ISTITUTO DI STUDI E ANALISI ECONOMICA

Inspecting the cyclical properties of the Italian Manufacturing Business survey data

by

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ABSTRACT

The aim of this paper is to empirically investigate the cyclical features of the main Italian Manufacturing Business Survey indicators using time and frequency domain techniques. In particular, it analyzes the dynamics of each survey variable over time and with respect to different benchmark business cycles.

The findings show that important changes have occurred in the periodicity and volatility of Manufacturing Survey data over the years. As expected, the contemporary cross-correlation of each Survey indicator is higher with respect to the industrial production than it is to the GDP cyclical component. Evidence of significant differences in the co-movements between each indicator with respect to GDP and industrial production is found. The cross-spectral analysis seems to reveal the existence of a common periodicity of all cyclical indicators with both the manufacturing and the whole-economy business cycle. This last result confirms the strength of Business Survey data used as short-run policy indicators.

Keywords: Business cycle, Cross-correlations, Spectral analysis, Manufacturing business survey data.

JEL Classification: C32, E32.

NON-TECHNICAL SUMMARY

Manufacturing Survey data (in Italy collected from business surveys carried out periodically by ISAE) are widely used as business cycle indicators because they provide information on the short-term economic activity evolution. Indeed, their cyclical profile and timeliness make them particularly useful in monitoring and forecasting the aggregate economic situation. Given their importance from a policy perspective, it is essential to evaluate the degree of similarity between the signals coming from such indicators and short-run movements in economic activity.

The aim of this paper is to assess the ability of business survey data to lead business cycle evolution and to inspect any possible changes that take place in their cyclical properties over time. For this purpose, frequency domain techniques (spectral analysis) in addition to time domain methods are used.

Whereas cross correlations allow to take into account the features of survey data in terms of co-movement with respect to the business cycle as a whole, spectral analysis enables evaluation of the survey data leading properties across frequencies through decomposition of the sample data variance based on Fourier analysis.

The cross correlation results show that the business survey indicators are indeed able to lead business cycle evolution.

Bivariate spectral analysis confirms the leading properties of most survey data. However their predictive power appears to be focalized mainly at high frequencies.

ANALISI DELLE PROPRIETÀ CICLICHE DELLE PRINCIPALI VARIABILI DELL'INDAGINE ISAE SULLE IMPRESE MANIFATTURIERE ED ESTRATTIVE

SINTESI

In questo lavoro si analizzano le caratteristiche dei principali indicatori ciclici desunti dall'indagine ISAE presso le imprese manifatturiere ed estrattive. Le dinamiche di ogni variabile congiunturale sono valutate nel corso del tempo e rispetto a differenti cicli economici di riferimento, applicando sia tecniche di analisi delle serie storiche condotte nel dominio temporale che nel dominio frequenziale.

I risultati evidenziano la presenza di rilevanti cambiamenti verificatisi nel corso del tempo nella volatilità e nella periodicità dei dati analizzati. La correlazione contemporanea di ogni indicatore rispetto al ciclo dell'industria risulta più alta di quella rispetto al ciclo economico aggregato ottenuto attraverso la stima della componente ciclica del Prodotto Interno Lordo. L'analisi delle correlazioni incrociate mostra l'esistenza di differenze significative nei comovimenti di tali variabili rispetto ai diversi cicli economici di riferimento. L'analisi spettrale bivariata rivela l'esistenza di componenti cicliche comuni tra le variabili di congiunturali ed i cicli dell'industria e dell'intera economia. Le evidenze empiriche confermano la validità dell'uso di tali dati come indicatori dell'evoluzione a breve termine dell'economia italiana.

Parole chiave: Ciclo economico, Correlazioni incrociate, Analisi spettrale, *Business survey data*.

Classificazione JEL: C32, E32.

CONTENTS

1 INTRODUCTION [1]

Over the past few years, an important strand of the literature has been focusing on the detection of regularities in the co-movements between macroeconomic variables and the aggregate business cycle (see, for instance, Stock and Watson, 1998; Canova, 1998; Bjornland, 2000; Agresti and Mojon, 2001). Analysis of the cyclical properties of the aggregate variables enables one to evaluate the performance of different business cycle models and to analyze the implications of their use in stabilization policies.

This paper adopts a similar approach to investigate the cyclical characteristics of the main Italian Manufacturing Business Survey indicators in terms of frequencies, periodicity, variability and timing. Manufacturing Survey data are widely used as business cycle indicators because they provide information on the short-term economic activity evolution. Indeed, their cyclical profile and their timeliness make them particularly useful in monitoring and forecasting the aggregate economic situation. Given their importance from a policy perspective, it is essential to evaluate the degree of similarity between the signals coming from such indicators and short-run movements in the economic activity.

The contribution of this paper is essentially empirical and consists of analyzing the cyclical properties of the main business survey data using both univariate and bivariate frequencies domain techniques (spectral analysis) in addition to the traditional time domain methods.

Firstly, traditional standard deviations are used to analyze volatility variations over the years, and the spectral density function is adopted to describe each cyclical indicator in terms of characterizing periodicities and of changes taking place in the relative importance of its frequencies over time. Secondly, cross-correlations and bivariate spectral analysis are used to obtain information concerning possible common properties of each Survey variable with respect to the benchmark business cycle. In addition, a sensitivity analysis concerning the industrial sector and the whole economy business cycle is carried out. In industrialized countries, business cycle dynamics are generally well captured by oscillations in industrial activity due to the inability of the

[1] I would like to thank M. Lippi for his helpful suggestions and comments. I am also grateful to D. S. G. Pollock and the participants at the CEPR/Loughborough University workshop on “Business cycle convergence” and the Computational and Financial Econometrics conference for their useful comments. The paper has also benefited from helpful discussions with G. Cubadda, C. Lupi and C. Pappalardo. The opinions expressed in the paper are those of the author and should not be taken as representing the views of ISAE or its staff.

remaining GDP components (services and agricultural sectors) to convey additional useful information about aggregate fluctuations. However, one should consider that, since the industrial production cyclical component is in general more volatile than the GDP business cycle (see, Hearn and Woitek, 2001), the signals coming from Manufacturing Survey indicators may not correctly detect whole economy cyclical dynamics. For these reasons, the Survey indicators features are evaluated with respect to both GDP and industrial production.

The remainder of the paper is organized as follows. Section 2 introduces the most relevant univariate and bivariate time and frequency domain techniques; Section 3 contains the empirical results; and Section 4 reports the concluding remarks.

2 IDENTIFICATION OF THE MAIN BUSINESS CYCLE PROPERTIES

This Section reviews the main instruments used to identify the cyclical characteristics of a macroeconomic variable. Accordingly, univariate and bivariate time domain and frequency domain techniques are introduced.

The use of standard deviations in order to evaluate changes in volatility over time is described in Section 2.1. The use of spectral density function as a tool to describe the survey data in terms of characterizing periodicities is introduced in Section 2.2, while Section 2.3 describes the use of cross-correlations as a time domain instrument to detect co-movements, and deals with the problem of sensitivity results with respect to the reference business cycle indicator. Section 2.4 introduces the cross-spectral analysis to evaluate the common cyclical properties between the Survey indicators and the reference business cycle.

2.1 Survey indicators volatility

The traditional way to evaluate the cyclical volatility of a macroeconomic variable is to use standard deviation. This statistics gives a general idea of the magnitude of business cycle fluctuations. In particular, the detection of a series variability over the years allows one to assess the changes occurred in the degree of economic fluctuations regularity. Similarly, the detection of survey data volatility changes let to evaluate the existence of a possible decline in their fluctuations over time.

Several studies provide evidence on the reduction of business cycle fluctuations in the most industrialized countries during the 1990s (see Mc Connell and Perez Quiros, 2000 and Stock and Watson, 2005). The literature offers a number of alternative explanations for this finding. Blanchard and Simon (2001) attribute the volatility moderation to changes in monetary and fiscal policy. Stock and Watson (2002) show that the volatility fall in the US macroeconomic variables is due not only to monetary policy improvements but also to less volatility in productivity shocks and in commodity price shocks. Gordon (2005) attributes the moderation mainly to a reduction in the macroeconomic shocks variance. Finally, Mc Connell and Perez Quiros (2000) propose an explanation based on better inventory management practice.

2.2 Univariate spectral analysis

Frequency domain analysis is an alternative way to investigate the cyclical properties of a variable with respect to the classic time domain instruments (i.e. standard deviations, auto-co-variances etc.).

More in detail, the application of spectral techniques gives an intuitive description of the cyclical structure characterizing a stationary series through decomposition of the sample data variance across different frequencies. In particular, the spectral density function of a variable conveys information concerning the relative contribution of each frequency to the total process variance. Given a stationary process $X(t)$, the general formula for the spectral density is:

$$f^{x}(w) = \frac{1}{2\pi}\left(\gamma_0 + \sum_{k=1}^{+\infty} \gamma^{x}(k)\cos(wk) \right) \tag{1}$$

where $w \in [-\pi, \pi]$ is the frequency, i indicates the imaginary unit equal to $\sqrt{-1}$, k is the lag, $\gamma(k)$ is the process auto-co-variance at lag k, and $1/2\pi$ represents a normalization factor. Given the Euler equation, the expression can also be written as:

$$f^{x}(w) = \frac{1}{2\pi} \sum_{k=-\infty}^{+\infty} \gamma^{x}(k) e^{-iwk} \tag{2}$$

The underlying area relative to this function corresponds to the total process variance. Admittedly, if a sub-interval is considered, the underlying area gives a contribution to the total variance equal to all the frequencies in that interval. Since the period represents the inverse of frequency, the frequency corresponding to the highest peak in the spectral density function allows evaluation of the cyclical wave determining the highest data variability with respect to the others.

2.3 Detecting co-movements

From a business cycle perspective it is essential to evaluate the co-movements of different variables with respect to a reference cyclical component.

The usual approach adopted to describe synchronicity between series is the use of cross-correlations (see, for details, Agresti and Mojon, 2001; Stock and Watson, 1998). By means of this technique, the correlations at all leads and lags between each variable and the benchmark business cycle component are calculated. In what follows, this approach is used to detect the leading and lagging properties of each Manufacturing Survey indicator with respect to the reference business cycle. If a variable leads the business cycle dynamics, it can be used to provide rapid information on its evolution. Business Survey variables, given their cyclical profile and their timeliness, are expected to be leading and should be able to predict turning points in the aggregate economic activity. The pro-cyclicality or counter-cyclicality of variables can be evaluated by observing the contemporary cross correlation with the business cycle. For example, positive contemporary cross-correlation indicates pro-cyclical co-movements between a given variable and the business cycle. Moreover, cross-correlation analysis allows to detect whether a Survey variable is a leading or lagging indicator of business cycle activity. In particular, a variable is labelled as leading with respect to the business cycle if it reaches maximum correlation with the business cycle in $t+i$ with $i>0$, whereas it is lagging in the opposite case.

To detect co-movements between each variable and the reference business cycle, we use both cyclical GDP components and cyclical industrial production components as benchmarks. Although Business Survey indicators are only referred to the manufacturing sector, they are generally also used to evaluate aggregate business cycle fluctuations. However, it may be that industrial sector volatility (reflected in the Business Survey indicators) cannot be used to detect whole economy dynamics properly. That is why to check whether there are significant differences in the Survey indicators' co-movements as against the different benchmark business cycles. To estimate the GDP and the industrial production cyclical components, we apply the Baxter and King (1999) band-pass filter. This non-parametric detrending method eliminates low frequencies (trend) and high frequencies (noise) components from the data, whereas it retains medium frequencies (cycle) through the application of a moving average with symmetrical weights:

$$y_t^* = a(L)y_t \tag{3}$$

where $a(L) = \sum_{K=-\infty}^{+\infty} a_K L^k$ represents the filter, L is a lag operator, y_t indicates the actual data series and y^*_t represents the filtered series. This filter is able to extract the frequencies into a specific range [*w', w''*], and for this reason the corresponding cyclical component is consistent with the Burns and Mitchell (1946) view of the business cycle. Since the filter is based on a symmetric moving average, it does not introduce phase shifts into the data, and hence does not modify the cross-correlations at all leads and lags between the variables.

2.4 Bivariate spectral analysis

The use of bivariate spectral analysis provides further evidence on the interrelations between the reference business cycle component and each Business Survey indicator through evaluation of the similarities in their frequencies**.** To this end, the cross-spectrum assessment allows one to detect the existence of a common periodicity between each Survey variable and the reference business cycle component.

Given two variables $X(t)$ and $Y(t)$, the co-spectrum *c(w)* defines the co-variances of the components of $X(t)$ and $Y(t)$ at frequencies $w \in [-\pi, \pi]$ which are in phase. The quadrature spectrum *q(w)* defines the co-variances of the components of $X(t)$ and $Y(t)$ at the frequencies *w* which are out of phase.

The cross-spectrum, similarly to the univariate case, represents the Fourier transformation of the co-variance, and it is given by:

$$g^{xy}(w) = \frac{1}{2\pi} \sum_{k=-\infty}^{+\infty} \gamma^{xy}(k) e^{-iwk} \tag{4}$$

where $\gamma^{xy}(k)$ indicates the cross co-variance between $X(t)$ and $Y(t)$. It provides the information concerning the relations between the two series. The cross-spectrum can also be expressed in terms of co-spectrum and quadrature spectrum in the following way:

$$g^{xy}(w) = c(w) - iq(w) \tag{5}$$

The cross-amplitude function is computed as the square root of the sum of squared co-spectral density and quadrature density. It can be interpreted as the measure of co-variance between the respective frequency components in the two series. The formula is:

$$g^{xy}(w) = c(w)^2 + q(w)^2 \tag{6}$$

The coherence function gives the correlation of the cyclical component of the two series at each frequency. The square coherence can be considered as the equivalent of the determination coefficient (R^2) in the time domain. In our case, the coherence is defined as:

$$\rho(w) = \frac{\left|g^{xy}(w)\right|}{\left\{f^{xx}(w)f^{yy}(w)\right\}^{\frac{1}{2}}} = \left\{\frac{c^2(w) + q^2(w)}{f^{xx}(w)f^{yy}(w)}\right\}^{1/2} \tag{7}$$

Since this measure takes account of both the co-spectrum and the quadrature spectrum, it is unaffected by the relative phase alignment of the two components. This means that, if the cyclical behaviour of the two series is exactly the same, but one of them is shifted with respect to the other, the coherence is high at each frequency even though it is shifted. This measure only gives an indication of the extent to which the shapes of two waves are similar, without considering whether or not they are lagged.

Evaluation of the time series co-movements taking into account also the leads and lags structure of each frequency can be performed by using the phase spectrum. The formula is:

$$\phi_{xy}(w) = \tan^{-1}\left[q_{xy}(w)/c_{xy}(w)\right] \tag{8}$$

This measure gives an idea of the phase shift between the two series at a given frequency and provides information on the extent to which each frequency leads the others.

3 DATA AND EMPIRICAL RESULTS

This Section reports the results of analysis concerning the main cyclical properties of the Italian Business Survey variables. All the indicators used in the analysis were taken from periodic Business Surveys carried out by ISAE on Italian manufacturing firms. More in detail, among the manufacturing industry variables, the empirical analysis described here focuses on the degree of plant utilization, the production level, order-book levels, inventories, production expectations, and the firms' confidence climate indicator.[2] Most of these data (except the degree of plant utilization) are qualitative and they were quantified by means of balances, which represent the most standard technique employed for qualitative survey data quantification.[3] The data used as benchmark business cycles are the Italian Gross Domestic Product based on year 2000 (seasonally adjusted) taken from the new System of National Accounts (SNA) and the seasonally-adjusted industrial production index for the C_D_E NACE sectors (OECD).

Since stationarity is a necessary condition for application of spectral analysis, we start with the standard unit root tests on all variables; the standard deviation of each variable is then reported in different sub-intervals. Changes in the cyclical indicator periodicity over the years are then evaluated by using univariate spectral analysis. The co-movements between the indicators and the business cycle are investigated using cross-correlation analysis. Finally, we analyze the common cyclical properties of each indicator with respect to the business cycle by using bivariate spectral analysis measures.

Although the data analyzed are expected to be stationary by construction, in particular samples they might display a stochastic trend. This is due to the fact that the existence of upper and lower bounds for the values of those variables do not eliminate the possibility of local non-stationary data trends. The Augmented Dickey Fuller (ADF) tests for unit roots were implemented to identify possible non-stationary behaviours in the Business Survey variables. The number of lags was chosen on the basis of the Schwartz information criterion. The results are reported in Table1.

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2 This latter variable is not collected directly, but is obtained as the mean of order-book level, inventories and production expectations.

3 By means of this method, qualitative survey variables are quantified as balances between positive and negative answer percentages.

Tab. 1 **Unit roots tests**

Variables	ADF (1970-03)	GLS (1970-03)	ADF (1981-03)	GLS (1981-03)	ADF (1986-03)	GLS (1986-03)
Degree of plant utilization	-3.05**	-1.96	-2.59***	-2.63*	-3.13**	-2.47**
Inventories	-6.11*	-2.86*	-2.28	-1.41	-3.10**	-2.59**
Production level	-3.74*	-1.94**	-2.37	-1.74***	-2.59***	-1.63***
Order-book level	-2.83***	-2.28**	-3.12**	-2.31**	-3.41**	-3.18*
Production expectations	-3.28**a	-1.60	-1.93	-1.72***	-2.59***	-0.71
Confidence climate	-2.99**	-3.00*	-2.71***	-2.50**	-3.13**	-1.94***

***** Rejection of the unit root hypothesis at 1% level.

****** Rejection of the unit root hypothesis at 5% level.

******* Rejection of the unit root hypothesis at 10% level.

a) Trend+intercept.

Since the low power of the ADF test,[4] a more powerful GLS test developed by Elliot, Rotemberg and Stock (1996) was also performed for the sub-sample periods 1981-03 and 1986-03 and for the whole sample (1970-03).

The results of the ADF test in the periods 1970-03 and 1986-03 indicate stationarity for all variables, although at different significance levels. Conversely, on looking at the sub-sample 1981-03, the production level, inventories and production expectations appear to be non-stationary. This is perhaps due to the fact that 1981 marks an expansionary period in the Italian economy. For this reason, the use of 1981q1 as the starting date introduces a downward trend in the data.[5] Indeed, the initial date should be chosen in correspondence to a cyclical phase which is not much above the ground, since this guarantees that no upward/downward trend is introduced into the data that might lead to a misleading unit roots results. In the 1981-03 sub-sample, the GLS test results confirm unit roots for inventories, but point to stationarity for production level and expectations. For each variable in both tests, no more than two lags are selected on the basis of the Schwartz criterion.

In order to evaluate the volatility changes of each Business Survey indicator over time, the following Table reports the standard deviations in the different sub-samples. In particular, the periods 1970-03 and the sub-samples 1970-85 and 1986-03 are considered. 1986q1 is chosen as the starting date in

4 See Campbell and Perron (1991) for a detailed description of this finding.

5 Considering the results of the KPSS test, which is not distorted towards the unit root hypothesis, all the variables in each sample are stationary.

the second interval because a change was made to the aggregation method of Manufacturing Survey microdata in that year.

Tab. 2 Standard deviations - Quarterly frequency

Variables	Std. Deviation 1970-03	Std. Deviation 1970-85	Std. Deviation 1986-03
Degree of plant utilization	3.03	3.23	2.25
Inventories	8.07	10.64	2.98
Production level	14.14	12.49	11.41
Order-book level	19.42	21.59	13.83
Production expectations	14.09	14.00	9.75
Confidence climate indicator	14.18	15.46	8.42

Table 2 shows that, for each indicator, there has been a remarkable volatility reduction in the most recent period compared to the past. This is particularly evident for inventories, production expectations and confidence climate. These results confirm the recent evidence on business cycle stylized facts (see, McConnell and Perez-Quiros, 2002; Stock and Watson, 2005), showing a volatility fall in most macroeconomic variables in industrialized countries. The business survey indicators dynamics reflect this decline over time.

To assess any possible variation occurred in the relative importance of the frequencies of each cyclical indicator over the years, we estimate the spectral densities at different time intervals. The changes in the power spectrum shape over the time give an indication of the evolution of the periodicities characterizing the variables.

Table 3 reports the length of periods in quarters corresponding to the two highest peaks of the estimated spectral densities of each Survey indicator at different time intervals. The intervals are 1970-03 and 1986-03. For all the Survey variables, the spectral density estimates were obtained by smoothing the periodogram using the Hanning window (see, for details, Blackman and Tukey, 1958) with weights standardized so that they sum to one. This window is generally used in order to reduce possible leakage problems in the estimated spectral density due to the occurrence of non periodic signals in the sample window. The spectra in the two periods for each variable are plotted in Fig. 1-6.

The results of frequency analysis in the two time intervals show that, in the whole sample and in the sub-sample, the spectra are characterized by a bimodal distribution.

Results in table 3 show that in the whole sample the degree of plant utilization and the production level seem to be described by two predominant peaks corresponding roughly to cycles of 8.5 and 3.2 years duration. Inventories, order book level, production expectations and the confidence climate indicator display a peak corresponding to a cycle of 3.2 years and another peak corresponding roughly to a cycle of 7 years' length (27.2 quarters in Table 3), both explaining most of the data variability.

Tab. 3 Changes in periodicity over time

	1970-03		1986-03	
Variables	1° peak	2°peak	1° peak	2° peak
Degree of plant utilization	34	12.4	24	12
Inventories	27.2	12.4	24	12
Production level	34	12.4	24	12
Order-book level	27.2	12.4	24	12
Production expectations	27.2	12.4	24	12
Confidence climate indicator	27.2	12.4	24	12

Notes: the period indicates the number of quarters.

The evidence of a 8.5 years wave in some of the variables may seem meaningless, because it does not fall within the medium-frequency range usually associated with the business cycle (1.5-8 years) on the basis of the Burns and Mitchell (1946) definition. However, a cyclical 9-year wave indeed exists in the Italian business cycle chronology and it took place between 1983 and 1992. As regards the more recent period, 1986-03, all the variables exhibit two peaks of 6 and 3 years length.[6] These results seem to indicate, for all the variables, a decrease in the length of predominant cycles and a convergence to the same periodicities in most recent years compared to the past.

The evidence of changes in the periodicity over time can be explained in light of different macroeconomic scenarios characterizing the two sub-samples. Moreover, the findings of a convergence towards a common periodicity in the most recent period in all the Survey variables can be interpreted as a closer similarity in the respondents' perceptions of the economic situation which are mirrored in their answers.

The analysis of the spectrum of survey data in the period 1970-03 shows that, for almost variables, the first peak is more important (in terms of variability) than the second one, except for inventories and the confidence climate indicator. In the more recent period (1986-03), the first peak shows the highest variability for all the variables.

[6] Note that the peak in periodicity is not an average cycle duration but only represents the cyclical component determining the highest data variability.

Looking at the spectral densities, one also notes that, for most Survey variables, a seasonal frequency corresponding to 4 quarters occurs. This is due to the fact that, although from a theoretical point of view the answers given by firms should be free from any seasonal component, agents are unable in practice to correctly evaluate the activity variations due to seasonal factors.

Looking at the spectra in the two periods analyzed (Fig. 1-6), the degree of plant utilization, production expectations, inventories, the production level and the confidence climate indicator also show some high frequency peaks corresponding to 2 quarters. Indeed, in the case of inventories, the degree of plant utilization and the production level, the peak is mainly due to seasonal factors. In the case of production expectations and the confidence climate indicator, this finding probably also reflects greater uncertainty among economic agents when they are asked to predict the evolution of certain aspects of their business activities.

Fig. 1 Estimated spectral densities of business cycle indicators Degree of plant utilization

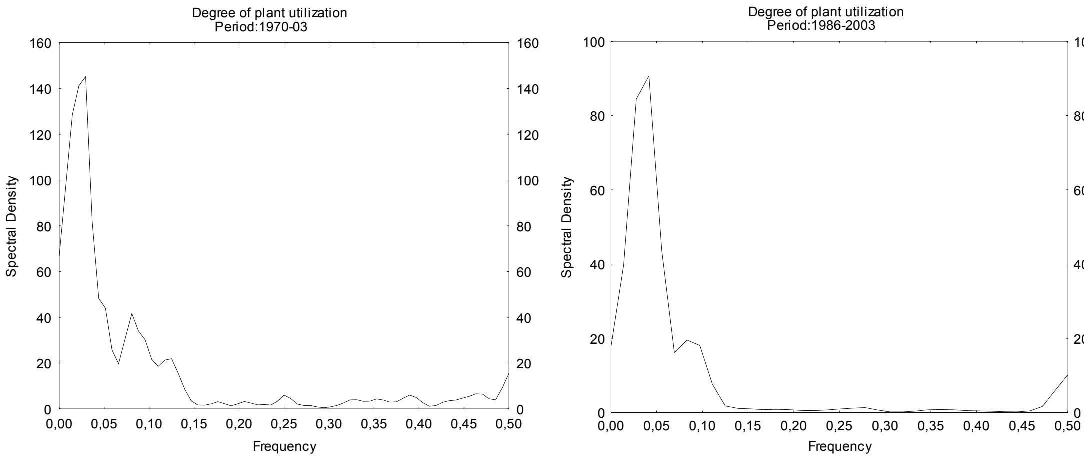


Fig. 2 Estimated spectral densities of business cycle indicators Inventories

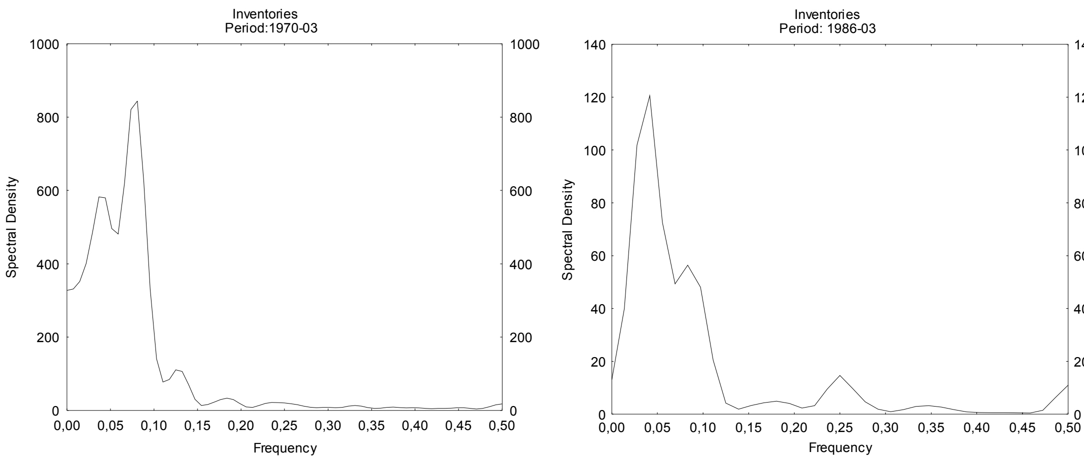


Fig. 3 Estimated spectral densities of business cycle indicators Order-book level

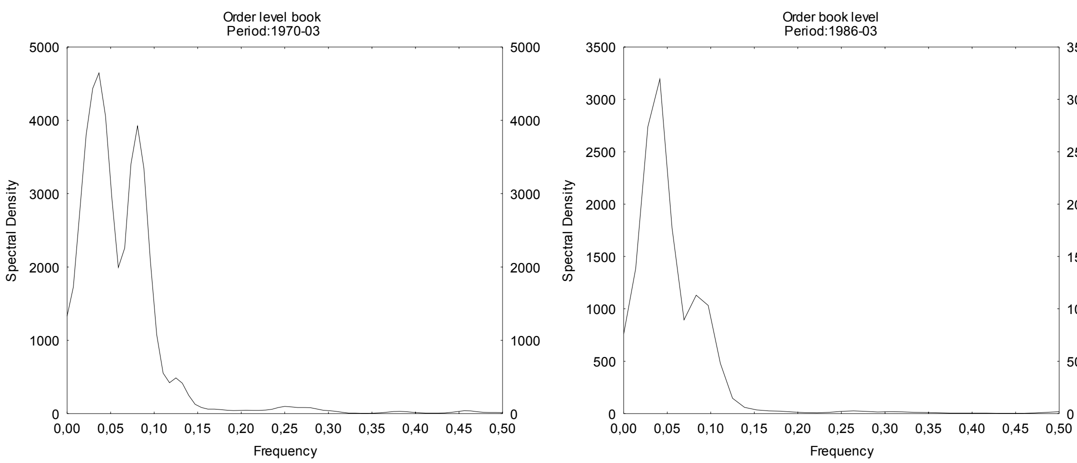


Fig. 4 Estimated spectral densities of business cycle indicators
Production level

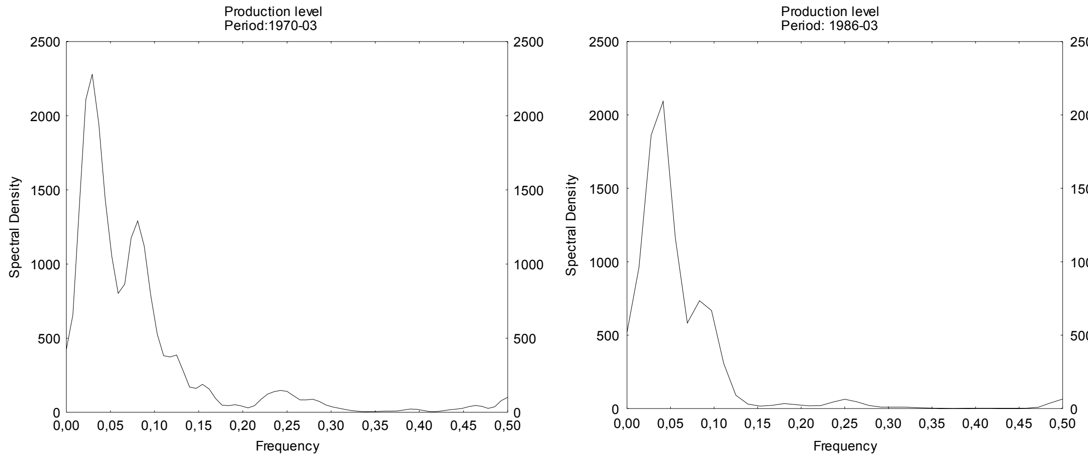


Fig. 5 Estimated spectral densities of business cycle indicators
Production expectations

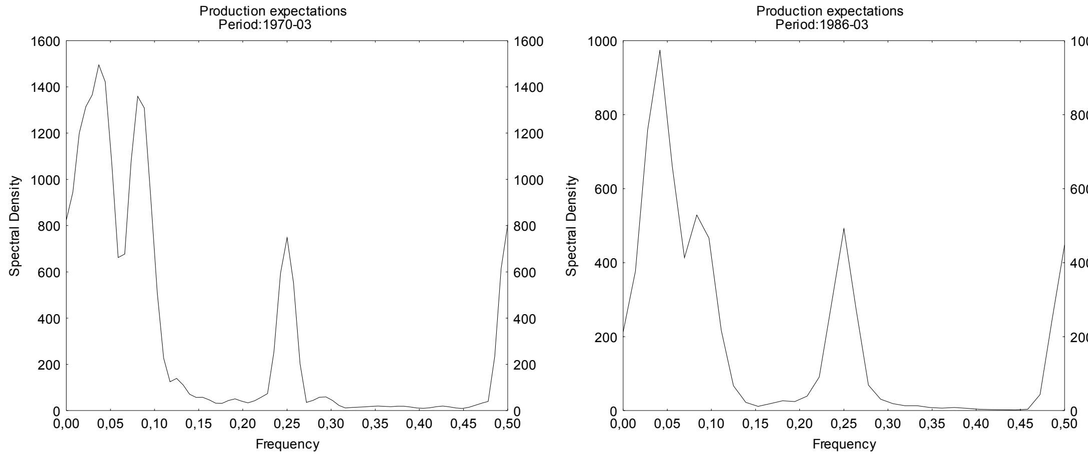
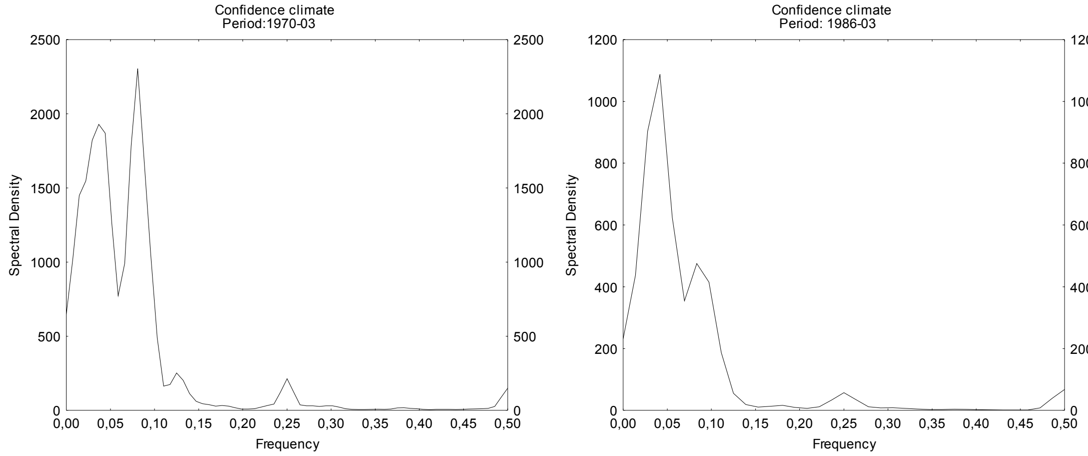


Fig. 6 Estimated spectral densities of business cycle indicators
Confidence climate indicator



The cross-correlations of the main Italian Manufacturing Survey indicators with GDP and industrial production are reported in Tables 3 and 4. The sample period is 1986q1-2003q4. In order to make a comparison with the GDP data frequencies, the monthly Survey data and industrial production were transformed into quarterly data using three-term moving averages. To extract the cyclical components from GDP and from the industrial production, the Baxter and King (1999) filter is applied by setting a value of the cut off parameter k equal to 12[7]. All the cycles between 1.5 and 9 years are considered[8]. The cross-correlations between each variable at time t and the cyclical component of GDP and industrial production at all leads and lags from t-6 to t+6 taken as benchmark indicators of the Italian business cycle were calculated. The results suggest that, as expected, for all the Survey variables, the contemporary correlation is higher compared to the industrial production than it is to the GDP cyclical component. Furthermore, most indicators exhibit slightly different behaviours with respect to GDP and industrial production respectively, namely:

The degree of plant utilization is pro-cyclical with a contemporary correlation of 0.71 with respect to GDP and 0.85 with respect to the industrial production index. While in the sample this variable leads GDP, it seems coincident with respect to industrial production.

Inventories are counter-cyclical by construction, since they grow during recessions and fall over expansion periods. They display a very low contemporary negative correlation with GDP (-0.14) and a slightly higher negative correlation with industrial production (-0.40). Moreover, they seem not to be in synchronicity with both benchmark business cycles resulting out of the phase.

The production level is pro-cyclical. It exhibits positive contemporary correlation with GDP and with industrial production of 0.57 and 0.84 respectively. In particular, it leads GDP in two quarters and industrial production in one quarter.

The order-book level is pro-cyclical and leads both GDP and industrial production in two quarters. The contemporary cross-correlation is 0.57 with respect to GDP and 0.83 with respect to industrial production.

Production expectations are pro-cyclical, with a contemporary correlation of 0.46 with GDP and 0.65 with industrial production. It leads GDP in two

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7 This is the threshold cut off suggested by Baxter and King (1999).

8 As noted by Pollock (2003 and 2006), the use of band pass filters may give rise to some leakage effects. However in this particular case, the effect only accounts for about 3.2% and 2.6% of the GDP and industrial production estimated spectra and consequently can be considered irrelevant.

quarters and industrial production in one quarter, thus confirming its predictive ability.

The confidence climate indicator is pro-cyclical. It is a composite indicator given by the linear combination of production expectations, order books and inventories, and it is expected to provide in-advance signals of economic activity changes. The contemporary correlation is 0.50 with respect to GDP and 0.77 with respect to industrial production. The cross-correlation analysis shows that this economic indicator is indeed able to lead two quarters' GDP and one quarter's industrial production.

Tab. 4 Cross-correlations of each indicator with GDP cyclical components Period 1986Q1-2003Q4

SERIES	GDP												
	t-6	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5	t+6
Plant utilization	-0.40	-0.26	-0.06	0.17	0.39	0.59	0.71	0.74	0.68	0.58	0.46	0.36	0.29
Inventories	0.58	0.62	0.58	0.47	0.30	0.08	-0.14	-0.29	-0.37	-0.4	-0.38	-0.34	-0.29
Production level	-0.67	-0.58	-0.42	-0.17	0.11	0.38	0.57	0.66	0.64	0.57	0.48	0.38	0.30
Order-book level	-0.67	-0.61	-0.46	-0.21	0.08	0.34	0.57	0.68	0.69	0.62	0.53	0.42	0.34
Production expectations	-0.52	-0.50	-0.42	-0.26	-0.03	0.23	0.45	0.57	0.60	0.54	0.44	0.32	0.22
Confidence climate	-0.67	-0.64	-0.52	-0.32	-0.04	0.26	0.50	0.63	0.66	0.61	0.52	0.41	0.31

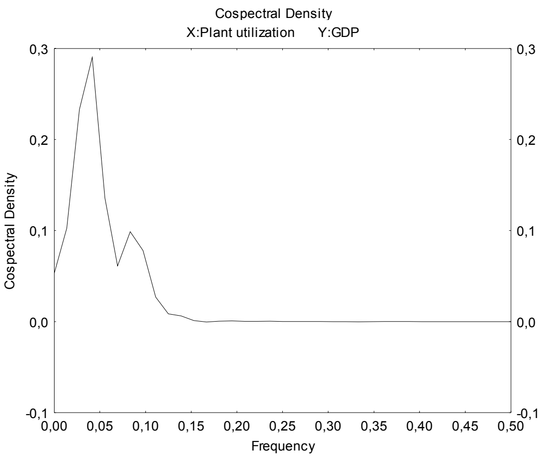
Tab. 5 Cross-correlations of each indicator with the Industrial production index Period 1986Q1-2003Q4

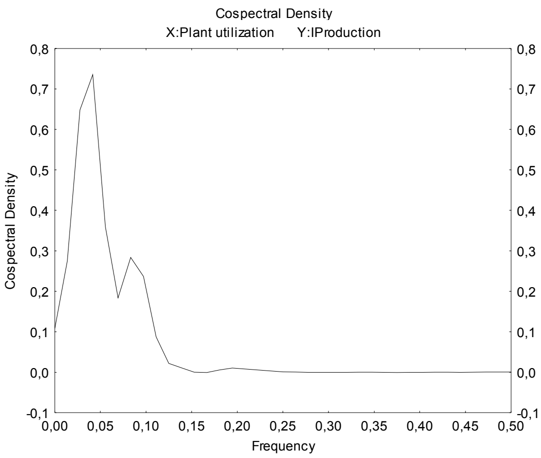
SERIES	Industrial production												
	t-6	t-5	t-4	t-3	t-2	t-1	t	t+1	t+2	t+3	t+4	t+5	t+6
Plant utilization	-0.08	0.06	0.25	0.46	0.66	0.79	0.85	0.81	0.67	0.47	0.28	0.12	0.00
Inventories	0.53	0.55	0.46	0.30	0.08	-017	-0.40	-0.56	-0.63	-0.60	-0.51	-0.38	-0.27
Production level	-0.45	-0.34	-0.14	0.12	0.42	0.68	0.84	0.87	0.77	0.60	0.40	0.22	0.10
Order-book level	-0.48	-0.38	-0.20	0.07	0.37	0.64	0.83	0.88	0.81	0.65	0.45	0.26	0.12
Production expectations	-0.36	-0.32	-0.23	-0.06	0.19	0.46	0.66	0.75	0.71	0.59	0.41	0.21	0.04
Confidence climate	-0.45	-0.39	-0.23	0.01	0.3	0.58	0.77	0.86	0.82	0.69	0.49	0.29	0.12

The sensitivity analysis reveals the existence of significant differences in the Business Survey indicators' cyclical properties with respect to the different reference business cycles. The empirical results apparently suggest that, for the degree of plant utilization, production expectations and order-book levels, the phase shift seems higher with respect to the GDP cyclical component than to industrial production. Admittedly, the cross-correlation results depend on the sample periods. Nevertheless, consistent estimates are also obtained for slightly different ones.[9]

In what follows, the results of the bivariate spectral analysis are reported. In particular, the cross-spectrum, coherence, phase and amplitude of each survey indicator is hereafter considered with respect to the business cycle. The sample runs from 1986q1 to 2003q4. Periodicity is reported in quarters. Coherence, phase and amplitude are evaluated for the periodicities ranging from 1.5 to 9 years, corresponding to frequencies that may be associated with business cycle fluctuations. The same Survey variables as in the previous section are considered, while both GDP and the industrial production index are used as reference business cycles.

Fig. 7 **Bivariate analysis-Degree of plant utilization**





Tab. 6 **Degree of plant utilization**

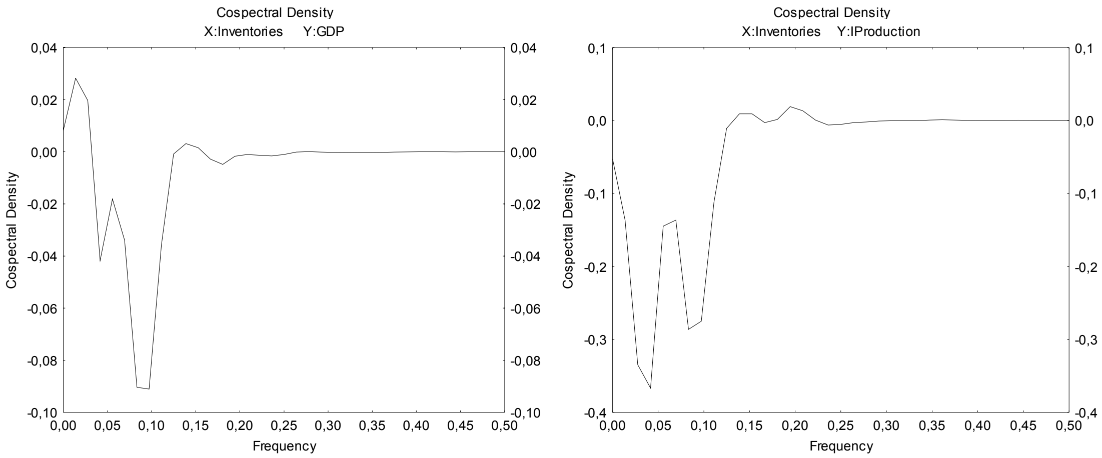
Frequency	Period	GDP			Industrial production		
		coherence	phase	amplitude	coherence	phase	amplitude
0.027778	36.00	0.869625	0.63712	0.297072	0.968304	0.04397	0.670757
0.041667	24.00	0.817637	0.51873	0.341629	0.926193	0.12926	0.760677
0.055556	18.00	0.622253	0.54935	0.162952	0.773865	0.23425	0.375555
0.069444	14.40	0.485704	0.31547	0.063810	0.669223	0.07416	0.179688
0.083333	12.00	0.832261	-0.04895	0.096829	0.903173	-0.10333	0.269473
0.097222	10.29	0.837214	-0.17082	0.077698	0.921055	-0.12695	0.224133
0.111111	9.00	0.651031	-0.21608	0.027323	0.813901	-0.08620	0.083260
0.125000	8.00	0.440250	-0.04564	0.008678	0.585053	0.15346	0.022752
0.138889	7.20	0.427342	-0.22184	0.006416	0.385946	0.17934	0.012245
0.152778	6.54	0.047108	-0.59948	0.001488	0.037124	0.61363	0.002560
0.166667	6.00	0.121863	1.97809	0.001364	0.078896	1.63943	0.002070

9 The results are not reported for brevity reasons.

Fig. 7 shows that the highest peak in the cross-spectral density of the degree of plant utilization corresponds to 6 years. This is the case when both GDP and industrial production are considered as reference business cycles. A peak of 3 years is also present (although it is less important). Table 6 reports the coherence, phase and amplitude of the degree of plant utilization with respect to GDP and industrial production.

In regard to coherence with respect to the GDP, the strongest correlation at business cycle frequencies occurs at 9 (87%), 6 (82%), 3 (83%) and 2.6 (84%) years' waves. The highest coherence with respect to industrial production occurs at frequencies corresponding to cycles of 2.8, 3, 6 and 9 years. The phase analysis indicates that the leading frequencies are those that correspond to the cycles between 1.6 and 3 years in length with respect to GDP and those within the range (2.2- 3) years with respect to industrial production.

Fig. 8 Bivariate analysis-Inventories

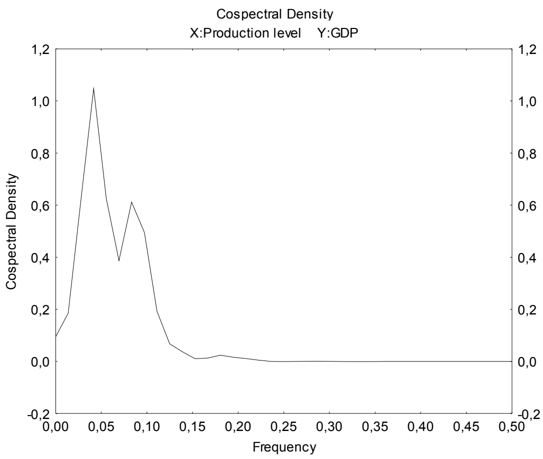


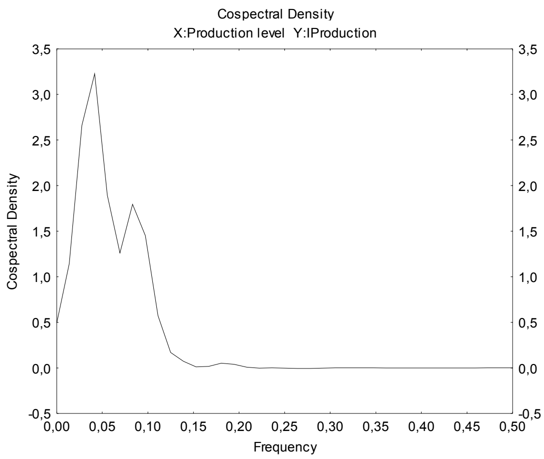
Tab. 7 Inventories

Frequency	Period	GDP			Industrial production		
		coherence	phase	amplitude	coherence	phase	amplitude
0.027778	36.00	0.764655	-1.50066	0.305843	0.969701	-2.06917	0.736968
0.041667	24.00	0.700246	-1.68475	0.364510	0.867890	-2.04719	0.848967
0.055556	18.00	0.382379	-1.68142	0.164808	0.533277	-1.97154	0.402228
0.069444	14.40	0.247604	-2.00256	0.079622	0.349108	-2.21636	0.226809
0.083333	12.00	0.625121	-2.24390	0.142650	0.686281	-2.31891	0.399296
0.097222	10.29	0.687776	-2.46045	0.114899	0.810741	-2.43254	0.343085
0.111111	9.00	0.479255	-2.68121	0.038549	0.661471	-2.57332	0.123426
0.125000	8.00	0.002928	1.67669	0.001093	0.018752	3.13117	0.006288
0.138889	7.20	0.121811	0.58709	0.004464	0.172495	0.54830	0.010668
0.152778	6.54	0.058595	0.46990	0.003003	0.101383	0.31067	0.007655
0.166667	6.00	0.053912	-1.69367	0.002101	0.006817	-1.82903	0.001409

Looking at the graphs in Fig. 8, one observes two peaks in the inventories' co-spectral density corresponding to 6 and 3 years respectively. This result is also confirmed by the cross-amplitude and holds with respect to both the whole economy and the industrial production business cycle. The coherence function indicates that the shape of the signal coming from inventories is closer to the industrial production cyclical component. At business cycle frequencies from 2.2 to 9 years, coherence ranges from 25% to 76% with respect to the GDP cyclical frequencies. For periods shorter than 2.2 years, the coherence is very low and close to zero. With respect to industrial production, coherence ranges from 35% to 97% for the cycles of between 2.2 and 9 years duration. The phase also indicates that this variable is leading at low frequencies with respect to both GDP and industrial production.

Fig. 9 **Bivariate analysis-Production level**





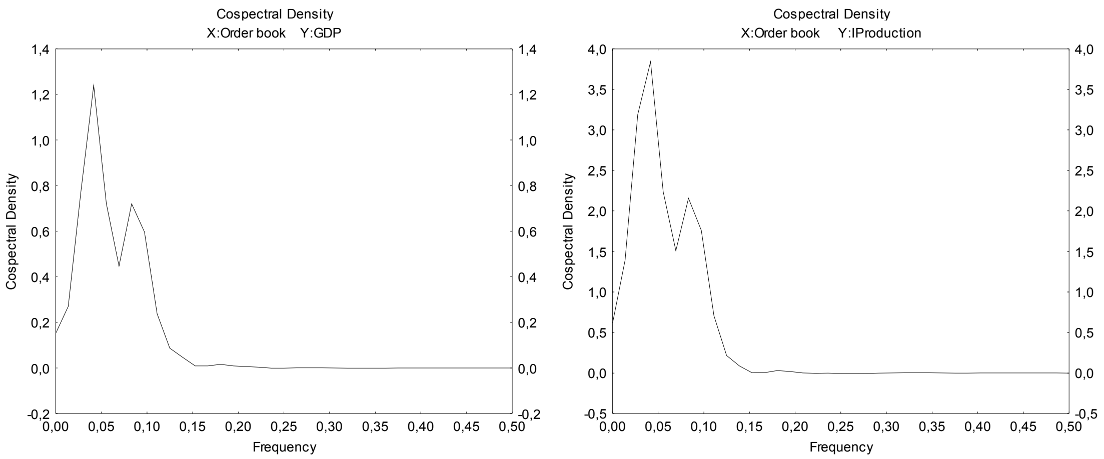
Tab. 8 **Production level**

Frequency	Period	GDP			Industrial production		
		coherence	phase	amplitude	coherence	phase	amplitude
0.027778	36.00	0.834002	1.09121	1.365914	0.976994	0.50802	3.163364
0.041667	24.00	0.868258	0.88775	1.690767	0.993816	0.49714	3.784314
0.055556	18.00	0.867812	0.87681	0.993503	0.980753	0.49914	2.182733
0.069444	14.40	0.744306	0.63419	0.474498	0.919431	0.32870	1.265162
0.083333	12.00	0.885176	0.22042	0.612909	0.957952	0.16252	1.703369
0.097222	10.29	0.893279	0.11416	0.487948	0.951053	0.15055	1.384687
0.111111	9.00	0.769723	0.06121	0.189543	0.899716	0.14558	0.558492
0.125000	8.00	0.548695	-0.16579	0.069268	0.736977	-0.02613	0.182566
0.138889	7.20	0.618103	-0.41850	0.040783	0.645193	-0.16467	0.083676
0.152778	6.54	0.244300	-0.70978	0.013637	0.105069	-0.30505	0.017332
0.166667	6.00	0.159970	-0.85595	0.008265	0.087719	-1.79678	0.011540

Regards to production level, the cross-amplitude analysis reveals the existence of a common periodicity corresponding to 6 and 3 years with respect to both GDP and industrial production.

The production level coherence function with industrial production is higher with respect to GDP at each frequency. More in detail, the frequencies corresponding to cycles of 2.6, 3, 4.5 and 6 years' length with respect to GDP show the highest coherence (from 87% to 89%). With respect to industrial production, the highest coherences (from 95% to 99%) are associated with periods of 2.6, 3, 4.5, 6 and 9 years. This variable leads both the GDP and industrial production only through very short cycles between 1.5 and 2 years length.

Fig. 10 **Bivariate analysis-Order-book levels**

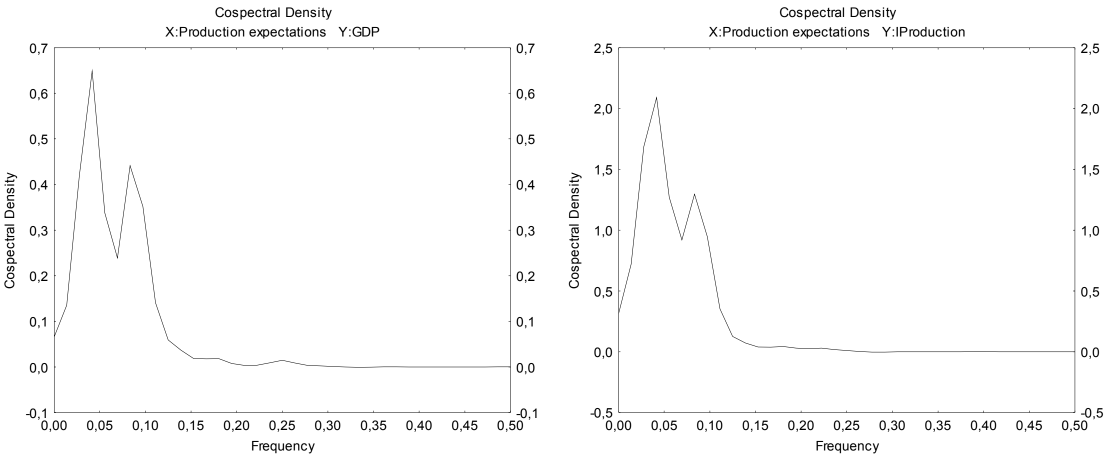


Tab. 9 **Order-book level**

Frequency	Period	GDP			Industrial production		
		coherence	phase	amplitude	coherence	phase	amplitude
0.027778	36.00	0.886296	1.09058	1.707550	0.974937	0.52412	3.832092
0.041667	24.00	0.904360	0.93721	2.131784	0.992577	0.55542	4.672282
0.055556	18.00	0.879264	0.93608	1.235293	0.980520	0.57417	2.695897
0.069444	14.40	0.761934	0.73593	0.594974	0.933102	0.44382	1.579546
0.083333	12.00	0.866653	0.35850	0.751837	0.953243	0.29720	2.106487
0.097222	10.29	0.868530	0.21806	0.598514	0.943954	0.25436	1.716039
0.111111	9.00	0.762988	0.10855	0.235682	0.897881	0.20139	0.696788
0.125000	8.00	0.561752	-0.16167	0.089335	0.733338	-0.01762	0.232129
0.138889	7.20	0.488722	-0.28006	0.050157	0.507432	-0.02414	0.102635
0.152778	6.54	0.075904	-0.34894	0.011256	0.051078	0.56344	0.017894
0.166667	6.00	0.057297	-0.54525	0.005354	0.024552	-1.94221	0.006608

Observing the graphs for order-book levels, two peaks of the co-spectrum are noticed corresponding to 3 and 6 years with respect to both industrial production and GDP, explaining most of the variance. The order-book coherence is higher with respect to industrial production than to GDP at each frequency. With respect to GDP, the highest correlation (90%) occurs at 0.05 frequency, corresponding to 6 years. With respect to industrial production, the highest correlation (99%) also occurs at 6 years wave. Similarly to the previous case, this indicator leads both GDP and industrial production only at very high frequencies, particularly at business cycle frequencies within 1.5 and 2 years.

Fig. 11 Bivariate analysis-Production expectations



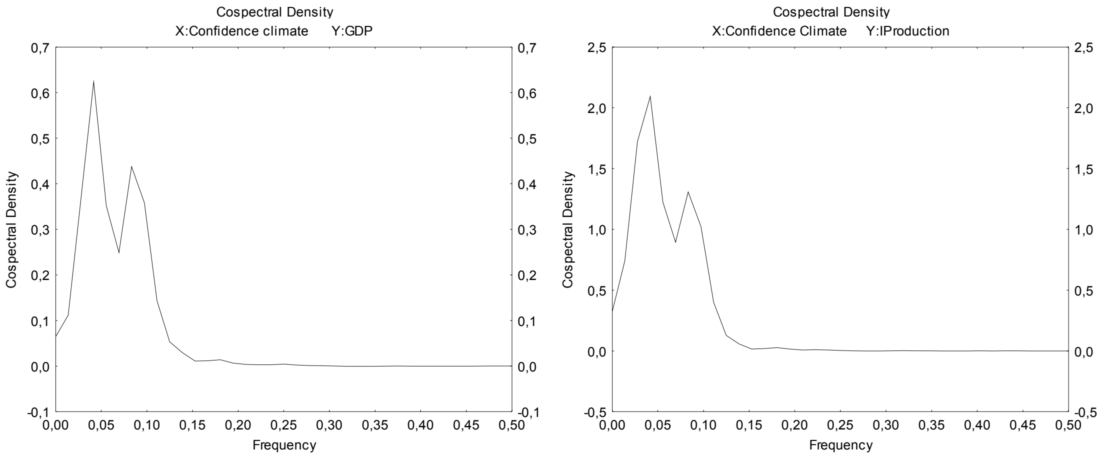
Tab. 10 Production expectations

Frequency	Period	GDP			Industrial production		
		coherence	phase	amplitude	coherence	phase	amplitude
0.027778	36.00	0.888264	1.07486	0.899570	0.966207	0.50857	2.007533
0.041667	24.00	0.870483	0.96062	1.154978	0.969507	0.56525	2.550021
0.055556	18.00	0.791617	1.06708	0.715088	0.937443	0.65485	1.608196
0.069444	14.40	0.743644	0.93989	0.399393	0.914462	0.62149	1.062500
0.083333	12.00	0.918645	0.62038	0.529444	0.940189	0.56092	1.430901
0.097222	10.29	0.935770	0.60759	0.417503	0.908424	0.64714	1.131328
0.111111	9.00	0.845499	0.59777	0.166775	0.831841	0.67368	0.450836
0.125000	8.00	0.608227	0.29939	0.062981	0.706012	0.40114	0.154316
0.138889	7.20	0.698379	-0.06100	0.036922	0.790648	0.15922	0.078894
0.152778	6.54	0.484585	-0.02289	0.016154	0.528757	0.07827	0.032702
0.166667	6.00	0.405600	0.43597	0.011981	0.276520	-0.08751	0.018653

Looking at the bivariate spectral density in Fig. 11, production expectations exhibit a common periodicity of 6 and 3 years with respect to the whole economy and to the manufacturing business cycle. Considering the business cycle frequencies, the coherence is maximum at 2.2, 3, 6 years and 9 years with respect to GDP and at 3, 4.5, 6 and 9 years with respect to the industrial production reference cycle. This indicator is lagging with respect to both GDP and industrial production at all business cycle frequencies within the range (1.6-9 years).

These results are apparently in contrast with the leading properties evidenced in the cross-correlation results. This is due to the fact that this cyclical indicator, like most of the others, leads the business cycle only at very high frequencies (cycles shorter then 1.6 years length).

Fig. 12 Bivariate analysis - Confidence climate indicator



Tab. 11 Confidence climate indicator

Frequency	Period	GDP			Industrial production		
		coherence	phase	amplitude	coherence	phase	amplitude
0.027778	36.00	0.874162	1.17906	0.974137	0.978670	0.62144	2.205492
0.041667	24.00	0.887133	1.02939	1.231724	0.990607	0.65073	2.722978
0.055556	18.00	0.846409	1.04996	0.718784	0.977555	0.68168	1.596407
0.069444	14.40	0.777699	0.86433	0.378265	0.960803	0.57460	1.008638
0.083333	12.00	0.921146	0.55369	0.502652	0.979746	0.48696	1.384891
0.097222	10.29	0.923122	0.46058	0.391070	0.961767	0.48846	1.097815
0.111111	9.00	0.796847	0.36170	0.150349	0.880606	0.43529	0.430753
0.125000	8.00	0.540354	-0.02789	0.053704	0.697052	0.10139	0.138716
0.138889	7.20	0.610822	-0.36122	0.031690	0.631880	-0.11742	0.064728
0.152778	6.54	0.236512	-0.47152	0.010913	0.153896	-0.20207	0.017060
0.166667	6.00	0.193340	0.12620	0.006967	0.105388	-0.58666	0.009698

As in the previous cases, the cross-spectral density evaluation of the confidence climate indicator reveals the existence of two peaks occurring at 6 and 3 years' periodicity with respect to both GDP and industrial production. This result is confirmed on looking at the cross-amplitude. Considering industrial production, the coherence is very high at 6 years periodicity (about 99%). With respect to GDP, the frequency with the highest correlation (about 92%)

corresponds to roughly 2.6 years. As regards the phase shift, the confidence climate indicator is lagging with respect to both GDP and industrial production at almost all business cycle frequencies. In this case, too, the variable is leading but only at high business cycle frequencies (from 1.6 to 2 years with respect to GDP and from 1.6 to 1.8 years with respect to industrial production).

The bivariate spectral analysis has provided evidence of common periodicities between each cyclical indicator and the benchmark business cycle corresponding to cycles of 3 and 6 years' length in the sample 1986-03. The coherence analysis suggests that, overall, the cyclical waves characterizing each survey indicator are more similar in terms of their shapes to the industrial production cyclical component. The phase effect also reveals that the survey indicator frequencies that lead the GDP are sometimes different from those leading the industrial production cyclical component. In any case, the survey data predictive ability is associated with high business cycle frequencies (less then two/three years).

4 CONCLUDING REMARKS

This paper provides some evidence on the cyclical properties of the main Italian Manufacturing Business Survey data.

The focus has been on analyzing the similarities and differences between the cyclical dynamics displayed by each survey variable with respect to those produced by the whole economy and industrial business cycles. To this end, both time domain techniques and frequency domain instruments have been used.

The findings from the univariate analysis reveal a volatility reduction in all Business Survey variables and a convergence in the length of waves explaining most of the Survey data variability over the years.

As regards bivariate techniques, time domain analysis provides evidence of a significant correlation between most of the survey data and the benchmark business cycles. The bivariate spectral analysis reveals the existence of common periodicities between each cyclical indicator and the benchmark business cycle corresponding to 3 and 6 years. Nevertheless, the predictive power of survey data is focalized at very short cycles (less then two/three years).

The leading properties of most Italian Business Survey data with respect to GDP and industrial production are thus confirmed, although they appear mainly determined by high business cycle frequencies.

APPENDIX: DEFINITIONS AND DATA SOURCES

The variables used in the analysis come from periodic manufacturing Business Surveys carried out by ISAE (Institute for Studies and Economic Analyses) and are defined as follows:

The degree of plant utilization displays quarterly frequency and is available from 1970.

The production level displays monthly frequency and is available from 1970.

Production expectations display monthly frequency and give a qualitative indication of production level evolution in the next three months. The indicator is available from 1970.

Inventories have monthly frequency . The indicator is available from 1970.

The order-book level has monthly frequency and is available from 1970.

The confidence climate indicator is obtained as a simple mean of production expectations, order books and inventories. This indicator is available from 1970.

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