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Common Factor versus Baxter-King Cycle in the Euro-zone

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Common Factor versus Baxter-King Cycle in the Euro-zone

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1. Introduction

Business surveys are conducted every month by the European Commission (Economic and Financial Affairs Directorate General) in the main sectors of European economies. They are essentially qualitative surveys that collect opinions directly from managers. As they are fast and reliable, they are often used by economists to assess the situation of the various economies. Recently, some studies have been conducted to construct coincident or leading indicators from them, for Member States but also for the Euro-zone (Doz and Lenglart [2] [3], FORNI and al [5] [6], INSEE [7], Saint-Aubin [9]).

DG ECFIN publishes, on a regular basis, a leading indicator, the so-called "business climate" computed from these surveys. The construction of this indicator is based on Dynamic Factor Analysis and it is defined as the common factor of a set of business survey indicators. Similar indicators have been compiled at the national level (INSEE [7]) making use of the same methodology.

This paper investigates the relationships between this indicator, at the national or Euro-zone levels, and estimates of business cycle indicator constructed with a Baxter-King filter. Section 2 is devoted to data and the various statistical methodologies used throughout the paper. Section 3 deals with the national and common factors. In particular, the stationarity of the variables, a key assumption of the model, is studied. The direct approach, construction of the Euro-zone common factor from the aggregated business survey data, is also compared to the indirect approach, common factor of the national common factors. The Baxter-King filters are constructed and synthesised in a common cycle in Section 4. At last, the synchronisation of the national cycles is studied when comparing the cycles

over time.

2. Methodology

The data come from the monthly business survey in Industry conducted in Europe by the European Commission (DG ECFIN, see [4]). We concentrate the study on this survey for several reasons. First, this is the oldest survey and we can benefit from long time series. Second, if the industrial sector represents less than 25% of the Euro-zone GDP, it explains more than 50% of its variations. Therefore, it is quite natural to look for possible turning points in the evolution of this sector. The questions used in the analysis are the seasonally adjusted balances of opinion about the levels of the recent output (question 1), of orders (question 2), of foreign orders (question 3), of inventories (question 4) and of the expected output (question 5). These five questions have been used for the Euro-zone (EMU12) and for the twelve concerned countries[1].

2.1 Factor Analysis

Factor Analysis is a statistical method used to summarise a set of variables by constructing a few "common factors" related to all the variables and "specific factors" related to each variable. The basic idea is that these variables presents some common movement. If we use the previous five questions at the national or Euro-zone level, this factor is supposed to represent the global industrial activity of the geographical entity. The "specific factors" represent therefore the specificities of each question. But, if we make a Factor Analysis of the twelve common factors, the new common factor is supposed to describe the industrial activity in the Euro-zone and the "specific factors" show the diversity of Member States. The basic model can be quickly defined.

- $y_{i,t}$ represents the balance opinion for question *i* at date *t*; *i* varies from 1 to *I* and *t* from 1 to *T*.
- $F_{j,t}$ represents the value of the common factor *j* at date *t*; *j* varies from 1 to *J*.
- $u_{i,t}$ represents the value of the specific factor *i* at date *t*;

The model can be written as follows:

$$\forall i \in [1;I], \forall t \in [1;T] \quad y_{it} = \lambda_{i1} F_{1t} + ... + \lambda_{iJ} F_{Jt} + u_{it}$$
$$E(u_{it}) = 0, \quad E(F_{jt} u_{it}) = 0, \quad V(F_{1t},...,F_{Jt}) = \mathrm{Id},$$
$$V(u_{1t},...,u_{It}) = Diag(\sigma_1^2,...,\sigma_I^2) = \Sigma$$

The input variables are supposed to be standardised, the common factors are supposed to be uncorrelated between each other and uncorrelated with the specific factors. λ_{ij} denotes the regression coefficient of the common factor *j* in the estimation of variable *i*.

Factor Analysis covers a wide range of sub-methods of estimation[2]. We use in our paper

[1] To work with a sufficient number of observations, we do not use questions 3 and 4 for Finland, and question 3 for Netherlands. These questions have been introduced quite recently in the surveys of these countries: in 1990 for Netherlands and in 1993 for Finland.

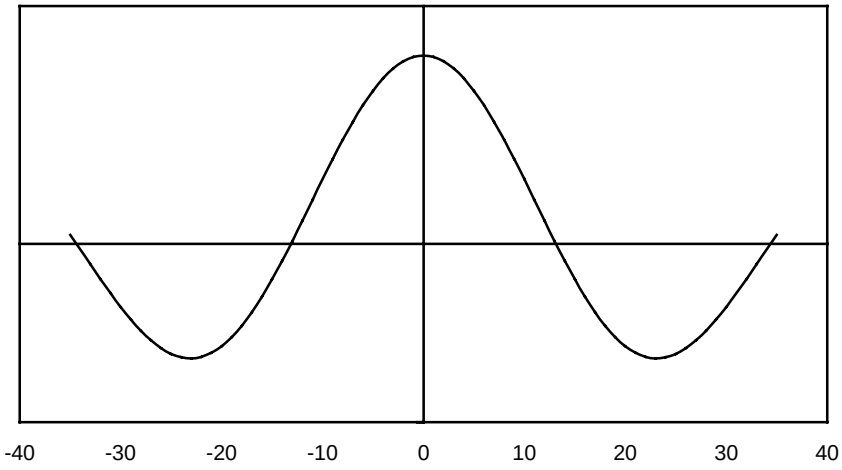
[2] LAWLEY and MAXWELL ([8]) provide a good description of these models.

a maximum likelihood estimation method. The factorial model is not *a priori* designed for time series as it does not take into account the autocorrelation structure of the data. But previous studies have shown that this kind of model gives, for the considered variables, results very close to the ones obtained by a correct and "optimal" Dynamic Factor Analysis (Doz and Lenglart [1], [3]). Let us note that in the Dynamic Factor Analysis, the input variables are supposed to be stationary.

2.2 Cycle extraction with a Baxter-King filter

The Baxter-King filter is a symmetric linear filter that permits to extract the cycle component from for example a seasonally adjusted series $X_t = T_t + C_t + I_t$, where T_t, C_t and I_t designate, respectively, the *trend*, the *cycle* and the *irregular* components. The trend is supposed to correspond to low frequencies and the irregular to high frequencies. The Baxter-King *band pass filter* (all the details for its construction can be found in Baxter and King [1]) extracts the intermediate frequencies associated with the business cycle. For a cycle defined by frequencies between 3 and 6 years, the coefficients of the filter of length 71 are presented in Figure 1.

Figure 1: Baxter-King filter coefficients. Low frequency: 3 years, High frequency: 6 years.



3. Application to the Euro-zone common factor.

In every statistical analysis, the maximum number of available observations has been used in order to provide more accurate estimates.

3.1 Stationarity tests

The input variables, for example the business survey balances, are supposed to be stationary. Some tests can be performed to verify this hypothesis. The results of the

Augmented Dickey-Fuller and Phillips-Perron stationarity tests are displayed in Table 1.

Table 1: Results of the stationarity tests for each variable of each geographical level. The significance level have been set to 5%.

	ADF tests		Philipps Perron Test	
	Rejected	Accepted	Rejected	Accepted
EMU12	0	5	5	0
AT	0	5	5	0
BE	0	5	2	3
DE	0	5	3	2
ES	3	2	4	1
FI	0	3	1	2
FR	0	5	4	1
GR	0	5	0	5
IE	0	5	0	5
IT	1	4	3	2
LU	0	5	0	5
NL	0	4	1	3
PT	0	5	1	4

Except for five geographical levels - Euro-zone, Austria, Greece, Ireland and Luxembourg - there is no statistical evidence of stationarity. The results can even be contradictory as in the EMU12 case.

3.2 Common Factors for the Euro-zone

Two common factors for the Euro-zone can be computed through Factor Analysis.

- The first one is obtained by the direct analysis of the five business survey variables aggregated at the Euro-zone level. In this aggregation, each country gets a weight proportional to its GDP.
- The second one is obtain by an indirect analysis; a common factor is first estimated for each countries and the twelve factors are then summarised in a single one by means of another factor analysis. In this aggregation the countries are not weighted.

The two factors are represented in Figure 2. One must note that if the two series give roughly the same message, there are quite important differences. First the indirect unweighted common factor is smoother than the direct one. Secondly, the timing of the turning points seems a bit different but without a systematic lag.

Table 2 presents the correlations between the national common factors and the indirect Euro-zone common factor. One must note the good correlations observed for France, Belgium, Spain, Italy and Netherlands and the surprising weak correlation for Germany.

Table 2: Correlations between the national common factors and the indirect Euro-zone common factor.

AT	BE	DE	ES	FI	FR	GR	IE	IT	LU	NL	PT
0.78	0.94	0.67	0.92	0.61	0.98	0.69	0.77	0.92	0.81	0.92	0.81

Figure 2: Direct and Indirect Common Factors for the Euro-zone

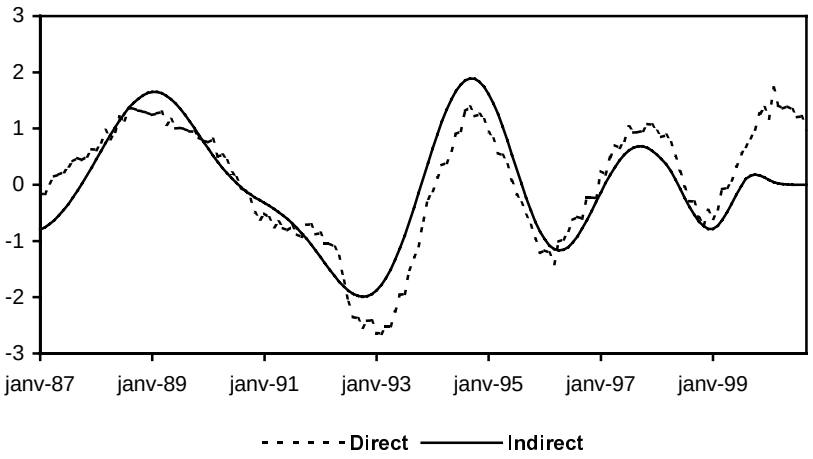
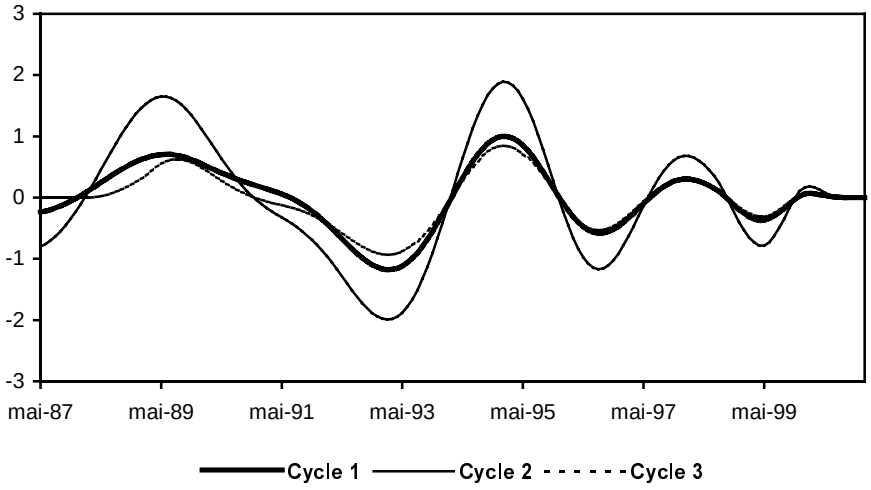


Figure 3: Direct and Indirect Cycles for the Euro-zone



4. Business Cycles in the Euro-zone

4.1 Euro-zone business cycles

Once more, we can derive several estimates of the Euro-zone business cycle by applying a Baxter-King filter to the direct Euro-zone common factor (cycle 1), the indirect Euro-zone factor (cycle 2) or to each national common factor and deriving a third estimate by factor analysis (cycle 3). The results are displayed in Figure 3. The three different estimations of the Euro-zone business cycle deliver the same economic message and one

cannot find any difference in the turning point datation.

Table 3: Correlations between the national cycles and the Euro-zone common cycle (Cycle 3).

AT	BE	DE	ES	FI	FR	GR	IE	IT	LU	NL	PT
0.91	0.94	0.75	0.91	0.45	0.98	0.93	0.79	0.95	0.96	0.93	0.75

Table 3 shows the correlations between national cycles and the Euro-zone common cycle (Cycle 3). These correlations are coherent with the ones computed between the common factors. These correlations are higher, except for the Finland which seems quite apart[3].
A cluster analysis on the 13 estimated cycles gives 4 different clusters that confirm the specificity of Finland:

- Cluster 1: EMU12, France, Greece, Italy, Luxembourg
- Cluster 2: Finland
- Cluster 3: Ireland
- Cluster 4: Austria, Belgium, Germany, Spain, Netherlands, Portugal

The cycles corresponding to each group are displayed in Figure 4.

4.2 Synchronisation of national cycles

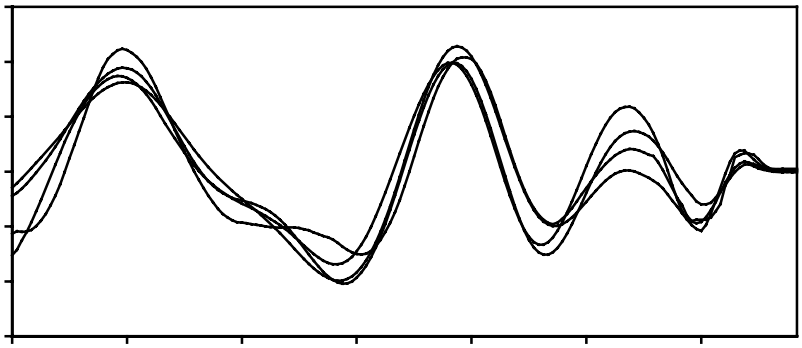
We can now check if there is a synchronisation of national cycles in the Euro-zone. To do that, we can just measure the evolution of Pearson correlation coefficients between each country cycle and the Euro-zone cycle. This has been done with sliding spans of a length of ten years. Figure 5 displays the results.
Three groups of countries can be exhibited.

- The first one contains countries for which their cyclical relationship does not change in time: for Belgium, France, Greece, Luxembourg and Netherlands the correlation remains very high across time. For Finland, the correlation remains really weak (less than 0.5).
- In the second group, we find Ireland and Italy whose correlation with the EMU business cycle has slightly decrease over these last years. The Italian correlation remains nevertheless very high.
- In the last group, we find the countries for which the correlation coefficient has increased a lot: Austria, Germany, Spain and Portugal.

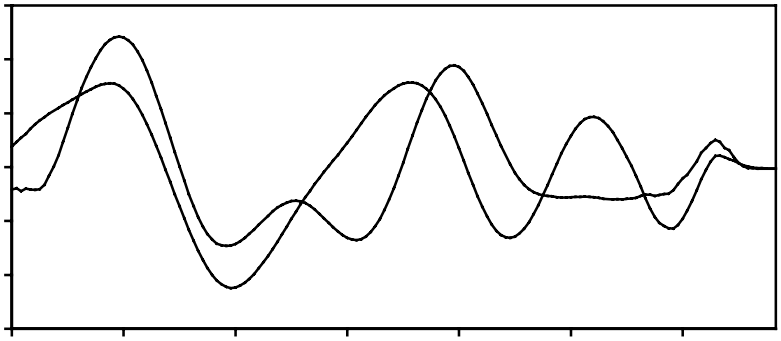
[3] The specify behaviour of Finland does not seem to be link to the fact only 3 questions of Business Surveys were taken into account for this country. The same analysis with these only 3 questions for all the countries has been done with the same kind of results.

Figure 4: Cluster analysis of the national cycles

Cluster 1: France, Greece, Italy, Luxembourg



Clusters 2 and 3: Finland, Ireland



Cluster 3: Austria, Belgium, Germany, Spain, Netherlands, Portugal

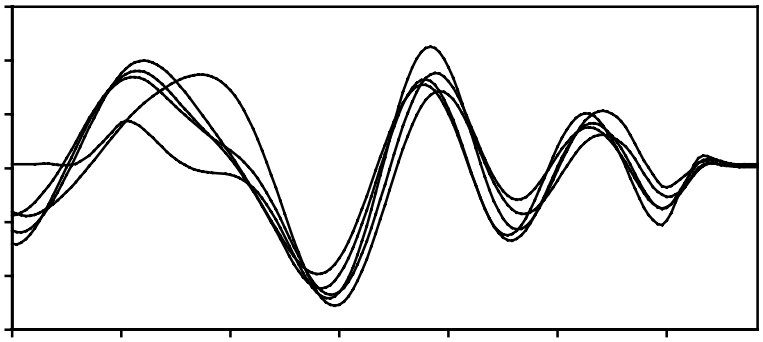
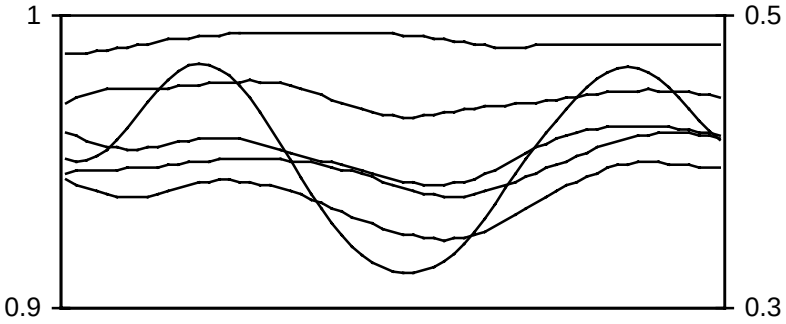
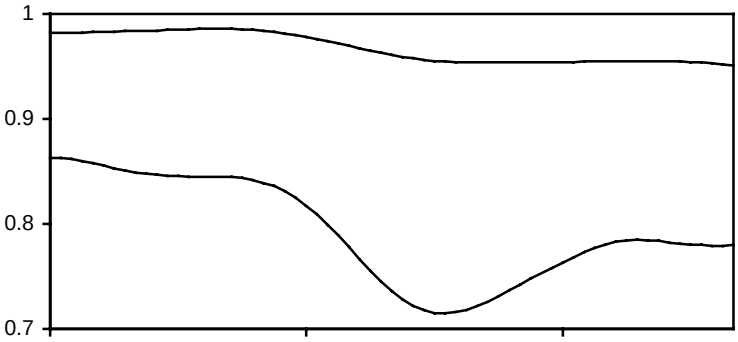


Figure 5: Evolution of the correlation coefficients between national cycles and Euro-zone cycle.

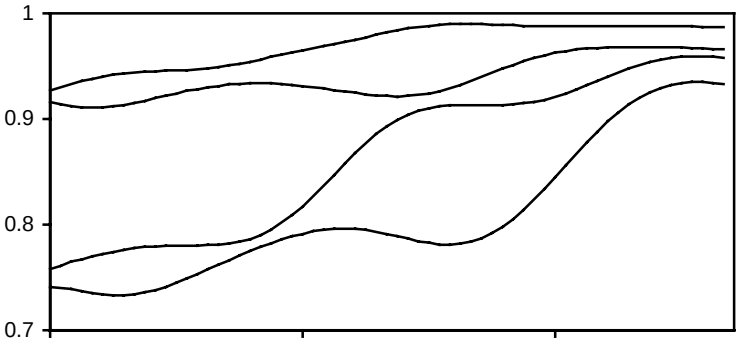
Group 1: Belgium, Finland, France, Greece, Luxembourg, Netherlands



Group 2: Ireland, Italy



Group 3: Austria, Germany, Spain, Portugal



5. Some Conclusions

From this very preliminary study, one can draw some interesting conclusions:

- The indirect common factor is smoother than the direct one. This is due to the fact there is a double smoothing of the data but it is not sure this indirect factor could be considered as more informative than the direct one. A dynamic simulation should be performed to assess this point.
- Some phase shifts appear between the direct and indirect approaches. These differences in turning point timing do not appear in the various cycle estimates and it could only be due to a different impact of the noise component.
- There is a strong evidence of cyclical synchronisation in Euro-zone as ten countries out of twelve present nowadays a correlation greater than 0.9 with the EMU12 cycle.

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