

## **Report of the Working Group on Economic Indicators**

Dr. Y.V.Reddy  
Deputy Governor  
Reserve Bank of India  
Central Office  
Mumbai 400 001

Dear Sir,

Sub: Report of the Working Group on Economic Indicators

We are pleased to submit the Report of the Working Group on Economic Indicators appointed vide the RBI memorandum dated October 10, 2001.

Yours faithfully,

Sd/-  
(Prof.Dilip Nachane)  
Member

Sd/-  
(Prof.M.J.Manohar Rao)  
Member

Sd/-  
(Dr.S.L.Shetty)  
Member

Sd/-  
(Sh.Saumitra Chaudhuri)  
Member

Sd/-  
(Dr.Ila Patnaik)  
Member

Sd/-  
(Dr.R.B.Barman)  
Convenor

June 28, 2002

## CONTENTS

<i>Section</i>	<i>Topic</i>
Executive Summary	
Section I	Introduction
Section II	Definition, Scope, Coverage and Methodological Issues
Section III	Economic Indicators: The Indian Context
Section IV	Measuring Capacity Utilisation: Concepts and Methodological Issues
Section V	Recommendations of the Working Group

### **APPENDIX**

Appendix 1	Memorandum: Working Group on Economic Indicators
Appendix 2	Compilation of Composite Index of Leading Indicators for India: An Illustrative Exercise
Appendix 3	Illustrative List of Cyclical Indicators
<i>References</i>	

## Executive Summary

In the light of the changing nature of Indian economy where more and more activities are being channelised through the organised business sector, business cycle analysis is of paramount importance. There is an urgent need to strengthen of information base on business cycle indicators, test various theories of business cycles in the Indian context and determine the reference cycle peaks and troughs thereby dating the expansionary and recessionary phases of the economy.

In view of the predominant role of weather and the lower role of interplay of market forces in determining the level of agricultural output, the non-agricultural GDP (in real terms) with quarterly frequency can be considered as the appropriate main reference series for business cycle analysis in India. However, Indian economy is continually evolving and is far too complex to be summarised by a single series, and therefore, in addition to the main reference series, it is also necessary to look at other major activity variables like private consumption, industrial production and private corporate sales for determining the reference cycle turning points.

Agricultural output has a strong influence on the aggregate demand but leading indicators for industrial and services output are not appropriate for predicting movements in agricultural output. In view of this, the methodology for forecasting fluctuations in agricultural output may be different from those for rest of the activities.

A majority of conventional business cycle indicators used in developed economies are not being used as information variables in India. The back period estimates of GDP for major activity sectors and private final consumption expenditure with consistent methodology on a quarterly basis at least since 1970-71 are necessary to facilitate studies in this area. Improvements in the database relating to business cycle analysis such as urban housing starts, organized employment, manufacturing and retail inventories, capacity utilization, consumer confidence, consumer loans, etc., are also necessary. The present information base on fiscal and financial sector variables can be explored for their possible use as leading indicators.

In view of the data limitations, it would be appropriate to implement some sort of trend-through-peaks or filtering based method for estimating of capacity utilization. The RBI may examine the methodological aspects to bring out quarterly series on capacity utilization in major industries and also the estimates of potential output and output gap on a quarterly basis.

The results of RBI's Industrial Outlook Survey are likely to be useful for business cycle analysis and for short-term economic forecasting using leading indicators approach. For this purpose, the survey design needs to be further improved, the time lag and the non-response factors are to be reduced and survey results should be published.

Research on business cycle in the Indian context has been scanty and generally confined to empirical aspects. For a better understanding of the phenomenon, it is necessary to promote research on theoretical aspects, including testing of competing paradigms on business cycle. The role of agricultural output, the changing character of propagation mechanism, the role of stock price, the transmission of international business cycle, the impulse responses emanating from macroeconomic policy variables such as interest rates, money supply, Govt. expenditure, etc., are very different from the phenomenon observed in developed industrial economies and, therefore, necessitate a hybrid approach in the Indian case.

Given the complexity of the issues involved, it would be most appropriate that the Reserve Bank, which has both technical skills and resources, plays a pivotal role in this area by making in-house efforts as well as by supporting outside institutions and individual researchers for pursuing further work in this area. Considering that substantial efforts are necessary to develop a system of leading indicators in India, the Reserve Bank could undertake these exercises initially and once the system gets reasonably developed, it can support a competent independent non-profit body to undertake the task. *Annual Conference on Business Cycles in*

*India* may also be held by the RBI in collaborations with research institutions and participation by institutions as well as individual researchers in the area.

A *Standing Committee for Business Cycle Analysis in India* may be constituted that can be entrusted with the responsibility of historical dating of business cycles in India and regular monitoring of economic time series and taking a view on the state of the economy. The proposed Standing Committee can also be made responsible for development of methodologies for issues such as combination of quantitative and qualitative data for composite leading indicators of business cycles, diffusion indices, dealing with seasonality, provisional first estimates, and give suggestions on further strengthening of database for work related to business cycles and related issues.

# Report of the Working Group on Economic Indicators

## Section – I

### Introduction

#### I.1 Genesis of the Committee

1.1 In view of the recent changes in the Indian economy with increasing openness and market orientation, it was felt necessary to examine the present information base for the analysis of business cycles, explore the leading indicators approach of forecasting and to suggest measures for strengthening the information base in order to facilitate the study of business cycles.

1.2 Accordingly, the Reserve Bank of India constituted the present Working Group through a Memorandum dated October 10, 2001 (Appendix 1). The composition of the Working Group is given below:

- |    |   |          |
|----|---|----------|
| 1. | Dr. R.B. Barman<br>Executive Director<br>Reserve Bank of India  | Convenor |
| 2. | Professor Dilip Nachane<br>Department of Economics,<br>University of Mumbai,<br>Vidyanagari Marg,<br>Mumbai – 400 098   | Member   |
| 3. | Professor M.J.Manohar Rao<br>Department of Economics,<br>University of Mumbai,<br>Vidyanagari Marg,<br>Mumbai – 400 098 | Member   |
| 4. | Dr. S.L. Shetty<br>Director,<br>EPW Research Foundation,<br>Mumbai – 400 101  | Member   |
| 5. | Shri Saumitra Chaudhuri<br>Economic Advisor & Research Co-ordinator<br>ICRA Limited<br>New Delhi – 110 001              | Member   |
| 6. | Dr. Ila Patnaik<br>National Council of Applied Economic Research<br>11, Indraprastha Estate,<br>New Delhi – 110 002     | Member   |

## **I.2 Terms of Reference**

1.3 The terms of reference of the Working Group were:

- (i) To suggest methodology for studying business cycles in the Indian context;
- (ii) To suggest methodology for working out composite leading, coincident and lagging indicator;
- (iii) To suggest ways for improving information base relevant for leading indicators of economic activity, including appropriate surveys on inventories at the level of manufacturers and distributors;
- (iv) To examine the feasibility of studies on capacity utilisation in major industries;
- (v) To consider any other related matter/s.

1.4 The memorandum authorised the Working Group to co-opt any other person/s for specific deliberations. The Working Group co-opted resource persons from the Department of Economic Analysis and Policy (DEAP), Department of Statistical Analysis and Computer Services (DESACS) and Monetary Policy Department (MPD) of the Reserve Bank of India.

## **I.3 Business Cycles in India and Leading Indicators**

1.5 Macroeconomic policies give crucial importance to the phase of business cycle, viz., whether the economy is in expansionary phase or is in a recessionary phase. An early recognition of economic recession is necessary for introducing countercyclical stabilisation policies. The curiosity to know about the stage of business cycle has led to the development of leading indicator approach. The leading indicator approach of forecasting turning points involves finding repetitive sequences of alternating phases of expansions and contractions in aggregate economic activity for identifying and forecasting emerging stages of business cycles. This approach uses the series of economic variables, which tend to lead, coincide with or lag behind the movements of aggregate economic activity.

1.6 Business cycle analysis is widely used in the developed economies where most of the activities are channelised through the organised sector. The availability of national accounts aggregates and other relevant variables on a quarterly basis for a long time-period facilitate such analysis. With the surge in economic activities, and more so in the business activities, there is increasing relevance of business cycles analysis in India. In the light of changing structure of the Indian economy and its increased openness and market orientation, the need for business cycle analysis is more relevant than ever before both for analysing the current state of the economy and the alternate policy measures and also for analysing how policy actions are transmitted to activity levels.

1.7 The Working Group strongly felt that business cycle analysis is of paramount importance in the light of the changing nature of Indian economy where more and more activities are being channelised through the organised business sector. There is an urgent need to strengthen of information base on business cycle indicators, test various theories of business cycles in the Indian context and determine the reference cycle peaks and troughs thereby dating the expansionary and recessionary phases of the economy. The Working Group is of the view that, given the complexity of the issues involved, it would be most appropriate that the Reserve Bank of India, which has both technical skills and resources, needs to play a pivotal role in this area. The Reserve Bank could make in-house efforts as well as support outside institutions and individual researchers for pursuing further work in this area. However, considering that substantial efforts are necessary to develop a system of leading indicators in India, the Group

suggests that these exercises could be undertaken initially by the RBI and once the system gets reasonably developed it can support a competent independent non-profit body to undertake the task.

#### **I.4 Scheme of the Report**

1.8 The Group deliberated on several issues in this context during the three meetings held in Mumbai. Based on these deliberations and the background work undertaken it finalised this Report at its third meeting. This report is organised in five main sections. Section II discusses the definition, scope, coverage and methodological issues relating to business cycle analysis. Section III discusses the availability and limitations of relevant economic indicators in the Indian context. It also discusses the further efforts to be made to aid the development of reliable coincident, leading and lagging indicators for Indian economy. Section IV focuses on the methodological aspects of preparing estimates of capacity utilisation in major industries. Section V presents the major recommendations of the Working Group. In addition, the Report has three Appendices. Appendix 1 provides the memorandum on constitution of the Working Group. Appendix 2 presents the results of an illustrative exercise of constructing an index of leading indicators for monthly / quarterly Index of Industrial Production (IIP) which is taken as proxy reference series. Appendix 3 presents an illustrative list of business cycle indicators commonly used in developed countries.

#### **I.5 Acknowledgements**

1.9 The Working Group co-opted Dr. Balwant Singh, Dr.A.S.Ramasastri and Dr.Mridul Sagar of the RBI who made valuable contributions in the deliberations. Dr.O.P.Mall joined as a part of the team of experts at the final stages and shouldered the important responsibility of preparing the draft report for the final meeting. The Working Group also places on record its appreciation for the secretariat support and also for their contribution in preparation of various approach papers, the presentation of RBI's Industrial Outlook Survey, the empirical exercise and the preparation of the report by the RBI team consisting of Shri Deepak Mathur, Dr.G.P.Samanta, Dr.Kaushik Bhattacharya, Dr.Sharmishtha Mitra, Shri Samarjit Das and Shri Gopal Joshi.

## Section – II

### Definition, Scope, Coverage and Methodological Issues

#### II.1 Definition

2.1 Business cycles are recurrent sequences of alternating phases of expansion and contraction in overall economic activity and its major sectors and in processes like output, employment, income, consumption, trading, etc. The National Bureau of Economic Research (NBER) dates classical business cycle peaks and troughs on identification and analysis of the clusters of peaks and troughs in such series marking the end of expansionary and contractionary phases (Zarnowitz, 1992). The following classical Burns and Mitchell (1946) definition is the most widely accepted definition of Business Cycle:

"Business cycles are a type of fluctuations found in the aggregate economic activity of nations that organise their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities followed by similarly general recessions, contractions and reviv-als that merge into the expansionary phase of the next cycle; this sequence of change is recurrent but not periodic. In dura-tion, business cycles vary from more than a year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own."

2.2 Recent empirical research on business cycles devotes more attention to long-term trend adjusted time series. Business cycles when defined as alternating sequences of high and low growth phases (rather than expansion and contraction in the levels of general economic activity) require trend estimation and estimation the cyclical components by trend elimination. These are termed as growth cycles (deviation from the long-run trend) [Canova (1998)].

2.3 Another way of looking at economic cycles is by observing the phases of high and low growth in the relevant series and such movements are known as growth rate cycles (cycles in terms of growth rates in a series). Difference cycles (cycles in terms of the k-th difference of the reference series) are also available in the literature [Mitchell (1951), Moore (1961), Mintz (1967), Moore and Zarnowitz (1986), and others].

2.4 Economic indicators serve as general tools for business condition analysis and prediction. Information regarding the current state of the economy can be captured through a host of variables, which are directly or indirectly, associated with the overall economic activity. Under the system of cyclical indicators, cyclical changes especially the turning points of economic cycles in the aggregate economy are used to monitor and confirm cyclical changes. These variables could be classified as coincident, leading or lagging variables. Selection of cyclical indicators are generally based on economic significance, statistical adequacy, timing at recessions and revivals, conformity to historically business cycles, smoothness of the series and timeliness.

2.5 A coincident indicator is a variable, the movement of whose cyclical component is synchronous with the movement in the cyclical component of the "reference series" (the economic variable whose cyclical movements are intended to be studied, e.g., the Real GDP) and the turning points (peak / trough) roughly coincide. The comovement of the coincident indicators is itself an essential characteristic of the business cycle.

2.6 Business cycles differ across a wide spectrum of variables and many economic time series register their turning points prior to the turning points of the corresponding business cycle. These



series are called leading indicators. Thus, a leading indicator is a variable with meaningful economic linkage to the reference series whose turning points precede the turning points of the reference series / coincident indicator(s). The flow and price variables that are highly sensitive to the overall cyclical influences are among major leading indicators.

2.7 A lagging indicator is the variable that is related to and whose turning points are observed after the reference series / coincident indicator turning points. Lagging indicators are generally studied for confirmation of cyclical turning points to check for false signals. Many of the lagging indicators are large stock variables and unemployment /wage related variables that have smoother cycles than the coincident and leading indicators.

2.8 To provide a more rigorous definition of coincident and leading indicators of economic activity (CLIEA) is, however, not easy. In any economy, the activities could be multi-dimensional, consisting of myriad aspects that change shape continuously over time. When the markets are neither efficient nor fully integrated, it is advisable to use multiple economic indicators for describing the level of aggregate economic activity. Information content of these 'indicators' could be, in principle, summarized into a composite index.

2.9 Defined in this way, an index of coincident indicators helps in assessing the current state of economic activity, while that consisting of leading indicators help assessing its future trajectory. In particular, the index of leading indicators attempts to find out whether or to what extent are there tendencies that the economy would be in a state of boom or recession.

2.10 Initial attempts in the construction of coincident and leading indicators of economic activity (CLIEA) were made after the great depression in the US economy during the mid-1930s. The approach owes its origin to the seminal contributions of Wesley Mitchell and Arthur Burns, Simon Kuznets, Julius Shiskin, Geoffrey Moore and others of the National Bureau of Economic Research (NBER) of the US. Burns and Mitchell (1946) made extensive use of macroeconomic and retail level data to study and predict waves of economic expansion and contraction. Shiskin and Moore (1968) prepared composite indices of Leading, Coincident and Lagging Indicators for the US Economy. During the early years of development, the main emphasis in the literature was on predicting the turning points of business cycles. Over the years, in addition to NBER approach, a few other approaches have also been developed, refined and applied. At present, besides the state of economic activities, applications of CLIEAs for an economy cover a broad spectrum, e.g., inflation rate, exchange rate, currency crisis, demand for specific products (e.g., automobiles), etc.

## **II.2 Scope and Coverage**

2.11 To construct coincident and leading indicators, one has to address a multitude of issues, like, (i) definition of economic activity, (ii) purpose of the coincident and leading indicators, (iii) selection process of the individual series to be included in the indicators, etc., besides the selection of appropriate statistical methodology for summarizing the information in several series into a single index and specification of norms for assessing the empirical performance of the constructed index, which will be taken up subsequently.

2.12 As discussed earlier, an appropriate definition of economic activity is difficult. Burns and Mitchell (1946) proposed that coincident indicators are synchronous with "reference cycle". However, the definition, somewhat intuitive, lacked a precise mathematical as well as empirical content. The difficulty comes in defining 'economic activity' precisely as it covers production, employment, consumption, trading, investment and other activities. In the empirical literature,

real GDP is a widely accepted measure of the overall economic activity and is often taken as the reference series. "... a recession is widely regarded as a period of prolonged decline in output experienced across much of the economy. To be more concrete, commentators often consider a recession to be in progress when total output (real gross domestic product) has declined for at least two consecutive quarters." (Osborn et al). Thus real quarterly GDP (QGDP) is generally accepted as a measure of economic activity and a 'benchmark'.

2.13 Diffusion indices measure the proportion of a set of indicators that are rising are useful in finding the spread of business cycle.

2.14 Economic activity reference series generally exhibit a cyclical pattern characterized by reasonably good number of turning points due to the interplay of market forces. The distances between the peak and trough turning points are generally not uniform and strong dominance of trend or seasonality in a series often leads to difficulties in identifying a cycle. Trends or seasonalities could be additive or multiplicative, stationary or non-stationary, deterministic or stochastic. In case, they are found to be present, it is essential to apply suitable transformation to the series to obtain a prominent cyclical pattern. As the tests for characterizing them often lack good statistical power, their empirical choice of a specific form also requires in-depth knowledge and the movements in other related variables.

2.15 The leading indicator approach is sometimes confined to assess the changes in the broad direction of a series, i.e., covering turning points and sometimes it is more specific in nature, e.g., forecasting the exact magnitude. However, the precise manner in which CLIEA analysis is carried out depends upon the purpose and the objective. The selection of variables depends on both these issues.

2.16 The turning point analysis tries to trace the cyclical movements in the target as well as the indicator series in terms of turning points. This involves juxtaposition of all major turning points of the reference series / coincident indicator(s) with other series. Point-by-point lead periods could be estimated from the average time gaps between peaks (or troughs) of reference series and the immediately preceding peak (or trough) of the leading indicator(s), while standard deviation of these gaps would indicate the reliability of the indicator.

2.17 The turning point analysis concentrates only on the relationship between peaks and troughs of different series and ignores the other observations. A slightly more rigorous approach is to observe the cross-correlations of different series with the reference series. While high cross-correlations often serve as reliable tools for a preliminary determination of the lead periods of different series with the reference series. Also, this approach utilizes all the observations pertaining to the reference series and the other series.

2.18 In the empirical literature, the long and variable lags through which one series begin to affect another are impediments in this process. This crucially depends on how the turning points (a peak or a trough) are defined. The turning point approach generally requires a long time series on variables that may not be available in many developing economies. Also, certain variables may indicate turning points in an economy precisely, but may not be useful for period-by-period point predictions. As the broad direction of the target variable around turning points is of crucial importance, the precise values of the forecasted variables is not insisted upon. Thus, the 'demand' on accuracy is far more less and is somewhat easy to meet. The point prediction, on the other hand, could be based on rigorous econometric models and can be evaluated by comparing the forecasted and the actual value.

2.19 The second important issue is to fix the forecast horizon. A composite indicator is said to be coincident when information of the series composing it upto time  $t$  is required to estimate economic activity at time  $t$ . A leading indicator, on the other hand, is said to be leading by  $k$  time periods, when information of the series composing it upto time  $t-k$  is required to forecast economic activity at time  $t$ . As different variables affect economic activity with different lags, selection of variables that would form the indicators is crucially dependent on it.

2.20 The leading indicator approach to macroeconomic forecasting is an alternative to the macroeconometric modelling approach and has certain advantages in terms of predicting power. Macroeconometric models typically involve quantitative analysis estimating a large number of parameters. Often, the data pertaining to the latest period used in such models are provisional and undergo substantial revisions at later stages and the latest information in a one or two series may not capture the extent of contemporaneous economic relationship. As a result, macroeconometric models – especially the large ones – have often been perceived as having limitations as their predictions of turning points often do not match closely with the actual. While the interest in constructing CLIEAs could be partly attributed to the limitations of econometric models, a major factor behind the popularity of the CLIEA approach is the development of theoretical foundations for the approach, the absence of which was a major criticism in the 1940s.

2.21 Also the time-series models that have strength in good projections of recent trends fail to give timely signals of broad changes in the economy around the turning points in major indicators. The leading indicator approach is often useful for a quick assessment of the current state of the economy. It could be based on data that are less likely to suffer from this problem and generally perform better in terms of forecasting ability especially around the turning points of business cycles where the reliability of short-term forecasts are very crucial.

### **II.3 Estimation of Business Cycles**

2.22 The selection of reference cycle turning point dates for the US is currently done by the NBER's Business Cycle Dating Committee. The actual selection of business cycle dates is not without its critics. However, the final selection of dates provides a framework for future analysis and forecasting. The empirical analysis at NBER involves hundreds of series.

2.23 The criteria for determining cycles as in Burns and Mitchell (1946) remain the benchmark of the traditional NBER method of determining cyclical turning points in a time series, distinguishing between specific and reference cycles. A specific cycle is a set of turning points observable in a particular series, in which the turns may or may not correspond to overall business cycle turning point dates. Specific turning points are selected based on some available algorithms. On the other hand, the basis for the reference cycle is to select turning point dates from a basket of economic indicators that represent the central tendency of a group of indicators reflecting aggregate supply and demand conditions. Thus, reference cycle chronology is based on the central tendency of individual turning points in the basket of coincident economic indicators.

2.24 Business cycle in the early NBER approach included the intra-cycle trend. Trend and cycles were believed to influence each other making their clear separation impossible and moving averages were preferred over time series models. However, it was later felt that the influence of trends and cycles on each other required further exploration for providing further insights into the mechanism of economic growth and for testing the related theories. This became more important in the era where economic expansions were interrupted by retardations rather than absolute declines in overall economic activity.

2.25 Several methods are available for detrending economic time series to estimate growth cycles. Zarnowitz and Ozyildirim (2002) argue that the Phase Average Trend (PAT) method is superior to other detrending methods in matters of details. The PAT method is approximated by connecting the mid-points of the mean values of phases determined according to the dates of cyclical peaks and troughs in the deviations of the series from its centred moving average.

2.26 Linear deterministic trend method is another method frequently used because of its simplicity but lacks precision. Nelson and Plosser (1982) argue that economic aggregates have no tendency to return to linear trends if they have difference stationary representation. Beveridge-Nelson method is one approach to estimate stochastic trend in time series.

2.27 Other commonly used method for fitting smooth trend is the Whittaker-Henderson Filter (known in economic literature as the Hodrick-Prescott Filter) which views the economic time series as the sum of growth component and the cyclical component and, for smoothness of growth component, the sum of square of the cyclical component and the sum of squared second difference of trend component is minimised. Band-Pass filter is an alternative method based on the frequency-domain analysis that decomposes series into trend, cycle and irregular components corresponding respectively to low, intermediate and high frequency parts of the spectrum. The method filters out all fluctuations at both low and high frequencies that are considered non-cyclical.

2.28 The Stock-Watson (SW) approach attempted to revise the indices of coincident and leading indicators using the tools of modern time series econometrics. Conceptually, SW specified a formal probability model that yielded the indices. In this way, they provided a concrete mathematical framework within which alternative variables and indices were evaluated. The SW approach also made the process of variable selection and the process of combining them into a single index more rigorous. Based on these developments, SW proposed three experimental indices for (i) Coincident Economic Indicators (CEI), (ii) Leading Economic Indicators (LEI) and (iii) Recession Index (RI).

2.29 The experimental CEI is an estimate of the value of a single unobserved variable – 'the state of the economy'. This unobserved variable is defined by assuming that the co-movements of observed coincident time series at all leads and lags arise solely from movements in it. The proposed LEI is the estimate of the growth of the unobserved factor over the next few periods, computed using a set of leading variables. The LEI in the SW approach is constructed by modelling the leading variables and the unobserved state of the economy as a vector autoregressive system (in terms of first differences) with some modifications. The parameters of coincident and leading models are estimated in two steps. In the first step, the parameters of the coincident model are estimated by maximum likelihood, where the Kalman Filter is also used to evaluate the likelihood function. In the second step, the leading model is estimated conditional on the estimated parameters of the coincident model. Technically, the entire model could be interpreted as a general state space model.

2.30 Simone (2001) has recently proposed an alternative approach for construction leading indicators based on specifying and estimating a small Autoregressive Distributed Lag (ADL) model of reference series (real GDP). Under this approach, a series that is individually cointegrated with real GDP is used as a starting point. Other series are added to the regression one at a time and the expanded vector is also tested for cointegration. The unrestricted models are tested to see if the contemporaneous variables could be eliminated in which case the unrestricted model is considered to be a candidate to construct a leading indicator. The several

models selected using this process are ranked according to the fit as well as out-of-sample forecast performance. Using the coefficients of the error correction mechanisms obtained in the estimation of the unrestricted models, the models selected in the third stage are written in the error correction form. Next, they are simplified using the general-to-specific modelling approach. Final model is chosen based on forecast accuracy. Given the limited database, this approach enjoys some advantage in the context of the developing countries.

## **II.4 Selection and Compilation of Leading Indicators**

2.31 A preliminary exercise in constructing CLIEAs generally involves exploring the relationship between the cyclical components of the reference series with a large number of other series perceived to be possible leading indicators.

2.32 The selection of individual candidate series to construct leading indicators follows certain steps. The first step is to prepare an exhaustive list and form a database of time series consisting of several variables. The second step is to classify the data series into a few important categories, each representing some general sectors where economic shocks can originate and propagate (e.g., real sector, government sector, financial sector, external sector etc.). The relative importance of variables among these categories would vary from country to country, depending upon its degree of openness and sectoral composition. The series with less than annual periodicity used for this purpose are often de-seasonalised by standard statistical techniques.

2.33 One approach to ascertain the lead-lag relationship is first finding out the cyclical components pertaining to any series which could be obtained through spectral analysis or other detrending / filtering methods. The plots of cyclical components of different series vis-à-vis the reference series gives a preliminary idea about the nature of pair-wise relationships. Statistical measures like cross-correlations at different lags can also be used to initially identify the possible lead periods of different series. Selected variables can be subjected to econometric procedures like Unit Root tests, Bivariate Granger Causality tests, Bivariate Cointegration tests etc. A series is discarded when its order of integration does not match the order of integration of the target variable and when it fails to Granger-cause the target variable. Series that is not individually cointegrated with the target variable but that Granger causes it and shares its order of integration is, however, kept. As discussed earlier, the choice of the variables strongly depends on the purpose, especially the period of the forecast horizon.

2.34 As different leading series have different levels of volatility, one approach is to use standardisation factor based on measures of dispersion of each series so that the more volatile indicators do not have dominating influence on the behaviour of the composite indicator. The finally selected leading indicators are combined into one single weighted or unweighted index. One approach to obtain weights is by using the principal component analysis (PCA) for summarising the information content of various leading indicators. The PCA is, however, a purely statistical procedure that yields one or more linear combinations of the series that explain major parts of variations where the interpretations of the weights are often not very clear. An alternative to this method of summarization of information is based on econometric modelling using distributed lags. In this approach, a general model of the reference series consisting of all possible relevant series and their lags is specified and statistically significant lags are retained. This approach of identifying coincident and leading indicator is perhaps the closest to econometric modelling and can be used for getting point forecasts of the reference series rather than turning points.

2.35 To test the forecasting accuracy of the composite indicators, at least two important dimensions must be taken into account. One is the performance of the composite indicator in generating ex ante and ex post forecasts of business cycle turning points. To judge the point prediction performance, standard measures of forecast performance like Mean Absolute Error (MAE), Root Mean Square Percentage Error (RMSPE), Theil U Statistic, etc. can be used.

2.36 The second norm for gauging the forecast performance is based on the performance of the indicator against rival candidates. If a standard benchmark for the same is already available, any new indicator proposed should perform at least as well as that benchmark. However, in case such benchmarks are not available, the best possible index should be selected among many plausible candidates.

## **II.5 International Experience**

2.37 There are a large number of leading indicators for many countries and it is difficult to summarise all of them here. Some prominent ones are discussed here. An illustrative list of leading indicators (taken from major country / region leading indicators) is presented in Appendix 3.

2.38 The Bureau of Economic Analysis (BEA) of the US Department of Commerce (1984) followed the NBER approach (Moore and Sishkin 1967) for preparing the Composite Index of Leading Indicators for forecasting changes in aggregate economic activity. Subsequently, BEA decided to transfer the work to an independent agency. For this purpose, BEA selected the Conference Board to be the custodian of the official composite leading, coincident and lagging indexes. The Conference Board is a private non-profit institution with a worldwide research and membership with a mission to improve the business enterprise system. The Conference Board has been independently releasing the business cycle indicators since 1996 on a regular basis. The Conference Board also prepares leading indicators to forecast changes in economic activities in Australia, France, Germany, Japan, Korea, Mexico, Spain and UK. The prediction performance of various series is constantly monitored and revisions, if necessary, are carried out in the composite indices. Several banks, state institutions, research institutions and private agencies compile their own leading indicators in the US.

2.39 The Organisation of Economic Development and Co-operation (OECD) has developed a System of Leading Indicators for its member countries, Euro-zone, G-7, and Total OECD on a monthly basis. It also helps prepares leading indicators for certain non-member countries and including the transition countries on a monthly or quarterly basis. It uses the Index of Industrial Production (IIP) as the reference series and uses the Phase Average Trend method for detrending all the series based on Bry-Boschan algorithm. The composite index of leading indicators is based on both regular economic time series and also the quantitative / qualitative data from business tendency surveys.

2.40 Six major economic institutes, viz., Centraal Planbureau (Den Haag), Deutsches Institut für Wirtschaftsforschung (Berlin), The Research Institute of Finnish Economy - ETLA (Helsinki), Institut für Weltwirtschaft (Kiel), National Institute for Economic and Social Research (London), Observatoire Francais des Conjonctures Economiques (Paris), PROMETEIA (Bologna) and Österreichisches Institut für Wirtschaftsforschung (Vienna), have joined together to form EUROFRAME to combine their knowledge in economic modelling and analysis give regular forecasts for the EU and the Euro Area. Their leading indicator is based on the results of industrial survey, retail survey, construction survey, car registration, interest rate spread, raw material price index, euro-dollar exchange rate and US output.

2.41 The Economic Cycle Research Institute (ECRI), New York set up by Geoffrey Moore has established a system for dates of business cycle recessions in 18 major economies to establish the official U.S. chronology, along with analogous peak and trough dates for international growth rate cycles, turning point recognition systems, composite index construction methods, transmission of cycles across economies, the role of cycles in foreign exchange movements, and the development of new international indicators systems to track cycles in growth and inflation.

2.42 There are two official leading indicators for the UK economy. The first is constructed to lead by a year or more called the longer-leading indicator (LLI); the other is intended to have a median lead of six months - the shorter leading indicators (SLI). The indices use estimates given by the Confederation of British Industry (CBI) survey and EC/Gallup survey.

2.43 Australia has a system of dating and predicting the business cycle movements using business cycle indicators. In addition to the aggregate economy level forecasts, the leading indicator system is also used for forecasting the sector specific demand for sectors like automobiles, telecommunications, etc. The Composite Leading Indicator of the Australian Bureau of Census summarises the business cycles present in a selection of economic indicators that have typically shown turning points ahead of the business cycle in GDP from the early 1970s to the early 1990s.

2.44 Statistics Canada compiles the Composite Leading Indicator for Canada, which is comprised of ten components which lead cyclical activity in the economy and together represent all major categories of Gross Domestic Product (GDP). It reflects the variety of mechanisms that can cause business cycles.

## Section – III

### Economic Indicators - the Indian Context

#### III.1 Coincident, Leading and Lagging indicators for Indian Economy

##### Selection of Reference Series and Coincident Indicators

3.1 Generally the focus of leading indicator approach is to forecast the fluctuations in business activity and therefore the starting point of the analysis would be the selection of a reference series, which represents the expansion and the contractions phases of the economic activity under consideration. In the business cycle literature for developed countries, the measure chosen for business activity has been real Gross Domestic Product (GDP) or some of its variation, such as the Net Domestic Product. The OECD system of Composite Leading Indicators uses a single economic variable as the reference series. This makes it possible to establish the timing classification of economic indicators as leading, coincident or lagging with respect to some pre-determined benchmark.

3.2 The relevance of CLIEAs for the developing countries varies depending upon the extent of sectoral rigidities, integration of markets, etc. In the Indian context, besides rainfall-dependent agriculture, full interplay of market forces was not possible due to the strong role of the public sector and institutional rigidities caused by the presence of regulated regime especially upto late 1980s.

3.3 It is noted that business cycle analysis using estimates of economic variables with annual periodicity is likely to miss the precise turning points of macroeconomic cycles. Annual estimates / forecasts of trend in economic activity would be of little help for RBI in conducting its monetary policy. In view of the importance of short-term economic forecasting for policy-makers and also taking into account the reducing production cycles (which is less than one year in a overwhelming majority of cases), it is considered appropriate to consider compilation of leading indicators with periodicity of less than one year. Again the monthly data has more noise and its use would have give varying lag-length in the lead-lag relationship. Therefore, the Group felt that the use of quarterly data for studying the lead-lag relationship would be more appropriate. This also ensures sufficient number of observations for studying cyclical patterns as well as to maintain the degrees of freedom at a convenient level.

3.4 The traditional business cycle analysis for developed countries excludes agricultural output and employment in agricultural sector from business cycle analysis in view of the dependence of the agricultural sector on natural factors like weather and the low role of interplay of market forces in determining their level.

3.5 Use of CLIEAs in forecasting economic cycles is popular in the industrial countries due to regularity of cyclical fluctuations in organized business activities in these countries. In a developing country like India, primary activities have very important share in the economy and agricultural output (where natural factors like rainfall play an important role) is an important factor affecting the level of aggregate output.

3.6 The performance of agricultural sector has a strong bearing on the private consumption expenditure and therefore is crucial for determining the level of aggregate demand. Thus, supply for this sector is not based on market forces but it has strong influence on the aggregate demand. In view of this, defining the overall economic activity that is prone to cyclical fluctuations, is more difficult for such an economy than for a typical developed industrial economy.



3.7 GDP as the main reference series has a distinct advantage over other candidate series as it captures the overall economic activity that is often the macroeconomic policy target. In the long run, it is ideal to move towards the use of quarterly GDP as the main reference series for developing economic indicators. Internationally, GDP has the preference over IIP due to the wider coverage of economic activities by the former.

3.8 Table 1 presents the cross-correlation coefficients of the cyclical components of major macroeconomic variables based on annual estimates for 1960-2000. The cyclical components of various time series are estimated by the widely used Whittaker-Henderson filter (more popularly known as Hodrick-Prescott filter) with the smoothing parameter as 100 . The correlation coefficients are similar when other methods like the band-pass filter used by Baxter and King (1995) and by Christiano and Fitzgerald (1999) were used.

**Table 1: Cross-Correlation coefficients of the Cyclical Components of Major Macroeconomic Variables (Based on Annual Data for 1960-2000)**

Variables	WPIM	IIPM	IIPG	SALES	GDCF	PFCE	GDPM	GDPNA	GDPA	GDP
GDP	-0.36	0.65*	0.72*	0.44*	0.51*	0.85*	0.64*	0.85*	0.62*	1.00
GDPA	-0.03	0.11	0.06	0.04	0.11	0.53*	0.20	0.11	1.00	
GDPNA	-0.43*	0.75*	0.87*	0.54*	0.58*	0.71*	0.68*	1.00		
GDPM	0.00	0.65*	0.83*	0.67*	0.68*	0.54*	1.00			
PFCE	-0.36*	0.56*	0.60*	0.41*	0.33	1.00				
GDCF	0.01	0.32	0.68*	0.39*	1.00					
SALES	0.40*	0.47*	0.50*	1.00						
IIPG	-0.33	0.75	1.00							
IIPM	-0.34	1.00								
WPIM	1.00									

Note: \* denotes significance of correlation coefficient at 5% level of significance

1. GDP Real GDP
2. GDPA Real GDP for Agricultural Sector
3. GDPNA Real GDP for Non-Agricultural Sector
4. GDPM GDP for Manufacturing Sector
5. PFCE Private Final Consumption Expenditure (Real)
6. GDCF Gross Domestic Capital Formation (Real)
7. SALES Index of Sales of the Private Corporate Sector
8. IIPG Index of Industrial Production – *General*
9. IIPM Index of Industrial Production – *Manufacturing*
10. WPIM Wholesale Price Index - *Manufacturing*

3.9 It can be seen from Table 1 that cyclical component of agricultural output (GDPA) is significantly related with the private consumption whereas its correlations with other variables are insignificant. The coefficient of correlation between current year's private consumption and previous year's agricultural GDP was found to be statistically significant at around 0.4. On the other hand, cyclical component of non-agricultural output is strongly related to the cyclical components of all other variables (except agricultural GDP) and these correlations are highly significant. This implies strong cyclical comovement between variables in the non-agricultural sector.

3.10 It was also noted that there is a likelihood of the presence of agricultural cycle which may have different periodicity than the non-agricultural sector. In such a case, combining the two sectors is likely to present a picture that unrelated to aggregate demand.

3.11 The group was of the view that in view of the predominant role of weather and lower role of market forces in determining the agricultural output, it would be inappropriate to have GDP from agriculture as part of the business cycle reference series. At the same time, the cyclical components of other output variables like IIP, GDP Manufacturing, private corporate sales, private consumption, non-agricultural GDP show high correlation among themselves.

3.12 In view of the above, it seems appropriate to recommend the non-agricultural GDP (in real terms) as the main reference series for business cycle analysis in India. The Group, however, suggests that the cyclical component of the agricultural output could be re-examined once QGDP

for the earlier years is compiled with a view to have a validation check on the appropriateness of non-agricultural GDP as the main reference series.

3.13 The group also felt that the selection of non-agricultural GDP as the main reference series should not be seen as limiting the study of cyclical fluctuations to a single aggregate series. It was recognised that agricultural output has a unique role to play in the aggregate demand management. However, the leading indicators for industrial and services output may not be appropriate for predicting movements in agricultural output. In view of this, the methodology for forecasting fluctuations in agricultural output may be different from those for rest of the activities in the economy.

3.14 A major problem in the Indian context is non-availability of time series data on many conventional coincident and leading indicators. Compilation of quarterly GDP started only from the first quarter of 1996-97. Estimates on private consumption, investment and other related macro aggregates are not available on a quarterly basis.

3.15 The National Statistical Commission made several recommendations for improving the statistical system in India in its report submitted in 2001. The implementation of these recommendations would provide information base on a number of economic variables that would be useful in business cycle analysis in the years to come.

3.16 Since long enough quarterly GDP time series is presently not available, there is an urgent need for institutional effort to generate such a series. It is, therefore, necessary to have the past estimates of quarterly GDP at least since 1970-71, with consistent methodology. The detailed estimates for major activity sectors are necessary to facilitate studies in this area. Though there are difficulties in this exercise, the Working Group considers it of a paramount importance to meaningful work on business cycles and for supporting any judicious use of such information for policy purposes.

3.17 Though the use of quarterly non-agricultural GDP as the main reference series would be appropriate, it is also necessary to look at other major activity variable like private consumption, industrial production and private corporate sales for the purpose of determining the reference turning points.

3.18 At present, quarterly national income estimates include only GDP for various activity sectors. For business cycle analysis, it is essential that movements in private consumption expenditure be also studied to ascertain the fluctuations in aggregate demand. It is necessary that the estimates of Private Final Consumption Expenditure are introduced in the quarterly estimates of national income and its estimates for the back period are also provided to researchers as proposed in the case of Real GDP. The long-run goal should be to prepare the quarterly estimates of capital formation also.

3.19 Employment and wages are extremely important variables that characterise business cycles in developed countries. In the Indian context, there is no regular flow of data on employment / unemployment at aggregate economy level that can be used for business cycle analysis. There is no consolidated information base on average weekly manufacturing hours – considered as a sound leading indicator in many developed countries. Also, in view of job security legislations, wages are not purely market-determined and, therefore, cannot be used for characterising business cycles in India.

3.20 Precise estimates of unemployment are extremely difficult to prepare due to the big share of the informal sector especially that of the agricultural employment in the total workforce and the resulting incidence of disguised unemployment. Also, in the absence of the aggregate data on unemployment insurance, indicators relating to unemployment benefit claims cannot be considered as inputs in such analytical exercise in the Indian context.

3.21 Proper information on aggregate supply of labour would aid the formulation of monetary policy for management of effective demand. With the growing role of the organised sector, efforts should be made to collect more data on organised employment that can serve inputs for such studies.

3.22 In the absence of regular database on agricultural / non-agricultural employment and also the fact that quarterly estimates of private consumption are not yet available, IIP-Manufacturing may be an appropriate coincident indicator. The other possible candidate for coincident indicator is corporate sales (Manufacturing and Trade) but this series can be compiled only with more than one quarter time-lag and long time series data cannot be obtained for use in exploratory exercise as quarterly corporate results are available only since 1998-99. However, information of current corporate sales can be used as additional information for validation of movements in the other coincident indicator.

### **III.2 The Absence of Conventional Leading and Lagging Indicators**

3.23 Generally, indicators are identified based on some economic rationales. For example, following de Leeuw (1991), selection of a leading indicator might be justified by one or more of the following five rationales – (i) Production Time, since for many goods it takes months or even years between the decision to produce and actual production, (ii) Ease of Adaptation, because certain dimensions of economic activity have lower costs of short-run variation than others (for example, weekly hours compared with employment), (iii) Market Expectations, because some time-series tend to reflect, or are specially sensitive to anticipations about future economic activity, (iv) Prime Movers determining that fluctuations in economic activity are driven basically by a few measurable forces, such as monetary and fiscal policies and (v) Change-versus-Level, i.e., whether changes in economic time series generally turn up or down before levels. Apart from these criteria, selection of an indicator may also depend upon many other practical considerations, such as, regular availability of reliable time series data, frequency and extent of revision of such data, etc.

3.24 The crux of the Leading Indicator approach to predict economic activity lies in the selection of leading indicators, whose movements precede, in a causal fashion, the changes of the target / reference variable. The choice of economic indicators is a very critical issue as the performance of ultimate forecasts depends heavily on the quality of individual indicator. Standard economic theories provide useful guidance in this regard. The desirability of covering a wide range of independent factors that determine economic activity leads to consider indicators from various broad sectors (say, real sector, financial sector, government sector, etc.), where general shocks can originate and propagate. An Illustrative list of Coincident, Leading and Lagging Indicators used for various countries is given in Appendix 3. It may be seen that long time series data on most of these variables are not available in the Indian context.

3.25 The Group noted that a majority of conventional leading indicators used in developed economies are not being used as information variables in India. Some of the conventional variables are not presently being compiled at reasonable levels of aggregation, such as the labour working hours, vendor deliveries, new orders or order book, overtime hours. Certain other

indicators, such as terms of trade or merchandise shipment come with a considerable time lag. In some other cases, such as automobiles sales, new loan equipment sales, manufacturing inventories data are available and can be utilised more easily for leading indicator analysis with some improvements in compilation and dissemination.

3.26 Housing Starts (building permits for new private housing units) is another strong traditional leading indicator used in developed economies where there is no organised database available in the Indian context. It is recognised that creation of this database would require monumental efforts and quick periodic updation is extremely difficult. At the same time, given the important information content of this variable it is necessary to bridge this data gap as far as possible. It may be appropriate to focus on gathering information on the urban housing starts as it may be costly and difficult to obtain information on the total housing starts that would cover rural kutchha and pukka constructions. This can perhaps be done by the National Buildings Organisation which can involve the local bodies in compilation of regular statistics on housing permissions and completions.

3.27 Information on inventory levels at the manufacturers' level is available annually and with a lag that it makes it inappropriate for getting lead information on business cycles. At the distributors' level, this information is almost non-existent. The Group felt that many of these data gaps could be addressed if institutional development is geared in coming years towards an organised compilation of leading indicators. However, the Group recommends that effort should be made on a priority basis for strengthening information on inventories.

3.28 The Group is of the view that the best way to strengthen the inventory database is by adopting a two-pronged approach. First, the inventories at the manufactures level should be compiled as part of the company accounts data. Inventories are part of the companies' balance sheets, but at present, only the annual audited accounts of the company provide such information. The unaudited quarterly accounts present the value of change in stocks from the profit and loss accounts. The Group emphasises the need to improve the quarterly financial reporting of the Indian firms, which on comparison with developed country practices were found to be inadequate. As such it recommends that the Department of Company Affairs (DCA) may be requested to initiate immediate action to make manufacturing inventory stock data (providing aggregates for work-in-progress, finished goods stocks as well as raw material and spares) as part of the quarterly financial reporting. Secondly, for assessing the retail inventories, the Group suggests institution of a well-designed quarterly survey that can be conducted by an institution engaged in large-scale sample surveys.

3.29 Information obtained on inventories, as above, could be validated by information that may simultaneously be collected on inventory financing through banking channels. While the Group sees the difficulty in establishing a one-to-one correspondence between stocks and their financing, it nevertheless feels that such verification could ensure some quality checks in statistical compilation and also provide a useful indicator to work with. Since working capital facility are almost always well documented with all necessary statements, it should be possible to establish a system that can be relied upon for collection of data on this aspect.

3.30 The group felt that the link between inventory and working capital finance by banks has become weaker over the years. It was of the view that it would be appropriate to conduct research studies to explore the extent of inter-linkage between inventory, working capital finance and economic activity in view of the recent structural changes in the economy. The linkage needs to be explored for greater understanding of their behaviour for major industries in the

recessionary / expansionary phase in the Indian context and of how policy actions are transmitted to activity levels.

3.31 In addition to inventories, the Group expressed the views that other forms of business data, specially opening of the Letters of Credit (LCs), bill discounting, bills dishonoured and factoring could also be explored for developing leading indicators. Similarly information content from region-wise diesel sales, tourist arrivals, hotel occupancy and flight passengers could also be used.

3.32 Efforts are also necessary to capture consumer confidence and consumer loans from surveys or from banking and financial channels. Data on credit card activity could throw useful information and suitable modalities could be worked out to compile this information from clearing channels.

3.33 Apart from the business sector, the fiscal sector throws vital information of use for leading indicators. The Group emphasised the need to utilise the information on government expenditure and its components such as revenue expenditure, development expenditure, etc. for their relationships with economic activity. Data on tax collections, sales tax, excise tax and specially the service tax also, as the latter is of crucial significance given the structural transformation in the Indian economy over the years.

3.34 Although data dissemination has improved vastly during the recent years both in the matter of quality and timeliness for many important economic indicators, a major impediment for this type of analysis is the non-availability of time series information on features like consumer expectations and business tendency. In the recent past, there have been efforts by various agencies like the National Council of Applied Economic Research (NCAER), Confederation of Indian Industries (CII), the RBI and some private agencies like Duns and Bradstreet, to conduct business tendency / industrial outlook surveys that provide useful indicators giving future gauge of the economy. At the same time, the quality and availability of data in India on other variables of relevance have also increased substantially. These developments would give the right kind of impetus in constructing appropriate CLIEAs.

3.35 The Group benefited from a detailed presentation by the RBI on its quarterly Industrial Outlook Survey being conducted since January 1998. The survey targets a sample of about 2200 non-government non-financial public limited companies and gets responses from about 600-800 companies and makes available (i) qualitative data on output, order books, inventory levels and capacity utilization rate for past two quarters; (ii) reasons for Banks / Financial institutions in not meeting the demand for Working Capital Finance; (iii) factors hindering the growth of production (also for the current quarter); (iv) qualitative questions on assessment for the current (on-going) quarter and expectations for the next quarter; etc. The results obtained on market expectations are more or less consistent with the actual data. However, some noteworthy limitations of the survey, which need to be taken care of are: (i) the survey results pertain to selected public limited companies with unsatisfactory response rate and hence its coverage is not adequately representative; and (ii) results, which are mostly based on the qualitative responses are not published.

3.36 The group felt that the survey results are useful for business cycle analysis and the short-term economic forecasting using leading indicator approach. For this purpose the Group felt that the RBI takes initiative to further improve the survey design and to reduce the time-lag and the non-response factor, so that the information could be purposefully used for business cycle

analysis and selected estimates thrown up by the survey can be examined for possible use as leading indicators. The group also felt that the survey results should be published.

3.37 The lagging series like unit labour cost, manufacturing and trade inventories, consumer instalment credit, Service price index etc. are not available in the Indian context. Analytical studies can be attempted on the use of interest rate and outstanding industrial loans that are used as lagging indicators in many countries.

### **III.3 Studies in Indian Context**

3.38 Despite these limitations, attempts to understand the features of business cycles and forecast their movements have been carried out in India by several researchers (Chitre, 1982; Joshi, 1997; Mall, 1999). Leading indicators of inflation has also been examined and summarized into a single index (Samanta, 2000). Among the studies on growth and business cycles, Chitre (1982) was the first major study on the analysis of growth cycles in Indian economy and examined the short-term fluctuations for the period 1951-76 using annual data on a large number of variables and found that many key economic processes show synchronous movements around their respective long-term (deterministic) trends. Chitre (1988, 1990) studied the cyclic behaviour of selected time series during 1951-82 and found that the growth cycles in India's non-agricultural income can be decomposed into three primary causes of it, viz., the fluctuations in agricultural income, the gross fixed investment in the public sector and the world industrial cycle. The growth cycle in India's non-agricultural income was shown to have a statistically significant but inverse relation to the world industrial cycle though the transmission mechanism was not empirically established. Chitre (2001) identified 11 economic indicators to determine the reference dates giving the cyclical turning points in India's economic activity. The reference dates based on these eleven monthly indicators were computed by three different methods, viz. diffusion index, composite index and first principal component index yielding reference dates which are more or less similar to each other.

3.39 Hatekar (1993) used annual data for the period 1950-85 and described individual historical path of major macroeconomic variables and their comovements with other variables. The study tested the real business cycle proposition that nominal magnitudes and real money balances cannot be exogenous during mechanisms of the business cycle. Joshi (1997) examined the growth aspects of real GDP and obtained significantly negative impact of monetary surprises on real GDP growth whereas cyclical fluctuations in public investment were found to affect the future output positively with a lag.

3.40 Gangopadhyay and Wadhwa (1997) used monthly data on IIP for the period 1975:Q2 to 1995:Q1 for obtaining the chronology of Indian business cycles using deterministic trend (annual growth rate of six per cent). They also attempted to forecast the level of annual GDP using monthly data on IIP which they argued could also be used to update the forecast of GDP especially once the data for the first half of the fiscal year is available.

3.41 Mall (1999) characterised Indian business cycles based on non-agricultural GDP as the reference series as its cyclical movements were found very synchronous with variables like aggregate GDP, private consumption, investment, manufacturing output, domestic trade, IIP, private corporate sales and value added. As the turning points of IIP-Manufacturing were found to be roughly coincident with major output variables in the non-agricultural sector of the economy, and the data on IIP is available with higher frequency, the study proposed a composite index of leading indicators with 14 components for IIP-Manufacturing with a forecast horizon of two quarters.

3.42 Dua and Banerji (1999) used the classical NBER approach to determine dates of Indian business cycles and growth rate cycles. Their Coincident Index had the limitation of using proxies with limited coverage. Dua and Banerji (2001) compiled index of leading indicators to track these turning points based on the ECRI methodology. However, the component series are not published in the study.

3.43 In its report entitled 'Business Cycle Indicators in the Indian Economy' (2001) submitted to the Reserve Bank of India, the National Council of Applied Economic Research (NCEAR) examined the evidence and literature that would enable the construction of a chronology of business cycles in India. It proposed a composite coincident indicator comprising of IIP-General, exports and non-petroleum imports, preceding the construction of a leading index.

3.44 Kanagasabhapathy and Goyal (2001) tested the hypothesis that yield spread could serve as a leading indicator of real economic activity for the Indian economy. By relating movements in the yield spread in the government securities market to movements in the index of industrial production, they found that yield spread could, inter alia, be considered as a leading indicator of industrial activity in India.

3.45 Layton et al (2001) have argued that basing the Indian Business cycle chronology just on industrial output, quarterly GDP or much narrower measure as IIP, is inappropriate to fulfil the proper conceptual definition of the business cycle. They opine that other measures, particularly employment measures, sales and income measures should prominently figure in the dating of a country's business cycle, particularly in India.

3.46 Darbha (2001) attempted to estimate the dynamic factor Markov-switching model for Indian data and found that there exists a common dynamic factor characterizing the cyclical movement across a selected set of macro aggregates (IIP, total personal disposable income at 1981-82 prices, total manufacturing sales at 1981-82 prices etc.). The analysis suggests that there are three different phases of business cycles during 1975-93.

#### **III.4 An Empirical Exercise**

3.47 The group had the benefit of examining the results of an empirical exercise on the use of leading indicator method for forecasting the growth rate cycles in the Index of Industrial Production (Monthly / Quarterly) using the available data. The methodology followed and the results of the empirical exercise are presented in Appendix 2. The group felt that such exercises bring to the fore the urgency of building of database on conventional leading indicators so that the methodology can be fully exploited for short-term economic forecasting in the Indian context.

3.48 The Group felt that ideally the leading indicators should be made available by a research institute / private body that could be run on the lines of the Conference Board of the United States. However, till such time as the database and methodologies are not strengthened and standardized, it is best to entrust further exploratory work to an official agency, which has the technical capability to handle this work. The Group recommends that RBI may take further initiative in this respect with the ultimate objective of transferring the final compilation and dissemination of information on leading indicators work to a research institute.



## **Section IV**

### **Measuring Capacity Utilisation: Concepts and Methodological Issues**

#### **IV.1 Introduction**

4.1 Capacity utilisation (CU) measures the proportion of available productive capacity (i.e. capacity or potential output) of an economic unit that is currently utilised. An economic unit may represent a firm, a plant, an industry or even an entire economy. At any instance of time, output may rise above (fall below) the trend path because people work overtime (less) and/or machinery is used for several shifts (below normal operating level).

4.2 Capacity utilisation is an extremely useful indicator in business cycle analysis. It serves as the barometer of observed cyclical fluctuations in economic activities and plays an important role in formulating monetary and fiscal policies. The industry-wide / economic-wide CU is useful to (a) determine whether production conditions are 'slack' or 'tight' and thus whether restrictive or expansionary macroeconomic policies would be effective; and (b) assessing the future investment demand that tends to vary directly with increases in CU.

#### **IV.2 Defining Capacity Utilisation/Output**

4.3 The CU is defined as the ratio of actual output to capacity (or potential) output. Sometimes, extent of CU is also measured by means of output gap which is simply the gap between actual output from its potential level. However, the concept of capacity or potential output lacks both consensus and precision. Estimate of capacity output based on installed capacity is considered as a direct measure of the former but is difficult to measure in the light of data limitations. In order to overcome these problems, capacity output has been defined in several indirect ways each having specific interpretation and usage. The major approaches are (a) maximum sustainable level of production under full employment scenario; (b) long-run trend/equilibrium level of output; (c) minimum point on a cost function; and (d) a full input point on an aggregate production function.

4.4 The Wharton School of Finance and Commerce in the US (hereafter, Wharton School) defines "the capacity of an industry at a particular time is the maximum sustainable level of output the industry can attain within a very short time if the demand for its product were not a constraining factor, when the industry is operating its existing stock of capital at its customary level of intensity" (Klein and Summers, 1966).

4.5 The capacity output defined under production function framework also shares the above concept, though the emphasis on 'sustainability' is not made explicitly in many instances. The capacity output defined here is simply the level of output, which could be produced during any given time period if all available factor inputs were being fully utilized (Giorno, et al, 1995; Klein and Preston, 1965). The full utilization, however, refers to the economic concept (not a physical concept) corresponds to the utilization rate of inputs that is normally achieved at peaks in business activity (Harris and Taylor, 1985) and does not indicate that every last drop of output is squeezed out of available inputs.

#### **IV.3 Approaches to Measuring Capacity Utilisation**

4.6 Estimates of capacity output and hence CU vary at times due to differences in the concept of capacity considered as well as the methodology adopted to measure any specific concept. The

simple measure of capacity output has limited use as it overlooks (a) the problems arising out of seasonal nature of certain operations; (b) augmentation of capacity due to fresh investment (RBI, 1996); (c) data on installed capacity may not be made available for all industries or economic units and (d) units of measuring installed capacity may differ for some industries (such as, cotton and jute textiles) from the units in which actual productions are expressed (Divatia and Varma, 1970).

4.7 Direct measure of CU may also be estimated through focused surveys (such as, the McGraw-Hill survey, Survey of Bureau of Economic Analysis of US, etc., mentioned in Morrison, 1985). In such a survey, questions asked to respondent, generally, relate to actual/optimal and preferred operating rates concerning overtime, shifts, holidays and available resources. But a potential problem with any survey-based measure stems from the inconsistencies among respondents in interpreting 'preferred' and 'optimal' utilisation rates as well as discretionary definition used by the respondents for capacity.

4.8 The methods available for estimating indirect measures of capacity output can be classified under four broad categories, viz., (i) trend-through-peaks methods; (ii) filter or trend based measures; (iii) measures based on minimum capital-output ratio, and (iii) approach based on economic theory of cost or production functions. Under each of these categories, several techniques co-exist to measure a specific concept of capacity.

4.9 The notable trend-through-peaks methods are due to (i) Wharton School (Klein and Summers, 1966) and (ii) RBI (Divatia and Varma, 1970). These methods make use of time series data on production for different economic units. The Wharton School method makes use of monthly time series data on production index for estimating capacity output. To fulfil the sustainability requirement, monthly series is adjusted for seasonality and aggregated to derive a quarterly series. The adjusted quarterly series is then used to identify the peaks. It is assumed that the output at each of these peaks equals capacity output. It is presumed that once capacity is built up, it will not decline in subsequent periods and such linearisation is not allowed if one peak is lower than its earlier chosen peaks. During intervening periods, capacity output is obtained by joining the successive peaks by straight line. For the time points prior to the first peak and after the last peak, capacity output are estimated by extrapolation. Divatia and Varma method is a modified version of Wharton School measure where (i) the peaks are identified in monthly output indices (instead of quarterly series used in Wharton School method); (ii) no adjustment for seasonality is made; and (iii) the interpolation to estimate capacity for periods between two successive peaks are not taken by joining the successive peaks but by considering the peak monthly output as the capacity output for that year. Hence the capacity output function looks like a step function in this case.

4.10 Another widely used concept of potential output is the trend output related with full employment (Taylor 1993, 1995). Measures of potential output under this category attach substantial importance to the basic statistical properties, such as, stationarity, around deterministic trend (as is the case for trend-stationary class of non-stationary process) and stochastic trend (as is the case of a series possessing unit root). The estimate of potential level would correspond to simply the sample (time invariant) mean for stationary series and estimated time-trend for a trend-stationary series (Nachane and Lakshmi, 2002). In the presence of stochastic trend, it would be appropriate to use specific filters, such as, Hodrick-Prescott (HP) filter or Kalman filter (Groenveld, 1998). Some researchers (for instance, Adams and Coe, 1990; Apel and Jansson, 1997) estimated potential output under a macro-econometric modelling framework.

4.11 The measure based on minimum capital-output ratio, developed by the National Industrial Conference Board of the USA (Sastry, 1978), is a modification of the above-mentioned methods and incorporates the relationship between output and one important input, namely, capital stock. In this method, a benchmark year is then selected on the basis of the observed lowest capital-output ratio (real fixed capital to real output) which is considered as corresponding to capacity output. In choosing the benchmark year other independent evidence is also taken into consideration. The lowest capital-output ratio is considered as corresponding to capacity output. The estimate of capacity is obtained from real fixed capital stock divided by minimum capital-output ratio.

4.12 The economic theory based measures of CU fall under two broad approaches; those, which uses full inputs points on production function (Klein and Preston, 1965; Giorno, et al, 1995) and those based on minimum points on average total cost function (Berndt and Morrison, 1981; Morrison, 1985). In a production function based approach, production function is first estimated by regressing output on important factor inputs (suitably transformed), such as, utilised capital, labour employed. Sometimes effects of technological changes are incorporated by an exponential function of time. The capacity output is estimated by the value of the estimated function at available (full) capital and estimated labour force/full employment level. On the other hand, if firm minimizes costs (given input prices and quantities of fixed input stocks) and if technology is characterised by long-run constant returns to scale, the capacity output may be defined as the level of output that minimizes short-run average costs.

#### **IV.4 Select Studies on Capacity Utilisation in India**

4.13 Though the CU measures are of vital importance for policy formulation, the track record of India in compiling these measures is very poor. The limited studies available in the Indian context are confined to specific sectors of the economy, lacking economy-wide representation. In one of the earliest study, RBI (1968) published annual estimates of CU for select industries (for the years 1965, 1966 and 1967) using conventional installed capacity figures obtained under the licensing regime. In 1970, RBI published estimates of 'potential utilisation rate' for manufacturing industries in India (Divatia and Varma, 1970) for the years 1960 to 1968 using a trends-through-peaks method as discussed earlier. The potential production was considered to be the resultant of several factors such as the installed capacity, extent of availability of inputs, availability of skilled labour, demand, etc. Ajit (1993) presented CU estimates for a segment of industrial sector in India for the years 1970 to 1990 based on installed capacity. RBI (1996) estimated capacity utilisation for manufacturing sector (for entire sector and for use-based groups) for the years 1994-94 to 1995-96 using the methodology suggested in RBI (1970). RBI (2002) estimated CU for 1971-72 to 2000-01 using two competing methods, viz., the Wharton School method and the method based on minimum capital-output ratio.

4.14 The study by Sastry (1978) relates to cotton textile mills in India during the years 1950-51 to 1973-74. He compared a number of CU measures, such as, Wharton School method, RBI's method (Divatia and Varma, 1970), capital-output ratio based measures, etc., and found that the estimates of CU vary according to the measure employed.

4.15 Kshitija and Saggarr (1999), in their note on the topic, have estimated potential output using HP-filter and Kalman filter methods. They applied (i) HP-filter for annual GDP for the years 1950-51 to 2000-01 and (ii) both of these filters for monthly IIP from April 1982 to March 2000. They however, noted that though these estimates by and large satisfactorily explained the upswings and downswings in the Indian economy during the study period, they needed to be

interpreted with considerable caution for several reasons, such as, these estimates in any way did not tell about the production possibility curve facing the economy.

#### **IV.5 Search for a Suitable Methodology for India**

4.16 The Working Group deliberated on various concepts of ‘capacity / potential output’ and examined the feasibility of preparing regular estimates of capacity utilisation for Indian economy. It recognised that there are certain conceptual difficulties in interpreting CU measures in developing countries where CU depends on both demand and supply factors unlike developed economies where CU is often viewed as a primarily demand side phenomena. Low rate of CU may be possible indication for sluggish growth in demand; may be a result of constraints in availability or under-utilisation of factor inputs. Empirical measurement of CU based on production frontier under full employment approach and under minimal cost approach are difficult to prepare in India mainly due to non-availability of data on certain variables, such as, unemployment and labour force, utilised capital, etc. Even, measurement of capital-output ratio based measures suffers from the limitations in measuring capital itself.

4.17 For deriving potential output level through macro-models, one has to build macro-model encompassing the structural relationship of various economic variables/indicators. Due to severe data limitations in the Indian context, research in this area are constrained to concentrate mostly on building models using annual data and thus still there is lack of short-run model (say quarterly model). In this circumstances, estimating CU measures at quarterly or higher frequency (what the Group envisaged to have for policy purpose) in the macro-model framework is not feasible unless the data gaps are bridged.

4.18 In view of the above, the methodology for estimating CU in India has to be guided primarily by the status of available data. On this consideration, an appropriate strategy for estimating CU in India would be to implement some sort of trend-through-peaks or filtering-based method. However, before finalizing any method, there is a need to undertake a fresh study to explore available competing methods emphasizing on conceptual suitability of different concept of capacity/potential output, assessment of existing data-gaps, and interpretation and usages of different measures.

4.19 The Group also felt that quarterly information may be made available on potential output and output gaps as means of assessing the trends and cycles in aggregate output. The Group noted individual research efforts in this direction. The Group, however, felt that while individual research could be encouraged, in this case an institutional approach is necessary. For this, the Group suggests that the RBI may explore the methodological aspects and examine the possibility of publishing a quarterly article in the RBI Bulletin.

## Section – V

### Recommendations of the Working Group

The Group, having examined several database and methodological issues relating to compilation of coincident, leading and lagging indicators of economic activity that could be relevant for summarization and evolution of fluctuations in aggregate economic activity was of the opinion that while there could be no unique approach to studying business cycles in Indian context, there are definitive advantages to charting out a course of action to further the knowledge base and its applicability to policies at macroeconomic as well as microeconomic levels of the Indian economy. The Group noted that contemporary information on existence or non-existence of patterns of aggregate economic fluctuations in India is grossly inadequate for meaningful policy reaction. The state of research in this area is somewhat antediluvian and the database is insufficient to meet the needs of policymakers. The changing structure of the Indian economy and its increased openness and market orientation has made it important that the deficiencies in evolving a meaningful approach to studying business cycle and economic indicators are removed. The Group is of the opinion that this is a difficult though not intractable task and would require strong institutional backing. Institutional support is necessary both from the viewpoint of database improvement and for evolving organised approach to studying business cycles. Greater standardization of possible economic indicators that may be used for the latter would help promote a scientific and credible approach to this approach of macroeconomic analysis which is becoming highly relevant in the Indian context.

Considering the above objective, the Group considered several specific issues. The Group felt that many of the issues would evolve and resolve as the institutional approach is promoted. However, the Group felt that perusal of its recommendations in the six areas would chart out a useful course of action that may ultimately bridge the knowledge gap and help produce economic indicators that are meaningful for policy purposes. The delineated six areas are:

1. Selection of reference series
2. Estimates of major aggregates relating to overall economic activity
3. Strengthening the database on inventories
4. Compiling regular information on capacity utilization
5. Improving the industrial outlook survey
6. Providing an institutional framework for organized work on dating of business cycles in India and compilation of the index of leading indicators on a regular basis.

Keeping the above framework in mind, the Group has the following recommendations to make:

#### V.1 Selection of Reference Series / Coincident Indicator(s)

- i. The traditional business cycle analysis for developed countries often excludes agricultural output and employment in agricultural sector from business cycle analysis in view of the dependence of the agricultural sector on natural factors like weather and the low role of interplay of market forces in determining their level. On the other hand, movement in the cyclical components of major output variables in the non-agricultural sector are closely related and, among such indicators of economic output, non-agricultural GDP has the maximum coverage. In view of this, the Working Group feels it appropriate to recommend the non-agricultural GDP (in real terms) as the main reference series for business cycle analysis (*i.e.*, the economic variable whose cyclical movements are intended to be studied) in the Indian context.

- ii. The selection of non-agricultural GDP as the main reference series, however, does not limit the study of cyclical fluctuations to a single aggregate series. It is well recognised that, in addition to its high share in total output, the performance of agricultural sector also has a strong bearing on the level of current and future aggregate demand. However, the leading indicators for industrial and services output are not appropriate for predicting movements in agricultural output. In view of this, the methodology for forecasting fluctuations in agricultural output may be different from those for rest of the activities in the economy.
- iii. As estimates with annual periodicity are likely to miss the precise turning points of macroeconomic cycles in view of less than one year production cycle for an overwhelming majority of products, use of series with periodicity less than one year is favoured for capturing cyclical fluctuations. Annual estimates / forecasts of trend in economic activity would be of little help for RBI in conducting its monetary policy. Also, use of annual estimates would provide insufficient lead-time to have meaningful leading indicators especially in the context of short-term macroeconomic forecasting for identification of appropriate stabilisation policy options. Accordingly, the group feels that it would be best to use non-agricultural GDP at quarterly frequency as the main reference series.

## **V.2 Estimates of major aggregates relating to overall economic activity**

- iv. Since long enough quarterly GDP time series is presently not available, there is an urgent need for institutional effort to generate such a series. For this purpose, CSO may be requested to extend the quarterly GDP series backwards with consistent methodology at least since 1970-71. The detailed estimates for major activity sectors are necessary to facilitate studies in this area. While the Group recognises the difficulties in this exercise, it considers such estimates to be of paramount importance to meaningful work on business cycles and for supporting any judicious use of such information for policy purposes.
- v. Indian economy is continually evolving and is far too complex to be summarised by a single series. At present, quarterly national income estimates include only GDP for major activity sectors. For business cycle analysis, it is essential that movements in private consumption expenditure be also studied to ascertain the fluctuations in aggregate demand. The Group recommends that CSO may be requested to introduce the estimates of Private Final Consumption Expenditure in their quarterly estimates of national income and also provide its estimates for the back period as proposed in the case of the Real GDP. The long-run goal should be to prepare the quarterly estimates of capital formation also.
- vi. Till such time as quarterly GDP series is made available for use as reference series, the Index Number of Industrial Production (IIP) – Manufacturing is considered by many as coincident indicator for constructing leading indicators. The Group itself the benefit of looking at an illustrative exercises using IIP as coincident indicator. The Group recognises the problems posed by the noise element in IIP and suggests use of state space models or other equivalent filters to mitigate this problem and to enable it being used as a coincident indicator.
- vii. In the absence of long quarterly time series on agricultural / non-agricultural output / employment and also the fact that quarterly estimates of private consumption are not yet available, IIP-Manufacturing may be an appropriate coincident indicator. The other possible candidate for coincident indicator is corporate sales (Manufacturing and Trade) but this series can be compiled only with more than one quarter time-lag and long time series data cannot be obtained for use in exploratory exercise as quarterly corporate results are available

only since 1998-99. However, information of current corporate sales can be used as additional information for validation of movements in the other coincident indicator.

- viii. On availability of the long time series data on quarterly real GDP, private consumption and other related variables, empirical exercises can be made to study how best the main reference series (total and its sub-components) can be tracked through various economic indicators. The availability of such data would also make it possible to have a closer look on the selection of quarterly non-agricultural GDP as the main reference series.
- ix. Employment is an extremely important variable in business cycle analysis and many developed countries use unemployment rate as a major reference series. In the Indian context, there is no regular flow of data on employment / unemployment at aggregate economy level that can be used for business cycle analysis. Proper information on aggregate employment would aid the formulation of monetary policy for management of effective demand. With the growing role of the organised sector, efforts should be made to collect more data on organised sector employment that can serve as inputs for such studies.
- x. Housing Statistics are important inputs in business cycle analysis where no regular data are available in the Indian context. National Buildings Organisation may be requested to take steps to bridge this important data gap by involving the local bodies in compilation of regular statistics on Housing permissions and completions.
- xi. The Group noted that a majority of conventional leading indicators used in developed economies are not being used as information variables in India. Some of the conventional variables are not presently being compiled at reasonable levels of aggregation, such as the labour working hours, vendor deliveries, new orders or order book, overtime hours. More importantly, information on inventory levels at the manufacturers' level is available annually and with a lag that it makes it inappropriate for getting lead information on business cycles. Certain other indicators, such as terms of trade or merchandise shipment come with a considerable time lag. In some other cases, such as automobiles sales, new loan equipment sales, manufacturing inventories data are available and can be utilised more easily for leading indicator analysis with some improvements in compilation and dissemination. At the distributors' level, this information is almost non-existent. The Group felt that many of these data gaps could be addressed if institutional development is geared on a priority basis towards an organised compilation of leading indicators.

### **V.3 Strengthening the Database on Inventories**

- xii. The Group recommends that effort should be made on a priority basis for strengthening information on inventories. The Group is of the view that the best way to strengthen the inventory database is by adopting a two-pronged approach. First, the inventories at the manufactures level should be compiled as part of the company accounts data. Inventories are part of the companies' balance sheets, but at present, only the annual audited accounts of the company provide such information. The unaudited quarterly accounts present the value of change in stocks from the profit and loss accounts. The Group emphasises the need to improve the quarterly financial reporting of the Indian firms, which on comparison with developed country practices were found to be inadequate. As such, it recommends that the Department of Company Affairs (DCA) may be requested to initiate immediate action to make manufacturing inventory stock data (providing aggregates for work-in-progress, finished goods stocks as well as raw material and spares) as part of the quarterly financial reporting. Secondly, for assessing the retail inventories, the Group suggests the institution of

a well-designed quarterly survey that can be conducted by an institution engaged in large-scale sample surveys.

- xiii. The Group also advocates that information obtained on inventories, as above, could be validated by information that may simultaneously be collected on inventory financing through banking channels. While the Group sees the difficulty in establishing a one-to-one correspondence between stocks and their financing, it nevertheless feels that such verification could ensure some quality checks in statistical compilation and also provide an useful indicator to work with. Since working capital facility are almost always well documented with all necessary statements, it should be possible to establish a system that can be relied upon for collection of data on this aspect.
- xiv. The group feels that the link between inventory and working capital finance by banks has become weaker over the years. It is of the view that it would be appropriate to conduct research studies to explore the extent of inter-linkage between inventory, working capital finance and economic activity in view of the recent structural changes in the economy. The linkage needs to be explored for greater understanding of their behaviour for major industries in the recessionary / expansionary phase in the Indian context and of how policy actions are transmitted to activity levels.

#### **V.4 Capacity Utilisation**

- xv. The Group recognises the importance of regular and timely estimates of capacity utilisation (CU) for getting an idea on output gap. Statistical compilation in the area of capacity utilisation has not been given due attention in India and an institutional approach to produce regular and comparable statistics on capacity utilisation are necessary. The Group examined several methodological options for estimating CU in the Indian context. Some indicators of CU can be obtained from the industrial outlook / business tendency surveys. It is felt that estimates of installed capacity suffer from serious limitations and it would be appropriate to implement some sort of trend-through-peaks or filtering-based method. However, before finalizing any method, there is a need to undertake a fresh study to explore available competing methods emphasizing on conceptual suitability of different concept of capacity/potential output, assessment of existing data-gaps, and interpretation and usages of different measures. The Group suggests that the RBI puts in place a system for estimating the series on capacity utilization in major industries preferably on a quarterly basis. The compiled series could be disseminated in the RBI's Monthly Bulletin the in form of one-time article explaining methodology followed by periodical statistics.
- xvi. The Group also suggests that quarterly information may be made available on potential output and output gaps as means of assessing the trends and cycles in aggregate output. The Group noted individual research efforts in this direction. The Group, however, felt that while individual research could be encouraged, an institutional approach in this case is necessary. For this, the Group suggests that the RBI may explore the methodological aspects and examine the possibility of publishing a quarterly article in the RBI Bulletin.

#### **V.5 Improving Industrial Outlook Survey**

- xvii. The Group examined the possibility of use of information being collected as part of Business expectation surveys / Industrial outlook surveys. It noted that at present such surveys are being undertaken by the RBI, NCAER and CII and certain private agencies like M/s Duns and Bradstreet. It is of the opinion that a properly designed industrial outlook



survey with broad coverage could give important results on business expectations index. Generally broad purposes of such surveys are to gain insight into the industry assessment and expectations of its performance and perceptions with regard to economic and industrial environment. Business expectations index / business optimism index provide useful leading indicator for economic activity. With representative coverage, the corollary information thrown up by such surveys, that may be qualitative or quantitative, could also be used as economic indicators.

- xviii. The Group benefited from a detailed presentation by the RBI on its quarterly Industrial outlook survey which is being conducted since January 1998. At present, it targets a sample of about 2200 non-government non-financial public limited companies and gets responses from about 600-800 companies on both the quantitative and qualitative aspects. The results obtained on market expectations are more or less consistent with the actual data. However, some noteworthy limitations of the survey, which need to be taken care of are: (i) the survey results pertain to selected public limited companies with unsatisfactory response rate and hence its coverage is not adequately representative; and (ii) results, which are mostly based on the qualitative responses are not published. In view of the utility of the survey results, the Group suggests that the RBI takes initiative to further improve the survey design to reduce the time-lag and the non-response factor. The survey results should be published so that the information could be purposefully used for business cycle analysis and selected estimates thrown up by the survey can be examined for possible use as leading indicators.

## **V.6 Institutional Framework for Dating of Business Cycles in India and Compilation of the Index of Leading Indicators**

- xix. The Working Group feels that research in business cycle area in the Indian context has primarily been scanty and confined mainly to empirical aspects. For a better understanding of the phenomenon, it is necessary to also promote research on theoretical aspects, including competing paradigms on business cycle. The theoretical and empirical work in conjunction could throw light on the relative importance of various causal factors, including role of productivity shocks that are emphasised by the real business cycle school. Calibrated models with microfoundations could be particularly useful for these. These could be viewed along with the models that capture the impulse responses that emanate from pure macroeconomic policy variables, such as interest rates, money supply Government expenditure, etc. The changing character of propagation mechanism, the transmission of international business cycle to India especially in the light of international stock price and exchange rate movements is another area that requires attention. The role of demand and supply factors in agricultural output, its strong linkage with rest of the economy are very different from the phenomenon in developed industrial countries and, therefore, necessitate a hybrid approach for analysis of business cycles in India.
- xx. Apart from theoretical issues, methodological advancements and capacity building is necessary to further knowledge base in this area. The Group recognises that in addition to the study of business cycle turning points, the severity (amplitude) of recession is of prime concern to policy-makers. It is felt that the methods based on techniques like discriminant analysis, fuzzy logic and pattern recognition, artificial neural networks bound self-organising maps, etc., can also be used for such purpose.
- xxi. The Working Group suggests that the Reserve Bank could promote further research in the area of leading indicators and business cycles through several steps, including support to a research network and user groups in this area. It can also organise 'Annual Conference on

Business Cycles' with collaborations from research institutions and participation by institutions as well as individual researchers in this area.

- xxii. The Group suggests that while research in the area needs to be encouraged, a research institute could be promoted that may run on the lines of the Conference Board of the United States in respect of business cycle analysis. However, till such time as the database and methodologies are not strengthened and standardized, it is best to entrust further exploratory work to an official agency, which has the technical capability to handle this work. The Group recommends that RBI may take further initiative in this respect by developing a system of leading indicators with the ultimate objective of transferring the final compilation and dissemination of information on leading indicators work to such a research institute.
- xxiii. The Group underlined the importance of developing institutional capabilities for undertaking leading indicators work. It was recognized that leading indicators released by RBI on a regular basis would suffer from the disadvantage of self-fulfilling prophecies. Nevertheless, the Working Group was of the view that the central banks' operations are becoming increasingly more transparent and, in the light of technical competence and resources available with RBI, it needs to take a pivotal role in the area of business cycle analysis. It noted that some other central bank institutions, specially the Federal Reserve Bank of New York (FRBNY) and the Banca 'd Italia have promoted the development of leading indicators, with the former even disseminating the same. Therefore, it will be useful for the Reserve Bank to adopt a similar approach in the initial phases. Its involvement at the initial stages is also necessary to ensure that robust indicators are developed and policy response is based on reliable information base in the field. It was felt that the transfer of the job relating to the analysis of business cycles in India from official institution to a non-profit research institution is likely to be a gradual and natural process.
- xxiv. The Group felt that once the back data on activity sector wise real GDP, private consumption and other relevant variables are available on a quarterly basis, a Standing Committee of experts may be constituted to look into the issue of dating of business cycles in India so that future researchers can have standard reference dates for their research studies in the area. The proposed Standing Committee of experts should also constantly monitor the prevailing macroeconomic behaviour and decide on the peak / trough periods of business cycles thereby giving a more credible assessment of whether the economy is in expansionary / recessionary phase.
- xxv. The proposed Standing Committee may be made primarily responsible for:
  - (i) Dating of reference peaks and troughs for business cycles in India using historical economic time series;
  - (ii) Development of methodologies for issues such as combining of quantitative and qualitative data for the composite leading indicators, diffusion indices, dealing with seasonality, provisional nature of first estimates, etc.;
  - (iii) Suggestions on further strengthening of the database for work related to business cycles, including collation of data series that could be disseminated in public domain;
  - (iv) Regular monitoring of economic time series and taking a view on the state of the economy – whether it is in recessionary phase or in expansionary phase at the aggregate level; and
  - (v) Promoting the study of business cycles in India by identifying the key areas of research and commissioning of research projects, holding the proposed annual conference on the topic.

**Appendix 1**  
**Memorandum**  
**Working Group on Economic Indicators**

In view of the changing dimensions of the Indian Economy with increasing openness and market orientation, it has been decided to set up a Working Group on “Economic Indicators” to suggest suitable approaches for research on relevant economic indicators.

2. The Terms of Reference of the Working Group are:

- (i) To suggest methodology for studying business cycles in the Indian context;
- (ii) To suggest methodology for working out composite leading, coincident and lagging indicator;
- (iii) To suggest ways for improving information base relevant for leading indicators of economic activity, including appropriate surveys on inventories at the level of manufacturers and distributors;
- (iv) To examine the feasibility of studies on capacity utilisation in major industries;
- (v) To consider any other related matter/s.

The constitution of the Working Group would be as follows:

Dr. R.B.Barman Executive Director Reserve Bank of India	Convenor
Prof. Dilip Nachane Department of Economics, University of Mumbai, Vidyanagari Marg, Mumbai – 400 098.	Member
Prof. M.J.Manohar Rao Professor & Director, Department of Economics, University of Mumbai, Vidyanagari Marg, Mumbai – 400 098.	Member
Dr. S.L.Shetty Director, EPW Research Foundation, Mumbai – 400 101.	Member
Dr. Saumitra Chaudhary Economic Advisor & Research Co-ordinator ICRA Limited New Delhi – 110 001.	Member
Dr. Ila Patnaik National Council of Applied Economic Research 11, Indraprastha Estate, New Delhi – 110 002.	Member

- a. The Working Group may, if necessary, invite other persons for specific deliberations. The Bank will reimburse expenses on travel, transport and incidentals for non-official members for attending the meetings of the Working Group.
4. The Working Group could draw resource persons from the Department of Economic Analysis and Policy (DEAP), Department of Statistical Analysis and Computer Services (DESACS) and Monetary Policy Department (MPD).
5. The Working Group may submit its Report within four months from its first meeting\*.
6. DESACS would provide secretarial assistance to the Working Group.

Sd/-  
(Y.V.Reddy)  
Deputy Governor  
October 10, 2001

---

\* The term of the Working Group was subsequently extended up to end-June 2002.

## Appendix 2

### Compilation of a Composite Leading Indicator for India: An Illustrative Exercise

- 1 The official estimates of quarterly GDP in India are available since April-June 1996. As the exploratory exercise require larger time horizon for tracking the cyclical movements, it was decided to use the Index of Industrial Production (IIP) as an alternative choice though it represents only 24% share in GDP. However, the services sector account for nearly half of the GDP and their cyclical pattern is not likely to be different from that of Industry, as demand for services are likely to be synchronous with the industrial production. Research work on the interlinkages of these three sectors has also found that changes in the industrial sector have greater influences on the services sector.
- 2 Sometimes, changes in certain economic variables may superficially precede changes in other economic variables and the leading series may produce false signals of future changes or may produce contradicting signals. According to Zarnowitz (1992) "To increase the chances of getting true signals and reduce those of getting false ones, it is advisable to rely on a reasonably diversified group of leading series with demonstrated predictive potential." In addition, practical problems like measurement errors in preliminary data used for giving forecasts and occasional presence of high noise in individual variables, also argue in favour of using a composite index of leading indicators rather than relying on a single leading indicator. An attempt has been made to construct a composite leading indicator for IIP to predict six-month ahead movement of IIP.
- 3 Traditionally, seasonal adjustment was developed as a tool for analysing seasonal economic time series in the absence of suitable statistical and economic models for such series. In recent years, as new modelling procedures have become available, the reasons for seasonal adjustment have become debatable. The seasonal adjustment procedures (e.g., X-11 or its other variants) start by decomposing the series into trend, cycle, seasonal and irregular component with the underlying assumption that these three components are orthogonal and the components are fixed (non-stochastic). However studies by Miron (1996) and Franses (1996) show that both the assumptions, in general, do not conform to reality. The seasonal fluctuations in many quarterly or monthly observed macroeconomic time series do not appear to be constant over time. Sometimes changes in seasonality are so pervasive that there is evidence for seasonal unit roots in several economic variables [Hylleberg, Engle, Granger and Yoo (1990)]. On the other hand, for several macroeconomic series it appears that the seasonal fluctuations and non-seasonal fluctuations are not independent, in the sense that one may observe different seasonal fluctuations in business cycle expansion periods from those in recession periods. Miron (1996) shows that seasonal and business cycle fluctuations are driven by similar economic propagation mechanisms and also show that seasonal fluctuations raise many of the same questions for welfare and policy analysis as do business cycle fluctuation. This interdependency of the components violates the key assumption of seasonal adjustment methods that one can identify independent seasonal and non-seasonal components. Moreover, when seasonally adjusted data are used, Ghysels (1990) and Ghysels and Perron (1993) show that there are many well-known undesirable effects produced by seasonal adjustment filters. The adjusted series are smoothed series. The smoothing most likely induces higher persistence in the series and higher first order autocorrelation. Lead-lag relationships are disturbed because adjustment filters (including X-11-ARIMA) are generally two sided. The finding of Ghysels and Perron (1993) shows that consistency of the OLS

estimates is not preserved with lagged dependent variables, when all variables are seasonally adjusted. In the light of these controversies, unadjusted data series has been used.

- 4 It has been attempted to analyse growth rate cycles as opposed to study the classical business cycle. Since business cycle is more often studied with GDP as the reference series, it requires expansion in aggregate GDP at the time of boom and contraction (absolute declines) at the time of recession. However, IIP being an index generally does not decline in absolute sense, which, in turn, necessitates the analysis of cycles in growth rates rather than cycles in the level. By calculating growth rates, the problems involved in removing trend (band pass etc) do not arise, as generally growth rates are stationary. As quarterly or monthly growth rates are more erratic in nature, the present work has been confined to the annual (point-to-point) growth rates.

### **Selection of Leading Indicators**

- 5 At the outset, 43 indicators have been chosen based on economic considerations. The list of variables has been given in Appendix 2.1. The entire data set, ranging from April 1992 to January 2002, has been divided into two subsets, viz., estimation set and validation set. The estimation set has been taken from April 1992 to October 1999 and validation set has been considered from November 1999 to January 2001 having 15 observations.
- 6 From this set of 43 indicators, finally only six Indicators have been selected based on cross correlation (up to lag 12) with the Index of Industrial Production. Cross Correlation, which essentially is simple product moment correlation between the indicator and the target series for various leads, projects the quality of the indicators as potential leading Indicators. Appendix 2.2 provides such cross correlation table for all these 43 indicators. However, since signs of some cross correlations do not conform to economic rationale, on the basis of the proper sign of the cross correlation, finally, 6 leading indicators (for lead period of at least six months) have been considered for the construction of composite index. Significance of cross-correlations has been evaluated adopting  $0.1568 (=1.645/\sqrt{n}$ , where n, the no. of observations=110) as the critical value. Appendix 2.3 provides all these six indicators along with their cross correlation with the target series IIP. The Group, however, recognises that this is an illustrative exercise and it may be possible to have additional indicators.
- 7 In common belief, M1 and Non-food credit should not be considered simultaneously. However, since the inclusion of these two series does not pose any serious multicollinearity problem, both these series have been taken into account together. It may be noted here that initially Net Foreign Exchange Assets with RBI (NFC) was considered. However, as far as Methods 2 and 3 (described later) are concerned, the inclusion of NFC, which turns out to be statistically insignificant, does not improve the forecast performance. Moreover, it creates serious multicollinearity problem in Method 2. Silver price has not been considered due to confusion over the proper sign.
- 8 To get a better feel of the appropriateness of such selection, graphs of growth rates have been provided in Appendix 2.4. There are six plots, each plot providing visual inspection of the lead lag relationship with the IIP growth rates.

### **The Composite Leading Indicator**

- 9 Out of the several variables possessing information about the future movement of industry growth, no single series can be said to definitely precede the expansionary and contractionary phases of business cycles/ growth cycle. Therefore, “to increase the chances of getting true signal and to reduce those of getting false ones, it is advisable to rely on a reasonably diversified group of leading indicators with demonstrated predictive potential” [Zarnowitz (1992)]. Moreover, the effect of outlier, high noise in some variables, etc., can be eliminated by taking combinations of several variables. It is, thus, perceived that an index composed of several of these leading series, selected from a variety of economic processes, may provide a better indication of future activity than any one particular series. Moreover, such composite leading indicator approach has the appeal of dimension reduction, and hence simplifies the underlying modelling strategy. Econometric models, e.g., Vector Autoregressive (VAR) considering all the leading variables may require estimating a large number of parameters, which in practice, may not be feasible.
- 10 The selected series are combined into one single Index, which is called the composite leading Indicator. Usually a weighted sum of the series is used for the purpose. Sometimes, the aggregation of important Economic Indicators (EI) are done by constructing a ‘diffusion Index’, which measures the proportion of indicators of economic activity in the overall economy that are experiencing expansion over a given span of time.
- 11 Another popular method of summarizing the information content of various Indicators is to apply ‘Principal Component’ Analysis (PCA). PCA is, however, a purely statistical procedure that yields one or more linear combinations of the series that explain major parts of the variations. Though PCA has a solid statistical background, the interpretations of the weights are often not very clear (Bikker and Kennedy, 1999, Samanta 2000). An alternative method is based on rigorous econometric modelling. A possible approach (Simone 2001) is “general to specific” modelling approach using distributed lags of several variables.
- 12 Three different methodologies have been considered for constructing the composite index. These are  
Method 1: Taking simple average of the indicators so chosen,  
Method 2: Regression based composite Index, with regression parameters as the weights for the composite index and where the regression analysis has been done with respect to the original growth series and not the standardised series and  
Method 3: PCA based Composite Index. A detailed discussion of the three methods is presented in Appendix 2.5.
- 13 After the construction of the composite index next task is to evaluate the performance of its out-of-sample forecasts. Performance mainly refers to the closeness of the predicted with the actuals. To test the forecasting accuracy of the composite indicator, we can use the usual distance measures like Root Mean Square Percentage Errors (RMSPE), Mean Absolute Error (MAE), Mean Square Error (MSE) and Mean Absolute Percentage Errors (MAPE) can be used. However, for our analysis we confine to MSE and MAE as performance criteria.
- 14 The forecast performance of the different methods is presented in Table 2.6A of Appendix 2.6. They indicate that Method 2 is relatively superior as compared to the other two methods with respect to both point wise forecast performance and direction. Here, it needs to be mentioned that for both the methods if the insignificant variables are excluded, forecast performances relatively worsens. Table 2.6B provides a comparative analysis of various method-based forecasts with the actuals. One important observation, which needs to be

emphasised, is that both money supply and non-food credit have significant positive effect on industrial output.

- 15 As in the context of monthly series, the same set of six indicators, viz., Narrow Money (M1), Non-food-credit (NFC), WPI-Raw materials (WPIIR) Production of Aluminium (Alu), Rails good traffic Originated (Gtr) and Production of Coal (Prod. Coal) have been considered in an empirical exercise based on quarterly data. Data period is from April 1993 to December 2000, whereas monthly series data were considered from April 1993 to January 2001.
- 16 The OLS results using quarterly data are summarized in Table 2.7A, which shows that only non-food credit is the significant variable. However, the other variables have not been dropped as forecast performances became relatively worse and DW statistic deteriorated when they are not included in the equation.
- 17 Comparing the results, it is observed that the in-sample performances of the quarterly data based results are better than the monthly data based results. Table 2.7C summarises the forecast (out of sample) performances of both quarterly as well as monthly series based forecasts. Forecasts are for two quarters (six months) ahead. The criteria used are mean square error (MSE) and Mean absolute error (MAE) and per cent of correct direction.



### Appendix 2.1: Initially-selected 43 Indicators based on Economic Considerations

Variable Name	Unit
Broad Money (M3)	In Rs.Crores
Narrow Money (M1)	In Rs.Crores
Reserve Money (RM)	In Rs.Crores
Currency with public (CWP)	In Rs.Crores
Aggregate Deposit (AD)	In Rs.Crores
Non-food credit (NFC)	In Rs.Crores
Bank credit (BC)	In Rs.Crores
Investment Deposit Ratio (IDR)	Per cent
Net foreign exchange asset with RBI (NFE)	In Rs.Crores
Call money rate (CMR)	% Per annum
Real Bank Rate (BR) **	% Per annum
Real Prime lending Rate (PLR) **	% Per annum
Exchange rate (Dollar Vs. Rs.) (ER)	
REER	
US\$ vs. Yen Exchange rate (ERY)	
US\$ vs. Pound Exchange rate (ERP)	
Export	In US \$
Import	In US \$
Stock of Foodgrains with Government (FCI)*	In Million Tonnes
SENSEX	Index
Gold Price (Mumbai)(GP)	Rs per 10 grams
Silver Price (Mumbai) (SP)	Rs. Per Kilogram
International Oil price (Dubai) (IOP)	In US\$ per Barrel
Dow-Jones Stock Price Index (DW)	Index
Registered Unemployment* (UMP)	Thousand Number
WPI All Commodities (WPI)	Index (1993-94=100)
WPI Manufactured Products (WPIMP)	Index (1993-94=100)
WPI Food Article (WPIFA)	Index (1993-94=100)
WPI Industrial Raw Material (WPIIR)	Index (1993-94=100)
CPIIW	Index (1982=100)
No. of Commercial Vehicle production* (CVP)	Thousand Number
Production of Steel* (steel)	Thousand Number
Production of Cement* (Cement)	Thousand Number
Production of Aluminium* (Alu)	Tonnes
Electricity-Total (Elec)*	Mn. Kwh
Hydro-Electricity (Hyelec)*	Mn. Kwh
Thermal Electricity (Thelec)*	Mn. Kwh
Railway Goods Traffic Originating* (Gtr)	Crores Tonnes
Railway Gross Earnings*	Rs. Crores
Tourists*	Number
Production of Coal*	Lakhs tonnes
Sale of Coal*	

**Note: All data except those marked with \* are from April 1982 to October 2001 and data corresponding to (\*) is from April 1992 to January 2001.**

\*\* Real interest rates are computed as nominal interest rates less WPI - *All Commodities* based inflation rate in this exercise

### Appendix 2.2: Cross-Correlation in Growth Rates with IIP-lags

Variable \ Lag	1	2	3	4	5	6	7	8	9	10	11	12
Broad Money (M3)	0.08	0.07	0.05	0.08	0.09	0.11	0.1	0.1	0.1	0.12	0.16*	0.18*
Narrow Money (M1)	0.32*	0.28*	0.23*	0.27*	0.23*	0.21*	0.19*	0.13	0.13	0.09	0.07	0.05
Reserve Money (RM)	0.18*	0.14	0.02	-0.05	-0.07	-0.15	-0.18*	-0.22*	-0.28*	-0.27*	-0.29*	-0.33*
Currency with public (CWP)	0.45*	0.39*	0.33*	0.30*	0.24*	0.19*	0.12	0.03	-0.02	-0.07	-0.05	-0.03
Aggregate Deposit (AD)	0.08	0.11	0.15	0.18*	0.20*	0.23*	0.24*	0.26*	0.29*	0.30*	0.33*	0.32*
Non-food credit (NFC)	0.39*	0.43*	0.45*	0.46*	0.44*	0.44*	0.42*	0.40*	0.39*	0.35*	0.33*	0.29*
Bank credit (BC)	0.32*	0.36*	0.37*	0.38*	0.36*	0.35*	0.33*	0.31*	0.29*	0.26*	0.25*	0.22*
Investment Deposit Ratio (IDR)	-0.18*	-0.20*	-0.19*	-0.2*	-0.22*	-0.18*	-0.21*	-0.21*	-0.21*	-0.20*	-0.23*	-0.22*
Net foreign exchange asset with RBI (NFE)	0.39*	0.43*	0.45*	0.46*	0.44*	0.44*	0.42*	0.4*	0.39*	0.35*	0.33*	0.29*
Exchange rate (Dollar Vs.Rs.) (ER)	-0.01	-0.02	-0.01	0.02	0.06	0.08	0.03	-0.01	-0.03	-0.06	-0.1	-0.1
REER	-0.05	-0.12	-0.19*	-0.18*	-0.26*	-0.22*	-0.19*	-0.22*	-0.20*	-0.17*	-0.15	-0.11
US\$ vs. Yen Exchange rate (ERY)	0.09	0.08	0.13	0.18*	0.22*	0.26*	0.24*	0.21*	0.17*	0.17*	0.20*	0.21*
US\$ vs. Pound Exchange rate (ERP)	0.09	0.20*	0.29*	0.36*	0.43*	0.47*	0.50*	0.52*	0.54*	0.57*	0.57*	0.54*
Export	0.24*	0.28*	0.20*	0.09	0.09	-0.01	0.04	-0.06	-0.09	-0.12	-0.18*	-0.19*
Import	0.27*	0.26*	0.20*	0.14	0.07	0.02	0.08	0.04	0.01	-0.08	-0.16*	-0.19*
Stock of Foodgrains with Government (FCI)	-0.13	-0.18*	-0.21*	-0.26*	-0.27*	-0.31*	-0.34*	-0.35*	-0.37*	-0.36*	-0.38*	-0.37*
SENSEX	0.04	0.05	0.05	0.02	0	-0.01	-0.05	-0.06	-0.07	-0.13	-0.18*	-0.24*
Gold Price (Mumbai) (GP)	0.19*	0.19*	0.16*	0.15	0.19*	0.15	0.11	0.07	0.03	-0.07	-0.12	-0.18*
Silver Price (Mumbai) (SP)	0.42*	0.47*	0.47*	0.43*	0.47*	0.39*	0.35*	0.28*	0.19*	0.04	-0.14	-0.25*
International Oil price (Dubai) (IOP)	0.15	0.19*	0.24*	0.25*	0.29*	0.27*	0.29*	0.29*	0.27*	0.28*	0.25*	0.21*
Dow-Jones Stock Price Index (DW)	0.36*	0.29*	0.25*	0.25*	0.19*	0.18*	0.11	0.1	0.07	0.06	0.02	0.05
Registered Unemployment (UMP)	-0.02	0.03	0.08	0.11	0.13	0.2	0.21*	0.19*	0.22*	0.24*	0.27*	0.29*

Note : \* denotes significance of correlation coefficient at 5 % level of significance

(Contd.)

**Appendix 2.2: Cross-Correlation in Growth Rates with IIP-lags (Concl.)**

Variable/ Lag	1	2	3	4	5	6	7	8	9	10	11	12
WPI-All Commodities (WPI)	-0.03	-0.01	0.05	0.08	0.1	0.15	0.18	0.22	0.25	0.26	0.24	0.22
							*	*	*	*	*	*
CPIIW	-0.15	-0.15	-0.14	-0.14	-0.15	-0.1	-0.1	-0.09	-0.09	-0.08	-0.1	-0.12
WPI Manufactured Product (WPIMP)	-0.14	-0.18	-0.23	-0.28	-0.32	-0.32	-0.35	-0.37	-0.38	-0.39	-0.40	-0.41
		*	*	*	*	*	*	*	*	*	*	*
WPI Food Article (WPIFA)	-0.17	-0.14	-0.04	0.01	0.07	0.14	0.19	0.27	0.33	0.39	0.38	0.37
	*						*	*	*	*	*	*
WPI Industrial Raw Material (WPIIR)	-0.16	-0.19	-0.18	-0.17	-0.18	-0.17	-0.17	-0.18	-0.18	-0.20	-0.22	-0.21
	*	*	*	*	*	*	*	*	*	*	*	*
No. of Commercial Vehicle production (CVP)	0.16	0.16	0.17	0.13	0.15	0.06	0.14	0.06	0.07	0.07	0.01	-0.02
	*	*	*									
Production of Steel (steel)	0.20	0.13	0.05	0	-0.06	-0.08	-0.14	-0.15	-0.18	-0.19	-0.16	-0.12
	*								*	*	*	
Production of Cement (Cement)	0.24	0.13	0.19	0.12	0.17	0.07	0.12	-0.01	-0.09	-0.14	-0.19	-0.08
	*		*		*						*	
Production of Aluminium (Alu)	0.21	0.18	0.13	0.21	0.25	0.21	0.15	0.13	0.18	0.17	0.21	0.09
	*	*		*	*	*			*	*	*	
Electricity-Total (Elec)*	0.22	0.14	0.04	-0.03	-0.03	-0.13	-0.01	-0.09	-0.1	-0.16	-0.28	-0.22
	*									*	*	*
Hydro-Electricity (Hyelec)	-0.26	-0.27	-0.32	-0.33	-0.28	-0.21	-0.05	-0.08	-0.04	-0.1	-0.08	-0.05
	*	*	*	*	*	*						
Thermal Electricity (Thelec)	0.41	0.34	0.28	0.22	0.18	0.03	0.03	-0.02	-0.06	-0.08	-0.22	-0.17
	*	*	*	*	*						*	*
Railway Goods Traffic Originating* (Gtr)	0.36	0.42	0.29	0.31	0.24	0.20	0.16	0.14	0.07	0	-0.03	0.01
	*	*	*	*	*	*	*					
Railway Gross Earnings	0.15	0.03	0.02	-0.05	-0.05	-0.04	-0.11	-0.13	-0.16	-0.19	-0.19	-0.06
									*	*	*	
Tourists	0.16	0.16	0.17	0.13	0.15	0.06	0.14	0.06	0.07	0.07	0.01	-0.02
	*	*	*									
Production of Coal	0.27	0.32	0.25	0.32	0.25	0.33	0.34	0.32	0.32	0.18	0.15	0.1
	*	*	*	*	*	*	*	*	*	*		
Sale of Coal	-0.20	-0.13	-0.12	-0.17	-0.11	-0.15	-0.06	-0.08	0	-0.01	0.01	0
	*			*								
Call money rate (CMR)	0.33	0.43	0.35	0.36	0.32	0.34	0.30	0.17	0.14	0.09	0.05	-0.01
	*	*	*	*	*	*	*	*				
Real Bank Rate (BR)	0.22	0.23	0.22	0.22	0.24	0.20	0.22	0.21	0.21	0.21	0.21	0.22
	*	*	*	*	*	*	*	*	*	*	*	*
Real Prime lending Rate (PLR)	0.32	0.33	0.33	0.32	0.33	0.28	0.28	0.26	0.26	0.24	0.24	0.25
	*	*	*	*	*	*	*	*	*	*	*	*

Note : \* denotes significance of correlation coefficient at 5 % level of significance

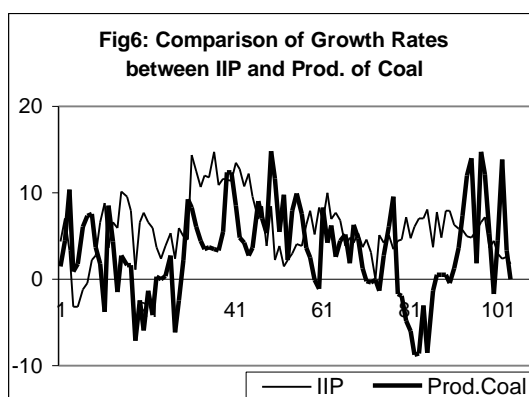
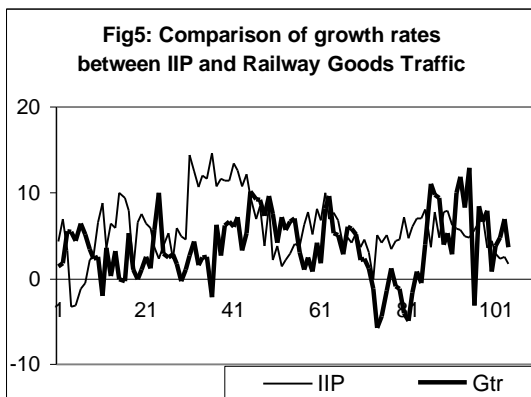
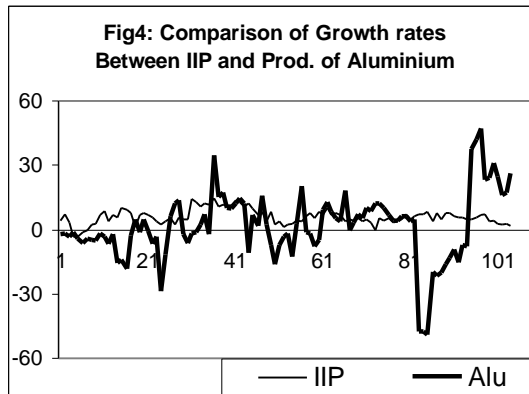
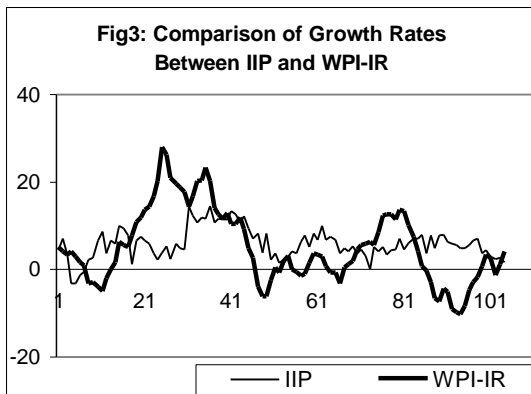
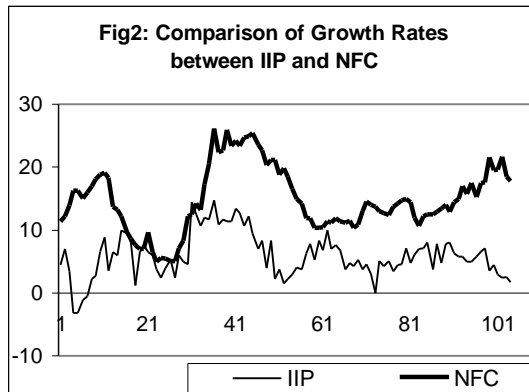
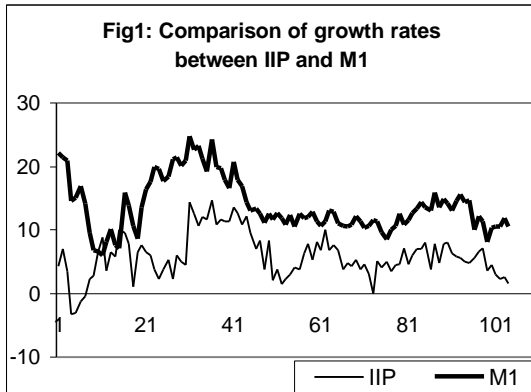
**Appendix 2.3: Finally Selected Indicators for Construction of  
Composite Index of Leading Indicators**

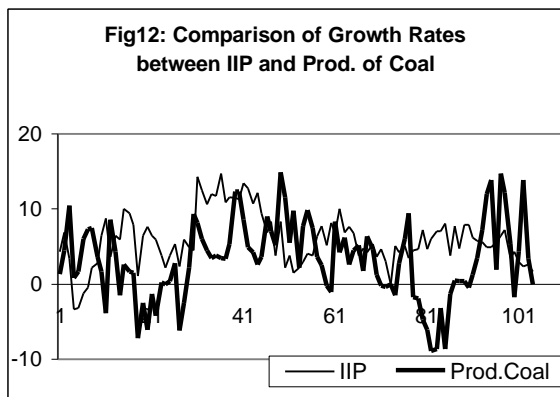
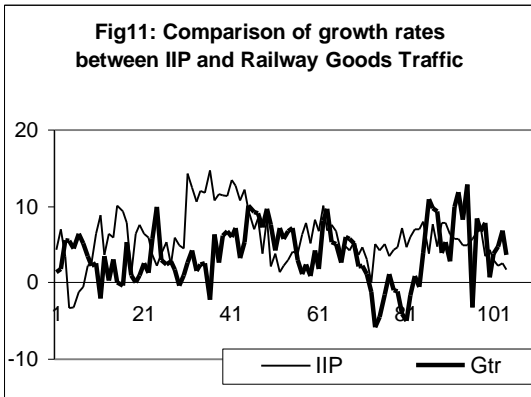
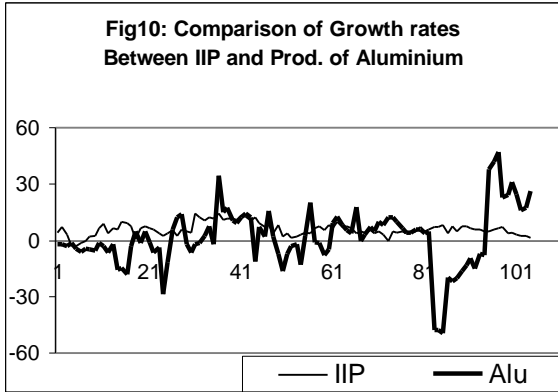
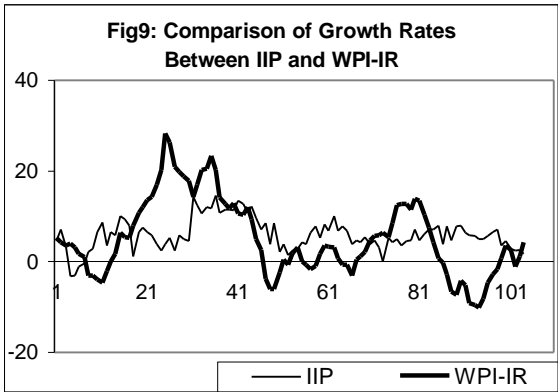
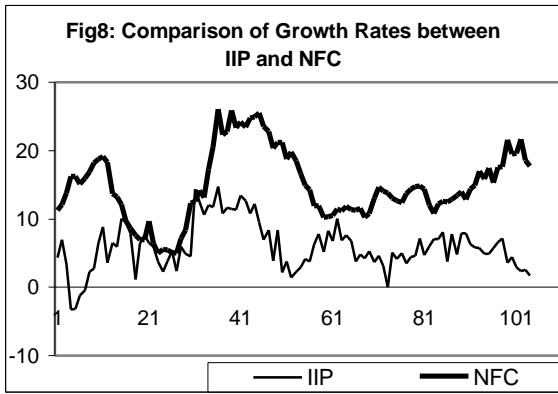
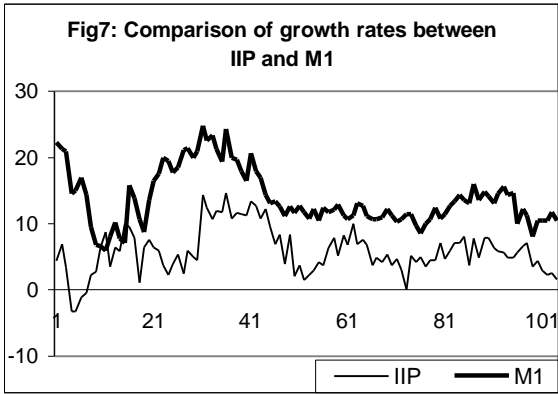
<b>Variable</b>	<b>Lead period (in months) for Composite Index</b>
M1	6 (0.21)
Non food credit	6 (0.44)
WPI-Raw materials	11 (-0.17)
Prod. Of Aluminium	6 (0.21)
Rails good traffic originated	6 (0.20)
Prod. Of Coal	6 (0.33)

**Note: Cross correlations are given in parenthesis (). The sign of the correlation indicates the nature of relationship with IIP.**

## Appendix 2.4

(Figures 1 - 6 are on the same time point, *e.g.*,  $IIP_t$  vs.  $M1_t$ , whereas Figures 7 - 12 are on the lead-lag, *e.g.*,  $IIP_t$  vs  $M1_{(t-6)}$ )





## Appendix 2.5: Methodologies for Construction of Composite Indicator

### Method 1

Let  $X_1$  and  $X_2$  be two leading indicators with lead period  $L_1$  and  $L_2$ , respectively. Then the composite leading index for the target series for the time period  $t$  is  $X_1(t - L_1) \cdot X_2(t - L_2)$ . This combination is formed with respect to the standardised series. This technique gives unequal weight inversely proportional to the standard deviation of the corresponding series. However, forecasts are given for the original growth series using inverse transformation.

### Method 2

Here the focus is on the fitted regression line. The linear regression, which looks like:

$$IIP_t = \beta_0 + \beta_1 M_1(t-6) + \beta_2 NFC(t-6) + \beta_3 WPIIR(t-11) + \beta_4 Alu(t-6) + \beta_5 Gtr(t-6) + \beta_6 Prod.coal(t-6) + \epsilon_t$$

is estimated by ordinary Least Square (OLS) method. The estimated OLS equation is as follows:

$$IIP_t = 1.58 + 0.30M_1(t-6) + 0.27NFC(t-6) + 0.04WPIIR(t-11) + 0.005Alu(t-6) + 0.08Gtr(t-6) + 0.07Prod.coal(t-6) + \epsilon_t$$

The OLS results are summarized in Table 2.5A, which shows that intercept, WPI for Industrial Raw Material (WPIIR), Production of Aluminium (Alu), Railway Goods Traffic Originating (Gtr) and Production of Coal (Coal) are insignificant. However, these variables have not been dropped as forecast performances became worse and DW statistic deteriorated after dropping them. Results of OLS after dropping these insignificant variables are presented in Table 2.5B.



**Table 2.5 A: OLS Results Corresponding to the IIP equation**

Coefficients and Different Test Statistics*	Different Explanatory Variables						
	Intercept	M1	NFC	WPIIR	Alu	Gtr	Coal
Coefficient	-1.58	0.30	0.27	0.04	0.005	-0.08	-0.06
t-statistics	-0.82 (1.65)	2.44 (1.65)	3.57 (1.65)	0.58 (1.65)	0.17 (1.65)	-0.69 (1.65)	0.75 (1.65)
Hansen's test (l)	0.14 (0.47)	0.16 (0.47)	0.21 (0.47)	0.25 (0.47)	0.26 (0.47)	0.60 (0.47)	0.27 (0.47)
Model criteria	R <sup>2</sup> =0.38; R <sup>2</sup> (adjusted)=0.33; DW= 0.90; F= 7.397						
Hansen's test (l) for variance	0.73 (0.47)						
Hansen's Joint test (L <sub>c</sub> )	3.79 (2.11)						
Condition Number (test for Multicollinearity)	16.94 (20-above)? signal for danger due to multicollinearity						

**Note: 5% critical values are given in brackets**

**Table 2.5 B: OLS Results for Significant Variables**

Coefficients and Different Test Statistics*	Different Explanatory Variables		
	Intercept	M1	NFC
Coefficient	-2.00	0.34	0.25
t-statistics	-1.49 (1.65)	4.73 (1.65)	4.26 (1.65)
Hansen's test (l)	0.12 (0.47)	0.18 (0.47)	0.18 (0.47)
Model criteria	R <sup>2</sup> =0.35; R <sup>2</sup> (adjusted)=0.33; DW= 0.87; F= 20.63		
Hansen's test (l) for variance	0.85 (0.47)		
Hansen's Joint test (L <sub>c</sub> )	1.94 (1.24)		
Condition Number (test for Multicollinearity)	8.49 (20-above)? signal for danger due to multicollinearity		

**Note: 5% critical values are given in brackets**

Durbin-Watson (DW) test statistic suggests that residuals are positively autocorrelated. This essentially implies that there is scope to improve the model and there is leftover information in the data. Several other specifications with other variables like prime lending rate, WPI-All commodities, CPIIW, production of cement, steel etc., were attempted without any improvement to DW statistic. In order to resolve the problem of DW, several lags of IIP were incorporated. Lag 1 has turned out significant and consequently DW has improved substantially. However, this specification involving autoregressive-distributed lag / transfer function model was ignored since the main purpose is to generate forecast for at least six-months ahead.

From Table 2.5A, it is evident that Hansen's 'I' (individual-parameter stability test) criteria evidenced parameter instability in variance and also in slope coefficient of 'Gtr'. Parameter instability in variance suggests there is scope for improvement of the model. The overall test or the joint test statistics i.e., 'Lc' criteria is 3.78 (5% critical value is 2.11) which also implies that the distributional parameters are time dependent. As the parameters are not stable, at the time of forecasting, for every new observation, the model has been re-estimated.

### Method 3

Typically, the form of principal components based on indicators  $X_l(t)$ 's,  $l=1,2,\dots,k$  is as below;  
 $P_j(t) = a_{j1} X_1(t) + a_{j2} X_2(t) + \dots + a_{jp} X_p(t); \quad j=1,2, \dots,k,$   
 where  $P_j(t)$  is the  $j$ -th principal component and  $a_{jl}, l=1,2,\dots,k$  are the coefficient, known as factor loadings, of  $l$ -th indicator in  $j$ -th principal component. In practice first (or at least first few) principal component(s) normally captures sufficient information to represent the multivariate data. Suppose  $k$  leading indicators are selected to form the composite index. Let  $l_j, j=1,2,\dots,k;$  be the lead period of  $j^{\text{th}}$  indicator/series  $X_j(t)$ , which is suitably transformed. Thus to assess the prospect of the target series (IIP) at time point  $t$ , one has to combine  $X_j(t-l_j), j=1,2, \dots,k$  values. Therefore, principal components (PCs) may be derived based on past information on  $X_j(t-l_j)$ 's. Composite index can be constructed by following two possible approaches; first by regressing target series on a few PCs and second, by regressing target series on summation of first few PCs. In both the approaches, one needs to choose first few PCs. The PCs can be chosen based on either of the two criteria. One is based on the cumulative contribution of chosen PCs to the total data variation where the number of PCs chosen is decided by some cut-off for the cumulative contribution. The other criterion is based on the out-of-sample forecast performance of the PCs. As the primary interest here is forecasting of the targeted series, the second criterion is adopted for selection of PCs. Based on this criterion, all the six PCs are chosen for further computation of the composite index. The cumulative contribution of various principal components (PC) is given below.

**Table 2.5 C**

Eigen values in ascending order	Cumulative contribution
195.6625	33.4459
165.7020	61.7704
103.1879	79.4090
69.2480	91.2460
32.6660	96.8298
18.5462	100.0000

**Approach 1:** In this approach, suppose two PCs are chosen then the composite index, say  $CI1(t)$ , is calculated from the relationship

$$CI1(t) = \alpha + \beta [ P_1(t) + P_2(t) ]$$

where  $\alpha$  and  $\beta$  are estimated from the following regression equation

$$Y(t) = \alpha + \beta [ P_1(t) + P_2(t) ] + e(t); e(t) \text{ being the residual series.}$$

**Approach 2:** In this approach, the target series,  $Y(t)$  is regressed on the first three PCs so chosen and the estimated value of  $Y(t)$  is treated as the composite index. Thus the form of this composite index, denoted by  $CI2(t)$ , looks like

$$CI2(t) = ? + ?_1 P_1(t) + ?_2 P_2(t)$$

where  $?$ ,  $?_1$ , and  $?_2$  are estimated coefficients in the regression equation

$$Y(t) = ? + ?_1 P_1(t) + ?_2 P_2(t) + e(t), e(t) \text{ being the residual series.}$$

However, the second approach, which is more general, has been considered..

The following table, Table 2.5D summarises the OLS results corresponding to Approach 2. Only the first two PCs (PC1 and PC2) have been found as significant. However, as far as DW is concerned this PC based OLS suffers from same problems as seen in applying Method 2.

**Table 2.5 D - OLS results based on Principal Components**

Coefficients and Different Test Statistics*	Explanatory Variables						
	Intercept	PC1	PC2	PC3	PC4	PC5	PC6
Coefficient	6.29	0.53	-1.21	0.55	-0.65	0.61	0.82
t-statistics	(17.97)	(2.12)	(-4.66)	(1.46)	(-1.59)	(1.09)	(1.05)
Hansen's test (l)	0.144	0.4152	0.3119	1.0510	0.6670	0.0622	0.3609
Model criteria	$R^2=0.38$ ; $R^2$ (adjusted)=0.33; DW= 0.90; F= 7.397						
Hansen's test (l) for variance	0.73 (0.47)						
Hansen's Joint test ( $L_c$ )	3.79 (2.11)						
Condition Number(test for Multicollinearity)	1.057 (20-above)? signal for danger due to multicollinearity						

**Notes:**

i. 5% critical values are given in brackets

ii. As expected (matter of tautology) that regression diagnostics of Table 2.5 A and Table 2.5 D are same. Similar fact also holds for forecasts (see Appendix 2.6 and 2.7). If insignificant PCs are dropped, the resulting OLS findings are summarised in Table 2.5 E.

**Table 2.5 E: The OLS results based on significant PCs only.**

Coefficients and Different Test Statistics*	Explanatory Variables		
	Intercept	PC1	PC2
Coefficient	6.22	0.56	-1.24
t-statistics	(18.01)	(2.26)	(-4.82)
Hansen's test (l)	0.1283	0.3985	0.5074
Model criteria	$R^2=0.31$ ; $R^2$ (adjusted)=0.29; DW= 0.86; F= 16.73		
Hansen's test (l) for variance	1.4286 (0.47)		

Hansen's Joint test ( $L_c$ )	2.31 (1.24)
Condition Number(test for Multicollinearity)	1.04 (20-above)? signal for danger due to multicollinearity

**Note: 5% critical values are given in brackets**

## Appendix 2.6: Forecast Performance of the Composite Indicator

**Table 2.6 A**

Forecast Performance Criteria	Various Methods				
	Method 1	Method 2		Method 3	
		All Variables	Only Significant indicators	All PCs	Only Significant PCs
MSE	6.3279	1.6235	2.4778	1.6235	2.5456
MAE	2.0594	1.0510	1.3826	1.0510	1.3847
Per cent of correct direction	47%	67 %	53%	67%	40%

**Note:**  $MSE = \frac{1}{k} \sum_{t=1}^k (y_t - yf_t)^2$ ,  $MAE = \frac{1}{k} \sum_{t=1}^k |y_t - yf_t|$ ,  $y_t$  and  $yf_t$ , are actuals and forecast, respectively, for the time point  $t$ ,  $k$ =number of forecasts. In our case  $k=15$ .

**Table 2.6 B - Actuals Vs Forecasts**

Month	Actuals	Forecasts				
		Method 1	Method 2		Method 3	
			All variables	Only Significant Indicators	All PCs	Only Significant PCs
Nov 1999	8.0495	2.9849	6.7507	5.8235	6.7507	6.2931
Dec 1999	3.7538	5.8309	5.4847	5.5990	5.4847	6.9260
Jan 2000	7.7587	6.0065	6.3088	6.7125	6.3088	7.2273
Feb 2000	4.7688	5.5620	5.6278	6.0268	5.6278	6.4651
Mar 2000	7.8497	4.8864	6.4235	6.6062	6.4235	6.0957
Apr 2000	7.9279	4.6340	5.8523	6.1315	5.8523	5.5754
May 2000	6.2623	4.5482	5.9476	6.1062	5.9476	5.3177
Jun 2000	5.7894	5.7632	5.7449	6.7594	5.7449	5.8787
Jul 2000	5.7120	6.8534	6.0128	7.5925	6.0128	6.1123
Aug 2000	4.9110	6.4689	5.1118	6.8407	5.1118	5.6911
Sep 2000	4.8727	9.5251	5.4151	7.3504	5.4151	6.4994
Oct 2000	5.7047	4.9716	5.6072	5.2060	5.6072	4.0401
Nov 2000	6.5640	8.6179	5.0639	6.5056	5.0639	5.4703
Dec 2000	7.1708	7.0247	5.1647	6.2431	5.1647	5.1032
Jan 2001	3.5486	6.4697	5.4658	5.9732	5.4658	4.3898

## Appendix 2.7: Results of Empirical Exercise using Quarterly Data

As in the case of monthly data, the following regression line has been estimated by Ordinary Least Square (OLS) method:

$$IIP_t = \beta_0 + \beta_1 M_1(t-2) + \beta_2 NFC(t-2) + \beta_3 WPIIR(t-4) + \beta_4 Alu(t-2) + \beta_5 Gtr(t-2) + \beta_6 Prod.coal(t-2) + \epsilon_t$$

The estimated OLS equation is as follows:

$$IIP_t = 2.63 + 0.02M_1(t-2) + 0.26NFC(t-2) + 0.18WPIIR(t-4) + 0.06Alu(t-2) + 0.19Gtr(t-2) + 0.22Prod.coal(t-2)$$

Here it can be noted that the monthly series based equation was:

$$IIP_t = 1.58 + 0.30M_1(t-6) + 0.27NFC(t-6) + 0.04WPIIR(t-11) + 0.005Alu(t-6) + 0.08Gtr(t-6) + 0.07Prod.coal(t-6)$$

The OLS results corresponding to Monthly data are given in Table 2.7A.

**Table 2.7 A: OLS Results corresponding to Regression based on Quarterly Data**

Coefficients and Different Test Statistics	Explanatory Variables						
	Intercept	M1	NFC	WPII R	Alu	Gtr	Coal
Coefficient	2.63	0.02	0.26	0.18	0.06	-0.19	-0.22
t-statistics	0.55 (1.65)	0.33 (1.65)	1.84 (1.65)	1.27 (1.65)	0.6 (1.65)	-0.60 (1.65)	-0.85 (1.65)
Hansen's test (l)	0.07 (0.47)	0.06 (0.47)	0.13 (0.47)	0.13 (0.47)	0.22 (0.47)	0.13 (0.47)	0.21 (0.47)
Model criteria	R <sup>2</sup> =0.66; R <sup>2</sup> (adjusted)=0.48; DW= 1.58; F= 3.17						
Hansen's test (l) for variance	0.43 (0.47)						
Hansen's Joint test (L <sub>c</sub> )	1.41 (2.11)						
Condition Number (test for Multicollinearity)	19.34 (20 and above) ? signal for danger due to multicollinearity						

\* 5% critical values are given in brackets

**Table 2.7 B: OLS Results corresponding to Regression based on Monthly data**

Coefficients and Different Test Statistics*	Explanatory Variables						
	Intercept	M1	NFC	WPIIR	Alu	Gtr	Coal
Coefficient	-1.58	0.30	0.27	0.04	0.005	-0.08	-0.06
t-statistics	-0.82 (1.65)	2.44 (1.65)	3.57 (1.65)	0.58 (1.65)	0.17 (1.65)	-0.69 (1.65)	0.75 (1.65)
Hansen's test (l)	0.14 (0.47)	0.16 (0.47)	0.21 (0.47)	0.25 (0.47)	0.26 (0.47)	0.60 (0.47)	0.27 (0.47)
Model criteria	R <sup>2</sup> =0.38; R <sup>2</sup> (adjusted)=0.33; DW= 0.90; F= 7.397						
Hansen's test (l) for variance	0.73 (0.47)						
Hansen's Joint test (L <sub>c</sub> )	3.79 (2.11)						
Condition Number (test for Multicollinearity)	16.94 (20 and above)? signal for danger due to multicollinearity						

\* 5% critical values are given in brackets

**Table 2.7 C: Comparison of Forecast Performances**

	Quarterly data	Monthly data
<b>MSE</b>	1.98	1.62
<b>MAE</b>	1.09	1.05
<b>Per cent of correct direction</b>	54%	67 %

## Appendix 3

### Illustrative List of Cyclical Indicators

#### Leading Indicators

Average weekly hours, mfg. (hours)  
Average weekly initial claims, unemploy. Insurance  
Vacancies  
Mfrs' new orders, consumer goods and materials (Amount)  
New Orders (from Business Surveys)  
Order Books (from Business Surveys)  
Balance of new orders  
New Company formation  
New car registrations,  
Vendor performance, slower deliveries diffusion index (pct.)  
Mfrs' new orders, nondefense capital goods  
Production bottlenecks (from Business Surveys)  
Financial surplus / deficit of industrial and commercial companies  
Building permits for new private housing units  
Raw material prices  
Index of Stock Prices  
Production (from Business Surveys)  
Money Supply  
Deposit  
Inverted yield curve,  
Interest rate spread, 10-year Treasury bonds less federal funds  
Short-term interest rate on prime bank bills (inverted),  
Exports  
Terms of Trade  
Change in consumers' outstanding borrowing  
Consumer expectations

*(Contd.)*



## Appendix 3

### Illustrative List of Cyclical Indicators (*Concl.*)

#### Coincident Indicators

Real GDP  
Real Non-Agricultural GDP  
Employees on nonagricultural payrolls  
Personal income less transfer payments  
Index of industrial production  
Manufacturing and trade sales

#### Lagging Indicators

Interest rate spread  
Average duration of unemployment in weeks (weeks)  
Ratio, Manufacturing and trade inventories to sales (chain 1996 \$)  
Change in labor cost per unit output, mfg. (6-m pct. AR)  
Average prime rate charged by banks, NSA (pct.)  
Commercial and industrial loans outstanding (mil. Chain 1996 \$)  
Ratio of consumer installment credit to personal income (pct.)  
Change in CPI for services (6-m pct. AR)

## *References*

- Adams, C. and D. Coe (1990), "A Systems Approach to Estimating the Natural Rate of Unemployment and Potential Output for the United States", *IMF Staff Papers*, 37 (2), pp.232-93.
- Ajit, D. (1993), "Capacity Utilization in Indian Industries", *Reserve Bank of India Occasional Papers*, March, Vol. 14, No. 1, pp. 21-46.
- Apel, M. and P.Jansson (1997), *Systems Estimates of Potential Output and the NAIRU*, Economics Department, Sveriges Riksbank.
- Auerbach, A.J. (1982): "The Index of Leading Indicators: Measurement Without Theory, Thirty-Five Years Later", *Review of Economics and Statistics*, pp 589-95.
- Barman, R.B., O.P.Mall and V.M.Doshi (1994), "Quarterly Estimates of India's National Income 1980-81 to 1990-91", *The Journal of Income and Wealth*, Indian Association for Research in National Income and Wealth, Vol. 16, No. 1, January, pp. 75-94.
- Baxter, Marianne and Robert G.King (1995): *Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series*, *Working Paper No. 5022*, National Bureau of Economic Research.
- Berndt, Ernst R. and Catherine J.Morrison (1981), "Capacity Utilization Measures: Underlying Economic Theory and an Alternative Approach", *American Economic Review*, Vol. 71, No. 2, pp 48-52.
- Beveridge, Stephen and Charles R.Nelson (1981): "A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the Business Cycle", *Journal of Monetary Economics*, 151-74.
- Bikker, J.A. and N.O. Kennedy (1999): "Composite Leading Indicators of Underlying Inflation of Seven EU Countries", *Journal of Forecasting*, 18,225-58.
- Burns, Aurthur F. and Wesley C.Mitchell (1946): *Measuring Business Cycles*, National Bureau of Economic Research, New York.
- Canova, Fabio (1998): "Detrending and Business Cycle Facts", *Journal of Monetary Economics*, 475-512.
- Chitre, Vikas S. (1982): "Growth Cycles in Indian Economy", *Arthvijana*, 293-450.
- Chitre, V.S. (1988) : *Fluctuations in Agricultural Income, Public Sector Investment, World Economic Activity and Business Cycles in India*, in *Business Cycles in Five ASEAN Countries, India and Korea*, Institute of Developing Economies, Tokyo.
- Chitre, Vikas S. (1990): "Transmission of World Growth Cycle to the Indian Economy", *Arthvijana*, 281-297.
- Chitre, Vikas (2001), Indicators of business Recessions and Revivals in India: 1951-1982, *Indian Economic Review*, *Special Issue on Analysis of Business Cycle*, Vol. XXXVI, No. 1

Christiano, Lawrence J. and Terry J.Fitzgerald (1999): "The Band Pass Filter", NBER *Working Paper No. 7257*.

Darbha, G. (2001), Identification of Cyclical Phases: A Dynamic Factor – Markov Switching Model in India, *Indian Economic Review, Special Issue on Analysis of Business Cycle*, Vol. XXXVI, No. 1

de Leeuw, Frank (1991): *Towards a theory of Leading Indicators* in Lahiri, K. & Moore, G.H. (ed.) : *Leading Economic Indicators*, Cambridge University Press.

Divatia, V.V and Ravi Varma (1970), "Index of Potential Production and Potential Utilization Ratio for the Manufacturing Industries in India", *Reserve Bank of India Bulletin*, April, 1970.

Dua, Pami and Anirvan Banerji (2001), "An Indicator Approach to Business and Growth Rate Cycles: The case of India", *Indian Economic Review*, Special Issue on Analysis of Business Cycles, Vol. XXXVI, No. 1, pp. 55-78.

Franses, P.H (1996): "*Periodicity and Stochastic Trends in Economic Time Series*, Oxford University Press. UK.

Frisch, Ragner (1933): "Propagation Problems and Impulse Problems in Dynamic Economics", *Economic Essays in Honour of Gustav Cassel*, Allen and Unwin, London, 171-205.

Gangopadhyay, Subhasis & Wilima Wadhwa (1997): *Leading Indicators for Indian Economy*, Report by Ministry of Finance & SERFA, New Delhi

Ghysels, E. (1990): "Unit Root tests and the Statistics Pitfalls of Seasonal Adjustment: The Case of US Postwar Real Gross National Product", *Journal of Business and Economic Statistics*, Vol.8, 145-152.

Ghysels, E. and P.Perron (1993): Effects of Seasonal Adjustment Filters on tests for a Unit Root", *Journal of Econometrics*, Vol.55, 57-98.

Giorno Claude, Pete Richardson, Deborah Roseveare and Paul van den Noord (1995), "Estimating Potential Output, Output Gaps and Structural Budget Balances", Economics Department, *Working Paper No. 152, Organisation for Economic Co-operation and Development*, Paris.

Greenwood, J., Z.Hercowitz. and Gregory Huffman (1988): "Investment, Capacity Utilisation and the Real Business Cycle", *American Economic Review*, 402-17.

Groeneveld, Johannes M. (1998), *Inflation Patterns and Monetary Policy – Lessons for the European Central Bank*, Edward Elgar, USA.

Gordon, Robert J. (ed) (1986): *The American Business Cycle: Continuity and Change*, University of Chicago Press.

Gordon, Robert J (1981): "Output Fluctuations and Gradual Price Adjustment", *Journal of Economic Literature*, 493-530.

Haberler, Gottfried (1937): *Prosperity and Depression*, George Allen and Unwin, London.

Hansen, E. B. (1992): "Testing for Parameter Instability in Linear Regression Models", *Journal of Policy Modeling*, Vol. 14, 517-533.

Harris Richard and Jim Taylor (1985), "The Measurement of Capacity Utilization", *Applied Economics*, Vol. 17, No.5, pp. 849-866.

Hatekar, Neeraj (1993): *Studies in Theory of Business Cycles (with special emphasis on Real Business Cycles and their Applications to the Indian Economy)*, Ph.D.dissertation, University of Bombay.

Hodrick, R.J. and E.C.Prescott (1980): "Postwar US Business Cycles: An Empirical Investigation", *Working Paper No. 451*, Pittsburgh, Carnegie-Melton University (reproduced in the *Journal of Money, Credit & Banking* (1997)).

Hylleberg, S., R.F.Engle, C.W.J. Granger and B.S. Yoo (1990): "Seasonal Integration and Cointegration", *Journal of Econometrics*, Vol.44, 215-38.

Johansen, S. (1988): "Statistical Analysis of Cointegrated Vectors", *Journal of Economic Dynamics and Control*, 231-54.

Joshi, Himanshu (1997): 'Growth Cycles in India : An Empirical Investigation', *Reserve Bank of India Occasional Papers*, 18, 655–679.

Kanagasabhapathy, K and Goyal, Rajan (2001): "Yield Spread as a Leading Indicator of Real Economic Activity: An Empirical Exercise on the Indian Economy", IMF Working Paper 02/91

King, Robert G. and Charles I.Plosser (1984): "Money, Credit and Prices in a Real Business Cycle", *American Economic Review*, 363-380.

Klein, L.R. and Robert Summers (1966), "The Wharton Index of Capacity Utilization", *Studies in Quantitative Economics, No. 1, Department of Economics, Wharton School of Finance and Commerce*, University of Pennsylvania.

Klein, L.R. and R.S.Preston (1967), "Some New Results in the Measurement of Capacity Utilization", *American Economic Review*, Vol. 57, pp 34-58 (Discussion Paper No. 7, Economic Research Unit, Department of Economics, University of Pennsylvania).

Klein, L. R. and Virginia Long (1973), "Capacity Utilization: Concept, Measurement and Recent Estimates", *Brookings Papers on Economic Activity*, Washington, D.C.: The Brookings Institution, Vol. 3, pp. 743-756.

Koopmans, Tjalling (1947): "Measurement without Theory", *Review of Economics and Statistics*, 161-172.

Kshitija, Donde and Mridul Saggur (1999), Potential Output and Output Gap: A Review", *Reserve Bank of India Occasional Papers*, Vol. 20, No. 3, Winter, pp. 439-67.

Kuznets, Simon (1968): *Towards a Theory of Economic Growth with Reflections on the Economic Growth of Nations*, Norton, New York.

Kydland, Finn E. & Edward C.Prescott (1982): "Time to Build Aggregate Fluctuations", *Econometrica*, 1345-70.

Lahiri, Kajal and Geoffrey H.Moore (1991): *Leading Economic Indicators: New Approaches and Forecasting Records*, Cambridge University Press.

Layton, Allan P. & Anirvan Banerji (2001), Dating the Indian Business Cycle: Is output all that Counts?, *Indian Economic Review, Special Issue on Analysis of Business Cycle*, Vol. XXXVI, No. 1

Long Jr., John B. and Charles I.Plosser (1983): "Real Business Cycles", *Journal of Political Economy*, 39-69.

Lucas Jr., Robert E. (1977): "Understanding Business Cycles", in Brunner, K. & Meltzers, A.H. (ed.): *Stablisation of the Domestic and International Economy*, North-Holland, 7-29.

Lucas Jr., Robert E. (1988): "On the Mechanics of Economic Development", *Journal of Monetary Economics*, 3-42.

Mall, O.P. (1999): Composite Indiex of Leading Indicators for Business Cycles in India, RBI Occasional Papers, Winter

Mintz, I. (1969): *Dating Postwar Business Cycles*, National Bureau of Economic Research, New York

Miron, J.A. (1996): *The Economics of Seasonal Cycles*, The MIT Press, Cambridge, UK.

Mitchell, Wesley Clair (1927): *Business Cycles: The Problem and its Setting*, National Bureau of Economic Research, New York.

Mitchell, Wesley Clair and Arthur F.Burns (1938): *Statistical Indicators of Cyclical Revival*, National Bureau of Economic Research, New York.

Mitchell, Wesley Clair (1951): *What Happens During Business Cycles?* National Bureau of Economic Research, New York.

Morrison, Catherine J. (1985), "Primal and Dual Capacity Utilization: An Application to Productivity Measurement in the U.S. Automobile Industry", *Journal of Business & Economic Statistics*, October 1985, pp.743-756.

Moore, Geoffrey H. (1961): *Business Cycle Indicators*, Princeton University Press, Princeton,NJ.

Moore, Geoffery H. and Julius Shiskin (1967): *Indicators of Business Expansions and Contractions*, National Bureau of Economic Research, New York.

Moore, Geoffrey H. and Victor Zarnowitz (1986): *The Development and Role of the National Bureau of Economic Research's Business Cycle Chronologies* in Gordon, Robert G.(ed.): *The American Business Cycle*, University of Chicago Press.

Moore, Geoffrey H. (1989): *Leading Indicators for the 1990s*, Homewood, Ill., Dow Jones-Irwin.

Nachane, D.M. and R. Lakshmi (2002), "Dynamics of Inflation in India – A P-Star Approach", *Applied Economics*, Vol. 34, pp. 101-10.

National Council of Applied Economic Research (2001): *Business Cycle Indicators in the Indian Economy*, Report submitted to the Reserve Bank of India, October.

National Statistical Commission (Chairman:C.Rangarajan) (2001) : Report Submitted to the Prime Minister (2 Vols), August

Nelson, C.R. and C.I. Plosser (1982): "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications", *Journal of Monetary Economics*, 139-62

Nilsson, Ronny (2001) : OECD System of Leading Indicators, Paper presented at the Joint ECLAC-OECD-IPEA Seminar on Leading Indicators, Rio De Janeiro, December

Organisation of Economic Development and Cooperation (1987): *Leading Indicators for OECD Countries: Sources and Methods*, OECD, Paris.

Osborn, Denise R., Marianne Sensier and Paul W.Simpson (2001): "Forecasting and the UK Business Cycle" in David F.Hendry and Neil R. Ericsson (eds): *Understanding Economic Forecasts*, The MIT Press

Ploberger, W. and W.Kramer. (1990): "The Local Power of the CUSUM & CUSUM of Square Tests", *Econometric Theory*, vol. 6, 335-347.

Priestly, M.B. (1981): *Spectral Analysis and Time Series*, Academic Press, London.

Rede, Lata Arun (1988): "Business Cycles and Rate of Profit in Indian Manufacturing Industries: 1950-51 to 1977-78", *Arthavijnana*, 287-313.

Reserve Bank of India (1968), "On the Recent Recessionary Trends in Organised Industry", *RBI Bulletin*, July.

Reserve Bank of India (1996), "An Estimate of Capacity Utilisation – Manufacturing Sector", *RBI Bulletin*, August, pp. 30.

Reserve Bank of India (2002), *Report on Currency and Finance, 2000-01*

Samanta, G.P. (2000): Inflation in India: Measurement, Forecast and Some Recent Issues, Ph.D. Dissertation, University of Mumbai.

Sastry, D.U. (1978), "Capacity Utilization in the Cotton Mill Industry in India", *E/59/78*, *Institute of Economic Growth*, University Enclave, Delhi, India.

Simone, A. (2001): 'In search of Coincident and Leading Indicators of Economic Activity in Argentina', IMF Working Paper, WP/01/30.

Sishkin, J. (1961): Signals of Recession and recovery: An Experiment with Monthly Reporting, National Bureau of Economic research, New York.

Stock, James H. and M.W.Watson (1989): "New Indexes of Coincidental and leading Economic Indicators", *NBER Macroeconomic Annual*, 351-94.

Stock, James H. and M.W.Watson (1993): "A Procedure for Predicting Recessions with Leading Indicators: Econometric Issues and Recent Performance", in *New Research on Business Cycle Indicators and Forecasting*, (eds) Stock, J.H. and Watson, M.W., University of Chicago.

Tinbergen, Jan (1939): *Statistical Testing of Business Cycle Theories*, The League of Nations, Geneva.

Zarnowitz, V. and Geoffrey H. Moore (1982): "Sequential Signals of Recession and Recovery", *Journal of Business*, 57-85.

Zarnowitz, Victor (1992): *Business Cycles - Theory, History, Indicators and Forecasting*, National Bureau of Economic Research.