COMPOSITE INDICATORS FOR THE EURO AREA ECONOMIC ACTIVITY*

*António Rua***

1. INTRODUCTION

Within the framework of a common monetary policy, the monitoring of economic developments in the euro area, on a regular basis, is of particular importance. Despite of the ongoing improvement, the data available for the euro area as a whole are still relatively limited and released with some lag. The assessment of the economic situation requires synthetic measures representative of activity in the economy as a whole. Gross Domestic Product (GDP) is the best measure acknowledged for this purpose. However, GDP is only made available on a quarterly basis and released with a significant lag, which makes it difficult to assess economic activity on a regular and timely basis. In fact, the first estimate for the euro area GDP in a given quarter is released 70 days after the end of that quarter.[1] Thus, one needs to resort to other synthetic measures which provide information on economic developments in the euro area on a more timely and frequent basis. The purpose of this article is to evaluate the performance of several economic composite indicators, which are currently released on a regular basis by several institutions, including the European Commission, the Organisation for Economic Co-operation and Development (OECD) and the Centre for Economic Policy Research (CEPR). The aim of this article is to assess to what extent these composite indicators allow the monitoring of GDP growth. For this purpose, we resort both to time and frequency domain analysis.

This article is organised as follows. Section 2 makes a brief description of the methodology used to evaluate the composite indicators. Section 3 presents the main features of the indicators released by the different institutions and makes an overall assessment of their performance. Section 4 addresses other issues regarding the practical use of the indicators and section 5 concludes.

2. METHODOLOGY

In order to assess the properties of a given composite indicator, it is necessary to compare it with a reference series considered to be representative of the economic developments in the euro area. We have chosen GDP, since it is the most comprehensive variable among the official statistics released for the euro area, and also because it is regularly used in the analysis of the economic situation. Since GDP is quarterly, the assessment of the indicators was made on a quarterly basis (notwithstanding the fact that these are monthly indicators). Thus, each composite indicator was compared with the quarter-on-quarter growth rate and/or the year-on-year growth rate of GDP, as appropriate. The sample period adopted was the longest common period available for the indicators assessed — 1988 I to 2001 IV — so as to ease the comparison of the results. Since the official series of the euro area GDP provided by Eurostat

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(1) Moreover, this estimate can be revised (the second and the final estimates are made available with a lag of 100 and 120 days respectively).

starts in 1991, it was necessary to retropolate this series, using the series built by Fagan *et al.* (2001).[2]

The evaluation of the composite indicator behaviour vis-à-vis developments in the reference series was made using both time and frequency domain techniques. First, the relationship between the indicator and GDP was analysed resorting to the cross-correlogram. The cross-correlogram is based on the linear correlation coefficient between the variables for several lags, which is a measure of the degree of linear association between the variables. The maximum correlation lag was used to classify the composite indicator as lagging, coincident or leading.

Second, we resorted to spectral analysis. The main idea underlying the frequency domain analysis is that any stationary process can be seen as the sum of an infinite number of uncorrelated periodic components (spectral representation theorem). The frequency domain analysis allows us to study the relationship between the periodic components of the variables of a given frequency ω, i.e. with periodicity $\dfrac{2\pi}{\omega}$ time units. Three measures were computed in the frequency domain: coherency, phase and dynamic correlation.[3] Coherency can be seen as the absolute cross-correlation coefficient between the two variables at a given frequency, without considering the possible time displacement between the two variables. The phase measures the time displacement between the variables at a given frequency. The dynamic correlation is the contemporaneous cross-correlation coefficient between the variables at a given frequency.

Third, the Granger causality was tested between the composite indicator and the reference variable, in order to assess whether past figures of the composite indicator contribute to improve the forecasts of the current value of the reference variable. In practice, this test resumes to estimate a bivariate vector autoregressive model (VAR) of irrestrict p order[4] and assess whether the composite indicator can be eliminated from the VAR part which describes the dynamics of the reference variable. The null hypothesis of the test is that the composite indicator does not Granger cause the reference variable.

Finally, the composite indicators were evaluated according to the timing of their release and to the fact that they are released on a monthly basis.

In order to assess the increased usefulness stemming from the use of each composite indicator in the monitoring of developments in GDP, the performance of the indicator was compared to that of a benchmark. This benchmark is intended to establish a minimum performance criteria for the indicators analysed. Thus, a possible benchmark would be to fit an autoregressive process to the reference series. This allows us to assess to what extent current developments in the reference series can be tracked using only past data. Thus, an autoregressive process of order p was fitted to the GDP quarter-on-quarter growth rate and, using a general-to-specific approach, the following AR(1) process was obtained for the GDP quarter-on-quarter growth rate (qoq) (with the corresponding t-ratios):

$$q\hat{o}q_t = 0.33 + 0.37\,qoq_{t-1}$$
$$\quad (3.57) \quad (2.96)$$

$R^2 = 0.14$ Standard deviation$= 0.44$ DW $= 2.05$ T $= 56$.

Chart 1 compares the developments of the benchmark with those of the reference series. The contemporaneous correlation between the GDP quarter-on-quarter growth rate and that obtained with the AR(1) model is 0.37. Once obtained the estimate for the GDP quarter-on-quarter growth rate for a given quarter, the computation of the corresponding year-on-year growth rate is immediate, since the data regarding the three previous quarters are available (Chart 2). The correlation between the year-on-year growth rate of GDP and that obtained with the mentioned estimate is 0.95.

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(2) It should be noted that the results presented in the following section do not differ substantially from those which would have been obtained using only the period for which the official Eurostat series is available.
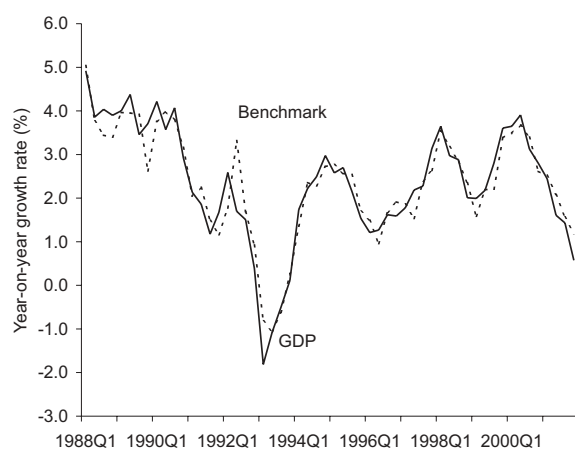
(3) See Annex for more details.

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(4) The VAR order was found by minimizing the Schwarz criteria.

Chart 1
GDP QUARTER-ON-QUARTER GROWTH RATE AND THE RATE RESULTING FROM THE AR(1) MODEL
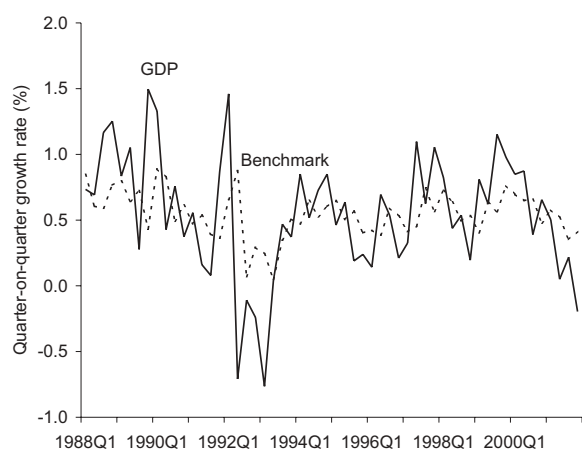
Chart 2
GDP YEAR-ON-YEAR GROWTH RATE AND THE RATE OBTAINED FROM THE AR(1) MODEL ESTIMATE FOR THE QUARTER-ON-QUARTER GROWTH

3. COMPOSITE INDICATORS

Composite indicators are intended to synthe-size the information contained in a range of economic variables into a single indicator. This range can include, for example, qualitative data from opinion surveys carried out in several economic sectors, indicators of real domestic and external activity, as well as monetary and financial variables. The selection of the variables to be included in the indicator is made on the basis of statistical and economic criteria, and, as far as possible, the composite indicator should represent the economy as a whole. In general, after this selection, the variables are normalised (so as to avoid series with higher cyclical amplitude overriding the indicator) and subsequently aggregated. Thus, a synthetic measure for the developments in economic activity is obtained.

The indicators analysed in this article are the €COIN released by the CEPR, the Composite Leading Indicator developed by the OECD, the Economic Sentiment Indicator and the Business Climate Indicator, both proposed by the European Commission, and the Handelsblatt Indicator used by the German newspaper Handelsblatt.
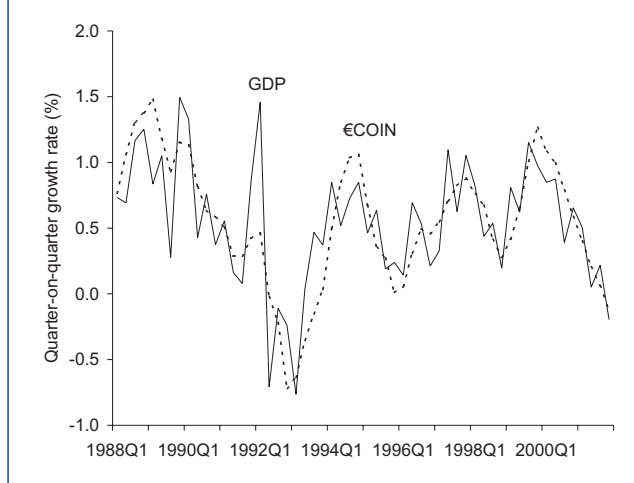
3.1 €COIN

The CEPR releases a coincident indicator for the euro area business cycle, the €COIN, which is intended to ease the assessment of the current economic situation.[5] The construction of this indicator is based on the assumption that GDP, despite of being a good synthetic measure of economic activity, is affected by measurement errors and noise, which difficult the analysis of the state of the economy. Thus, the aim of the indicator is to provide the policy maker with a noise-free measure of activity. The indicator is published on a monthly basis and is based on a wide set of information (which includes data referring to both the six largest euro area economies and the euro area as a whole and covering the different economic activity sectors). The model underlying the €COIN can be summarised as follows. Each variable is considered as the sum of two independent components, the common component and the idiosyncratic component. The common component is determined by a reduced number of factors common to all variables,[6] while the idiosyncratic component is exclusively affected by factors specific to the variable itself. In turn, the common component is considered as the sum of two independent components, the cyclical component and the short-term component, the latter being characterised by high

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(5) See Altissimo *et. al* (2001).

(6) Empirically, four common factors were considered.

(7) In particular, all fluctuations with a periodicity lower than 14 months were included in this component.

Chart 3
GDP AND €COIN

namic correlation is quite high. Moreover, it presents a particularly high coherency at low frequencies (i.e. at long cycles), when compared with the one at high frequencies (i.e. at short cycles), given that the indicator disregards the component associated with the latter. Moreover, the €COIN Granger causes the GDP quarter-on-quarter growth rate. Given that the indicator shows a higher correlation with the GDP quarter-on-quarter growth rate than that obtained with the AR(1) model, it is evident that the resulting estimate for the year-on-year growth rate will also be better. In fact, the correlation between the GDP year-on-year growth rate and that obtained with the estimate provided by the indicator for the quarter-on-quarter growth rate is 0.98.[11]

3.2 Composite Leading Indicator

The OECD developed a range of composite indicators to enable a better analysis of the current economic situation and to anticipate future developments in member countries. The main purpose of the Composite Leading Indicator (CLI)[12] is to predict economic turning points. It results from the aggregation of several variables which show a leading relationship with the business cycle (in particular with the industrial production cycle, chosen by the OECD as a proxy for the economic activity). However, given the similarity between the industrial production cycle and the GDP cycle, the OECD states that the CLI can be used to lead the latter. The definition of cycle used by the OECD refers to deviations from the long-term trend.[13] The pre-selection of the series to be included in the composite indicator, which is published on a monthly basis, was made according to the following criteria: economic significance, cyclical behaviour and data quality (i.e. the statistical coverage of the series should be broad; series should be compiled on a monthly basis; timeliness; there should be no breaks in the series and should not be revised frequently). The final set of the CLI components was selected in order to maxi-

volatility.[7] The identification of these unobservable components is made by resorting to the wide set of information mentioned above, in which all the variables are seasonally adjusted, stationarized and normalised.[8] The €COIN is defined as the cyclical component of the common component of GDP.[9]

The €COIN is used by the CEPR to track the developments in the euro area GDP quarter-on-quarter growth rate.[10] Based on the graphical analysis (Chart 3) the effect that results from the elimination of short-term fluctuations when the indicator is computed is clear. In fact, the €COIN provides a smoothed version of developments in the GDP quarter-on-quarter growth rate, thus permitting to avoid the problems when interpreting developments in economic activity caused by the irregular pattern of the above rate.

The maximum correlation between this indicator and the GDP quarter-on-quarter growth rate is given by the contemporaneous correlation, 0.78 (i.e. higher than that obtained with the AR(1) benchmark model) (Chart 4). The properties of the coincident indicator are confirmed in the frequency domain. The lag is negligible and the dy-

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(8) The method used is based on the methodology proposed by Forni *et al.* (2000).

(9) The monthly series for GDP was obtained through the linear interpolation of the quarterly series.

(10) It should be noted that the CEPR points out that the latest figures for the indicator should be interpreted with caution since they are based on partial and preliminary data.

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(11) The indicator was normalised so as to have the same mean and standard deviation of the GDP quarter-on-quarter growth rate in the sample period considered.

(12) See OECD (1987).

(13) This trend is estimated using the Phase Average Trend (PAT) method developed by the NBER.

Chart 4
COMOVEMENT MEASURES BETWEEN GDP QUARTER-ON-QUARTER GROWTH RATE AND €COIN

Cross-correlation[a]

Phase[c]

Coherency[b]

Dynamic correlation
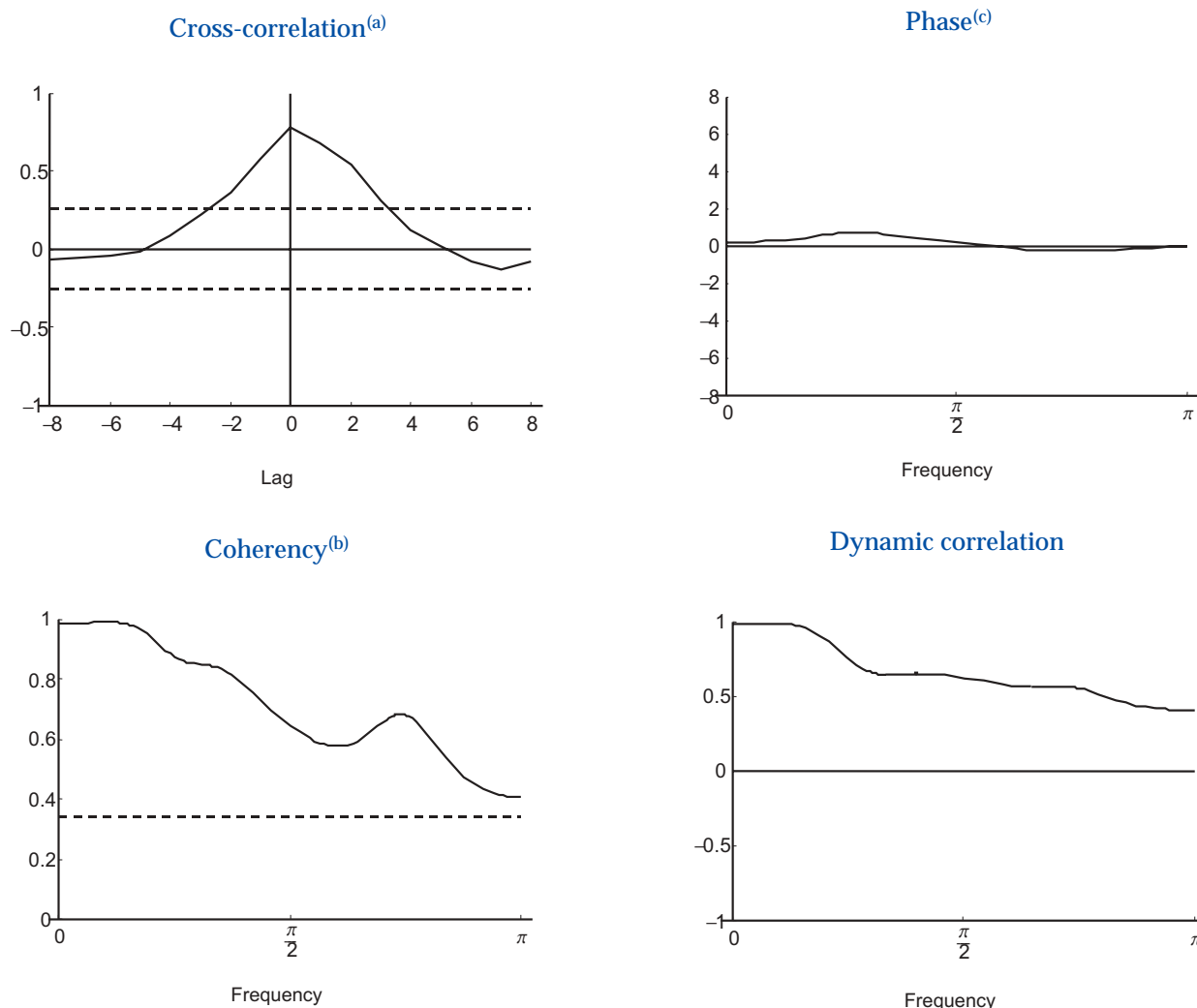
Notes:

(a) A positive lag should be interpreted as the delay, in terms of periods, of the composite indicator vis-à-vis the reference variable. Figures outside the interval bounded by the dotted lines are considered to be significantly different from zero. The confidence interval (with a significance level of 5%) is given approximately by $\pm 1.96/\sqrt{T}$, where T is the total number of observations.

(b) The figures above the dotted line are considered to be significantly different from zero (with a significance level of 5%) (see Koopmans (1974)).

(c) The phase is measured in time periods. In this case, a positive figure for the phase should be interpreted as the delay, in terms of periods, of the composite indicator vis-à-vis the reference variable.

mise its performance in terms of detection of turning points, correlation with the reference series and coverage, as far as possible, of the different sectors of the economy. The series chosen to be included in the CLI undergo several transformations: the quarterly series are converted into monthly series through linear interpolation, smoothed (in order to reduce the irregularity of the final indicator), normalised, weighted and finally aggregated (in the form of deviations from

the long-term trend).[14] In general, the CLI for each country is a simple average of the components.[15] The CLI for the euro area results from the aggregation of its member countries, using weights derived from industrial production.

The OECD releases the CLI both as ratio to trend, i.e. as deviation from the long-term trend,

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(14) Moreover, the cyclical amplitude of the CLI is adjusted so as to match that of the reference series.

Chart 5
GDP AND CLI
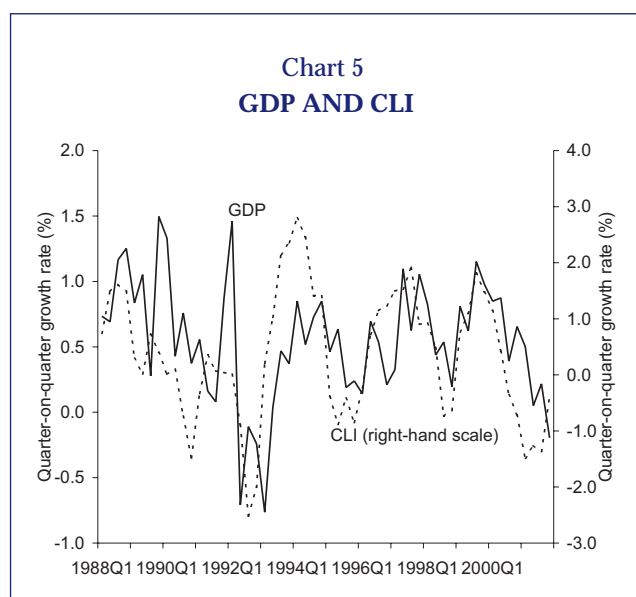
and as trend restored[16], i.e. in a form directly comparable with the original reference series. Thus, the behaviour of the CLI trend restored was analysed, and its quarterly growth rate was compared with the corresponding rate of change in GDP. Based on a graphical analysis (Chart 5), the quarterly growth rate of CLI appears to be a leading indicator.

This is confirmed by the fact that the maximum correlation, 0.55, is reached at lag -1 (i.e. not only is the maximum correlation higher than that obtained with the AR(1) model, but it also shows a lead) (Chart 6). It should be noted, however, that the cross-correlation at lag -2 is almost the same as at lag -1. Resorting to spectral analysis, the lead is confirmed in particular at relatively low frequencies, i.e. at relatively long cycles. It also Granger causes the GDP quarter-on-quarter growth rate. Moreover, using past data available and the estimates provided by the indicator for the GDP quarter-on-quarter growth rate[17], the maximum correlation with the GDP year-on-year growth rate is 0.82 at lag -1.

3.3 Economic Sentiment Indicator

The opinion surveys conducted within the various economic sectors provide one of the main sources of information on economic activity, given that the developments of the latter are determined by economic agents' behaviour, which in turn is conditioned by the surrounding environment. The economic agents are surveyed both on aspects directly related to their activity and on variables over which they have no control. Based on the opinion surveys conducted on a monthly basis in the euro area countries, the European Commission constructed a composite indicator, known as the Economic Sentiment Indicator (ESIN), in order to reflect developments in the overall economic activity.[18] The ESIN is the weighted average of the confidence indicators for different sectors of the economy, namely industrial (with a weight of 40 per cent), consumer (20 per cent), construction (20 per cent) and retail trade (20 per cent).[19] It should be noted that each confidence indicator is calculated as a simple average of the balance of respondents (seasonally adjusted (s.a.)) to some questions in the corresponding survey. In order to calculate ESIN, the first differences of the series comprising it are normalised, weighted (using the above mentioned weights) and subsequently accumulated in order to obtain an index.

Following the European Commission, the evaluation of this indicator was done against the GDP year-on-year growth rate. From the graphical analysis of its development over time (Chart 7), it can be concluded that ESIN has reasonably moved in line with the reference series, despite a less satisfactory behaviour at the end of the sample period.

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(15) It should be noted that, in particular, the latest figures for the CLI may be subject to significant revisions. This is due to the fact that the timely release of the CLI requires its computation on the basis of data regarding only part of its components. Moreover, the trend estimates, in particular for the most recent period, may be substantially revised with additional data.

(16) Obtained by multiplying the CLI ratio to trend by the trend of the reference series. The trend for a geographical zone is obtained by aggregating the trends of the countries belonging to that zone using the corresponding weights.

(17) After normalisation, as indicated in footnote 11.

(18) See European Commission (1997).

(19) It should be noted that the current composition of ESIN was introduced in 2001 (see European Commission (2001)), in order to confine ESIN to the results of business and consumer opinion surveys and to improve its statistical properties as a composite indicator. According to information provided by the European Commission, the remaining calculation procedures of the indicator (see European Commission (1997)) remained unchanged.

Chart 6
COMOVEMENT MEASURES BETWEEN GDP QUARTER-ON-QUARTER GROWTH RATE
AND QUARTER-ON-QUARTER GROWTH RATE OF CLI

Cross-correlation
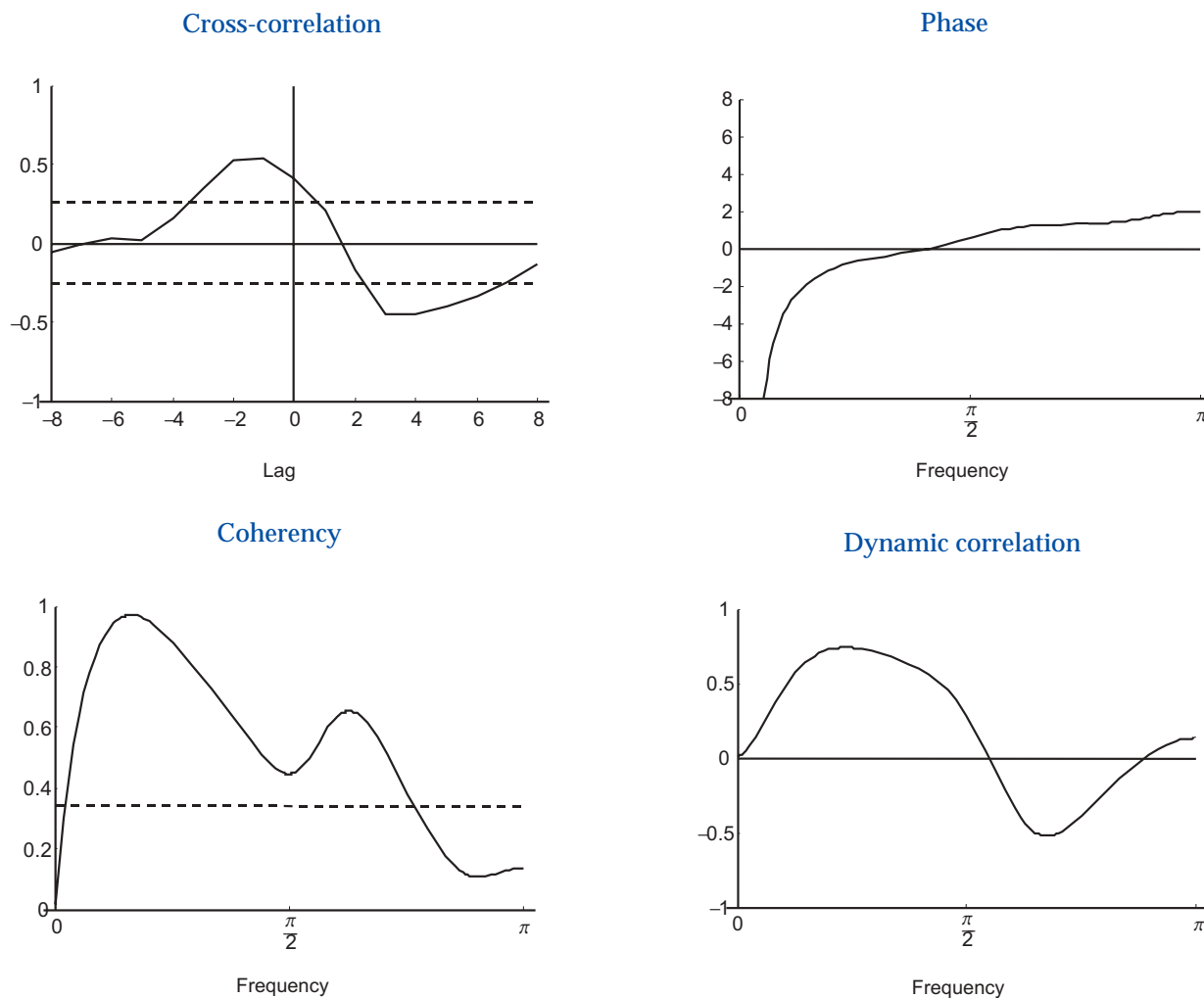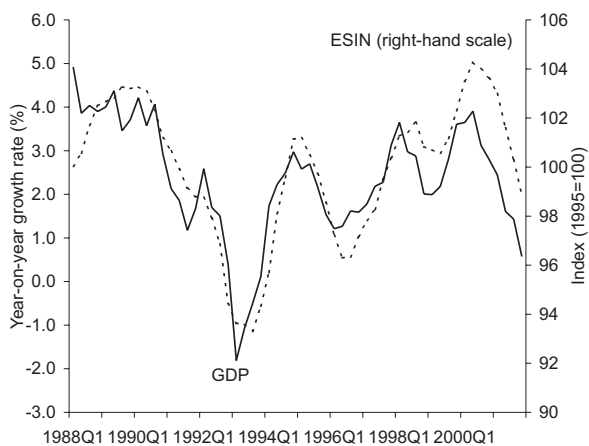

Phase

Coherency

Dynamic correlation

Chart 7
GDP AND ESIN

Given the cross-correlations obtained (Chart 8), ESIN reaches the maximum correlation with the GDP year-on-year growth rate, 0.86, at lag 1, which seems to suggest that the indicator is slightly lagging. Thus, in terms of both maximum correlation and lag, this indicator performs worse than the benchmark considered. Resorting to spectral analysis it can be seen that, at relatively low frequencies, ESIN presents a high coherency and a slight lag. Moreover, ESIN Granger causes the GDP year-on-year growth rate.

3.4 Business Climate Indicator

To improve the understanding of the business cycle in the euro area, the European Commission has developed the Business Climate Indicator

Chart 8

COMOVEMENT MEASURES BETWEEN GDP YEAR-ON-YEAR GROWTH RATE AND ESIN

Cross-correlation

Phase

Coherency

Dynamic correlation
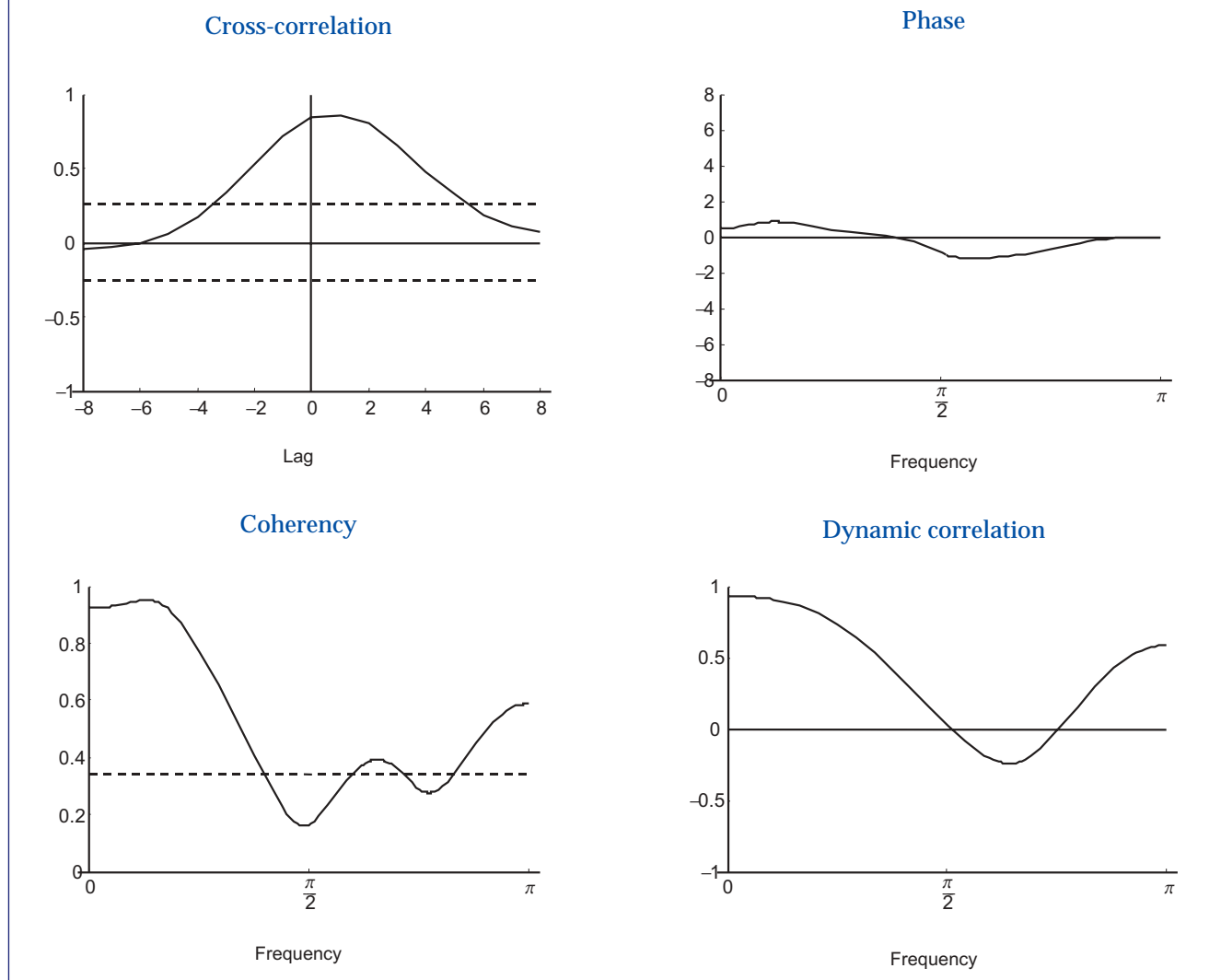
(BCI),[20] an indicator based on the monthly survey of the manufacturing industry designed to allow a timely assessment of the cyclical situation within the euro area. Although industry accounts for less than 25 per cent of the production in the euro area, this choice was due to the lack of data, in particular, regarding services, and by the fact that more than half of the variations in GDP is accounted for by fluctuations in industrial activity. The European Commission decided to consider for this indicator the following questions of the manufacturing survey: production trends in recent months, order books, export order books, stocks and production expectations.[21] The seasonally adjusted balance of respondents to each of these questions

is used when calculating the BCI. The indicator aims at identifying the component that is common to the series, assuming that each variable can be described as the sum of a factor that is common to all series and an idiosyncratic component.[22] According to the European Commission, the BCI may be read as a survey result, i.e. its level can be interpreted against a historical average and both short-term movements and trend can be analysed.

(21) Only the question regarding selling-price expectations for the next months was excluded, given that the graphical analysis suggests that it would be less directly related to expectations regarding the business climate in the euro area.
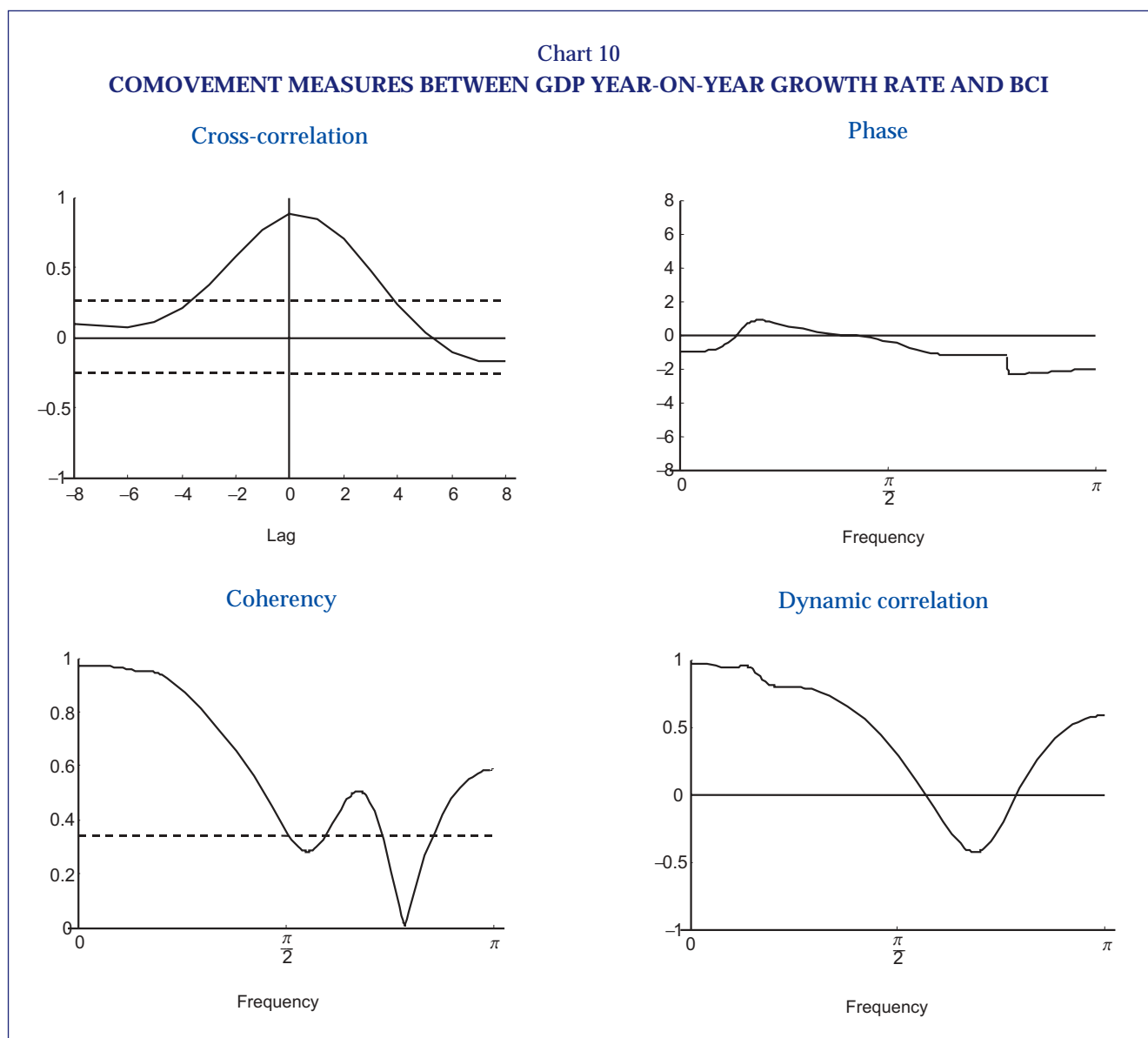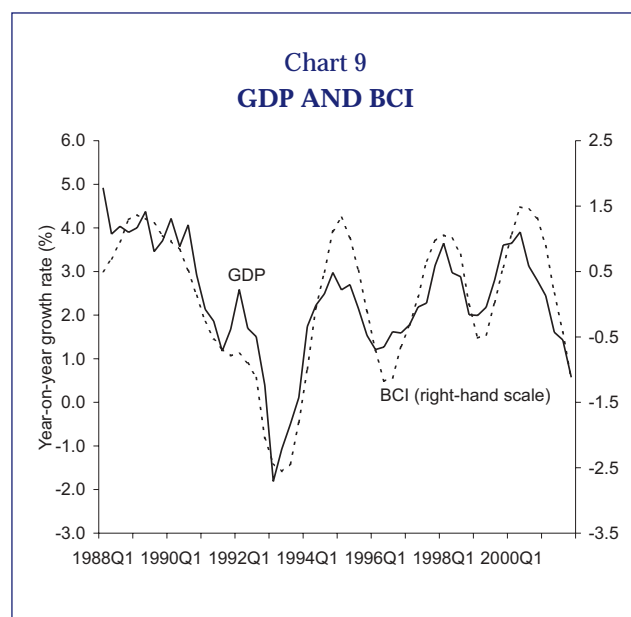
(22) The model is estimated by maximum likelihood and does not take into account the temporal and autocorrelated nature of the variables, i.e. in a static framework, in contrast with, for example, the dynamic model of Stock and Watson (1992).

(20) See European Commission (2000).

Thus, a high (low) level points to a favourable (adverse) cyclical situation and a rise (fall) points to an improvement (deterioration) of economic activity.

The European Commission compares the developments of this indicator with the year-on-year growth rate of the euro area industrial production. Similarly, in this article, for the evaluation of BCI, the GDP year-on-year growth rate was used to measure developments in economic activity. The graphical analysis (Chart 9) shows that the BCI has been recording a behaviour similar to the one of the GDP year-on-year rate of change.

The maximum cross-correlation with the reference series corresponds to the contemporaneous correlation, i.e. 0.88 (Chart 10). That is, the BCI is a coincident indicator with a high degree of linear association (although lower than that obtained

Chart 9
GDP AND BCI

Chart 10
COMOVEMENT MEASURES BETWEEN GDP YEAR-ON-YEAR GROWTH RATE AND BCI

Cross-correlation

Phase

Coherency

Dynamic correlation

with the suggested benchmark). The conclusion drawn from the frequency domain is similar. At relatively low frequencies, the BCI presents a high coherency and, on average, a zero phase, which naturally translates into a high dynamic correlation. Moreover, this indicator also Granger causes the GDP year-on-year growth rate.
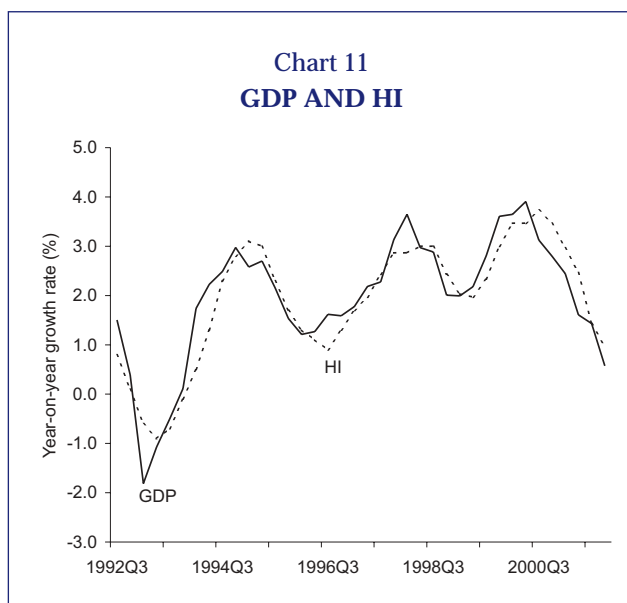
3.5 Handelsblatt Indicator

In contrast with the two previous composite indicators, which are only based on opinion surveys, the indicator released by the German newspaper Handelsblatt (HI) also uses quantitative data.[23] This monthly indicator, aimed at monitoring the economic situation in the euro area, is calculated as a weighted average of six series (after normalisation). The series are: European Commission industrial and consumer confidence indicators s.a. (with weights of 40 and 10 per cent, respectively), monthly growth of the industrial production (excluding construction) s.a. (20 per cent), year-on-year growth of the monetary aggregate M2 (10 per cent), year-on-year growth of the harmonised index of consumer prices (10 per cent, with symmetric sign) and the difference between the ten-year government bond yield and the three-month interest rate (10 per cent).

Handelsblatt uses as reference series the annual rate of change in GDP ended in each quarter. Therefore, it was decided to assess the performance of HI against the GDP year-on-year rate of change. Their evolution seems to be quite similar[24] (Chart 11).

The HI seems to be highly correlated with the GDP year-on-year growth rate, with the highest value being recorded by the contemporaneous correlation, 0.92 (Chart 12). However, this correlation is lower than that obtained with the benchmark. It should also be noted that the cross-correlation at lag 1 is almost identical to the contemporaneous correlation, suggesting that the indicator is coincident or slightly lagging. In the frequency domain,
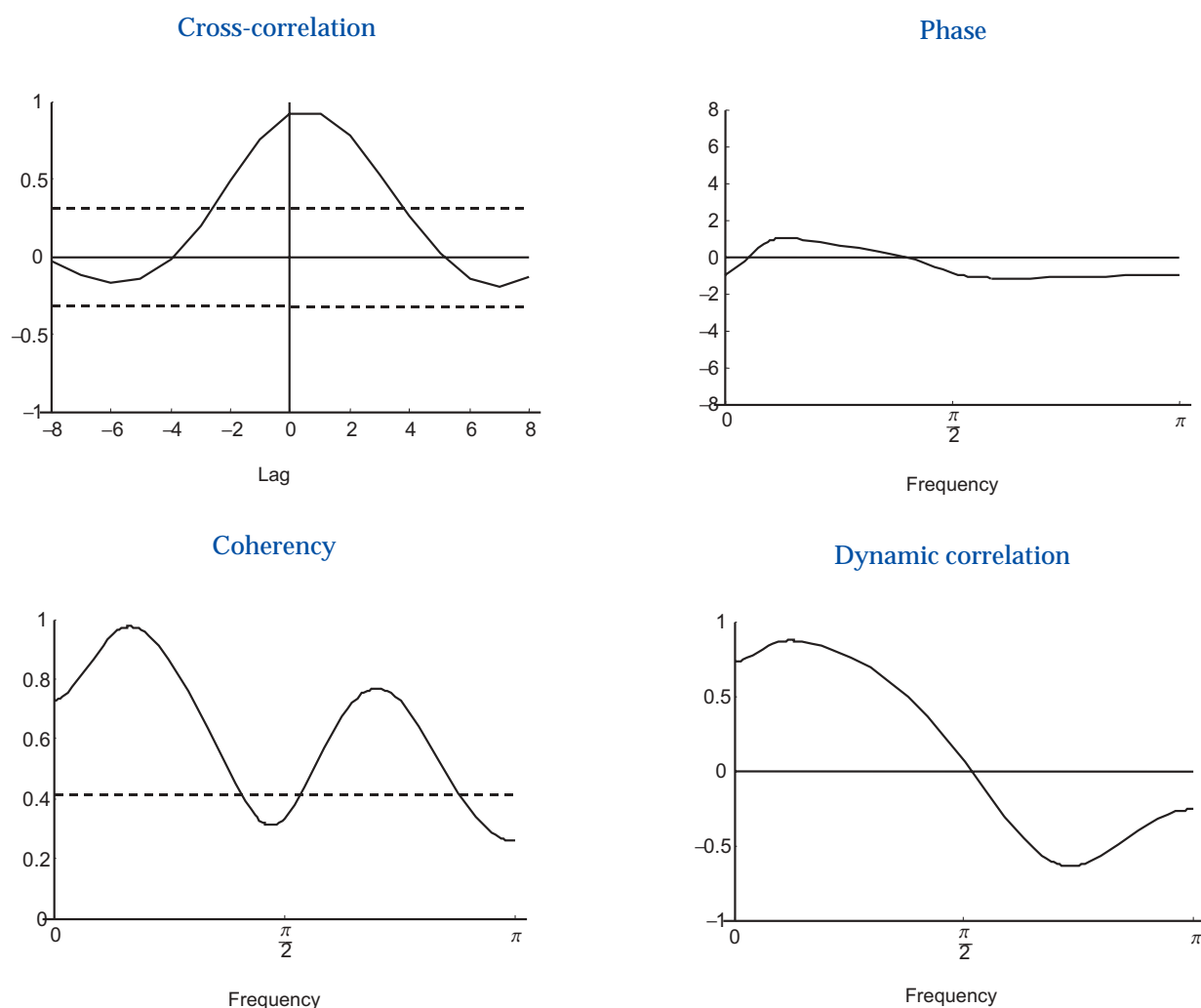

Chart 11
GDP AND HI

the dynamic correlation is high, in particular at relatively low frequencies, and it presents a slight lag, confirming the conclusions drawn with the cross-correlations. This indicator Granger causes the GDP year-on-year growth rate.

4. REMARKS ON THE USE OF THE INDICATORS

The previous section presented a detailed analysis of the behaviour of the various composite indicators tracking GDP evolution. It was possible to draw some conclusions regarding their performance. The €COIN proved to be a coincident indicator able to track in a rather satisfactory manner the development path of the GDP quarter-on-quarter growth rate. In fact, €COIN presents a high correlation with the reference series, which is much higher than that obtained with the AR(1) model. In turn, CLI is the sole indicator with lead characteristics for the GDP quarter-on-quarter growth rate. Regarding the GDP year-on-year growth rate, both ESIN and BCI lose some of their usefulness because they present a lower correlation than that obtained with the benchmark, more so in the case of ESIN, given that this indicator presents a slight lag. Regarding HI, the classification as coincident or lagging is probably not robust to the sample period considered and, therefore, the uncertainty as to the relevant lag might make its use more difficult. Moreover, it also presents a worse performance than that obtained with the benchmark.

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(23) See Handelsblatt (1999). It should be noted that methodological information about this indicator is rather limited.

(24) Due to the lack of data, it was not possible to analyse the HI for the same sample period of the other indicators; only the sub-period starting in the third quarter of 1992 was considered. Given the small size of the sample, the results should be interpreted with caution.

Chart 12

COMOVEMENT MEASURES BETWEEN GDP YEAR-ON-YEAR GROWTH RATE AND HI

Cross-correlation

Phase

Coherency

Dynamic correlation

A relevant issue yet to be analysed is related with the timeliness of each indicator. In fact, the indicators' usefulness might be reinforced due to the fact that they are more readily available than the reference series for a given quarter (Table 1). For example, indicators classified, in terms of cross-correlations, as coincident (€COIN, BCI and HI) end up being more interesting due to the fact that their release is prior to that of GDP. Clearly, the indicator previously classified as leading (CLI) becomes more useful. Regarding lagging indicators, the additional gain in terms of timeliness may not be sufficient to offset the lag in terms of cross-correlations (like, for example, in the case of ESIN). It should be noted that, in terms of release, the AR(1) benchmark is not so demanding, given

that to calculate it, it is only necessary to know the GDP of the previous quarter.

After taking into account this additional element of comparison, i.e. the release schedule, it can be concluded that any indicator whose reference series is the GDP year-on-year growth rate continues to present a worse performance than that obtained with the benchmark. Regarding the remaining indicators, although available after the benchmark, €COIN's usefulness still lies in the fact that it presents a far higher correlation with the GDP quarter-on-quarter growth rate.[25] The CLI remains the indicator that provides more timely information about activity.

Another factor to be taken into account when assessing the usefulness of the indicators is their monthly nature. In fact, even before the end of the

Table 1

PERFORMANCE OF THE INDICATORS
(IN QUARTERLY TERMS)

	Reference series GDP	Maximum cross-correlation	Maximum cross-correlation lag (in months)[a]	Lag in terms of publication (in months)[b]
€COIN	q-o-q	0.78	0	-1.5
	y-o-y	0.98		
CLI	q-o-q	0.55	-3	-1
	y-o-y	0.82		
ESIN.	y-o-y	0.86	3	-2
BCI	y-o-y	0.88	0	-2
HI	y-o-y	0.92	0	-3
Benchmark (AR(1)). . . .	q-o-q	0.37	0	-3
	y-o-y	0.95		

Notes:

(a) Although the evaluation was made in quarterly terms, quarters were converted into months in order to make it easier to read the table.

(b) Difference, in terms of months, between the time when the indicator is made available for a given quarter and the time when the first GDP estimate is released for that quarter.

quarter, the indicators provide partial information on that quarter which can be used to anticipate developments in the reference series. If, on the one hand, this allows a gain in terms of release, on the other hand, an indicator based on an incomplete data set can present a significant deterioration of its performance. Table 2 summarises the performance of the indicators, in terms of cross-correlations, when partial data are used for each quarter. It should be noted that the use of data up to the second month of the quarter has negligible costs in terms of performance and allows an additional gain of one month comparing with the situation when the whole quarter of the indicator is used. However, when data only up to the first

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(25) Moreover, the performance of €COIN was also compared with that of the industrial production index, which is acknowledged as a monthly indicator contemporaneously well correlated with developments in economic activity and that may be used directly, given that it is not subject to the statistical treatment underlying the construction of a composite indicator. However, €COIN's performance was better than that of industrial production when tracking GDP quarter-on-quarter growth rate. Taking into account the fact that the industrial production is released after €COIN, the quarterly growth rate of the industrial production index presents a contemporaneous correlation of 0.65 with the GDP quarter-on-quarter growth rate.

Table 2

PERFORMANCE OF THE INDICATORS WITH INCOMPLETE DATA FOR EACH QUARTER

	Reference series GDP	Using only data available[a]					
		Up to the 1st month of the quarter			Up to the 2nd month of the quarter		
		Maximum cross-correlation	Maximum cross-correlation lag (in months)[b]	Lag in terms of publication (in months)	Maximum cross-correlation	Maximum cross-correlation lag (in months)[b]	Lag in terms of publication (in months)
€COIN	q-o-q	0.73	3	-3.5	0.76	0	-2.5
	y-o-y	0.96			0.98		
CLI.	q-o-q	0.54	-3	-3	0.55	-3	-2
	y-o-y	0.82			0.82		
ESIN	y-o-y	0.86	3	-4	0.86	3	-3
BCI.	y-o-y	0.86	3	-4	0.88	0	-3
HI[c]	y-o-y	0.78	0	-5	0.81	0	-4

Notes:

(a) It was empirically found that, for all indicators excluding CLI, it is better to use only the months already available for the quarter. In the case of CLI, it is better to use data on the last three months (ending in each month of the quarter).

(b) Although the evaluation was made in quarterly terms, quarters were converted into months in order to make it easier to read the table.

(c) Due to the lack of data, the sample period considered was from Jan-97 to Dec-01.

month of the quarter is used, some indicators show some deterioration in terms of their overall performance (namely BCI and €COIN). In spite of the additional usefulness arising from the monthly nature of the composite indicators considered, comparatively, €COIN and CLI still seem to be the most interesting. In fact, when used to obtain an estimate for the GDP year-on-year growth rate, these indicators show a better performance than the remaining ones.

5. CONCLUSION

This article was intended to assess to what extent the composite indicators proposed by different institutions provide useful and timely information on the developments of economic activity in the euro area, measured by GDP. The performance of the composite indicators was evaluated resorting to techniques both in time and frequency domain. However, the practical use of these indicators should take into account not only the analysis in terms of statistical properties, but also the fact that these indicators are released more quickly and frequently than the reference series. Using as reference series the GDP quarter-on-quarter growth rate, €COIN proved to be a highly correlated coincident indicator, with the additional advantage of providing timely and relatively smoothed information, thus facilitating conjunctural analysis. In turn, the Composite Leading Indicator proved to be a leading indicator and it presents a gain in terms of publication. It should also be noted that any of these indicators allows us to obtain an estimate for the GDP year-on-year growth rate. Regarding the indicators whose reference series is the GDP year-on-year growth rate, namely Economic Sentiment Indicator, Business Climate Indicator and Handelsblatt Indicator, none of them presents a better performance than that which is possible to obtain either with the previous indicators or, for example, by fitting an auto-regressive process to

the GDP quarter-on-quarter growth rate and obtaining the resulting year-on-year growth rate given past data available.

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<div align="center">**ANNEX**[26]</div>

In the frequency domain, the analogous to the autocovariance matrix, $\Gamma(\tau)$, is given by the multivariate spectrum,

$$F(\omega) = \frac{1}{2\pi} \sum_{\tau=-\infty}^{\infty} \Gamma(\tau) e^{-i\omega\tau}, \quad -\pi \leq \omega \leq \pi$$

where ω is the frequency measured in radians. For the bivariate process $\{x_t, y_t\}$, the diagonal elements of the multivariate spectrum refer to the individual spectrum of x_t and y_t and the off-diagonal elements refer to the cross-spectrum. In general, the cross-spectrum is complex valued, so it can be broken down into a real and an imaginary part,

$$f_{xy}(\omega) = c_{xy}(\omega) - i q_{xy}(\omega).$$

Coherency is defined as

$$C_{xy}(\omega) = \frac{|f_{xy}(\omega)|}{\sqrt{f_x(\omega) f_y(\omega)}}, \quad 0 \leq C_{xy}(\omega) \leq 1.$$

Phase is given by

$$\phi_{xy}(\omega) = \tan^{-1}\left(-\frac{q_{xy}(\omega)}{c_{xy}(\omega)}\right)$$

and should be divided by ω in order to be expressed in time units.

Dynamic correlation was proposed by Croux *et al.* (2001) and is defined as

$$\rho_{xy}(\omega) = \frac{c_{xy}(\omega)}{\sqrt{f_x(\omega) f_y(\omega)}}.$$

The estimation of the multivariate spectrum is necessary to obtain these measures. In this article, the multivariate spectrum was estimated using the pre-whitening technique, resorting to a VAR(4), and using a Parzen window with a truncation parameter equal to $\sqrt[3]{T}$.

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(26) See Wei (1990) for an introduction to spectral analysis.