ECONOMIC ANNALS, Volume LXII, No. 213 / April – June 2017
UDC: 3.33 ISSN: 0013-3264

**DOI:10.2298/EKA1713007P**

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# AN EMPIRICAL ANALYSIS OF INDIAN BUSINESS CYCLE DYNAMICS

**ABSTRACT:** *This paper attempts to construct a monthly Composite Index of Leading Indicators (CILI) for the Indian business cycle between April 1994 and December 2015. The cyclical component of the Index of Industrial Production (IIP), generated by Baxter-King band pass filters, is considered as a reference series for Indian business cycle analysis. A set of indicator variables pertaining to different sectors of the economy are chosen on the basis of their strong leading correlation with the reference series. Further, Principal Component Analysis (PCA) technique is applied to assign an appropriate weight to each leading variable, and a CILI is constructed. The performance of the CILI is validated using the turning-point analysis of BryBoschan and Harding-Pagan. The CILI accurately predicts two major troughs in the Indian business cycle, with six and eleven month leads respectively.*

**KEY WORDS:** *Business Cycle, Composite Index of Leading Indicators.*

**JEL CLASSIFICATION:** B22, E17.

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## 1. INTRODUCTION

Economics literature defines a business cycle as recurring and fluctuating levels of economic activity that an economy experiences over a long period of time. The periods of high activity are called upswings or expansions, and the periods of low activity are called downswings. In between there are recovery phases, which link the consecutive peaks and troughs of the business cycle. Unlike in physics, the cycles of economic activity are uneven and not smooth enough to show regularity in terms of periodicity over a long time horizon. There are several approaches to this definitional notion of a business cycle. In the 1940s, Burn and Mitchell (1946) summarized empirical definitions of the business cycle as "a type of fluctuation found in the aggregate economic activity of nations that organize 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 revivals which merge into the expansion phase of the next cycle". The new paradigm of economic research on business cycles starts with the real business-cycle theory of Lucan (1980) and Kydland and Prescott (1982). Kydland and Prescott (1982) describe business cycles as recurrent natural events. Their basic objective is to build an artificial imitation of the real economy where each agent optimizes their choice in a perfectly competitive market structure and works under repeated shocks to productivity. In this context it is important to note that real business cycle theory does not subscribe to the effectiveness of monetary policy, and price fluctuation is the main reason for continuous market clearing. The real business cycle, as the most wellknown school of thought, has faced numerous challenges from other thinkers such as James Tobin (1996). He criticizes the 'Robinson Crusoe' macroeconomic model of the real business-cycle school since it fails to address important factors like coordination between different economic agents. Over time, different ideas and schools of thought have explained the fluctuation in the major macroeconomic variables in various ways.

New Keynesian economists like Mankiw and Romer propagate a different approach to change in output and other macro-variables by asserting that non-neutrality of money and imperfect market structure are contrary to the real business cycle way of understanding the economic dynamic of an economy. Apart from these schools of thought, there are heterodox schools of thinkers, like Marxian economists who believe that profit is the sole factor in the market economy's propagation but that there is an inherent tendency of profit to decline over time and create crises in the economy, and the recurrence of crisis leads to business cycle fluctuation in output and employment.

Recent developments in business cycle research centre around the empirical modelling of the unobservable cyclical part of time series. The theoretical evolution of business cycles has paved the way for the development of a wide range of affiliated economic literature. The prediction of business cycle movement has become increasingly important in the context of the recent globalization, since unanticipated shocks of both global and domestic origin play a significant role in shaping the business cycle movement of an economy. The macroeconomic policies of an economy greatly affect crucial components like output, inflation, employment, and, at the aggregate level, business cycle fluctuations. Economists and policymakers' priority has become establishing an empirical exercise for predicting both recessions or the economic downturn of these components – and aggregate output. There are three major approaches to analysing business cycle movements, through classical cycles, growth cycles, and growth rate cycles. The classical business cycle measures the upswing and downswing in the absolute levels of any economic activity in an economy. A Generally Coincidental Index covering different sectors of the economy is constructed to represent current economic activity. The movement in the absolute level of this coincidental index indicates the different phases of the economy. One of the most popular determinants of recession is an absolute decline in the level of the coincidental index for two successive quarters. The growth cycle tracks the upswings and downswings through deviations of the actual growth rate of the economy from its long-run trend of growth. If growth in economic activity is higher (lower) than the long-run trend, then the corresponding phase is called an economic boom (recession). But calculation of the long-run trend is a problematic issue. Generally, methods like the Hodrick-Prescott (HP) filter and Phase-Average-Trend (PAT) are widely used to estimate the trend component from a time series. However, these estimates are subject to some crucial shortcomings, like end-point bias.

Owing to the above limitation, the growth rate cycles approach has replaced the growth cycle method. Growth rate cycles are cyclical upturns and downturns in the growth rate of economic activity. The most common forms of the growth rate are the month-to-month (quarter-to-quarter) changes in any time series. Though monthly data contains more noise than quarterly series, it is preferred over the latter because of its richer information. An alternative way to estimate the growth rate cycle is the six-month smoothed growth rate that is used by the

Economic Cycle Research Institute (ECRI), which is the ratio of the latest month's figure to its average over the preceding twelve months. In business cycle analysis, identification of a benchmark or reference series is very important, since it represents the whole or major part of the economy. A major exercise for policymakers is finding a suitable proxy, either as a single series or as a combination of several series. According to Moore (1982), "No single measure of aggregate economic activity is called for in the definition because several such measures appear relevant to the problem, including output, employment, income, and trade, and no single measure is either available for a long period or possesses all the desired attributes". This is why economic activity may be represented by four broad sectors: output, employment, income, and trade. Gross Domestic Product (GDP) can be treated as a single series which covers all these sectors and represents them at an aggregate level. An alternative way to capture a complete representation of the economy is to make a composite index for the economy by considering important factors pertaining to different economic sectors. This new composite indicator series can be broadly classified into three groups: leading, coincidental, and lagging indicators. The leading indicator is an economic time series that precedes the reference series in terms of its fluctuations and can forecast a recessionary phase in advance. The coincidental indicator moves in tandem with the reference series. The cyclical component of the lagging indicators turns after the turns of the reference series, which is important for analysing the reference series' past behaviour. Of these three indicators, the composite index of leading indicators (henceforth CILI) is the most important tool for macroeconomic policymakers since it predicts business cycle fluctuations in advance.

## 2. EMPIRICAL STUDIES OF INDIAN BUSINESS CYCLES

Most of the empirical works on the Indian economy's business cycle are based on the growth cycle approach. A few studies concentrate on the other two methods. Chitre (1982) empirically constructs an economic indicator comprising 15 variables from different sectors ranging from industry to finance, and shows the synchronized movement of five growth cycles for the Indian economy during the period 1951 to 1975. Dua and Banerji (1999) determine the dates of the classical business cycle and growth rate cycles for the Indian economy by modifying the National Bureau of Economic Research (NBER) method. They construct a Coincidental Index that incorporates five major economic indicators: real GDP at factor cost, Index of Industrial Production (IIP), wages to workers in the factory sector, registered unemployment, and industrial production of consumer goods. Their findings support the existence of six recessions and five recovery phases for the Indian business cycle, with an average span of more than six years. Mall (1999) analyses the Indian business cycle and proposes that non-agricultural GDP can be considered as the reference series in this regard. He formulates a Composite Index of Leading Indicators with the help of 14 major factors, and predicts IIP-manufactured product over the period 1989:Q1 to 2000:Q1 with a lead period of two quarters. Chitre (2001) constructs five leading indicators on the basis of three different techniques, viz. the Diffusion Index, the Composite Index, and the First Principal Component. He uses 94 monthly indicators to study the business cycles in India over the period 1951–1982. Eleven indicators are chosen from different sectors of the economy and empirical findings show similarity in predicting a reference series and its cyclical pattern. Five leading indicators, namely production of pig iron, electricity production, cheque clearance, ratio of manufactured product prices to industrial raw materials prices, aluminium production, production of capital goods, and motor cycle production are identified as the main driving force behind the Indian business cycle boom. In another paper, Dua and Banerji (2001) construct a CILI which covers three major sectors of the Indian economy, the monetary, construction, and corporate sectors. This CILI on average can predict an upswing of the Indian economy with a lead of three months. Mohanty et. al. (2003) develop a monthly CILI for the Indian economy based on 14 economic indicators: commercial bank deposits, commercial banks' non-food credit, currency demand, money supply growth, industrial raw material prices, manufactured product prices, yield on 91-day treasury bills, stock prices, freight loading of the railways, cargo handled at the major ports, non-oil imports, exports, and US GDP. The CILI is found to have an average lead period of approximately six months for both peaks and troughs of the reference series. The Reserve Bank of India (2006) has drafted a detail report of leading indicators for Indian business cycles, which analyses the Indian business cycle on the basis of both quarterly and monthly data. In the contexts of both monthly and quarterly data series, six indicators, viz. marrow money, non-food credit, WPI raw materials, production of aluminium, rails good traffic, and coal production of are identified as leading indicators of the Indian business cycle between April 1993 and December 2000. The monthly growth rate cycle of industrial output is analysed with the help of two non-linear techniques, probit model and Artificial Neural Network method. Empirical findings suggest that the average duration of expansion and recession phases is 16 months and 14 months respectively, and the best economic indicator of future movements in the economic business cycle is found to be the yield on Treasury Bills with residual maturity of 15–91 days in the secondary market.

Though there are some research contributions, very few of them are devoted to developing a monthly CILI to analyse the Indian business cycle. This is why this paper attempts to construct a monthly CILI of the Indian business cycle which can predict turning points of the reference series in advance. Apart from domestic factors causing business cycle downturn in India, global economic disorders like the recent financial crisis have played havoc with Indian business cycle behaviour. Therefore, formulating a suitable and inclusive CILI that possesses the predictive power to forecast such recessionary phases in the Indian business cycle is an important contribution to the literature, and is the main objective of this paper.

## 3. DATA AND METHODOLOGY

This section covers the empirical exercise and each subsection describes different steps in the development of the CILI. At the outset, all variables are de-seasonalised using the X-12 ARIMA method developed by the US Census Bureau. Then the Baxter-King (1996) filtering technique is applied to each variable to extract the cyclical component. The suitable parameters of business cycle length for each filter are considered based on the standard definition[1] of Burn and Mitchell (1946)[1]. In the next step, all variables are expressed in their standardized format; i.e., the ratio of their deviation from the corresponding mean and standard deviation is taken.) Standardization of each variable will trim the possible over-influence (under-influence) of some variable over another due to scale difference. Construction of the CILI is based on the statistical method of Principal Component Analysis (PCA).

### 3.1 Selection of the Reference Series

The construction of a composite indicator for business cycle analysis starts with the selection of a reference series that is a suitably representative of the whole economy. Since this paper's aim is to formulate a monthly CILI for Indian business cycle fluctuations, data for the reference series should be available on a monthly basis. Though the industrial sector accounts for a small proportion of total GDP in India, it makes a 25% contribution to Non-Agricultural GDP (NAGDP). In many research papers, NAGDP is considered as the reference series, but since NAGDP data cannot be compiled at the monthly level, IIP data is considered as the reference series for the Indian business cycle.

1. Burns and Mitchell (1946) prescribed 2-8 years as the duration of a business cycle. The corresponding duration for monthly data is 24-96 months

However, the reference series should possess similar cyclical properties to a standard business cycle indicator. Since no other data on a macroeconomic variable is available for India on a monthly basis, an empirically accepted and standard amplitude-adjusted OECD composite leading indicator is used for comparison with the IIP cycle. The cyclical fluctuation of the IIP is extracted from deseasonalised IIP data with the help of the Baxter-King filter. This filteringtechnique is detailed in the subsequent section. Spectral analysis is employed to check the similarity of the cyclical behaviour of these two series. Stationarity of both series is a prerequisite for the cross-spectral exercise. The results of a few unit root tests are reported in the following table.

**Table1:** Results of Unit Root Tests

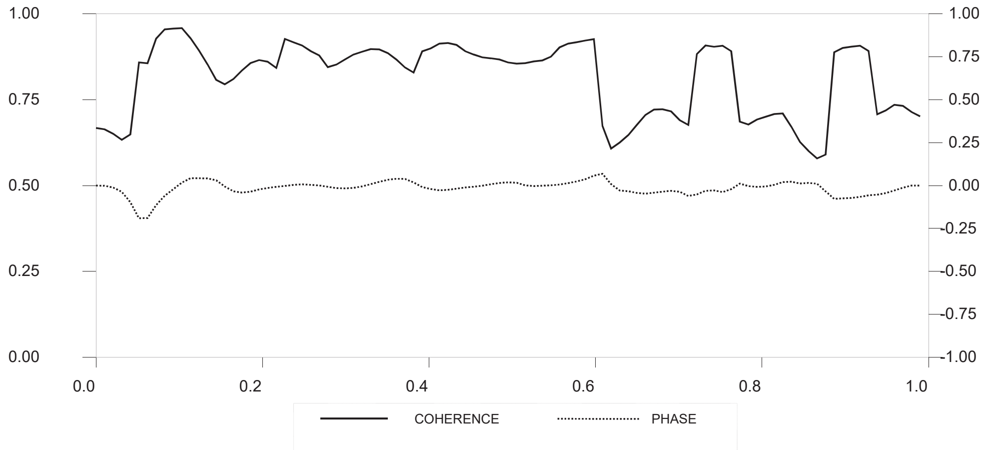
| Variables | Augmented-DF statistic | Zivot-Andrews test statistic |
|---|---|---|
| IIP cycle | -2.612 | -6.398 |
| OECD-CILI | -7.007 | -4.947 |

**Source** - Authors' calculation

**Note:** Critical values for ADF test are -2.969, -2.679 at 5% and 10% level of significance respectively. Critical value of Zivot-Andrews test is -4.80 at 5% level of significance.

Both tests confirm the stationarity of the two series, since the obtained test statistic value for both tests are more than the critical values for the corresponding tests at 5% and 10% levels of significance.

**Figure 1:** Cross-Spectrum of IIP cycle and OECD–CILI




**Source** - Authors' calculation

The cross-spectrum of these two stationary series is shown in the above diagram. The low phase value with very little fluctuation signifies that both variables move together in the long run. The phase statistic measures the lead–lag relationship between two variables at each frequency and this concept is similar to the notion of Granger causality used in the time series analysis. Similarly, the high coherence value at different frequencies signifies the greater degree of association of these two cycles. These findings lead to adoption of the IIP cycle as the reference series for analysing monthly business cycle fluctuation in India.

### 3.2 Baxter-King Filter and Construction of the CILI with Principal Component Analysis

This section analyses cyclical features of the Indian business cycle. A Baxter-King filter is used to extract the cyclical component of the IIP time series for monthly data between April1996 and December 2015.

Baxter and King (1996) propose the ideal band pass filtering technique based on the Burns and Mitchell (1946) definition of a business cycle. The band pass filter proposed by Baxter and King (1995) passes through the time series components with fluctuations ranging between 6 quarters (18 months) and 32 quarters (96 months) and removes the higher and lower frequencies. Since it does not introduce any phase shift and generates a stationary business cycle component from the time series, irrespective of the time length of the sample, the Baxter-King filter is considered to be the ideal and superior filtering technique.

The Baxter and King method (1995) is based on the use of the symmetric finite odd-order M = 2K + 1 moving average such that:

$$Y(t) = \sum_{h=-K}^{K} a(h)y\,(t-h)$$

$$= a(0)y(t) + \sum_{h=1}^{K}\{a(h\,)y(t-h\,) + \; y(t+h)\} \quad (1)$$

The set of W weights *a(h)* is obtained by truncating the ideal filter weights at W under the frequency response function constraint:

$$H(0) = \Delta t \sum_{h=-N/2}^{(N-1)/2} a(h) \quad (2)$$

where *N* is the number of observations and *t* is the periodicity of the sample. The frequency response function is built such that at ω= 0 *H*(0) = 0 for band pass and high pass filters and *H*(0) = 1 for low pass filters.

The B-K coefficients are obtained from the following maximization problem:

$$min \int_{-(1/2\Delta t)}^{(1/2\Delta t)} \sum_{-K}^{K} |(a_h^{B-K} - a_h^{ideal}\,)\; e^{-i2\pi n\omega\Delta t^2}|^2 \, d\omega \quad (3)$$

Solving the maximization problem subject to the aforementioned constraint shows that the B-K coefficients are equal to the ideal band pass filter coefficients with some constant shift:

$$a_h^{B-K} \;= a_h^{ideal} \; + \frac{H(0) - \Delta t \sum_{h=-K}^{K} a(h) ideal}{M\Delta T} \quad (4)$$

The chronology of the cyclical component of the IIP, as extracted from the aforementioned BK filter, is shown in the following two figures. Figure 2 depicts the peaks and troughs of the business cycle as suggested by the Bry-Broschan (1971) procedure. Subsequently, in Figure 3 the business cycle turning points are shown using the Harding and Pagan (2002) method. Both give almost similar turning points for the IIP cycle.

**Figure 2:** Peaks and Troughs of Business Cycle (Bry-Boschan Method)

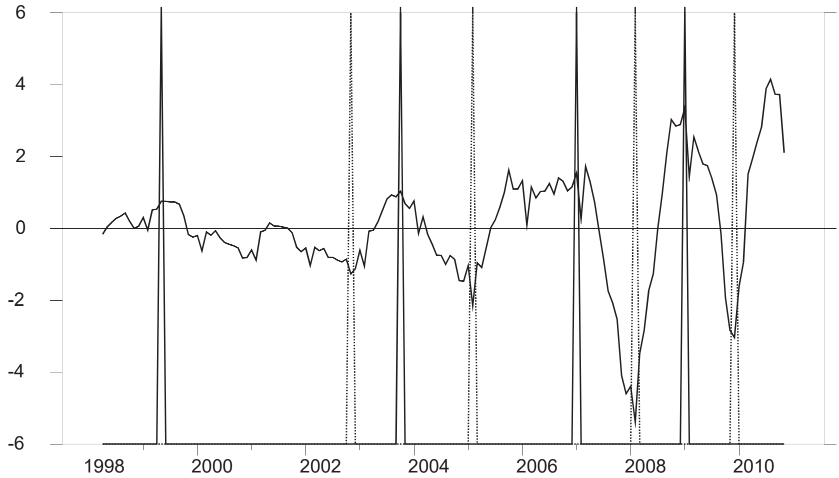
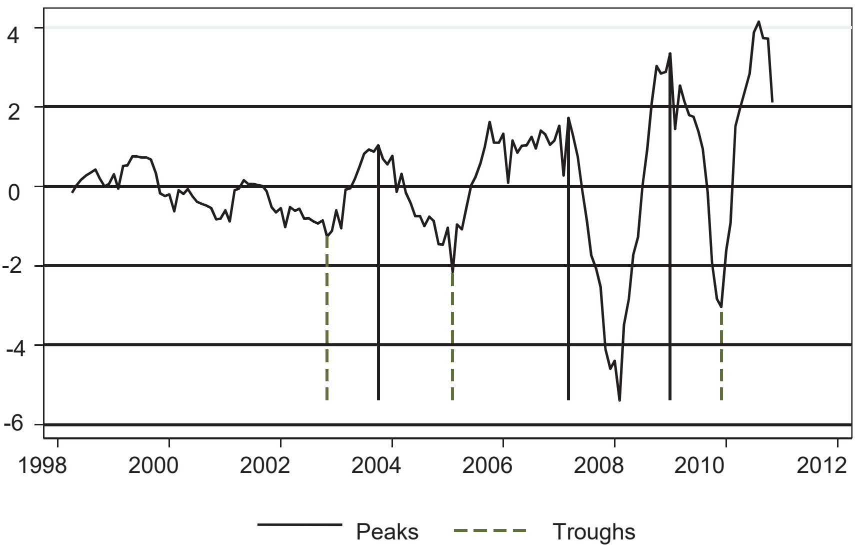



**Figure 3:** Peaks and Troughs of Business Cycle (Harding-Pagan Method)




**Source** - Authors' calculation

Table 2 presents the chronology of the business cycles in industrial production, determined by the rules defined in the Bry-Broschan and Harding and Pagan procedures. Three business cycle phases are identified during the time period under consideration. Both methods identify very similar turning points. The expansion phase varies within the range of 11 to 25 months, while the recession phase persists for 11 to 16 months. The duration of the Indian business cycle is found to vary between 17 to 36 months. The average and median values for the Indian business cycle are calculated as 25 and 22 months respectively.

**Table 2:** Turning Points in the Indian Business Cycle

| Peaks | | Troughs | | Expansion (Trough to Peak) | | Recession (Peak to Trough) | | Cycle Duration (Trough to Trough) | |
|---|---|---|---|---|---|---|---|---|---|
| BB | HP | BB | HP | BB | HP | BB | HP | BB | HP |
| May 1998 | ----- | Nov. 2002 | Nov. 2002 | ---- | ----- | ----- | ----- | ------ | ----- |
| Oct. 2003 | Oct. 2003 | Feb. 2005 | Feb. 2005 | 11 mos | 11 mos | 16 mos | 16 mos | 17 mos | 17 mos |
| Jan. 2007 | March 2007 | Feb. 2008 | Feb. 2008 | 23 mos | 25 mos | 13 mos | 11 mos | 34 mos | 36 mos |
| Jan. 2009 | Jan. 2009 | Dec. 2009 | Dec. 2009 | 11 mos | 11 mos | 11 mos | 11 mos | 22 mos | 22 mos |

**Source** - Authors' calculation

**Note** - BB and HP signify Bry-Boschan and Harding-Pagan methods respectively

### 3.2.1 Choice of Indicator Variables for Construction of the CILI.

The second stage of the construction of the leading composite indicator for predicting Indian business cycle movement is the selection of appropriate indicators. Based on the criteria of availability of monthly data from the Reserve Bank of India (RBI) and the Organization for Economic Co-operation and Development (OECD) databases for all the variables, the time period chosen was April 1996 to December 2015. Initially a number of variables pertaining to different sectors of the economy were considered for the construction of the CILI. In the end, the following eleven indicator variables from five major sectors –monetary, banking, financial, real, external – were selected on the basis of their strong correlation with the reference series.

Narrow money (M1) is considered a proxy for money supply. An increase in the nominal money supply may have two conflicting effects on output: it may lead to output growth but it may also cause inflation, which in turn hampers output. Interest rate spread (SPREAD) is chosen as a measure of the difference between the yields of short- and long-term securities, as denoted by the monthly average of secondary market yield on Treasury Bills with a residual maturity of 15–91 days. Declining interest spread signifies a prospering economy, since lower spread generates lower return for investors but during a recessionary phase increased spread leads to high demand for risk premium. The third indicator variable, wholesale price index (WPI), comes from the real sector. The inflation and output nexus is a well-established fact in the economic policy domain. Supply-side argument supports a positive relation between these two variables, since a price rise is an incentive for higher production but may drag down demand. Non-food credit (NFC) is also observed to have a strong impact on output growth. Banerjee (2011) has established non-food credit-output causality for the Indian economy. The pro-cyclicality of industrial credit with reference to business cycle phases is an empirically verified fact in the post-liberalization period. Real effective exchange rate (REER), defined as the weighted average (36 countries and export-based) of nominal exchange rates adjusted for relative price differentials between domestic and foreign prices, is considered as part of the external sector. Similarly, performance of the INR against the USD is chosen for the analysis. Increase in exchange rate (EXC) influences output in two possible channels. It may lead to export competitiveness and boost output but it can also fuel high import costs and adversely affect industrial output.

Bombay stock exchange (BSE-30) stock prices are chosen as an indicator variable from the financial market since the BSE lists thirty major companies and is representative of the Indian financial condition. Two variables are chosen from the external sector. These are import (IMP) and export (EXP) of goods, as they are the major component of India's output. In the context of an open capital account and increasing globalization, the effect of US (US-CILI) and euro area (EURO-CILI) business cycle performance, as captured by the OECD leading indicator, are also included in the construction of the CILI of the Indian business cycle, since India still has considerable macroeconomic dependence on these two economies.

All variables except BSE-30 stock price and the CILIs of the US and euro area are filtered with the help of the Baxter-King method to extract the cyclical component from each time series. The return of BSE-30 stock prices is considered by taking the first difference of logarithmic values. The CILIs of the US and the euro area are already expressed as amplitude-adjusted cycles. Next, all the cycles are standardized by subtracting their corresponding mean and taking the ratio with respect to their respective standard deviation. The following table confirms the stationarity of all indicator variables under consideration, which is a crucial prerequisite for statistical analysis of any time series. Two unit root tests, augmented Dicky Fuller and KPSS (Kwiatkowski, Phillips, Schmidt, and Shin) are employed.

**Table 3:** Unit Root Tests for Indicators

| Variables | Augmented Dicky-Fuller test statistic (Without trend) | KPSS test statistic (Without trend) |
|---|---|---|
| M1 | -7.163 (1) | .155 |
| SPREAD | - 5.838 (1) | .146 |
| WPI | -2.289 (4) | .0365 |
| NFC | -1.856 (13) | .0657 |
| REER | -4.555 (2) | .137 |
| EXC | -7.308 (1) | .123 |
| BSE-30 | -7.269 (1) | .162 |
| IMP | -9.753 (2) | .0529 |
| EXP | -7.043 (2) | .0762 |
| US-CILI | -3.383 (5) | .047 |
| EURO-CILI | -2.078 (5) | .0603 |

**Source** - Authors' calculation

**Note:** Figures in parentheses signify optimal lag-length for ADF test as suggested by Schwarz information criterion.

### 3.2.2 Construction of the CILI

This section discusses the construction of a CILI for predicting the cyclical fluctuation of the Indian business cycle. First, the lead-lag relationship between each of the indicator variable series and the reference series is established on the basis of correlation analysis, and then a CILI is constructed with the help of Principal Component Analysis (PCA). The most important feature of a good leading indicator is that it should have high correlation with the reference series at a specified lead. In the following table, correlation values at specific leads/lags for all the indicator variables are shown.

**Table 4:** Correlation Coefficient of Indicator Variables with Reference to Reference Series, at Different Lead Lengths

| Variables | Maximum Correlation Coefficient | Lead Length |
|---|---|---|
| M1 | 0.5984 | 3 |
| SPREAD | 0.5707 | 6 |
| WPI | 0.3743 | 5 |
| NFC | 0.6061 | 10 |
| REER | 0.5684 | 5 |
| EXC | -0.3874 | 8 |
| BSE-30 | 0.2508 | 4 |
| IMP | -0.7748 | 8 |
| EXP | -0.5353 | 9 |
| US-CILI | 0.5932 | 2 |
| EURO-CILI | 0.6409 | 2 |

**Source** - Authors' calculation

All the variables bear strong correlation with the reference series at specific leads. In the next step, a CILI will be constructed with the help of these indicator variables. The weighted average of all these series will generate a CILI which should predict the fluctuations of the Indian business cycle. Assigning weights to each indicator variable is the crucial part of the exercise, since each component has a different impact on the reference series. A simple way of assigning equal weights to each series is not an appealing way of constructing a good CILI. Therefore, the PCA method is adopted to assign appropriate weights to each component. The PCA involves the construction, from an original set of variables $X_j$ *(j=1, 2, ...k,* of, a new set of variables $P_i$ *(i=1,2,...k),* called principal components (PCs). These new variables are linear combinations of the '*X*'s:

$$P_1 = a_{11}X_1 + a_{12}X_2 + \dots + a_{1K}X_K$$

$$P_K = a_{K1}X_1 + a_{K2}X_2 + \dots + a_{KK}X_K \quad (5)$$

The weights applied to the original series ($a_{ij}$) in the construction of the PCs are known as factor loadings. They are chosen so that the PCs satisfy the following conditions: i) they are uncorrelated (orthogonal) – in other words, there is zero multicollinearity among the PCs; and ii) the first PC accounts for the maximum possible proportion of the variance of the set of '*X*'s, the second PC accounts for the maximum of the remaining variance, and so on, until the last PC absorbs all the remaining variance not accounted for by the preceding components. In practice, the first principal component usually captures sufficient variation to be an adequate representation of the original set. Based on the result of the eigenvalues of the eleven calculated PCs and their proportional explanatory contributions applied to the reference series, the contribution of the first two components is observed to be more than 75%. Therefore, a factor loading (eigenvector) corresponding to the second PC is considered as the weight for the different indicator variables. Finally, the CILI is constructed with all the weights attached to different indicator variables bearing different lead lengths with respect to the reference series. The equation of the CILI assumes the following form:

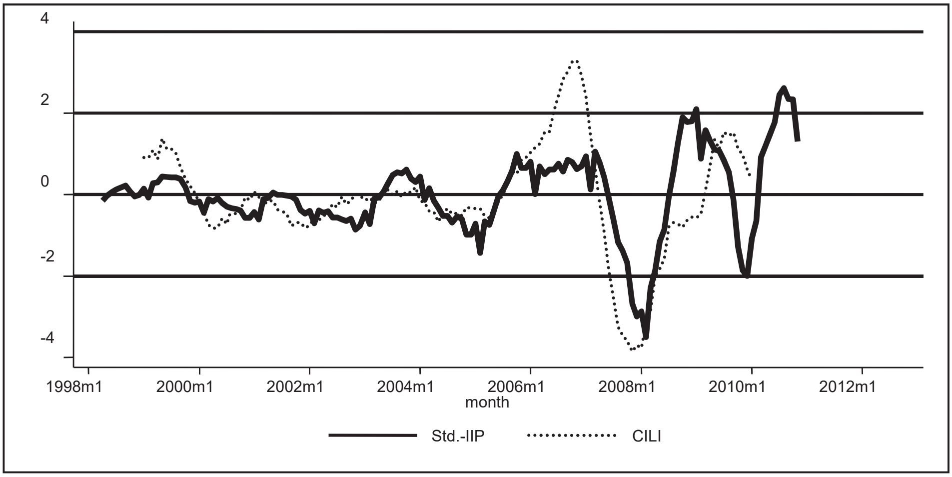
$$\begin{aligned} CILI(t) = {} & 0.0073 * M1(t+3) + 0.3618 * SPREAD(t+6) + 0.3160 \\ & * WPI(t+5) + 0.2929 * NFC(t+10) + 0.2956 * REER(t+5) \\ & - 0.2545 * EXC(t+8) + 0.1120 * SE30(t+4) + 0.3591 \\ & * IMP(t+8) + 0.4050 * EXP(t+9) + 0.3372 * US - CLI(t+2) \\ & + 0.3392 * EURO - CLI(t+2) \end{aligned} \tag{6}$$

where ($t$+$i$) symbolize the lead length of each series with respect to the standardized IIP cycle.

### 3.2.3 Performance of the CILI

This section assesses the performance of the newly constructed CILI. An ideal CILI should possess the power to predict the turning points and especially the troughs of the reference series.

**Figure 4:** Comparison of Standardized IIP Cycle and CILI




**Source** - Authors' calculation

In Figure 4 and Table 5 the performance of two series, the standardized IIP cycle and the newly constructed CILI, is compared in order to examine the predictive power of the CILI. For example, the CILI predicts the recent financial crisis of mid-2008 in November 2007, while the IIP cycle does not. Similarly, the CILI predicts another trough in December 2001, 11 months before the trough is realized in the IIP cycle. On the other hand, the CILI also predicts three different peaks. Out-of-sample forecast by this CILI is difficult, since application of the Baxter-King filter with a parameter for lead-lag length specification sacrifices a few terminal points from each time series.

Table 5 compares the turning points of the CILI and the reference series, i.e., the standardized IIP cycle.

**Table 5:** Comparison of Peaks and Troughs of Reference Series and CILI

| Peaks (IIP cycle) | | Troughs (IIP cycle) | | Peaks (CILI) | | Troughs (CILI) | |
|---|---|---|---|---|---|---|---|
| BB | HP | BB | HP | BB | HP | BB | HP |
| May 1998 | ------- | May 1998 | ------- | | ----- | ----- | ------- |
| Oct. 2003 | Oct. 2003 | Oct. 2003 | Oct. 2003 | Jan. 2001 | Jan. 2001 | Dec. 2001 | Dec. 2001 |
| Jan. 2007 | March 2007 | Jan. 2007 | March 2007 | Dec. 2003 | Dec. 2003 | April 2005 | April 2005 |
| Jan. 2009 | Jan. 2009 | Jan. 2009 | Jan. 2009 | Nov. 2007 | Nov. 2007 | Nov. 2007 | Nov. 2007 |

**Source**-Authors' calculation

**Note:** BB and HP signify Bry-Boschan and Harding- Pagan methods respectively

## 4. CONCLUDING REMARKS

This paper attempts to chronicle different phases of the Indian business cycle for the time period April 1994 to December 2015. The main objective of this empirical work is to propose a leading monthly indicator for the Indian economy using macroeconomic variables chosen from different crucial sectors of the economy. The choice of the indicators is based on their statistically significant leading nexus with the reference series, i.e., the IIP cycle, and strong correlation with IIP series at respective and suitable lag lengths. Variables such as narrow money, WPI, NFC, exchange rate, Sensex, imports, exports, and US and euro area business cycle indicators are chosen for the construction of an India business cycle predictor. The Baxter and King ideal band pass filter is used to extract the cyclical component from each time series. Then the PCA technique is used to assign weights to each indicator to construct the CILI, which is found to have strong predictive ability as it captures the downturn in the IIP cycle during the 2008 financial crisis in advance: it predicts the crisis accurately in November 2007. Thus, based on the past data of the macro-factors, the future dynamic of the Indian business cycle can be predicted, making this index very important for policymakers. Since both leading indicators, constructed with the help of two different filtering techniques, have very strong predictive power regarding the turning points in the IIP series, a future course of action to correct an imminent downturn can be devised, with the right set of policies to revive business and consumer confidence and to ensure steady growth of the Indian economy. The right mix of advance policies, designed to smooth the cyclical downturn and lead growth in the right direction, can control the possibility of an imminent recession.

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Received: November 15, 2016.
Accepted: April 24, 2017.