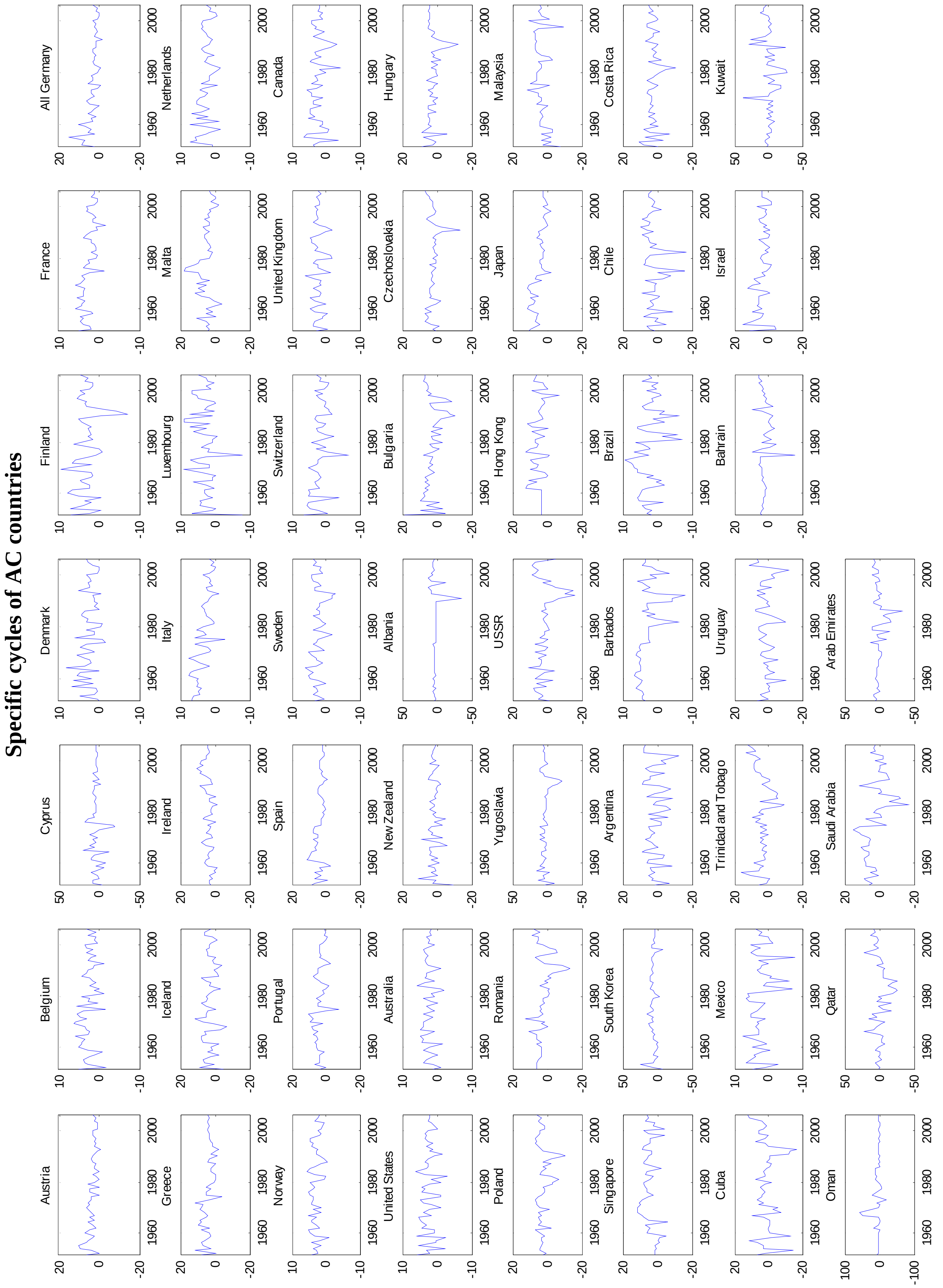
ANNEX

Figure 1: Specific cycles of the countries (106)



Specific cycles of OEADEs countries

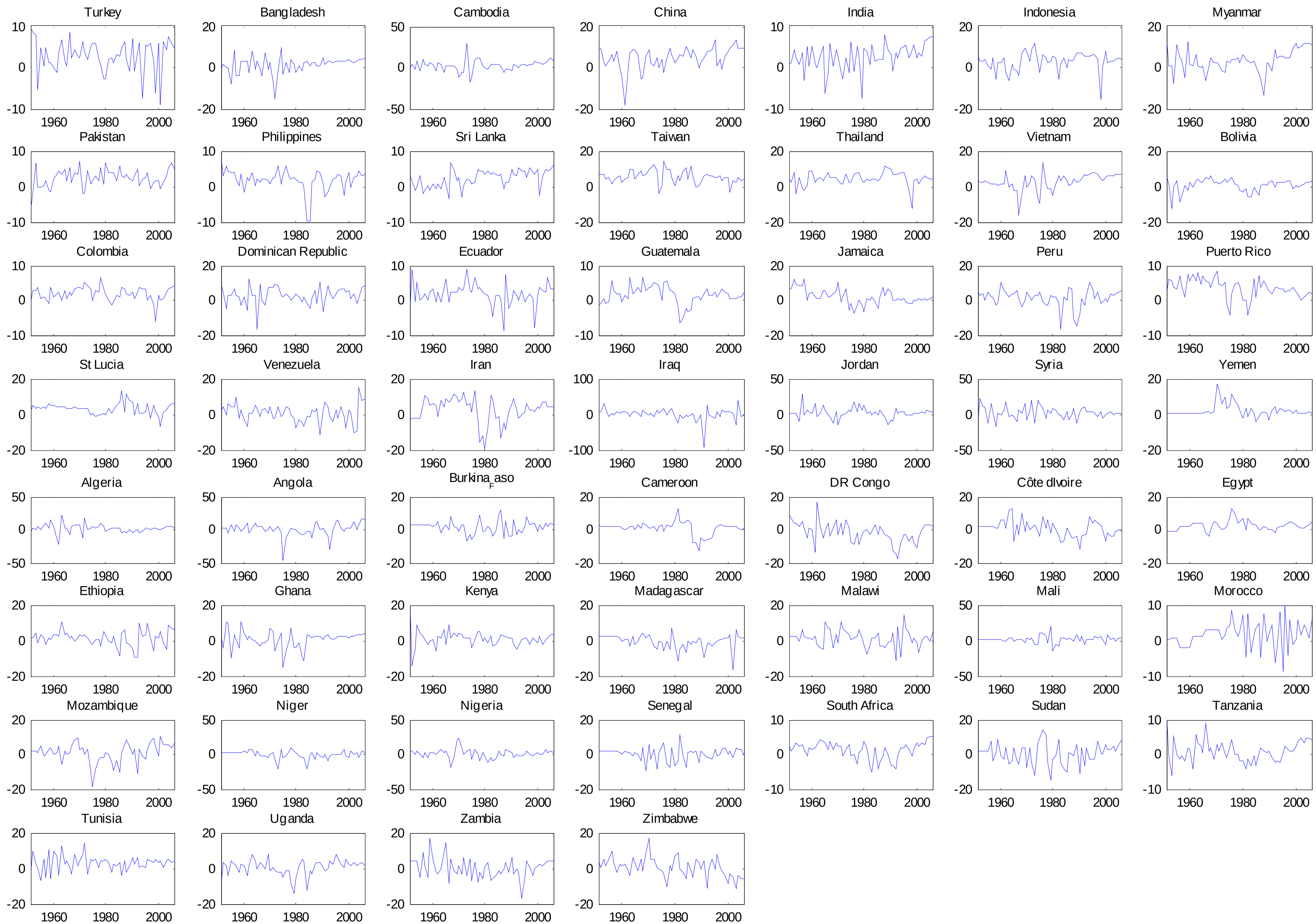
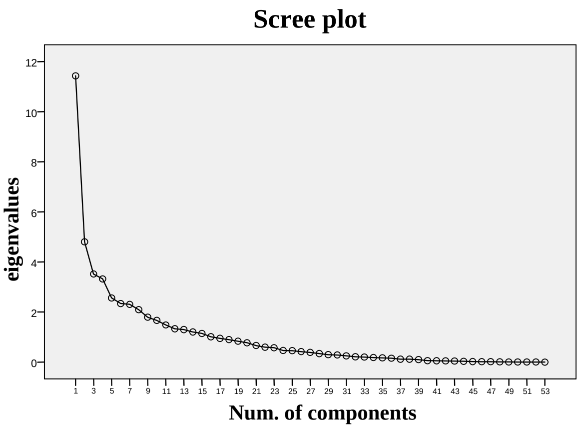


Figure 2: Scree plots of preliminary factor models

Scree plot of ACs



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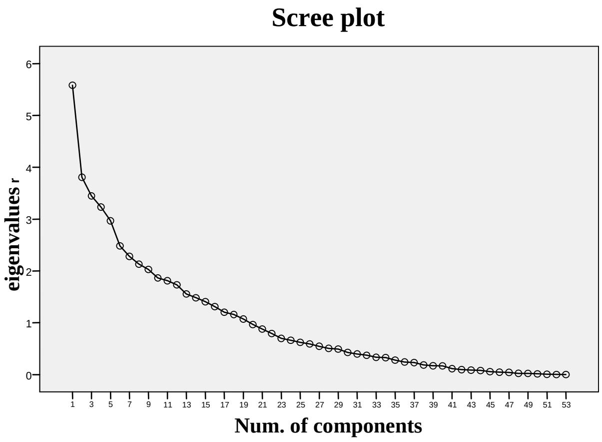
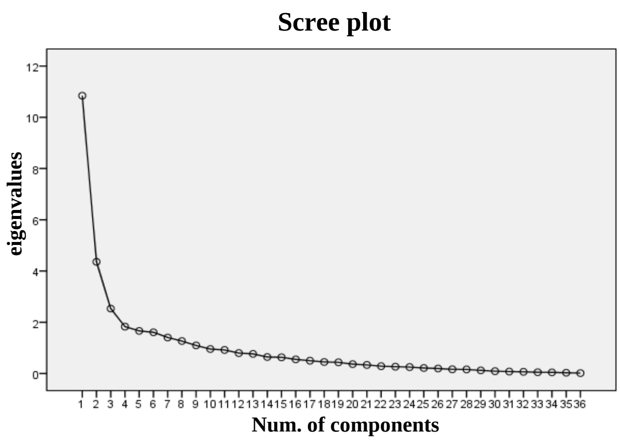


Figure 3: Scree plots of factor models

Scree plot of ACs



Scree Plot of OEADEs

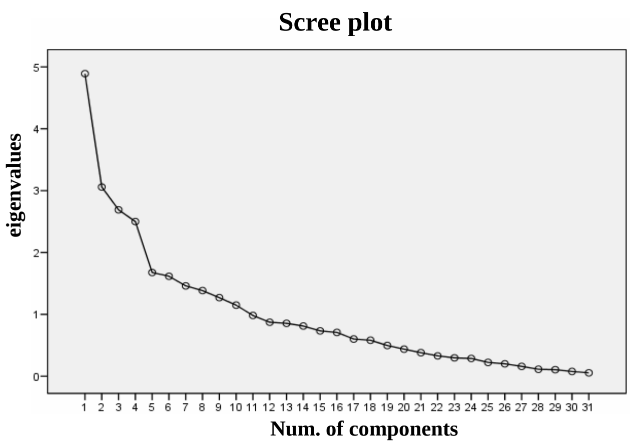
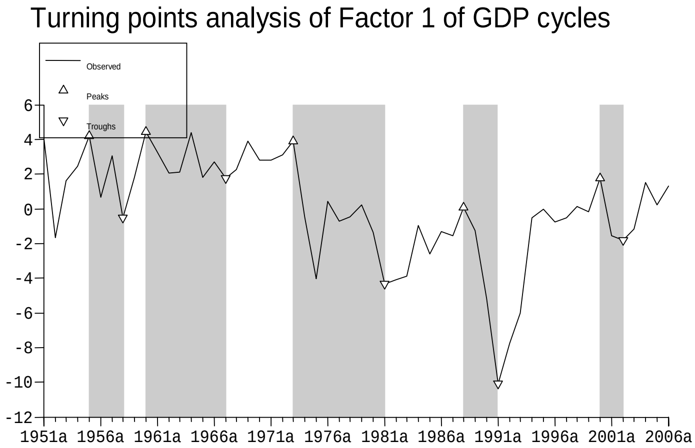
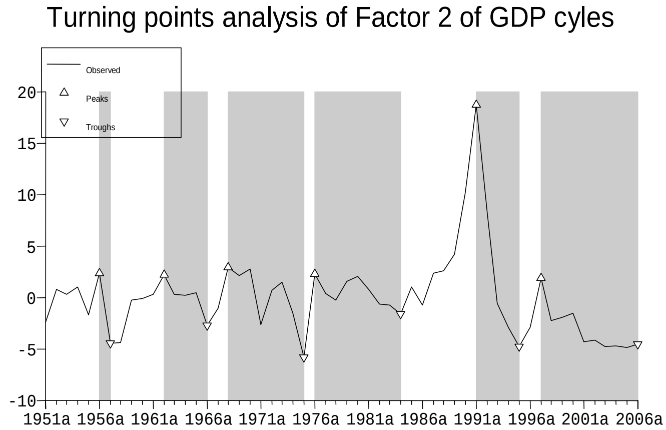


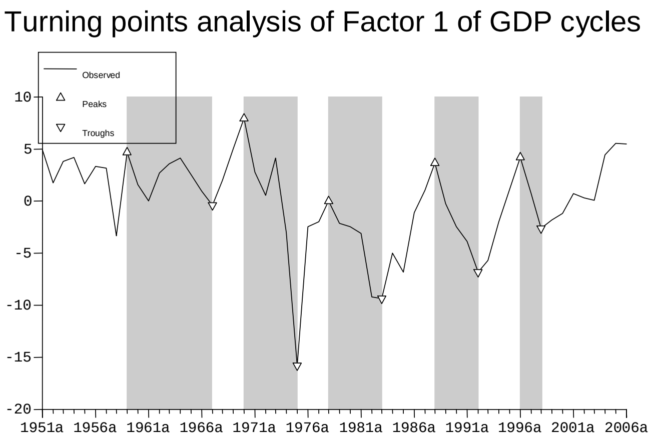
Figure 4: Cyclical dating of common factors (shaded bands indicate contractions)

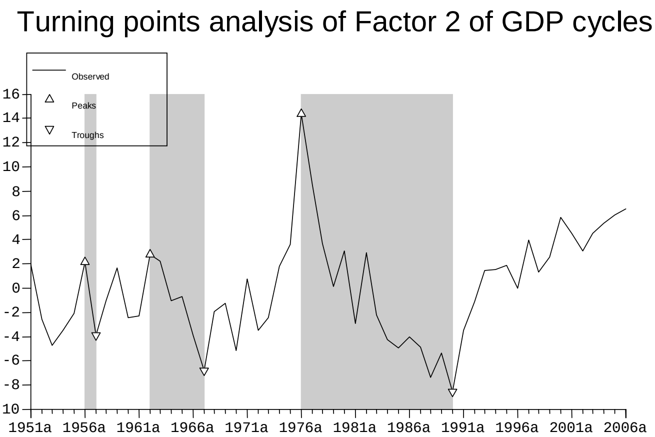
Cyclical dating of ACs

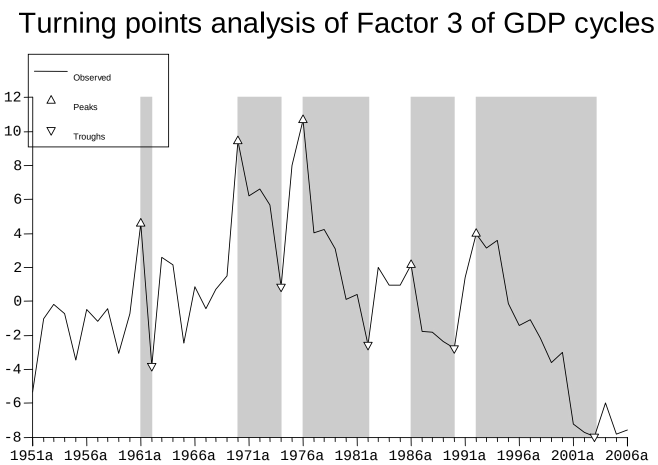




Cyclical dating of OEADESs







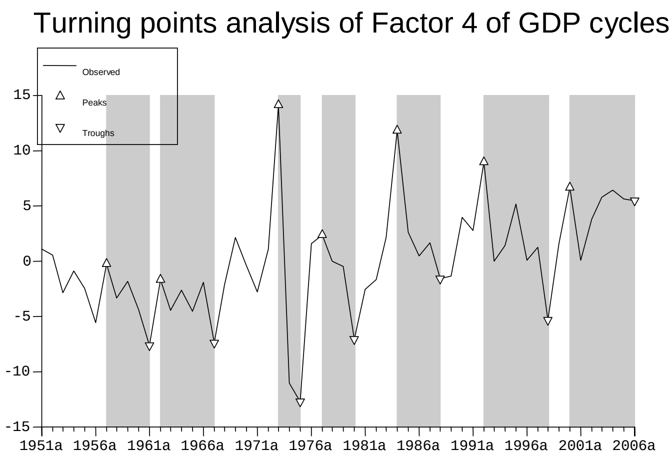
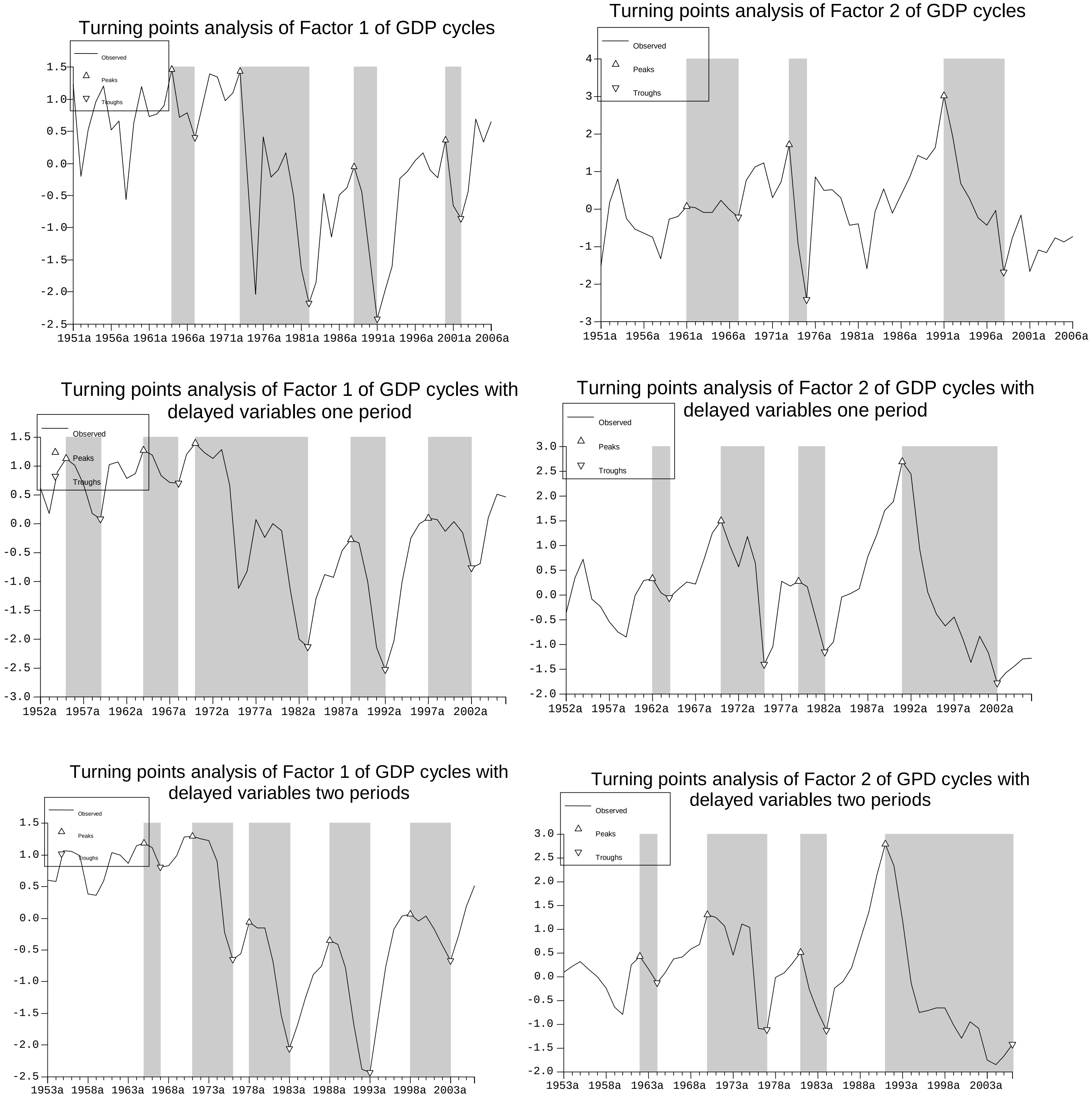


Figure 5: Cyclical dating of common factors with the full sample (106 countries)
(shaded bands indicate contractions)



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