A turning point chronology for the Euro-zone

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Abstract  This paper aims at constructing a turning point chronology for the Euro-zone business and growth cycles. The need for a cycle turning point chronology is now widely recognised by experts and practitioners of economic analysis, but there is no official dating for the whole Euro-zone. Various statistical dating techniques have been introduced since the seminal work of Burns and Mitchell (1946) on business cycles, ranging from ad hoc rules to recent non-linear time series modelling. In this paper, we review the diverse Euro-zone turning point chronologies, we discuss issues inherent to such a construction and we propose a methodology based on a non-parametric algorithm and diverse criteria assessment, such as duration, deepness, diffusion and synchronisation, as well as experts judgements.

Keywords: economic cycles, turning points, chronology, Euro-zone
JEL Classification: C14, C22, E32

I Introduction: Why, what and when dating?

I.1 Why dating?
The need for a cycle turning point chronology is now widely recognised by experts and practitioners of economic analysis. As an example of application, it may help to compare the cycles between nations or to point out links between the cycles and diverse economic aggregates. However, it turns out that the most important use of the turning point chronology consists in establishing a reference cycle dating for a given country or economic area. Indeed, this reference cycle is often used in empirical studies either to classify economic series (leading, coincident or lagging) or to validate real-time detection and forecasting methods. While there is a reference chronology for the US business cycle, maintained by the Dating Committee of the NBER, there is no such chronology as regards the Euro-zone economy.

It is obvious that dating is an ex post exercise. In this respect, accuracy is a more important criterion than timeliness. Because of the lack of timeliness, dating may not be useful for economic decision-making. As a matter of fact, governments and central banks are very sensitive to indicators showing signs of deterioration in growth to allow them to adjust their policies sufficiently in advance, avoiding more deterioration or a recession. In this respect, timing is important and the earlier the signal, the better. This issue is linked to the “real-time detection” concept. However, to validate their methods of real-time detection, researchers need a reference turning point chronology.
I.2 What dating?
As our aim is to date cycle turning points, a turning point has to be clearly defined. In this paper, we define a turning point as a peak or a trough in the economic cycle. This definition in turn implies precision of what we call the economic cycle. In economic literature, two kinds of cycles are generally considered: the classical business cycle and the growth cycle. The classical business cycle refers to fluctuations in the level of the series while the growth cycle is the deviation to the long-term trend. It should be emphasised that academic literature has focused mainly on the analysis of the classical business cycle. For instance, the NBER gives only a reference chronology for this kind of cycle. In this paper, we refer to the ABCD approach of both classical and growth cycles proposed in Anas and Ferrara (2002a) and we call A the peak of the growth cycle, B the peak of the classical cycle, C the trough of the classical cycle and D the trough of the growth cycle. This approach implies that point A is always before point B and similarly point C is always before point D. This will be a constraint in the construction of the business and growth cycles dating chronologies. A third type of economic cycle is often analysed by practitioners, namely the growth rate cycle. Indeed, some economists talk about a recovery when the GDP growth rate has reached a local minimum. However, the growth rate cycle is subject to very short-term fluctuations due to transitory events making the peaks of this cycle extremely difficult to date, which removes any practical interest for the signal. For this reason, we only focus on the classical and growth cycles in this paper.
If dating the classical business cycle is not so easy, then dating the growth cycle is even more difficult since the series must first be de-trended. Several growth cycle extraction methods have been proposed in statistical literature, ranging from filtering techniques (Baxter-King, Hodrick-Prescott, Christiano-Fitzgerald…) to parametric modelling, mainly based on state-space and Markov-Switching models. However, each method possesses its own advantages and drawbacks and, up to now, it is not very clear which method should be used by practitioners. This supplementary step in the growth cycle dating methodology adds some noise to the signal, since dating depends on the chosen filter (Canova, 1994).

I.3 When dating?
There is a substantial delay before announcing the cycle turning points dates in the United States. For example, the July 1990 peak in the classical US cycle was announced by the NBER in April 1991 and the March 1991 trough only in December 1992. Concerning the last classical cycle, the March 2001 peak was announced in November 2001 and the November 2001 trough was announced just after the Dating Committee meeting of July 2003. This delay is certainly due to the idea that the dating should not be revised. In this respect, dating must be as accurate as possible. One issue with the dating process lies in the degree of revision of raw data on which the dating method is applied. We should wait for the last revision of the data, which may be disturbing in the case of GDP. Indeed, GDP figures are constantly revised because of new available surveys and methodological innovations (we refer, for example, to Fischer chain-linked price series in the case of the United States or to the recent revision of national accounts in Japan and United Kingdom). Using series other than GDP may reduce this drawback. But in this case, the availability and the homogeneity of these series over a long period of time are necessary to provide consistent dating through time, which is the main difficulty concerning the Euro-zone.
II A review of turning point chronologies for the Euro-zone

The construction of a reference turning point chronology raises some issues related to the choice of methods to be used. For instance, starting from a single time series, two different dating procedures can lead to distinct dating results. It may therefore happen that different estimates are available on the market. There is increasing literature relevant to this specific topic, based on comparisons between the results computed by authors and a reference dating chronology. Unfortunately, this literature is specific to the American economy and not the Euro-zone, mainly because of the lack of reference chronology. Usually, when a researcher develops a method to estimate the turning point chronology of a given country, the ultimate criteria to assess this method is to compare the resulting dating with a benchmark. However, in our case, we want to construct this reference dating chronology! Therefore, the assessment of diverse dating methods is not obvious. Some properties can help us to compare the methods:

(i) Transparency: the dating method must be replicable to every one.
(ii) Adaptability of the method to different series and countries.
(iii) Robustness to extreme values and to the sample.
(iv) The chronology must not be revised through time.

Although an official dating chronology is not yet available, some studies have tried to provide one for the Euro-zone cycles. In this section, we present a non-exhaustive review of the various existing chronologies and we discuss the most important issues concerning the choice of the dating methods.

II.1 Dating the classical business cycle

Regarding the business cycle, most of the authors have constructed their chronology based on the Euro-zone GDP, either aggregated or country-specific, which appears as the most appropriate univariate time series to be used. This is the reason why the proposed chronologies are generally quarterly, while a monthly dating would be more accurate. For example, Anas (2000) and Harding and Pagan (2001) provide a monthly dating chronology by considering a set of monthly series, such as the industrial production index (IPI) or series related to the employment, by reference to the NBER’s dating committee. This committee studies four macroeconomic series simultaneously to date with non-parametric techniques the classical cycle of the American economy: employment, personal income less transfer payments, volume of sales in the manufacturing and wholesale-retail sectors and IPI. However, there is no measure of monthly aggregate economic activity. Recently, taking the growing available information into account, some authors (for instance Forni et al., 1999, and Watson, 2000) have proposed “big data” dynamic factor models to construct coincident indexes, with roughly 500 series spanning 500 months. For instance, regarding the Euro-zone, a recent coincident index called EuroCOIN has been developed by the CEPR (see Altissimo et al. 2001), based on a set of 951 series related to the Euro-zone economy.

In the diverse studies, the turning points of the business cycle are either estimated non-parametrically (Anas, 2000, Lommatzsch and Stephan, 2001, or Harding and Pagan, 2001) or parametrically (Artis, Krolzig and Toro, 1999, Krolzig, 2001, 2003, and Anas and Ferrara, 2002b). For the most part, non-parametric procedures in turning point dating are based on recognition pattern algorithms. The most famous one is the Bry and Boschan (1971) procedure, still used in many countries and in academic works when estimating business cycle turning points. Another class of non-parametric dating procedure consists in ad hoc rules and experts claims. For instance, the Conference Board refers to the 3D’s rule to identify turning points (diffusion, deepness, duration)
and the Centre for Economy Policy Research (CEPR, 2003) has formed, very recently, a dating committee of eight experts to set the dates of the Euro-zone business cycle, based on the NBER experience. However, this class of procedure suffers under a lack of transparency. Apart from these non-parametric approaches, a great number of parametric models have been developed lately to date turning points in the classical business cycle, based mainly on the Markov-Switching model popularised in economics by James Hamilton (1989) in order to take into account a certain type of non-stationarity inherent to some time series that cannot be caught by classical linear models. In the univariate and multivariate framework, many attempts have been undertaken to provide a Euro-zone dating chronology of the business cycle through the MS-AR model and its multivariate generalisation introduced by Krolzig (1997). However, in order to establish a reference chronology, the diverse experiences lead to the conclusion that it seems advisable to have an expert analysis based on non-parametric procedure, at least for the business cycle. This is due to the necessary calibration of parametric models on dating and to the lack of robustness to the model to the sample (see Anas and Ferrara, 2002b).

Another issue is specific to large economic areas including several national economies. In order to provide a turning point chronology, is it more appropriate to analyse the economies of each country of the zone (indirect approach) or the whole economy of the zone directly (direct approach)? Regarding the indirect approach, the most difficult part is how to aggregate the multivariate information. Once we get a turning point chronology for each country of the Euro-zone, first of all it is necessary to evaluate whether there is sufficient diffusion of the cyclical movements across countries and whether there is synchronisation among these countries. If there is evidence of diffusion and synchronisation, then it is necessary to define a way to aggregate those information to provide a chronology for the Euro-zone. In practice, this is not so clear how to measure independently the diffusion and the synchronisation of the cycles. Several non parametric measures have been proposed in the literature but they provide simultaneously an evaluation of diffusion and synchronisation. The simplest one is to calculate a diffusion index measuring the percentage of countries that exhibit the same regime (for example a recession) at a certain time $t$. Other authors (see for example Krolzig and Toro, 2001, Harding and Pagan, 2002, Artis et al., 2002) compute a concordance index which measures the fraction of time that the cycles of different series are in the same phase (recession or expansion). An algorithm has been proposed by Harding (2002) to cluster various turning points after defining a distance between turning points and a function which measures the centre of tendency of turning points in a cluster. We will use a version of this methodology in section 3.

Most of these chronologies start in 1980 and are quarterly because based on the GDP. As regards all the dates of peaks and troughs provided by these studies, the results appear to be more or less coherent. The 1974-75 recession due to the first oil shock seems to be clear. Generally, from 1980, three recessions periods are detected: 1980-81, 1982 and 1992-93. While the 1992-93 period has been underlined by all the studies with the same accuracy (especially the peak), there is an issue as regards the 1980-81 and 1982 periods. Indeed, both recessions of 1980-81 and 1982 can be seen as a single recession phase, as did by Artis, Krolzig and Toro (1999), Krolzig (2003) and CEPR (2003). It is noteworthy that other studies have also considered the issue of business cycle dating, but only for separate countries and not for the aggregate Euro-zone economy (see, for instance, Rabault, 1993, or the Economic Cycle Research Institute).
II.2 Dating the growth cycle
The Euro-zone growth cycle has been studied much less often compared to the classical cycle. It is perhaps due to the de-trending problem and to the lack of popularity of this concept. The growth cycle extraction is well known by practitioners as an intricate issue. Since the introduction of the growth cycle concept by Ilse Mintz of the NBER in 1969, the literature has been very extensive on this topic, but up to now there is no clear recommendation. Several methods have been proposed ranging from the simple linear de-trending method (see for instance Harding, 2002) to the unobserved components approach (Harvey, 1989). One of the most used approach is the PAT methodology, still in use by the OECD for example (see Zarnowitz and Ozyildirim, 2002). However, most of the recent methods involve band-pass filters which aim at retaining unaltered the cycle stylised facts while removing high and low frequency components. Generally, the movements with a period lower than 1.5 years and greater than 6 or 8 years are disregarded in the spectral domain. The most popular filters, often found in empirical applications, are the Beveridge and Nelson filter (1981), the Baxter-King and the Hodrick-Prescott filters and the Christiano-Fitzgerald (1999) filter. These filters differ only in the way they approximate the ideal band-pass filter.

In the empirical studies, the estimates are based, most of the time, on the Euro-zone GDP series (only the OECD prefers their CLI index, see Arnaud, 2000 and Arnaud and Hyong, 2001) and the papers differ mainly according to the cycle extraction method. The Hodrick-Prescott filter is used in Vanhaelen et al. (2000), the PAT procedure is used by OECD and Harding and Pagan (2001) remove a linear deterministic trend from the Euro-zone GDP. In Anas (2000), an empirical comparison of the Hodrick-Prescott and Baxter-King filters with an unobservable components model, developed by Harvey (1989), is undertaken. It is worth saying that all these studies have used a non-parametric dating procedure, based on the Bry and Boschan algorithm adapted for quarterly series. On the contrary, Peersman and Smets (2001) have proposed a parametric dating of the growth cycle based on a multivariate Markov-Switching model applied to the de-trended IPI of a set of European countries.

III Methodology
Several studies have shown the existence of a common Euro-zone cycle. Among others, we can quote for instance the paper of Mitchell and Mouratidis (2002) which underlines the common features of the different measures of the growth and business cycles of the Euro-zone. Moreover, they show that the synchronisation between Euro-zone business cycles has increased since the 1980’s, which is « coherent with the emergence of a common Euro-zone business cycle ». We can also refer to the paper of Artis, Krolzig and Toro (1999) which points out a “clear evidence of co-movement in output growth among European countries” by using descriptive statistics in the time and frequency domains and by applying different Markov-Switching models. Starting from all these previous studies, we assume first the existence of common Euro-zone business and growth cycles. Therefore, we can use Euro-zone aggregates (for example GDP, IPI and employment) as proxies for the co-movement.

Business and growth cycles are distinct concepts. As the growth cycle is defined by the deviation to the trend, once the trend has been extracted, the peaks A and troughs D of the ABCD approach are not so difficult to locate because of the symmetry of the growth cycle. In this paper, we consider the “two-stages” Hodrick-Prescott filter (see Artis et
al., 2002) which allows to design a band-pass filter as the difference of two Hodrick-Prescott de-trending filters, the first one working on higher frequencies (for example 1.5 years) and the second one on lower frequencies (for example 6 years). However, the business cycle is non-linear and strongly asymmetric, insofar as expansion and recession periods do not present the same stylised facts as regards, for instance, duration, persistence or volatility (see for example Clements and Krolzig, 2003, for a discussion on business cycle asymmetries). Therefore, points B and C are more difficult to locate: the business cycle asks for further concepts to be measured.

To start with, we assume the description of Burns and Mitchell (1946) of the business cycle into two regimes: expansions and recessions. We assess the occurrence of a Euro-zone recession by measuring the criteria of duration, deepness, diffusion and synchronisation across the countries. Starting from a set of candidate turning points provided by the non-parametric algorithm applied to the Euro-zone aggregates, we will give a measure of these criteria and say that the Euro-zone is in recession if these criteria are simultaneously fulfilled. Duration and deepness are measured starting from the Euro-zone aggregated time series (direct approach), while diffusion and synchronisation are estimated starting from the specific countries (indirect approach). It is noteworthy that our methodology is a general-to-specific one, insofar as we consider all the candidate turning points of the business cycle provided by the non-parametric procedure and we eliminate them progressively when they do not fulfil one of the criteria.

III.1 A non-parametric algorithm

As noted previously in this paper, we are in favour of non-parametric procedures instead of parametric ones in the framework of turning points dating chronology. Indeed, it has been shown that the model specification step is an intricate issue and can lead to inappropriate results. First, a set of candidate periods of recession has to be selected on the aggregated series. The non-parametric procedure developed in this section to get a dating chronology on a single time series is based on the following algorithm:

1. Outliers are disregarded in the seasonal adjustment (SA) step executed by the Demetra software.
2. Irregular movements in the series are excluded in the SA step in the case of monthly data. In the case of GDP quarterly data the SA-WDA series is not smoothed out.
3. Determination of a first candidate set of turning points on the time series of interest \(y_t\) is determined by using the following rule, which is the heart of the Bry and Boschan (1971) algorithm:
   
   Peak at \(t\) :
   \[
   \begin{cases} 
   y_t > y_{t-k} , \\ y_t > y_{t+k} , \\
   \end{cases}
   \]
   \(k=1,\ldots, K\)

   Trough at \(t\) :
   \[
   \begin{cases} 
   y_t < y_{t-k} , \\ y_t < y_{t+k} , \\
   \end{cases}
   \]
   \(k=1,\ldots, K\),

   where \(K=2\) for quarterly time series and \(K=5\) for monthly time series.
4. Turning points within six months of the beginning or end of the series are disregarded.
5. A procedure for ensuring that peaks and troughs alternate is developed by using the following rule:
   - in the presence of a double through, the lowest value is chosen.
   - in the presence of a double peak, the highest value is chosen.

III.2 Deepness and duration assessment

Once the candidate periods have been retained by the non-parametric algorithm on the aggregates, we assess first the criteria of duration and deepness. The duration means
that a recession must last “more than a few months”, as noted by the NBER in its seminal definition of a recession, but there is no reference minimum duration. Usually, it is often advocated that, for the business cycle, a phase of the cycle must last at least six months and a complete cycle must have a minimum duration of fifteen months. The deepness refers to the amplitude of the recession. Indeed, as noted by the NBER, a recession is a “significant decline in activity”. Obviously, the practical difficulty is to assess when the fall of the economy is “significant” enough. To measure this amplitude, we use the following value of deepness, for a recession:

\[
Deepness = \frac{X_P - X_T}{X_P},
\]

(3.1)

where \(X_P\) and \(X_T\) are respectively the values of the series at the peak and trough of the business cycle to be considered. In the case of normalised indexes, such as the IPI, we simply look at the difference between the values of the series at peak and trough. Moreover, as regards the growth cycle, because of its symmetry, we simply consider the absolute difference for each phase.

To summarise the information on both duration and deepness we assess the measure of, what we call, severity (denoted \(S\)) of a recession defined by:

\[
S = 0.5 \times Deepness \times Duration.
\]

(3.2)

This measure is in fact the percentage of loss during the phase of the cycle. This severity measure is also referred in the literature to as the “triangle approximation” to the cumulative movements, see for example Harding and Pagan (1999). Note that there is a wide literature concerned with the concept of “shape” of the cycle, we refer to the recent paper of Clements and Krolzig (2003) for the diverse definitions of the shape.

III.3 Diffusion and synchronisation assessment

Once duration and deepness have been estimated for each candidate recession period through the severity index, we assess now their diffusion and synchronisation over the countries by considering an indirect analysis. The spatial diffusion means that almost all of the countries have to be affected by the exogenous shock in the case of a recession while the concept of synchronisation refers to the timing impact of the exogenous shock which creates leads and lags in cyclical movements of countries. For instance, the industrial growth cycle in 1995 didn’t turn into a recession because it was not synchronised (see section 4). Indeed, Italy and Netherlands were in recession later than the other countries. As another example, the 1998 impact of the Asian crisis was not diffused to all the countries in the Euro-zone, only Italy and Belgium were affected by an industrial recession.

In this paper, we introduce a version of the simultaneous measure of diffusion and synchronisation between \(N\) cycles introduced by Boehm and Moore (1984) and revisited in Harding and Pagan (2002). Actually, Boehm and Moore (1984) developed an algorithm which tries to mimic the NBER dating procedure by identifying clusters of turning points and applied it to the Australian economy. One of the advantage of this method is to provide as a by-product a dating chronology of the business cycles, that we call in the remaining indirect dating.

First, we compute a dating chronology for each country \(i\), for \(i=1,\ldots,N\), according to the method described in the previous subsection. Then, we define \(\tau_{ij}^p\) (respectively \(\tau_{ij}^T\)) as the observation date of the \(j^{th}\) peak (respectively trough) in the country \(i\). We define
\(d_i^p(t)\) (respectively \(d_i^T(t)\)) as the distance in time from \(t\) to the nearest peak (respectively trough) in the country \(i\). That is, for \(i=1,\ldots,N\) and for \(t=1,\ldots,T\):

\[
d_i^p(t) = \text{Min} \left| t - \tau_i^p \right|.
\]

(3.3)

In order to aggregate the information relative to the countries, we consider the following statistics, which are the distances to cycle peaks and troughs for the whole Euro-zone:

\[
d^p(t) = \sum_{i=1}^{N} \omega_i d_i^p(t),
\]

(3.4)

and

\[
d^T(t) = \sum_{i=1}^{N} \omega_i d_i^T(t),
\]

(3.5)

where \((\omega_i)_i\) are the weights of the countries in the Euro-zone according to a given economic aggregate. We can consider the GDP of the country or the weights given in the national account statistics or in the short term business statistics.

Dates at which \(d^p(t)\) and \(d^T(t)\) achieve their local minima can be assumed to be the dates of the centres of a cluster of, respectively, peaks and troughs for the Euro-zone. Thus, we get a set of dates \(t^p_j\) and \(t^T_j\) defined as the estimated indirect dates of peaks and troughs for the Euro-zone. Finally, as a measure of the diffusion/synchronisation, we choose the following statistic, for the \(j^{th}\) peak (respectively trough):

\[
DS_j = \frac{1}{d^p(t^p_j)} \times 100.
\]

(3.6)

For a candidate cycle where there is no local minimum, we set to zero the DS measure. Thus, when the value of the DS statistic is high we can conclude that the turning point is well diffused and synchronised, when DS is low the turning point is neither diffused nor synchronised and when DS has an intermediate value, it means that the cycle is either not enough diffused or not synchronised.

As we do not know anything about the probability distribution of these measures of severity and diffusion/synchronisation, it is difficult to make statistical inference. In this study, these values serve only as a basis to compare diverse periods of time. The final decision as regards the choice of the dates is done by expert judgements based on a combination of the three following principles:

1) a comparison of direct and indirect dating
2) an objective of coherence between the turning points of both growth and business cycles (ABCD approach)
3) an objective of coherence between industrial and GDP cycles.

### IV Applications

In this section, we propose a dating chronology for both business and growth cycles in the Euro-zone, based on IPI and GDP.

**IV.1 A chronology based on the Industrial Production Index**

**IV.1.1 Dating of the Euro-zone industrial business cycle**

The methodology is carried out on the Euro-zone aggregated monthly IPI in order to date the industrial business cycle. By applying the non-parametric algorithm to the
Euro-zone IPI series over the whole period 1970-2002, we select first 10 candidate recession periods. The main economic events since 1970 are present, namely the first oil shock in 1974-75, the second oil shock and its “double-dip” in 1980-81 and 1981-82, and the 1992-93 recession. Obviously, as no censoring rule is applied, a lot of mini-cycles are also taken into account. For example, the candidate recessions of 1995 and 1996 are only of 3 months, while the most longer candidate recession (16 months) occurred in 1992-1993. Note also that the usual censoring rule related to the minimum duration of a complete cycle is always respected, excepted between the cycle in 1991 and the one in 1992-93. This means that one of these two candidate recessions should not be retained at the end of the study. In the recent period, there is a candidate industrial recession in 2001 and a candidate peak in June 2002.

By assessing the duration and the deepness of each candidate recession, summarised by the severity criteria defined by equation (3.2), and by assessing the diffusion and the synchronisation of the recessions among the countries through an indirect approach, we finally retain five industrial recession phases in the Euro-zone. The dating chronology is contained in the following table 1 for the IPI business cycle.

Table 1: Final business cycle chronology for the aggregated Euro-zone industrial production.

<table>
<thead>
<tr>
<th>Dates</th>
<th>Peak B</th>
<th>Trough C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974-75</td>
<td>m4 1974</td>
<td>m5 1975</td>
</tr>
<tr>
<td>1980-81</td>
<td>m2 1980</td>
<td>m1 1981</td>
</tr>
<tr>
<td>1981-82</td>
<td>m10 1981</td>
<td>m12 1982</td>
</tr>
<tr>
<td>1992-93</td>
<td>m1 1992</td>
<td>m5 1993</td>
</tr>
<tr>
<td>2000-01</td>
<td>m12 2000</td>
<td>m12 2001</td>
</tr>
</tbody>
</table>

IV.1.2 Dating of the Euro-zone industrial growth cycle
The methodology is carried out on the Euro-zone aggregated IPI in order to date the growth cycle. First, the industrial growth cycle is estimated through the two-step Hodrick-Prescott filter described in section 2, the cut-off frequencies being of 1.5 and 6 years. The growth cycle appears to be symmetric and the peaks and troughs (respectively points A and D in the ABCD approach) seem easier to locate than the business cycle ones. By using the same methodology as previously, we finally retain 9 complete growth cycles (from trough to trough) presented in the following table 2:

Table 2: Final growth cycle chronology for the aggregated Euro-zone industrial production

<table>
<thead>
<tr>
<th>Dates</th>
<th>Peak</th>
<th>Trough</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971-72</td>
<td>NA</td>
<td>m11 1971</td>
</tr>
<tr>
<td>1974-75</td>
<td>m1 1974</td>
<td>m6 1975</td>
</tr>
<tr>
<td>1976-78</td>
<td>m11 1976</td>
<td>m3 1978</td>
</tr>
<tr>
<td>1980-81</td>
<td>m2 1980</td>
<td>m1 1981</td>
</tr>
<tr>
<td>1981-82</td>
<td>m10 1981</td>
<td>m12 1982</td>
</tr>
<tr>
<td>1985-87</td>
<td>m11 1985</td>
<td>m10 1987</td>
</tr>
<tr>
<td>1992-93</td>
<td>m1 1992</td>
<td>m6 1993</td>
</tr>
<tr>
<td>1995-96</td>
<td>m2 1995</td>
<td>m10 1996</td>
</tr>
<tr>
<td>1998-99</td>
<td>m2 1998</td>
<td>m4 1999</td>
</tr>
<tr>
<td>2000-?</td>
<td>m11 2000</td>
<td></td>
</tr>
</tbody>
</table>
IV.2 A chronology based on the Gross Domestic Product

IV.2.1 Dating of the Euro-zone GDP business cycle
The methodology is carried out on the Euro-zone aggregated GDP in order to date the business cycle. By applying the non-parametric algorithm on the Euro-zone GDP series over the whole period Q1 1970- Q2 2003, we select first four candidate recessions periods. Here again, we observe that the main economic events since 1970 are described, namely the first oil shock in 1974-75, the second oil shock and its “double-dip” in 1980-81 and 1981-82, and the 1992-93 recession. Contrary to the IPI, none mini-cycle appear. In fact, the GDP is less sensitive to short-term economic shocks. Three of the four candidate recessions last at least 3 quarters, only the 1982 recession is of one quarter. As regards the recent period, no peak is detected by the algorithm.

As previously, we look simultaneously at the duration and the deepness of each candidate recession, summarised by the severity criteria, to assess the occurrence. The most severe candidate recession is the one due to the first oil shock in 1974-75. In fact, this latter recession is the deepest, its value is twice the 1992-93 one. There is an issue as regards the 1982 candidate recession, because its severity is very low in comparison with the others. We assess then the diffusion and the synchronisation of the recessions among the countries through an indirect approach. First, a non-parametric dating procedure is carried out for each of the 6 considered Euro-zone countries. We consider the four main countries (Germany, France, Italy, Spain) since 1970 and Belgium and Netherlands since 1980. To avoid to mini-cycles, we impose a minimum duration of 2 quarters for each phase of the cycle. The DS measures for the peak and trough of the 1974-75 recession are very strong, because we only consider 4 countries. However, the recessions in these countries are diffused to all and extremely synchronised, especially the through. The measures for the other recession candidates are similar. Especially, the 1982 recession candidate is diffused to four countries over six, only France and Spain are not affected by this double-dip. Thus, albeit very mild, this candidate recession cannot be dropped from the final selection. As regards, the 1992-93 recession, the indirect dating provides exactly the same dates. It is noteworthy that a recession in 2001 appears in the indirect dating. However, the DS measure for the trough is very low. Moreover, it seems to be too soon to be able to confirm this recession, because the GDP figures will certainly be revised. Finally, we retain four recession phases based on the Euro-zone GDP. The dating chronology is contained in the following table 3.

Table 3 : Final business cycle chronology for the aggregated Euro-zone GDP

<table>
<thead>
<tr>
<th>Dates</th>
<th>Peak B</th>
<th>Trough C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974-75</td>
<td>Q2 1974</td>
<td>Q1 1975</td>
</tr>
<tr>
<td>1980</td>
<td>Q1 1980</td>
<td>Q4 1980</td>
</tr>
<tr>
<td>1982</td>
<td>Q4 1981</td>
<td>Q4 1982</td>
</tr>
<tr>
<td>1992-93</td>
<td>Q1 1992</td>
<td>Q1 1993</td>
</tr>
</tbody>
</table>

IV.1.3 Dating of the Euro-zone GDP growth cycle
The methodology is carried out on the Euro-zone aggregated GDP in order to date the growth cycle. First, the GDP growth cycle is estimated through the two-step Hodrick-Prescott filter, the cut-off frequencies being of 1.5 and 6 years. By using the same methodology, we retain 8 growth cycles over the period 1970-2000 (see table 4), four of
them being followed by a business cycle. Indeed, the growth cycles peaks of 1974, 1979, 1981 and 1992 (points A) were followed by business cycle peaks (points B). The delays between points A and points B are less or equal to one quarter, while the delays between points C and points D are less or equal to two quarters.

Table 4: Final growth cycle chronology for the aggregated Euro-zone GDP

<table>
<thead>
<tr>
<th>Dates</th>
<th>Peak</th>
<th>Trough</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974-75</td>
<td>Q1 1974</td>
<td>Q3 1975</td>
</tr>
<tr>
<td>1977-78</td>
<td>Q1 1977</td>
<td>Q2 1978</td>
</tr>
<tr>
<td>1979-81</td>
<td>Q4 1979</td>
<td>Q1 1981</td>
</tr>
<tr>
<td>1981-82</td>
<td>Q4 1981</td>
<td>Q4 1982</td>
</tr>
<tr>
<td>1986-87</td>
<td>Q1 1986</td>
<td>Q2 1987</td>
</tr>
<tr>
<td>1991-93</td>
<td>Q1 1992</td>
<td>Q3 1993</td>
</tr>
<tr>
<td>1995-96</td>
<td>Q1 1995</td>
<td>Q4 1996</td>
</tr>
<tr>
<td>1998-99</td>
<td>Q1 1998</td>
<td>Q1 1999</td>
</tr>
<tr>
<td>2000-?</td>
<td>Q3 2000</td>
<td></td>
</tr>
</tbody>
</table>

Conclusion
In this paper, we are looking for the dates of the Euro-zone business and growth cycles. As a complement to the traditional direct approach based on the study of Euro-zone aggregates, the main contribution of this paper is to measure the degree of diffusion and synchronisation of the cycles among the countries. From this study, it seems clear that the Euro-zone has experienced four economic recessions since 1970:
- the first oil shock (Q2 1974 – Q1 1975, 3 quarters)
Moreover, we have dated an industrial recession starting in early 2001. Since we found empirically on the period 1970-2000 a full equivalence between industrial recessions and global recessions in the Euro-zone, there is a possibility of a global recession in the recent period.

Bibliographie
Arnaud, B. and Hyong E.-P. (2001), Comparison of compilation methodologies for the composite Leading indicators of Euro area, manuscript OECD.