

Dating Business Cycles in India

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Radhika Pandey, Ila Patnaik and Ajay Shah



National Institute of Public Finance and Policy
New Delhi

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Radhika Pandey*, Ila Patnaik and Ajay Shah

Abstract

This paper presents a chronology of Indian business cycle in the post-reform period. The period before reforms primarily saw monsoon cycles. We find three episodes of recession in the post-reform period: 1999Q4 to 2003Q1, 2007Q2 to 2009Q3, and 2011Q2 to 2012Q4. We find that the average duration of expansion is 12 quarters and the average duration of recession is 9 quarters. The diversity in duration of expansion is seen to be 0.34 while the diversity in duration of recession is 0.31. We find that the amplitude of recession is relatively more diverse at 0.45 while the diversity in amplitude of expansion is 0.38.

JEL Classification Codes: E32, E66

Keywords: Business Cycle, Growth Cycle, Detrending, Stabilisation

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1. Introduction

Stabilising business cycles is a key objective of macroeconomic policy. Understanding recessions and expansions of business cycles is essential for putting in place frameworks for stabilisation. This requires identifying the chronology of business cycle turning points. In the U.S, the National Bureau of Economic Research (NBER) has a dedicated research program for identifying the dates of business cycle turning points. A number of studies have applied the NBER approach to dating the business cycles for developed and emerging economies (Stock and Watson, 1999; Plessis, 2006). Similarly the CEPR Euro Area Business Cycle Dating Committee establishes the chronology of recessions and expansions of Euro Area member countries. In India there have been some attempts at determining the chronology of business cycles (Dua and Banerji, 2000; Chitre, 2001; Dua and Banerji, 2001a; Patnaik and Sharma, 2002; Mohanty et al., 2003). Majority of these studies focus on the pre-liberalisation period. Business cycle downturns in the pre-liberalisation period were associated with drought or oil price hike and saw sharp declines in GDP. There were no investment-inventory cycles or periods of expansion followed by periods of contraction that are typically seen in industrialised countries. This is hardly surprising given the economy was largely a planned economy. There are very few studies that extend the business cycle chronology analysis to the post reform period (Mohanty et al., 2003; Dua and Banerji, 2007). In the post-reform period, an understanding of business cycle chronology assumes importance as the nature of cycles has changed. After 1991, we have not seen an actual fall in output like in the pre-reform years but episodes of slowdown in the aggregate economic activity.

There are different approaches for measuring business cycles. One approach refers to “growth cycles,” and relies on detrending procedures to extract the cyclical component of output. The cycle is defined to be in the boom phase when actual output is above the estimated trend, and in recession when the actual output is below the estimated trend. The classical approach identifies expansion and contraction based on the level of output. In contrast, “growth rate cycle” identifies turning points based on the growth rate of output. For the post-reform period in India, growth or growth rate cycle approach is more appropriate than the classical cycle approach to analyse business cycle turning points (Mohanty et al., 2003; Dua and Banerji, 1999, 2007). In our analysis we use the growth cycle approach and examine the component adjusted for trend to detect turning points. To isolate the cyclical component we use the filter by Christiano and Fitzgerald (2003). The Christiano and Fitzgerald (2003) filter belongs to the category of band-pass filters. Band-pass filters extract cycles of a chosen frequency. We extract cycles using the NBER business cycle periodicity of 2-8 years. We check the robustness of our findings by extracting cycles using the Hodrick-Prescott filter (Hodrick

and Prescott, 1997). To the cyclical component we apply the dating algorithm developed by Bry and Boschan (1971) and improved by Harding and Pagan (2002). The dating algorithm provides; among others, rules for minimum duration of phase and a complete cycle. The application of the dating algorithm to our dataset gives dates of peaks, troughs and average duration and amplitude of expansions and recessions.

We use seasonally adjusted quarterly GDP series from 1996 to 2014 to arrive at a chronology of business cycles. We find three episodes of recession. The first period of recession was from the period 1999Q4 to 2003Q1. The second period of recession was from 2007Q2 to 2009 Q3. The third episode of recession began in 2011 Q2 till 2012Q4. Our findings on business cycle chronology are robust to the choice of filter and to the choice of the measure of business cycle indicator. The average duration of an expansion in India is seen to be 12 quarters while the average duration of a recession is 9 quarters.

In recent decades, a number of emerging economies have undergone changes in the policy environment resulting in structural transformations of the economy. One major strand of business cycle literature examines the changes in business cycle stylised facts in response to structural transformation (Kim et al., 2003; Alp et al., 2012; Ghate et al., 2013). The main conclusion of these studies is that emerging economy business cycle facts have changed in the post-reform period. We build on this literature by offering evidence of change in the average duration of cycle. Drawing on the analysis by Plessis (2006) and Viv B. Hall (2009) we report the coefficient of variation (CV) in amplitude and duration across expansions and recessions. The CV shows how diverse are the duration and amplitude of specific expansions and recessions from their mean value. We find that the phases of expansion and recession have become relatively more diverse in the post-reform period. Using a longer time series of IIP, we report evidence of these changes.

Table 1: Sectoral share (Expressed as a % to GDP)

This table shows the sectoral composition of GDP. The table shows that the share of agriculture has declined from 51.4% in 1951 to 13.9% in 2013. The share of services has increased from 29.6% to 59.9% during the same period.

	Agriculture	Industry	Services
1951	51.4	16.7	29.63
1981	35.7	26.23	37.49
1992	28.5	26.7	44.05
2013	13.9	26.12	59.9

2. Indian business cycles

The nature of Indian business cycles has changed over time. In the pre-reform years, good times and bad times were primarily determined by weather. Good times were characterised by good monsoons and vice-versa. Another determinant of bad times was the oil price shock. Business cycles in the conventional sense involving an interplay of investment and inventory did not exist. In addition, the high share of public sector in investments meant a high degree of stability in investment demand.

In the following years, all this changed (Ghate et al., 2013; Shah and Patnaik, 2010). The share of agriculture has declined and the share of services has increased (See Table 1). The impact of agriculture on the supply of raw material and food price on the one hand, and demand for non-agricultural products on the other was much stronger when the economy was a closed economy with a large agriculture sector. Decline in the share of agriculture implies that monsoon shocks matter less for the economy.

Further, there has been a significant change in the environment in which firms operate. In the pre-reform period, the economy was characterised by controls on capacity creation and barriers to trade with limited role for private investment. One prominent source of investment was government investment in the form of plan expenditure, which did not exhibit any cyclical fluctuations. In the post-reform period with eased controls on capacity creation and dismantling of trade barriers, private sector investment as a share of GDP has shown a significant rise. With reduced barriers, competition has increased. Profits are uncertain, and expectations about profit drive investment decisions, as is the case with firms in market economies. After 1991, India has seen a sharp increase in private corporate sector investment as a share of GDP. However, this share has shown sharp upswings and down-swings. Figure 1 shows the time series of private corporate gross fixed capital formation (GFCF) expressed as a percent to GDP. In the mid-1990s, private corporate GFCF rose from 5% of GDP in 1991-1992 to 9% of GDP. This fell dramatically in the business cycle downturn of 2000-03 and hovered around 5% of GDP. It again surged to 12-14% of GDP in the period 2005-07 before moderating in the recent years. Investment-inventory fluctuations are today central to understanding the emergence of business cycles in India. This is also reflected in the performance of firms. Figure 2 shows the quarterly net profit margin of non-financial firms. The series exhibits business cycle fluctuations as opposed to short-lived shocks associated with monsoons (Shah, 2008).

Understanding the chronology of recessions and expansions in business cycles is an essential foundation to putting in place appropriate frameworks of stabilisation. Chronology of business cycle turning points enables policy makers and academicians to

ask and answer questions such as: Has macroeconomic policy been successful in achieving stabilisation? What events trigger contractions? How synchronised are recessions across countries (Christoffersen, 2000)? In the next section, we describe the methodology for establishing the chronology of business cycle turning points.

3. Methodology

The detection of turning points begins with defining the concept of a cycle. In the classical cycle, fluctuations in the absolute level of the series are identified. The early NBER approach identified cycles as recurrent sequences of alternating phases of expansion and contraction in the levels of a large number of economic time series (Burns and Mitchell, 1946; Bry and Boschan, 1971).

During the 1960s, real decline in the economic activities in major industrial economies gave way to slowdowns in the pace of expansion. Accelerations and slowdowns in growth rather than expansion and contraction in the level of variables became a prominent feature of business cycles. Thus, the need for a concept of business cycle more in line with reality led to emergence of the concept of growth cycle (Mintz, 1974). The growth cycle is defined as the ups and downs in the deviations of the actual growth rate of the economy from the long-run trend growth rate.¹

Since we do not see an absolute decline in the level of variables in the post-liberalisation period, the growth cycle approach is suitable for the present analysis. Boschan and Banerji (1990) point out that a main limitation of this methodology is that it is not suited for real time analysis of turning points because the trend estimate over the last two years is subject to revision. Another concept of cycle is the growth rate cycle approach where cyclical upswings and downswings in the growth rate of economic activity are analysed. However, since our objective is to present a chronology of business cycle turning points in the post-liberalisation period, the growth cycle approach seems appropriate. In the subsequent sub-sections we describe the steps involved in the identification of turning points.

¹ There is a conceptual difference between expansion and contraction as identified in the classical approach and high-growth and low-growth phase identified in the growth cycle approach. The high growth phase in a growth cycle coincides with the business cycle recovery and the expansion mid-way, while the low growth phase is identical to the later phase of expansion leading to recession.

Figure 1: Private corporate gross fixed capital formation

This figure shows the private corporate gross fixed capital formation expressed as a percent to GDP. The share shows sharp upswings and downswings. In the mid-1990s, private corporate GFCF rose from 5% of GDP in 1991-1992 to 9% of GDP. This fell in the business cycle downturn of 2000-03 and hovered around 5% of GDP. The ratio rose in the upswing of 2005-07 before moderating in the recent period.

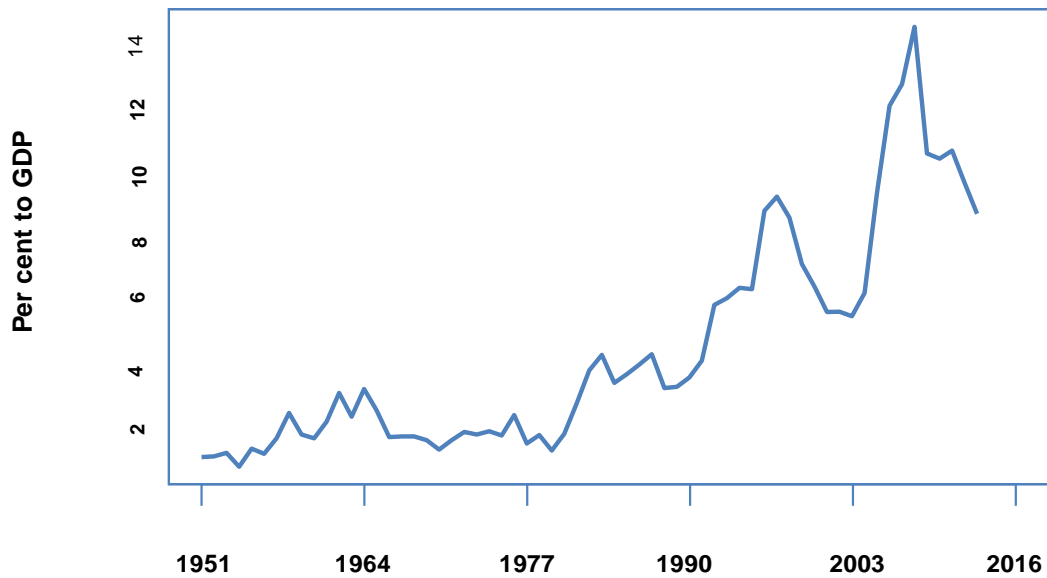
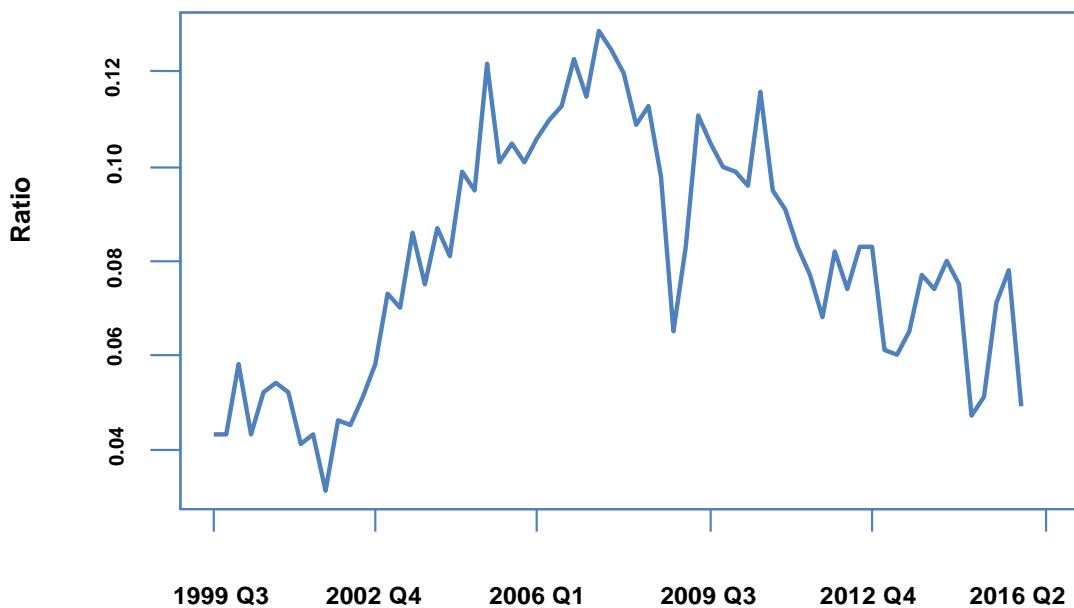


Figure 2: Net profit margin of firms

This figure shows fluctuations in the net margin of firms. The fluctuations are indications of emergence of conventional business cycles.



3.1 Seasonal Adjustment and adjustment for outliers

The first step is to adjust the series for seasonal fluctuations. In India, a framework for seasonally adjusted series is not provided by the official statistical agency. We seasonally adjust the series using the x-13-ARIMA-SEATS seasonal adjustment program. The seasonal adjustment program also extracts the seasonally adjusted series adjusted for extreme values (Bhattacharya et al. 2016).

3.2 Extraction of cycles

To extract the cyclical (stationary) and trend (non-stationary) component, the series adjusted for seasonality and extreme values are filtered.

A large literature exists on the choice of the filter to extract the business cycle component of the relevant time series (Canova, 1998; Burnside, 1998; Bjornland, 2000; Pedersen, 2001). Canova (1998) argues that the application of different de-trending procedures extract different types of information from the data. This results in business cycle properties differing widely across de-trending methods. However, commenting on Canova (1998), Burnside (1998) shows through spectral analysis, that the business cycle properties of variables are robust to the choice of the filtering methods if the definition of business cycle fluctuations are uniform across all the de-trending methods.

To derive the cyclical component, the literature on business cycles mainly relies on either the Hodrick-Prescott filter or the band-pass filters proposed by Baxter and King (Baxter and King, 1999) and Christiano-Fitzgerald (Christiano and Fitzgerald, 2003). Band-pass filters eliminate very slow moving trend components and very high frequency components while retaining the intermediate business cycle fluctuations.

A limitation of the commonly used Hodrick-Prescott filter is that the findings on business cycle facts are sensitive to the different values of the smoothing parameter (Bjornland, 2000). Alp et al. (2011) find that the choice of the smoothing parameter in the HP filter has important implications for the volatility of the trend term and average business cycle length observed in the data.² An inappropriate choice of this parameter may result in business cycle facts, which are at odds with the data. Nilsson and Gyomai (2011) compare the revision properties of different de-trending and smoothing methods (cycle estimation methods), including Phase-Average-Trend with smoothing, a double

² The higher the value of smoothing parameter, the smoother the trend will be. The trend term is found to be smooth i.e. does not move much with actual cycles in the data when the smoothing parameter gets a high value, whereas it follows the data more closely when smoothing parameter gets a small value.

Hodrick-Prescott (HP) filter and the Christiano-Fitzgerald (CF) filter. The results indicate that the HP filter outperforms the CF filter in the stability of turning points but has a weaker performance in absolute numerical precision.³

We use the Christiano-Fitzgerald filter to isolate the trend and cyclical component. The NBER defines, business cycle as fluctuations having periodicity ranging between 8 to 32 quarters. We use the NBER definition of business cycle to extract the cyclical component. The cyclical component is standardised before the application of the dating algorithm. The cyclical component is standardised by subtracting the mean of the cyclical component from it and dividing by the standard deviation of the cyclical component.

3.3 Application of dating algorithm

The standardised cyclical component forms the input series for the application of the dating algorithm by Bry and Boschan (1971). The procedure was subsequently revised and quantified in a better way by Harding and Pagan (2002). The Bry and Boschan (1971) algorithm is based on a standardised set of rules that facilitates comparison of business cycle turning points across countries, regions and time-periods. The Bry-Boschan (BB) and Harding Pagan (HP) algorithms find the turning points as follows:

- The data is smoothed after outlier adjustment by constructing short- term moving averages.
- The preliminary set of turning points are selected for the smoothed series subject to the criterion described later.
- In the next stage, turning points in the raw series is identified taking results from smoothed series as the reference.

The identification of turning point dates is done subject to the following rules:

- The first rule states that the peaks and troughs must alternate.
- The second step involves the identification of local minima (troughs) and local maxima (peaks) in a single time series, or in y_t after a log transformation.
- Peaks are found where, y_s is larger than k values of y_t in both directions.
- Troughs are identified where y_s is smaller than k values of y_t in both the directions.
- Bry and Boschan (1971) suggested the value of k as 5 for monthly frequency which Harding and Pagan (2002) transformed to 2 for quarterly series.
- Censoring rules are put in place for minimum duration of phase (from peak to

³ For a detailed analysis of the detrending techniques see Appendix A.

trough or trough to peak) and for a complete cycle (from peak to peak or from trough to trough).

- Harding and Pagan identify minimum duration of a phase to be 2 quarters and the minimum duration of a complete cycle to be 5 quarters.
- For monthly data, the minimum duration is 5 months and 15 months for phase and cycle respectively.
- The identification of turning points is avoided at extreme points.

The algorithm also generates key summary statistics such as the duration and amplitude of each phase.

1. Duration: It is computed as the number of quarters from peak to trough during a slowdown phase or from trough to the next peak in the speed-up phase.
2. Amplitude: The amplitude is calculated as the maximum drop (rise) from peak (trough) to trough (peak) during episodes of recession (expansion).

The application of the Harding-Pagan dating algorithm is done using the R package BCDating.⁴

4. Research on Indian business cycles

Research on business cycles in the Indian economy has applied the three approaches: the classical business cycle (Dua and Banerji, 2012), growth cycle (Chitre, 1982, 2004; Mall, 1999) and growth rate cycle (Dua and Banerji, 2012). Table 2 shows the dates of peaks and troughs identified in the literature using the three approaches. Mall (1999) filtered output to examine cyclical behaviour of the Indian economy since 1950. Six sets of turning points in IIP-Manufacturing were identified as the peaks and troughs of the cycle in the period. Patnaik and Sharma (2002) identify four episodes of contraction in the period 1950-51 to 1999-2000. The authors suggest that the application of “growth cycle approach” offers a more appropriate characterisation of cycles in the post liberalisation years. Mohanty et al. (2003) identify 13 growth cycles of varying durations during the period 1970-71 to 2001-02 using monthly IIP series. The computation of cycles, recessions and expansions are based on the dates identified using Bry-Boschan algorithm. The average duration of recession is reported to be 16 months while expansions are of relatively shorter duration averaging 12 months. The average duration of cycles is 27 months.

Chitre (2004) identified turning points in an index based on 94 monthly series for the period 1957-1982. He identifies 8 peaks and 8 troughs using this index. Dua and Banerji (2012) reported seven business cycle recessions in the Indian economy for

⁴ <https://cran.r-project.org/web/packages/BCDating/BCDating.pdf>

the period 1964-1996. The OECD identifies turning points for individual countries including India. Using the growth cycle approach, three periods of recession are identified for the period from October 1997 to September 2014 (OECD, 2016).

We use the growth cycle approach to identify the chronology of business cycle turning points in the post-reform period. Revisiting the analysis of business cycle turning points assumes importance as the nature of cycles has changed in the post-reform period. The period before reforms saw cycles driven by weather and oil price shocks. In the post-reform period we have seen the emergence of conventional business cycles driven by investment-inventory fluctuations. We build on the earlier studies by presenting evidence of change in the nature of Indian business cycles over time. Using descriptive statistics namely average duration and average amplitude; and coefficient of variation in amplitude and duration we show that the attributes of Indian business cycles have changed over time.

5. Empirical analysis

We use the quarterly GDP series (Base year 2004-05) to identify the chronology of business cycle turning points.⁵ This series is available from 1996 Q2 (Apr-Jun) to 2014 Q3 (Jul-Sep). The series is adjusted for seasonality and then filtered for outliers. The cyclical component is extracted using the Christiano-Fitzgerald filter using the NBER business cycle periodicity and then standardised. The standardised cyclical component is then subject to the rules of the dating algorithm by Harding and Pagan (2002). In addition to reporting the peak and trough dates, we also report descriptive statistics about the nature of cycles. These include the average duration and amplitude of expansion and recession and the coefficient of variation of duration and amplitude of expansion and recession. These summary statistics enable us to form judgements about the nature of business cycles.

5.1 Business cycle turning points

First, we extract the cyclical component of GDP using the NBER business cycle periodicity of 2-8 years and then apply the dating algorithm by Harding and Pagan (2002). The application of dating algorithm gives us periods of expansion and recession along with their duration and amplitude.

Figure 3 and Table 3 shows three episodes of recession in the economy during

⁵ The Central Statistical Organisation revised the GDP series with a new base year of 2011-12. The revised series is available only from 2011 Q2. Hence we stick to the series with the old base year for our analysis.

the period 1996-2014. Using GDP as the reference series, the first episode of recession was in the period: 1999Q4 to 2003Q1, the second recession was in the period 2007Q2 to 2009Q3, and the third recession was in the period 2011Q2 to 2012Q4.

Our findings are consistent with the reference chronology of turning points identified by OECD for India. The OECD provides the chronology of turning points in the reference series for individual countries. Up to 2012, the main reference series used was the IIP. Since 2012, GDP is used as the reference series for identification of turning points. They apply the growth cycle approach for the identification of turning points. The first period of recession is from 1999 December to 2003 January. This is similar to the first period of recession identified by us: 1999 Q4 (October-December) to 2003 Q1 (January- December). The OECD identifies the second period of recession from 2007 October to 2009 March. This is again similar to our second period of recession: 2007 Q2 (April-June) to 2009 (July-September). The OECD identifies the third period of recession from 2011 January to 2013 March.

Again, this is broadly similar to the period of recession identified through our approach: 2011 Q2 (April-June) to 2012 Q4 (October-December) (OECD, 2016).

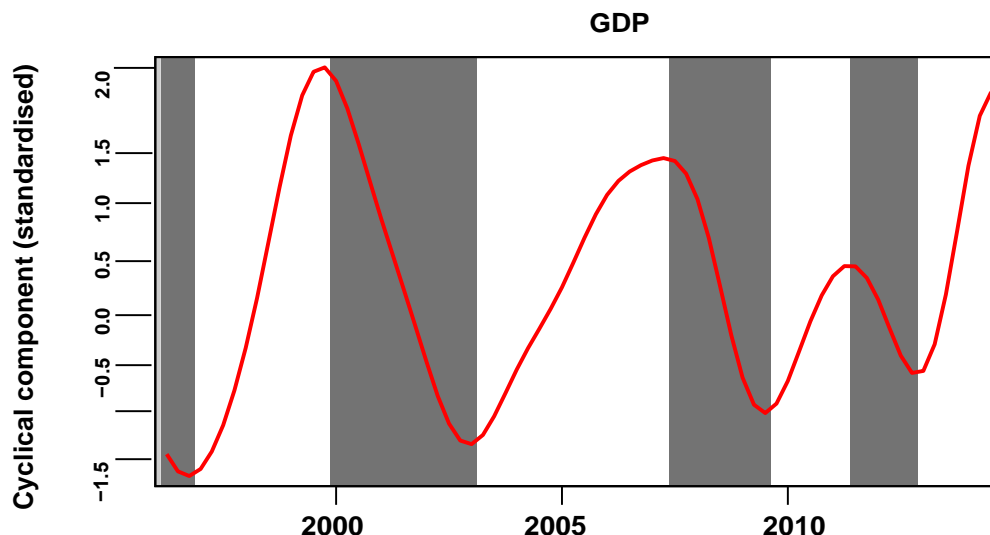
Table 2: Trough and peak dates in literature

This table captures the dates of troughs and peaks identified in the literature on Indian business cycle using different approaches to business cycle measurement.

Trough	Peak
Mall (1999), growth cycle approach	
	1951-52
1953-54	1956-57
1959-60	1964-65
1967-68	1969-70
1974-75	1978-79
1980-81	1989-90
1992-93	1995-96
Patnaik and Sharma (2002), classical approach	
	1956-57
1957-58	1963-64
1965-66	1978-79
1979-80	1990-91
1991-92	
Mohanty (2003), growth cycle	
1971 November	1972 December
1973 October	1974 July
1976 January	1976 August
1978 March	1979 March
1980 September	1982 May
1983 September	1984 September
1986 December	1987 July
1988 April	1989 January
1989 November	1990 September
1993 March	1993 November
1994 September	1995 May
1995 December	1996 August
1998 March	2000 November
2001 September	
Chitre (2004), growth cycle	
	January 1952
November 1953	June 1956
June 1958	March 1961
February -1962	March-1965
January - 1968	April-1970
November - 1970	February - 1972
January - 1975	November - 1976
October - 1977	May - 1978
April - 1980	
Dua and Banerji (2012), classical approach	
	November 1964
November 1965	April 1966
April 1967	June 1972
May 1973	November 1973
February 1975	April 1979
March 1980	March 1991
September 1991	May 1996
November 1996	
OECD (2016), growth cycle	
1997 October	1999 December
2003 January	2007 September
2009 March	2010 December
2013 April	

Figure 3: Turning points from 1996 to 2014

This figure shows the turning points in the cyclical component of GDP. Here the cyclical component is extracted using the CF filter using the NBER definition of business cycle periodicity of 2 to 8 years.


Table 3: Dates of turning points in GDP: 1996-2014

This table shows the chronology of turning points using GDP as the reference series. The first period of recession is from 1999 Q4 to 2003 Q1. The period of expansion starts in 2003 Q1 and continues till 2007 Q2. This is followed by a period of recession from 2007 Q2 to 2009 Q3. This is followed by a period of expansion from 2009 Q3 to 2011 Q2, followed by a period of recession from 2011 Q2 to 2012 Q4.

Phase	Start	End	Duration	Amplitude
Recession	1999Q4	2003Q1	13	3.3
Expansion	2003Q1	2007Q2	17	2.5
Recession	2007Q2	2009Q3	9	2.3
Expansion	2009Q3	2011Q2	7	1.3
Recession	2011Q2	2012Q4	6	0.9

Table 4 shows the average amplitude and duration of phases (recession and expansion) extracted using the CF filter applying the NBER business cycle periodicity of 2 to 8 years. The average duration of expansion is 12 quarters and the average duration of recession is 9 quarters. In addition to reporting the average numbers for duration and amplitude of phases, Table 4 also reports coefficient of variation (CV) which is a measure of diversity in duration (CVD) and amplitude (CVA) of expansion and recession phases (Plessis, 2006; Viv B. Hall, 2009). This measure shows how diverse are the

duration and amplitude of expansion and recession phases across specific cycles. A higher value of the coefficient indicates greater diversity across cycles.

$$CV_D^{Expansion} = \frac{\sqrt{\frac{1}{K} \sum_{i=1}^K (D_i^{Expansion} - \bar{D}^{Expansion})^2}}{\frac{1}{K} \sum_{i=1}^K D_i^{Expansion}}$$

$$CV_D^{Recession} = \frac{\sqrt{\frac{1}{K} \sum_{i=1}^K (D_i^{Recession} - \bar{D}^{Recession})^2}}{\frac{1}{K} \sum_{i=1}^K D_i^{Recession}}$$

where,

$D_i^{Expansion}$ is the duration of the expansionary phase of specific cycle i .

$\bar{D}^{Expansion}$ is the average duration of expansionary phases

$$CV_A^{Expansion} = \frac{\sqrt{\frac{1}{K} \sum_{i=1}^K (A_i^{Expansion} - \bar{A}^{Expansion})^2}}{\frac{1}{K} \sum_{i=1}^K A_i^{Expansion}}$$

$$CV_A^{Recession} = \frac{\sqrt{\frac{1}{K} \sum_{i=1}^K (A_i^{Recession} - \bar{A}^{Recession})^2}}{\frac{1}{K} \sum_{i=1}^K A_i^{Recession}}$$

Table 4: Summary statistics of GDP growth cycles

This table shows the summary statistics of growth cycle turning points. It shows the average duration and amplitude of expansion and recessions. The average amplitude of expansion is seen to be 2.5% while the average amplitude of recession is 2.2%. The average duration of expansion is seen to be 12 quarters while the average duration of recession is seen to be 9.3 quarters. The table also shows the coefficient of variation (CV) in duration and amplitude across expansions and recessions. We find that diversity in durations of expansions and recessions is similar. The diversity in duration of expansion is seen to be 0.34 while the diversity in duration of recession is 0.31. Turning to the diversity in amplitude, we find that the amplitude of recession is more diverse at 0.45. The diversity in amplitude of expansion is 0.38. This implies that some episodes of recession are more severe than the others across specific cycles.

Exp/Rec	Average amplitude (in per cent)	Average duration (in quarters)	Measure of diversity in duration (CVD)	Measure of diversity in amplitude (CVA)
Expansion	2.5	12.0	0.34	0.38
Recession	2.2	9.3	0.31	0.45

where,

$A_i^{Expansion}$ is the amplitude of the expansionary phase of specific cycle i .

$A^{Expansion}$ is the average amplitude of expansionary phrases.

Table 4 shows that the diversity in duration of recessions and expansions are similar (both are equally diverse) whereas we see greater diversity in the amplitude of recessions when compared to expansions. This implies that some recessions are more severe relative to the others across different cycles.

We compare our findings on average duration of phases with the findings reported in earlier literature. The average duration of phases is found to be longer than the duration reported by the earlier literature (Mohanty et al., 2003; Rand and Tarp, 2002; Dua and Banerji, 2012) (See Table 5). Mohanty et al. (2003) applies the growth cycle approach to IIP and identifies 13 growth cycles during the period 1970-71 to 2001-02. The authors find that the average duration of expansion is 4 quarters. Recessions are characterised by relatively longer duration of 5 quarters. Dua and Banerji (2012) using the growth rate cycle approach for the period 1960-2010 find that the average duration of speed-up is 5 quarters and average duration of slowdown is 6 quarters. One plausible explanation for relatively shorter durations of phases in earlier studies could be that these studies cover the pre-reform period. In the pre-reform period, the fluctuations were driven by short-lived and volatile weather and oil price shocks. Inventory-investment fluctuations which

is central to a conventional business cycle did not play a prominent role⁶.

Table 5: Changing nature of Indian business cycle: Evidence from the literature

This table presents a comparison of the average duration of expansion and recession reported in the literature. It provides evidence of change in the nature of business cycle turning points. We find that the average duration of expansion is 12 quarters and the average duration of recession is 9 quarters. This is in contrast to the relatively shorter duration reported in the literature ((Mohanty et al., 2003; Dua and Banerji, 2012))

	Reference time period of expansion	Average duration of recession	Average duration
Mohanty (2003)	1970-2001	4 quarters	5 quarters
Dua and Banerji (2012)	1960-2010	5 quarters	6 quarters
Our findings	1996-2014	12 quarters	9 quarters

Table 6: Change in U.S business cycles over time

This table reports the average duration of recession (peak to trough), expansion (trough to peak) and cycle (peak to peak and trough to trough) for the U.S over three distinct time periods. If we compare the period 1854-1919 and 1919-1945, we find that recessions (peak to trough) have become shorter and expansions have become longer in 1919-1945. Consequently the cycles have become longer in 1919-1945 as compared to 1845-1919.

Cycles	Peak to trough	Trough to peak	Trough to trough	Peak to peak
1854-1919 (16 cycles)	21.6	26.6	48.2	48.9
1919-1945 (6 cycles)	18.2	35.0	53.2	53.0
1945-2009 (11 cycles)	11.1	58.4	69.5	68.5

5.2: Characteristics of turning points: Have the cycles changed over time?

Do the characteristics of business cycles change over time? Table 6 shows the changing nature of U.S business cycles over time. Comparing two distinct periods—1854-1919 and 1945-2009, we find that recessions (from peak to trough) have become shorter and cycles (from trough to trough; or from peak to peak) have become longer.

In recent decades, a number of emerging economies have undergone structural transformation and reforms aimed at greater market orientation. There is an emerging strand of literature that studies the changes in business cycle facts in response to these changes (Kim et al., 2003; Alp et al., 2012; Ghate et al., 2013). A key finding of this

⁶ We cannot compare the findings on coefficient of variation as to the best of our knowledge this statistic is not reported in earlier studies.

literature is that, emerging economy cycles have changed in the post reform period. Alp et al. (2012) compare business cycle properties of the Turkish economy between the pre and post 2001 period. The authors find that the post 2001 period is associated with a significant decline in the volatility of GDP, consumption and investment. In a broader study Kim et al. (2003) analyse the cyclical features of seven Asian countries⁷ spanning the period 1960-1996. Since most of these countries experienced structural transformation, the authors compare the business cycle characteristics between two sub-periods (1960-1984) and (1984-1996) to understand whether business cycle characteristics change in response to structural transformation and policy reforms. A key finding emerging from the analysis is that the amplitude of economic fluctuations in Asian economies seems to be dampening over time. The decrease in amplitude of economic fluctuations is explained by a shift in sectoral composition away from agriculture.

For India, Ghate et al. (2013) present a comparison of the business cycle stylised facts for the pre and post reform period. The authors find that post reform Indian business cycle stylised facts resemble that of an economy in transition. While the volatility of macroeconomic variables in the post-reform period in India is high and similar to emerging market economies, in terms of correlation and persistence, the Indian business cycle looks similar to advanced economies, and less like emerging market economies.

Studies find that business cycle stylised facts change over time. In this section we formally explore whether the duration of business cycle has changed over time. This analysis cannot be performed using GDP since the quarterly series is available only from 1996. In order to gain intuition into the changing nature of cycles, we use IIP for which we have a longer time series. We analyse the series in two phases: pre-reform phase from 1971-1990 and post-reform phase from 1992-2015. We follow the same approach. We adjust the series for seasonality and apply the CF filter to extract the cyclical component. The NBER business cycle periodicity of 2-8 years is used to extract the cyclical component. To the standardised cyclical component of pre and post-reform IIP, we apply the dating algorithm by Bry and Boschan (1971).

Table 7 shows the average duration of expansions and recessions in the two sub-periods. Table shows that while expansions have become longer, recessions have become shorter in the post-reform period. As an outcome, cycles have become longer. This analysis shows over time the duration of cycles have changed.

⁷ The authors study: Indonesia, Korea, Malaysia, The Philippines, Singapore, Taiwan, and Thailand.

Table 7: Average duration in quarters: Evidence from pre and post IIP

This table presents a comparison of the average duration of expansion, recession and overall cycle between the pre and post reform period. We find that the average duration of expansion has increased and the average duration of recession has reduced. As a result the average duration of cycle has increased.

Reference time period	Average duration of expansion	Average duration of recession	Average duration of cycle
1971-1990	5.2	6.7	11.9
1992-2014	5.9	6.3	12.2

Table 8: Have the phases of cycles become more diverse over time?

Phase	CV _D		CV _A	
	Expansion	Recession	Expansion	Recession
1971-1990	0.28	0.32	0.61	0.59
1992-2014	0.43	0.46	0.74	0.71

Table 8 reports the coefficient of variation in duration and amplitude of phases across different cycles in the pre and post reform period. Table shows that in the post-reform period both expansions and recessions have become diverse in terms of duration and amplitude. Some episodes of recession are relatively deeper and severe relative to others in the post-reform period. Similarly, there is considerable variation in the duration of expansion and recession across specific cycles in the post-reform period. Some are short-lived while others are relatively more persistent. This dimension of change is hidden if we limit our analysis to comparing average duration and amplitude of phases in pre and post reform period. Our analysis points to interesting features about the Indian business cycles. While the average cycle has become longer in the post-reform period, episodes of expansion and recession are relatively more diverse in the post-reform period.

We present a description of the characteristics of the business cycle turning points in the post-reform period. Using seasonally adjusted quarterly GDP from 1996Q2 to 2014 Q3 we identify three episodes of recession: 1999Q4 to 2003Q1, 2007Q2 to

2009Q3 and 2011Q2 to 2012Q4. The average duration of expansion is seen to be 12 quarters while the average duration of recession is seen to be 9.3 quarters. We also report coefficient of variation: a measure of diversity of amplitude and duration of expansion and recession across specific cycles. We find that while the duration of both expansion and recession are equally diverse, recessions have a more diverse amplitude as compared to expansions. We offer evidence of change in the characteristics of turning points over time using IIP. In addition to reporting evidence of change in the average duration and amplitude of expansion and recession, we also show change in the diversity of amplitude and duration of expansion and recession over time.

6. Sensitivity of turning points chronology: Some robustness checks

In this section we present robustness checks to examine the sensitivity of our findings on business cycle chronology to the choice of filter and to the choice of the reference variable. We perform two robustness checks. First, we check the sensitivity of our results to the detrending procedures. To do this, we use the Hodrick-Prescott filter in place of the CF filter to extract the cyclical component. We perform this check to test if cyclical components derived from different detrending procedures yield similar turning points. Second, we check the robustness of our findings to the choice of reference series. We use IIP, non-agricultural, non-Government GDP and firms' net sales index as a proxy for analysing business cycle chronology to test if the chronology of turning points is sensitive to the choice of the reference series.

6.1 Robustness check I: Using Hodrick-Prescott filter

In this section we report the sensitivity of our findings to the choice of filter to detrend the series. Figure 4 and Table 9 shows the turning points in the cyclical component of GDP extracted using the HP filter. As discussed earlier the choice of the smoothing parameter is crucial for the application of the HP filter. With quarterly data, the smoothing parameter is set prior to 1600. With this value of smoothing parameter, the HP filter defines the cyclical component as fluctuations with a period less than 8 years. HP filter with a smoothing parameter of 1600 is comparable to a CF filter which extracts cycles of periodicity ranging between 2-8 years. This enables comparison of cycles extracted through both the filters.

It is noteworthy that broadly similar periods of recession (2000 Q1–2003 Q1, 2007 Q4–2008 Q4 and 2011 Q1–2014 Q1) are identified using the cyclical component extracted through the Hodrick-Prescott filter. A comparison of Table 3 and Table 9 shows that the application of HP filter to extract cyclical component yields more number

of cycles. This is attributed to the property of HP filter. The reason is that the HP filter puts weight on high frequencies whereas the two band pass filters do not put any weight on these frequencies. As an outcome some high frequency cycles are also extracted through the application of HP filter. A visual inspection of the cyclical component extracted through the CF and HP filter also shows that the CF filter extracts smoother cycles compared to the HP (See Figures 3 and 4).

Figure 4: Turning points from 1996 to 2014 using HP filter

This figure shows the turning points in the cyclical component of GDP. Here the cyclical component is extracted using the HP filter (using the conventional smoothing parameter of 1600).

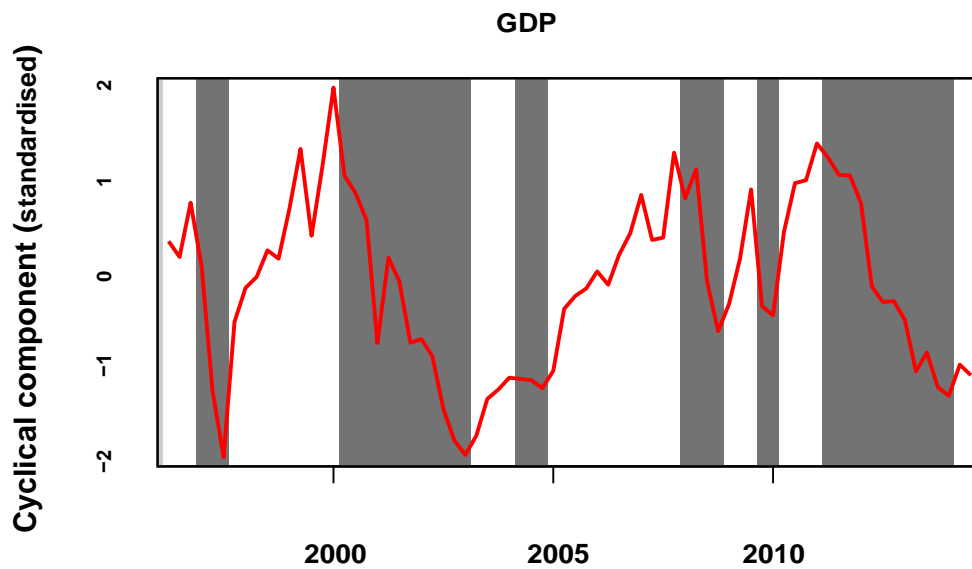


Table 9: Dates of turning points in GDP using HP filter: 1999-2014

This table shows the business cycle chronology using HP filter. Broadly similar periods of recession (2000 Q1–2003 Q1, 2007 Q4–2008 Q4 and 2011 Q1–2014 Q1) are identified using the cyclical component extracted through the HP filter. In addition, some high frequency cycles are also extracted through the application of the HP filter.

Phase	Start	End	Duration	Amplitude
Recession	2000Q1	2003Q1	12	4.3
Expansion	2003Q1	2004Q1	4	0.9
Recession	2004Q1	2004Q4	3	0.1
Expansion	2004Q4	2007Q4	12	2.7
Recession	2007Q4	2008Q4	4	2.1
Expansion	2008Q4	2009Q3	3	1.6
Recession	2009Q3	2010Q1	2	1.5
Expansion	2010Q1	2011Q1	4	2.0
Recession	2011Q1	2014Q1	12	2.9

6.2 Robustness check II: Growth cycle chronology using other reference series

We turn to examine the turning points using some additional series that could be considered as proxy indicators to study the business cycle chronology. We use IIP, GDP excluding agriculture and government and firms' net sales index as reference series to analyse the business chronology. We exclude agriculture since agriculture is affected by strong seasonal fluctuations which depend on the outcome of the monsoon. In contrast, the government sector is affected by significant short run volatility due to the dynamics of public sector outlays. GDP excluding agriculture and excluding government focuses on the output of individuals, small firms and large firms and is closely related to business cycles.

Next, we use a measure of output utilising firm data. We construct an index of firms net sales. For the construction of the firms' net sales index we focus on all listed firms observed in the CMIE Prowess database other than finance and oil companies. We exclude finance companies since they follow very different accounting concepts. We also exclude oil companies since their balance-sheets show large changes owing to government's decisions about administered prices. These fluctuations are not an indication of underlying business cycle conditions. For the rest of the firms we construct an index of their net sales. This is done as follows: For each pair of quarters, we construct a panel of firms observed in both quarters, and work out the percentage change in the sum of net sales across all the firms. These percentage changes are used

to construct a net sales index.⁸

Following our baseline methodology we use the CF filter to extract the cyclical component and then apply the Bry-Boschan algorithm. Tables 10, 11 and 12 show the phases of expansion and recession in IIP, GDP excluding agriculture and excluding government and firms' net sales respectively. The periods of recession identified using the three series are broadly in conformity with the periods of recession identified in the GDP series. IIP as a reference series yields 2000 Q2 to 2003 Q3, 2007 Q4 to 2009 Q2 and 2011 Q1 to 2013 Q4 as periods of recession. These are broadly similar to the three periods of recession identified using GDP as the reference series. GDP excluding agriculture and government yields the three periods of recession: 2000 Q1 to 2003 Q1, 2007 Q2 to 2009 Q3 and 2011 Q2 to 2012 Q4. These are almost identical to the recessions identified using GDP as the reference series. Firms' net sales index yields 2000 Q2-2002 Q4, 2007 Q4- 2009 Q3 and 2011 Q2 to 2013 Q4. These are broadly in conformity with the recession periods identified using GDP as the reference series⁹.

Table 10: Dates of turning points in IIP: 1999-2014

This table shows the business cycle chronology using IIP as the reference series. The periods of recession: 2000 Q2 to 2003 Q3, 2007 Q4 to 2009 Q2 and 2011 Q1 to 2013 Q4 are broadly similar to the three periods of recession identified using GDP as the reference series.

Phase	Start	End	Duration	Amplitude
Recession	2000Q2	2003Q3	13	2.2
Expansion	2003Q3	2004Q4	5	1.3
Recession	2004Q4	2006Q1	5	1.5
Expansion	2006Q1	2007Q4	7	3.8
Recession	2007Q4	2009Q2	6	5.3
Expansion	2009Q2	2011Q1	7	3.5
Recession	2011Q1	2013Q4	11	1.6

On the whole, the robustness checks show that the chronology of recession is broadly robust to the choice of the detrending procedure and to the choice of the reference series.

⁸ For details on the methodology to construct net sales index see <http://ajayshahblog.blogspot.in/2013/07/a-better-output-proxy-for-indian-economy.html>

⁹ In addition to the three common recession periods, an additional short period of recession is identified in each of the three series in the period ranging from mid-2004 to early 2006

7. Description of recessions and expansions

Figure 5 shows the performance of key macroeconomic variables during the three identified periods of recession. The shaded portions show the period of recession identified in the cyclical component of GDP. The first figure in the first row shows the year-on-year change in GDP growth. The year-on-year growth shows sharp moderation during the three shaded periods of recession from 1999 Q4 to 2003 Q1, from 2007 Q2 to 2009 Q3 and from 2011 Q2 to 2012 Q4. The second figure in the first row shows the year-on-year growth in IIP. The growth in IIP also shows a decline during the shaded periods of recession. Similar trend is seen in credit growth and investment growth. Both the series show considerable decline during the shaded periods of recession. The above analysis shows that the trends in standard indicators conform to the chronology of recession.

A brief description of the macro-economic conditions during the periods of expansion and recession is presented below. To set the context, we begin by giving a brief overview of the macroeconomic conditions in the nineties.

**Table 11: Dates of turning points in GDP (excluding agriculture and Government.)
1996-2014**

This table shows the chronology of business cycle turning points using GDP excluding agriculture and Government as the reference series. The periods of recession: 2000 Q1 to 2003 Q1, 2007 Q2 to 2009 Q3 and 2011 Q2 to 2012 Q4 are almost identical to the recessions identified using GDP as the reference series.

Phase	Start	End	Duration	Amplitude
Recession	2000Q1	2003Q1	12	2.7
Expansion	2003Q1	2004Q2	5	0.6
Recession	2004Q2	2005Q1	3	0.2
Expansion	2005Q1	2007Q2	9	2.2
Recession	2007Q2	2009Q3	9	3.3
Expansion	2009Q3	2011Q2	7	1.8
Recession	2011Q2	2012Q4	6	0.7

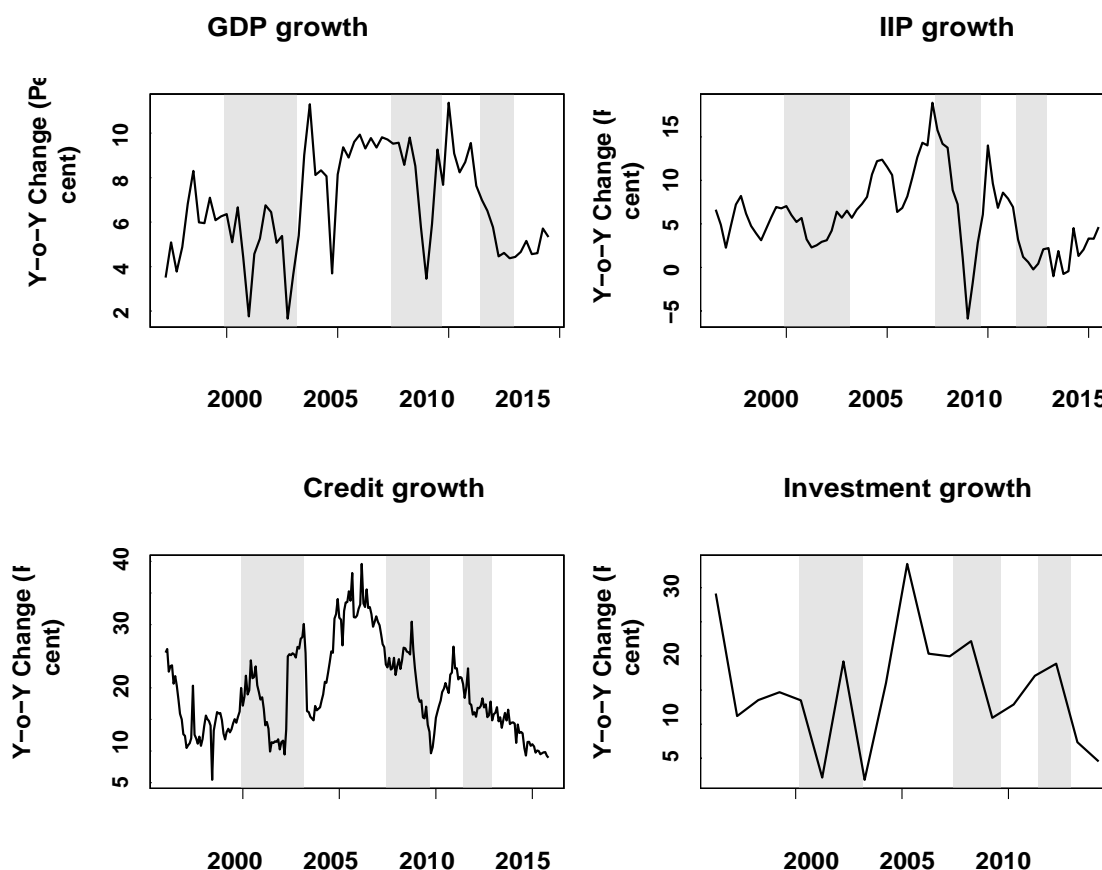
Table 12: Dates of turning points in firms' net sales: 1999-2014

This table shows the chronology of business cycle turning points using firms' net sales as the reference series. The periods of recession 2000 Q2 to 2002 Q4, 2007 Q4 to 2009 Q3 and 2011 Q2 to 2013 Q4 are broadly in conformity with the recession periods identified using GDP.

Phase	Start	End	Duration	Amplitude
Recession	2000Q2	2002Q4	10	2.7
Expansion	2002Q4	2004Q3	7	1.9
Recession	2004Q3	2005Q4	5	0.9
Expansion	2005Q4	2007Q4	8	1.2
Recession	2007Q4	2009Q3	7	3.2
Expansion	2009Q3	2011Q2	7	3.8
Recession	2011Q2	2013Q4	10	3.1

Figure 5: Slowdown in macro-economic variables during the identified periods of recession

This figure shows the growth patterns in key macro-economic variables during the identified periods of recession. The figure shows that the year-on-year growth in GDP, IIP, non-food credit and investment shows considerable decline during the shaded periods of recession.



The decade of nineties: The decade of nineties saw far reaching changes in economic policy. The Balance of Payments crisis in the early nineties triggered wide ranging reforms. These led to a spurt in economic growth in the first half of the nineties. Some of the key reforms introduced in the early nineties were:

1. Devaluation and transition to a market determined exchange rate.
2. Phased reduction of peak custom duties.
3. Policies to encourage foreign direct and portfolio investment.
4. Abolition of industrial licensing
5. Gradual liberalisation of interest rates
6. Setting up of Securities and Exchange Board of India (SEBI) as capital market regulator and decontrol of Government over capital issues

Against the backdrop of these reforms the external and real sector witnessed a sharp turn round. Table 13 shows a spurt in growth in GDP and its components in the initial post crisis years. GDP growth reached a peak of around 8% in 1996-97. Agriculture, industry and services also grew in the initial years of the nineties. Figure 6 shows a sharp growth in industrial production and exports during the initial years of the nineties. The initial post crisis years saw a sharp growth in IIP with growth peaking at 13.7% in mid-1995. Export growth surged to 20% in 1993-94. The external debt indicators also witnessed an improvement (Table 14). The external debt stock to GDP ratio improved from 38.7% in 1991-92 to 30.8% in 1994-95 and further to 22% in 1999-00. The ratio of short-term debt to total debt declined from 8.3% in 1991-92 to 4.3% in 1994-95 to 4% in 1999-00. Ratio of foreign exchange reserves to total debt and the ratio of short-term debt to foreign exchange reserves also witness an improvement in the nineties.

Table 13: Growth rate in GDP and its sectors

This table shows the growth rate in GDP and its sectors in the nineties. The table shows a pick-up in growth rate during the initial post-crisis years from 1992-1996. Since 1997 a broad-based moderation is seen in growth rates for overall GDP, agriculture and industrial GDP. GDP growth surged from 1.36% in 1991-92 to 7.97% in 1996-97 before slowing down in 1997-98. The growth in GDP (Industry) reached its peak at 11.29% in 1995-96 before slowing down in subsequent years. GDP (Agriculture) also slowed down in the second half of nineties.

Year	GDP	Agriculture	Industry	Services
1991-92	1.43	-1.95	0.34	4.69
1992-93	5.36	6.65	3.22	5.69
1993-94	5.68	3.32	5.5	7.38
1994-95	6.39	4.72	9.16	5.84
1995-96	7.29	-0.7	11.29	10.11
1996-97	7.97	9.92	6.39	7.53
1997-98	4.3	-2.55	4.01	8.93
1998-99	6.68	6.32	4.15	8.28
1999-00	7.59	2.67	5.96	11.19

Aggregate savings and investments were also buoyant during the first half of the nineties. Gross domestic savings as a percent to GDP rose from 21.3% in 1991-92 to 24.15% in 1997-98. Similarly gross domestic capital formation rose from 22.5% in 1991-92 to reach a peak of 26.1% in 1995-96 before slowing down to 22% in 1996-97.

From 1997 onwards we see a deceleration in India's growth story (Acharya,

2012). GDP growth moderated to 4.3% in 1997-98 from 8% in 1996-97. Agriculture and industrial growth also slowed down in 1997-98. The growth in manufacturing fell sharply to less than 1% in 1997-98 from 9.5% in the previous year. Figure 6 shows a slump in industrial production and exports in 1997. The moderation in growth from 1997-98 onwards could be attributed to the investment boom of the previous years. The investment boom of the previous three years had built up large capacities, which discouraged further expansion. Another reason could be the advent of coalition governance had dampened business confidence.

The subsequent paragraphs present an overview of the phases of expansion and recession from 1999 onwards.

Figure 6: Industrial production and exports in the nineties

This figure shows the year-on-year growth in industrial production and exports in the nineties. The first figure shows the growth in IIP and the second figure captures the growth in exports. The growth in both these variables witnessed a surge in the initial years of the nineties before moderating from 1996-97 onwards.

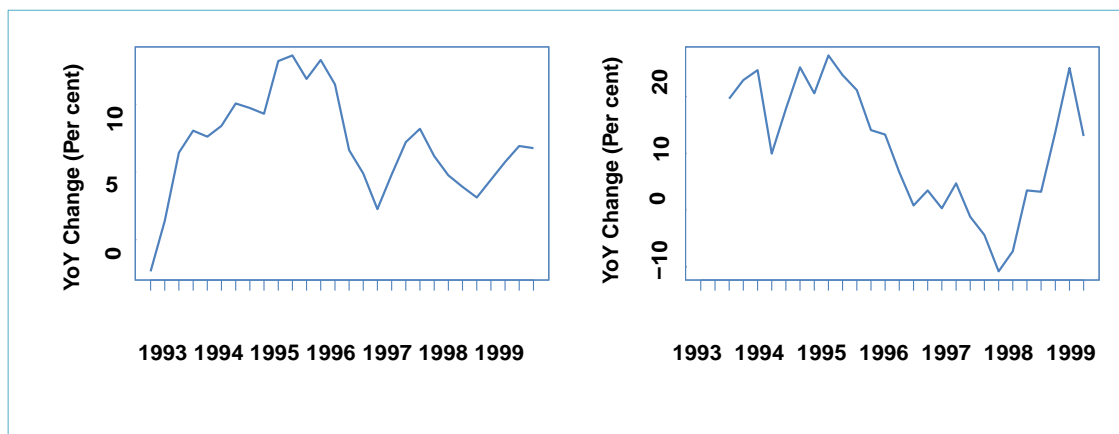


Table 14 External debt indicators in the nineties

This table shows the key external debt indicators in the nineties. One of the outcome of the reform measures introduced in the nineties was the improvement in the external debt indicators. The stock of external debt to GDP improved from 38.7% in 1991-92 to 22% in 1999-2000. Improvements are visible in other indicators of external debt such as ratio of short-term debt to total debt, ratio of foreign exchange reserves to total debt and ratio of short-term debt to foreign exchange reserves.

Year	External debt to GDP (%)	Ratio of short-term debt to total debt	Ratio of foreign exchange reserves to total debt	Ratio of short-term debt to foreign exchange reserves
1991-92	38.7	8.3	10.8	76.7
1992-93	37.5	7.0	10.9	64.5
1993-94	33.8	3.9	20.8	18.8
1994-95	30.8	4.3	25.4	16.9
1995-96	27.0	5.4	23.1	23.2
1996-97	24.6	7.2	28.3	25.5
1997-98	24.3	5.4	31.4	17.2
1998-99	23.6	4.4	33.5	13.2
1999-00	22.0	4.0	38.7	10.3

Source: India's external debt: A status report (2014-15)

Table 15: Key macro-economic conditions in 2000-03

This table shows the growth rate in GDP, gross fixed investment as a ratio to GDP and savings as a ratio to GDP during 2000-03 period. We see a moderation in GDP growth rate. Broadly, the savings rate exceeded the investment rate in this period.

	1999-2000	2000-01	2001-02	2002-03
Annual GDP growth rate	7.6	4.3	5.5	4.0
Gross fixed investment (% to GDP)	24.1	22.8	25.1	23.7
Savings (% to GDP)	25.7	23.8	24.9	25.93

End 1999 to 2003Q1 recession: Table 15 shows the performance of key macro-economic indicators during the period 2000-03. GDP growth slowed down from 7.6% in 1999-2000 to 4.3% in 2000-01. The ratio of gross fixed investment to GDP was lower than the ratio of savings to GDP. With low private investment demand, foreign investment was sought to improve the investment climate. However in the aftermath of the Asian financial crisis, FDI inflows did not gain momentum. The bursting of the dotcom bubble and the brief decline in software export growth after the "Y2K" problem also contributed to the slowdown (Nagaraj, 2013). On the whole, the macro-economic conditions were largely benign. But conditions began to look positive from 2003 onwards. The upswing from 2003 onwards was driven by a boom in investment and a

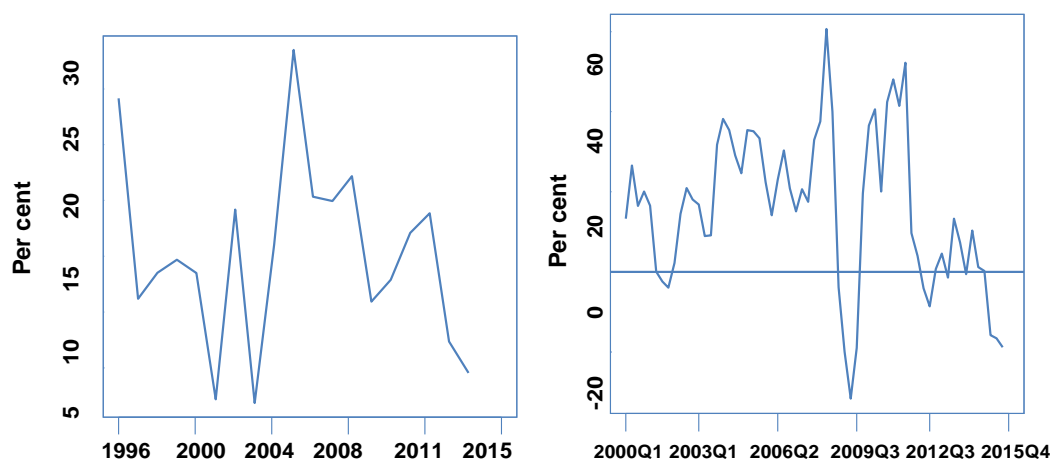
revival of foreign capital inflows that had dried up after the Asian financial crisis.

Year 2003 to mid-2007 expansion: The economy witnessed an upswing in the cycle, primarily led by high credit growth during this period when firms borrowed and initiated a number of projects. What triggered this boom? From 2001 to 2004, RBI engaged in sterilised intervention. In early 2004, it ran out of bonds. This period was marked by currency trading that was not backed by sterilisation. Without sterilisation dollar purchases resulted in injection of rupee in the economy. The economy became flush with funds, interest rates went down. This kicked off a bank credit boom from 2004 to 2007. The third graph of Figure 5 shows a surge in credit growth between 2004 and 2007. The credit growth reached a peak of 40% during this period. GDP growth remained strong at 8-10% during this period.

Mid-2007 to mid-2009 recession: Global financial crisis affected India through trade and financial linkages. Export growth saw a sharp deceleration in this period (Patnaik and Shah, 2010; Patnaik and Pundit, 2014). This could have been the result of greater synchronisation of domestic cycles with global cycles (Jayaram et al., 2009). The immediate transmission of the financial crisis to India was through a slowdown of credit flows which was reflected in the spiking of overnight call money rates that rose to nearly 20 per cent in October and early November 2008. Investment growth also slowed down in 2008-09 (See the first graph of Figure 7).

Figure 7: Slowdown in investment and exports in 2008-09

This figure shows the slowdown in investment and exports growth during the 2008-09 period. The first graph shows the year-on-year growth in investment and the second graph shows the

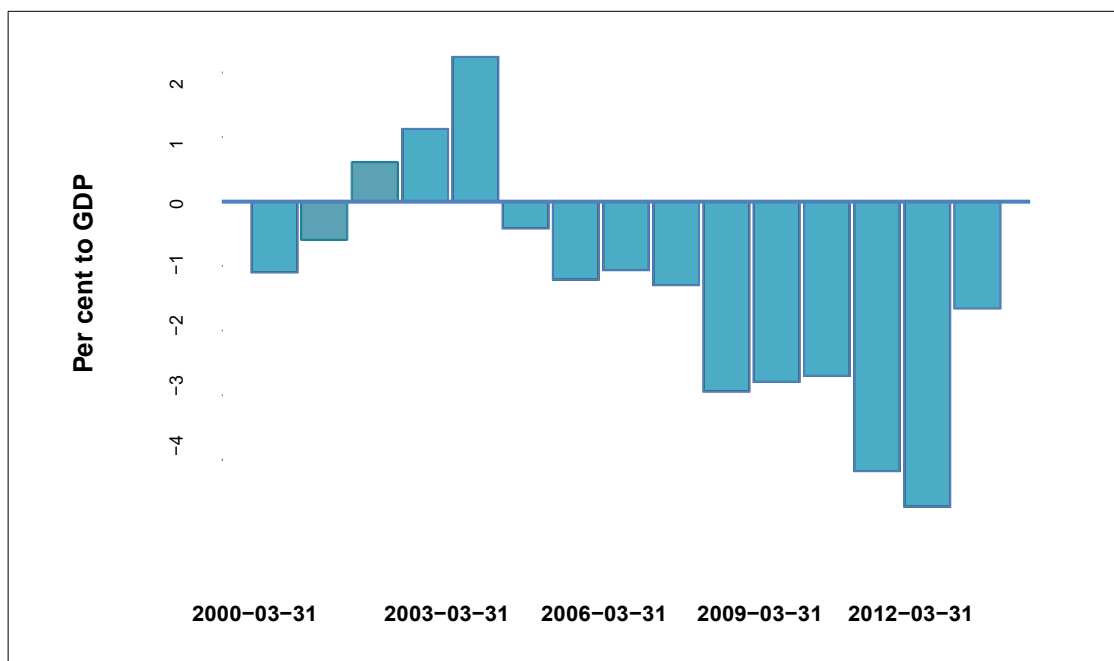


year-on-year growth in exports.

Mid-2009 to mid-2011 expansion: We saw a business cycle upswing in 2009. GDP growth recovered to 8.6% in 2009-10 from 6.72% in 2008- 09. The growth further strengthened to 8.9% in 2010-11. The upswing was an outcome of a coordinated monetary and fiscal policy stimulus package announced in 2008-09. For example, the government introduced fiscal stimulus in the form of tax cuts and increased expenditure to boost consumer demand and production in key sectors. The Fiscal Responsibility and Budget Management (FRBM) Act, 2003, according to which, the government is required to follow fiscal prudence to reduce its deficits to a target rate, was suspended in 2009 in order to accommodate the stimulus policies. On the monetary side, the Reserve Bank of India introduced measures, such as rate cuts, to boost liquidity and ease credit in order to boost investment. The rate cut cycle began in October 2008 and continued till March 2010. Guidelines for External Commercial Borrowing were also liberalised to ease firms' access to external finance (Patnaik and Pundit, 2014).

Mid 2011 to 2012 recession: Since 2011, again, we saw a business cycle slowdown. GDP growth plummeted to 6.7% in 2011-12 and further to 4.47% in 2012-13. This was a culmination of a number of factors. The macroeconomic policy stimulus intended to cushion the fallout of crisis culminated in high inflation and current account pressures. The quality of the fiscal stimulus, which focused on tax cuts and increased revenue expenditure, added to demand pressures, resulting in high inflation. The efficacy of monetary policy to deal with inflation was blunted by persistent rise in food prices (Bhattacharya and Sen Gupta, 2015).

Figure 8: Surge in current account deficit as a ratio to GDP during 2011-12

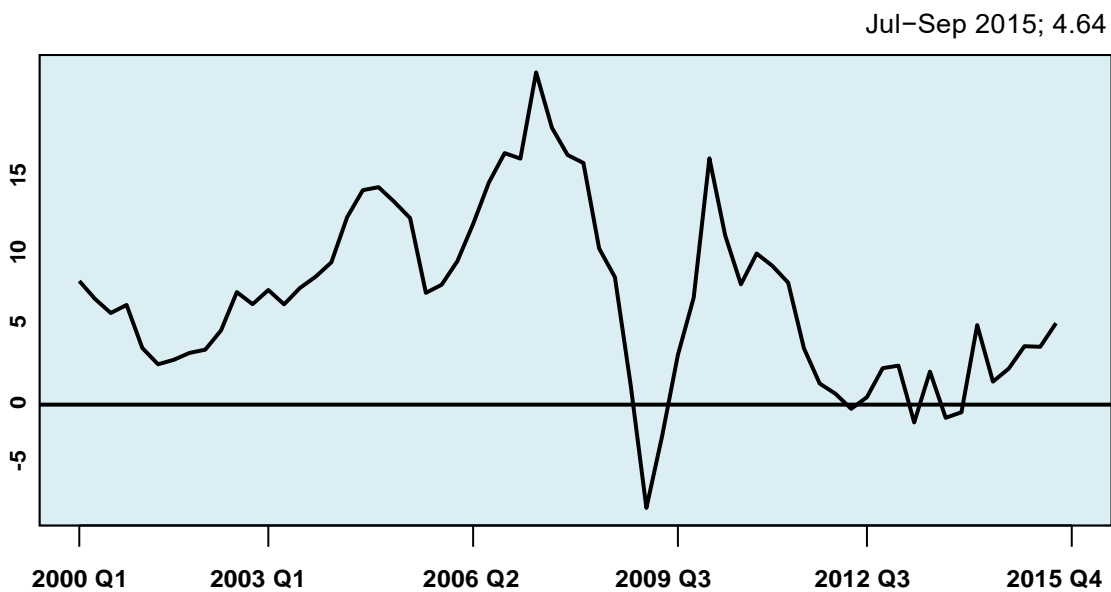


Inability to achieve fiscal consolidation coupled with surging current account deficit contributed to slowdown in the economy. The fiscal deficit as a ratio to GDP rose from 4.8 in the year ending March 2011 to 5.73 percent in the year ending March 2012. The current account as a percent to GDP also rose beyond comfort levels to 4.17% for the year ending March 2012. High domestic inflation and negative real interest rates on deposits encouraged gold imports thus adding to CAD pressures.

A key manifestation of the growth slowdown was the weakness of the manufacturing sector during this time. An explanation for the weakness in industrial activity can be traced to the emergence of policy bottlenecks like obtaining environmental clearances, hurdles in land acquisition etc. which resulted in stalling of a large number of projects (Mohan and Kapur, 2015).

Figure 9 Weakness in industrial production since the mid 2011

This figure shows the year-on-year growth in IIP. The figure shows a slowdown in IIP since mid 2011.



8. Conclusion

Using the growth cycle approach, this paper presents a chronology of business cycle turning points in the post reform period. We identify three main episodes of recession in the period from 1996 to 2014. We show evidence to support that the characteristics of Indian business cycle turning points have changed over time. While the cycles have become longer, we see greater variability in duration and amplitude of expansions and recessions across specific cycles in the post-reform period.

Application of the growth cycle approach across a number of variables to identify turning points could constitute an interesting area for future research. The identification of turning points could be used to identify candidates for coincident, leading and lagging indicators to the reference series. Since we do not have a long GDP series, the identified coincident, leading and lagging indicators could be used to arrive at an assessment of the state of the economy. Another avenue for future research could be the application of this methodology across multiple emerging economies to explore if the characteristics of business cycle turning points have changed over time in response to changes in policy environment.

Appendix

Detrending techniques

Cycle extraction is a crucial step in the growth cycle approach. Instead of observing the series in the time domain, it is useful to translate the series in a frequency domain framework. In the frequency domain, we can treat the series as a construction of sine waves of different wave length. The trend part of the series is comprised by the low frequency (high wave length) sine waves, whereas the noise is formed by a set of high frequency sine waves (OECD, 2016)..

Once we have the series in the frequency domain, we can single out the cycles we are interested in, and eliminate the components whose wave length is too long (trend) or too short (noise). The category of band-pass filters help in extracting cycles of a chosen frequency (Christiano and Fitzgerald, 2003; Baxter and King, 1999). The detrending methods need to be aligned with the chosen business cycle frequency or periodicity.

Hodrick-Prescott filter:

$$y_t = \tau_t + c_t$$

$$\min_{\tau_t} \sum_t (y_t - \tau_t)^2 + \lambda * \sum_t (\tau_{t+1} - 2 * \tau_t + \tau_{t-1})^2$$

The initial y_t series is decomposed into τ_t , the trend component and c_t , the cyclical component, with the objective being to minimise the distance between the trend and the original series and, at the same time to minimise the curvature of the trend series. The trade-off between the two goals is captured by the λ parameter.

It is possible to transform the Hodrick-Prescott filter into frequency domain. The literature uses 1600 as the value of λ for quarterly series but it is possible to align the λ parameter with the goal of filtering out cycles in a certain frequency range depending upon our definition of business cycle with the help of the transformation into the frequency domain (Pedersen, 2001).

References

- Acharya, S. (2012). India: Crisis, reforms and growth in the nineties. Working Papers 139, Stanford Center for International Development. Retrieved from: <http://scid.stanford.edu/publications/india-crisis-reforms-and-growth-nineties>
- Aguiar, M., Gopinath G. (2004). Emerging Market Business Cycles: The Cycle is the Trend” NBER Working Papers 10734, National Bureau of Economic Research, Inc.
Retrieved from: <http://ideas.repec.org/p/nbr/nberwo/10734.html>.
- Alp, H., Baskaya Y., Kilinc M, Yuksel C. (2011). Estimating Optimal Hodrick- Prescott Filter Smoothing Parameter for Turkey, *Iktisat Isletme ve Finans*, 26(306): 09–23.
Retrieved from: <http://EconPapers.repec.org/RePEc:iif:iifjrn:v:26:y:2011:i:306:p:09-23>.
- Alp, H, Baskaya YS, Kilinc M, Yuksel C. (2012). Stylized Facts for Business Cycles in Turkey” Working Papers 1202, Research and Monetary Policy Department, Central Bank of the Republic of Turkey.
Retrieved from: <https://ideas.repec.org/p/tcb/wpaper/1202.html>.
- Baxter, M, King R. (1999). Measuring business cycles: approximate band-pass filters for economic time series. *Review of Economics and Statistics*, 81(4): 575–593. ISSN 0034-6535.
- Bhattacharya, R, Pandey R, Patnaik I, Shah A. (2016). Seasonal adjustment of Indian macroeconomic time-series. Working Papers 16/160, National Institute of Public Finance and Policy. Retrieved from: <https://ideas.repec.org/p/npf/wpaper/16-160.html>.
- Sen Gupta A. (2015). Food Inflation in India: Causes and Consequences. Working Papers 15/151, National Institute of Public Finance and Policy. Retrieved from: <https://ideas.repec.org/p/npf/wpaper/15-151.html>.
- Bjornland, H. (2000). Detrending methods and stylized facts of business cycles in Norway- an international comparison. *Empirical Economics*.
- Board, TC. (2000). Business Cycle Indicators Handbook. The Conference Board, USA.
- Boschan, C, Banerji A. (1990). A reassessment of composite indexes. In *Analysing business cycles*, M.E Sharpe, New York.
- Bry, G., Boschan C. (1971). Cyclical Analysis of Time Series: Selected Procedures and Computer Programs. National Bureau of Economic Research.
Retrieved from: <http://www.nber.org/chapters/c2145>.
- Burns, A., Mitchell W. (1938). Statistical indicators of cyclical revivals. *NBER Bulletin*, 69.
- Burns, AF., Mitchell WC. (1946). Measuring Business Cycles. National Bureau of Economic Research.
- Burnside, C. (1998). Detrending and business cycle facts: A comment. *Journal of*

- Monetary Economics*, 41(3): 513-532.
- Calderon, C., Fuentes R.(2006). Characterising business cycle fluctuations in emerging economies. Central bank of Chile working papers.
- Canova, F. (1998). Detrending and business cycle facts, *Journal of Monetary Economics*, 41(3): 475-512.
- Chitre, V. (1982). Growth Cycles in the Indian Economy. Artha vijñana reprint series. Gokhale Institute of Politics & Economics.
Retrieved from: <https://books.google.co.in/books?id=o-SwAAAAIAAJ>.
- (2001). Indicators of Business Recessions and Revivals in India: 1951- 1982. *Indian Economic Review*, 36(1): 79–105. Retrieved from: <http://ideas.repec.org/a/dse/indecr/v36y2001i1p79-105.html>.
- (2004). Indicators of business recessions and revivals in India 1951 - 82.
- Christiano, L., Fitzgerald T. (2003). “The band pass filter.” V *International Economic Review*, 44(2): 435–465.
- Christoffersen, PF. (2000). Dating the Turning Points of Nordic Business Cycles. EPRU Working Paper Series 00-13, Economic Policy Research Unit (EPRU), University of Copenhagen. Department of Economics.
Retrieved from: <https://ideas.repec.org/p/kud/epuwp/00-13.html>.
- Dua, P., Banerji A. (1999). An Index of Coincident Economic Indicators for the Indian Economy. *Journal of Quantitative Economics*, 15, 177–201.
- (2000). An Index of Coincident Economic Indicators for the Indian Economy. Working papers 73, Centre for Development Economics, Delhi School of Economics. Retrieved from: <http://ideas.repec.org/p/cde/cdewps/73.html>.
- (2001a). An Indicator Approach to Business and Growth Rate Cycles: The Case of India. *Indian Economic Review*, 36(1): 55–78. Retrieved from: <http://ideas.repec.org/a/dse/indecr/v36y2001i1p55-78.html>.
- (2001b). A Leading Index for the Indian Economy, Working papers 90, Centre for Development Economics, Delhi School of Economics. Retrieved from: <http://ideas.repec.org/p/cde/cdewps/90.html>.
- (2007). Business Cycles in India. Working Paper 146, Centre for Development Economics, Department of Economics, Delhi School of Economics. Retrieved from: <http://www.cdedse.org/pdf/work146.pdf>
- (2012). Business and Growth Rate Cycles In India. Working papers 210, Centre for Development Economics, Delhi School of Economics.
Retrieved from: <https://ideas.repec.org/p/cde/cdewps/210.html>.
- Dua, P., Kumawat L. (2005). Modelling and Forecasting Seasonality in Indian Macroeconomic Time Series. Working papers 136, Centre for Development Economics, Delhi School of Economics.
Retrieved from: <http://ideas.repec.org/p/cde/cdewps/136.html>.
- Dubois, E., Michaux E. (2008). Grocer 1.3: An Econometrics toolbox for Scilab.

- Retrieved from: <http://dubois.ensae.net/grocer.html>.
- Gavin, M., Perotti R. (1997). Fiscal Policy in Latin America” In “NBER Macroeconomics Annual 1997, Volume 12,” NBER Chapters, pp. 11–72. National Bureau of Economic Research, Inc.
- Retrieved from: <https://ideas.repec.org/h/nbr/nberch/11036.html>.
- Ghate, C., Pandey R, Patnaik I. (2013). Has India emerged? Business cycle stylized facts from a transitioning economy. *Structural Change and Economic Dynamics*, 24(C): 157–172.
- Retrieved from: <https://ideas.repec.org/a/eee/streco/v24y2013icp157-172.html>.
- Harding, D, Pagan A. (1999). Knowing the Cycle. Melbourne Institute Working Paper Series wp1999n12, Melbourne Institute of Applied Economic and Social Research, The University of Melbourne.
- Retrieved from: <http://ideas.repec.org/p/iae/iaewps/wp1999n12.html>.
- (2002). Dissecting the cycle: a methodological investigation* 1.” *Journal of Monetary Economics*, 49(2): 365–381. ISSN 0304-3932.
- (2003). A comparison of two business cycle dating methods. *Journal of Economic Dynamics and Control*, 27(9): 1681–1690.
- Retrieved from: <http://ideas.repec.org/a/eee/dyncon/v27y2003i9p1681-1690.html>.
- (2006). Synchronization of cycles. *Journal of Econometrics*, 132(1): 59–79.
- Retrieved from: <http://ideas.repec.org/a/eee/econom/v132y2006i1p59-79.html>.
- Harvey, AC., Jaeger A. (1993). Detrending, Stylized Facts and the Business Cycle. *Journal of Applied Econometrics*, 8(3): 231–47. Retrieved from: <http://ideas.repec.org/a/jae/japmet/v8y1993i3p231-47.html>.
- Hall, Viv, B., CJM. (2009). The New Zealand Business Cycle. *Econometric Theory*, 25(4): 1050–1069. ISSN 02664666, 14694360.
- Retrieved from: <http://www.jstor.org/stable/20532482>.
- Hodrick, RJ., Prescott EC. (1997). Postwar U.S. Business Cycles: An Empirical Investigation. *Journal of Money, Credit and Banking*, 29(1): 1–16.
- Retrieved from <http://ideas.repec.org/a/mcb/jmoncb/v29y1997i1p1-16.html>.
- Ilzetzki, E., Vegh CA. (2008). Procyclical Fiscal Policy in Developing Countries: Truth or Fiction? NBER Working Papers 14191, National Bureau of Economic Research, Inc. Retrieved from: <https://ideas.repec.org/p/nbr/nberwo/14191.html>.
- Jayaram, S., Patnaik I, Shah A. (2009). Examining the Decoupling Hypothesis for India. *Economic and Political Weekly*, 44(44), 109–116. ISSN 00129976, 23498846.
- Retrieved from: <http://www.jstor.org/stable/25663740>.
- Joshi, H. (1997). “Growth cycles in India: an empirical investigation.
- Kaminsky, GL., Reinhart CM, Vegh CA. (2004). When it Rains, it Pours: Procyclical Capital Flows and Macroeconomic Policies. NBER Working Papers 10780, National Bureau of Economic Research, Inc.
- Retrieved from: <https://ideas.repec.org/p/nbr/nberwo/10780.html>.
- Kim, SH., Kose MA, Plummer MG. (2003). Dynamics of Business Cycles in Asia:

- Differences and Similarities. *Review of Development Economics*, 7(3): 462–477.
Retrieved from: <https://ideas.repec.org/a/bla/rdevvec/v7y2003i3p462-477.html>.
- Klein, PA., Moore GH. (1985). Developing Growth Cycle Chronologies for Market-Oriented Countries, In “Monitoring Growth Cycles in Market-Oriented Countries: Developing and Using International Economic Indicators, NBER Chapters, pp. 29–69. National Bureau of Economic Research, Inc. Retrieved from: <https://ideas.repec.org/h/nbr/nberch/4165.html>.
- Layton, AP., Banerji A. (2001). Dating the Indian Business Cycle: Is Output All That Counts? *Indian Economic Review*, 36(1), 231–240.
Retrieved from: <http://ideas.repec.org/a/dse/indecr/v36y2001i1p231-240.html>.
- Mall O. (1999). Composite Index of Leading Indicators for Business Cycles in India. RBI Occasional Papers, 20(3), 373–414.
- Mintz, I. (1974). Dating United States Growth Cycle. Technical report, NBER.
- Mohan, R., Kapur M. (2015). Pressing the Indian Growth Accelerator: Policy Imperatives. IMF Working Papers 15/53, International Monetary Fund.
Retrieved from: <https://ideas.repec.org/p/imf/imfwpa/15-53.html>.
- Mohanty, J., Singh B, Jain R. (2003). Business cycles and leading indicators of industrial activity in India. *Mpra paper*, University Library of Munich, Germany.
Retrieved from: <http://EconPapers.repec.org/RePEc:pra:mprapa:12149>.
- Nagaraj, R. (2013). India’s Dream Run, 2003-08. *Economic and Political Weekly*, 48(20): 39.
- Nandi, A. (2010). India’s cosine curve: A business cycle approach of analysing growth, 2007 onwards” Corporate Economic Cell, Aditya Birla Management Corporation.
- Nilsson, R., Gyomai G. (2011). Cycle Extraction: A Comparison of the Phase- Average Trend Method, the Hodrick-Prescott and Christiano-Fitzgerald Filters. OECD Statistics Working Papers 2011/4, OECD Publishing.
Retrieved from: <https://ideas.repec.org/p/oec/stdaaa/2011-4-en.html>.
- OECD. (2016). OECD Composite Leading Indicators: Turning Points of Reference Series and Component Series” Technical report, OECD.
Retrieved from: <http://www.oecd.org/std/leading-indicators/CLI-components-and-turning-points.pdf>.
- Panagariya, A. (2008). India: The emerging giant. Oxford University Press. Patnaik I, Pundit M (2014). “Is India’s Long-Term Trend Growth Declining?” ADB Economics Working Paper Series 424, Asian Development Bank.
Retrieved from: <http://EconPapers.repec.org/RePEc:ris:adbewp:0424>.
- Patnaik, I., Shah A. (2010). Why India choked when Lehman broke. Finance Working Papers 22974, East Asian Bureau of Economic Research.
Retrieved from: <https://ideas.repec.org/p/eab/financ/22974.html>.
- Patnaik, I., Sharma R. (2002). Business cycles in the Indian economy, *MARGIN*, New Delhi, 35, 71–80. ISSN 0025-2921.

- Pedersen, TM. (2001). The Hodrick Prescott filter, the Slutsky effect, and the distortionary effect of filters. *Journal of Economic Dynamics & Control*, 25: 1081–1101.
- Plessis, SD. (2006). Business Cycles in Emerging market Economies: A New View of the Stylised Facts. Working Papers 02/2006, Stellenbosch University, Department of Economics.
Retrieved from: <https://ideas.repec.org/p/sza/wpaper/wpapers16.html>.
- Rand, J., Tarp, F. (2002). Business Cycles in Developing Countries: Are They Different? *World Development*, 30(12): 2071–2088.
- Shah, A. (2008). New issues in macroeconomic policy. *Business Standard, India*, 26–54.
- Shah, A., Patnaik I. (2010). Stabilising the Indian business cycle, Working papers, National Institute of Public Finance and Policy.
Retrieved from: <http://EconPapers.repec.org/RePEc:nfp:wpaper:10/67>.
- Stock, J., Watson M. (1999). Business cycle fluctuations in us macroeconomic time series” In JB Taylor, M Woodford (eds.), “Handbook of Macroeconomics,” volume 1, Part A, chapter 01, (3–64). Elsevier, 1 edition.
Retrieved from: <http://EconPapers.repec.org/RePEc:eee:macchp:1-01>.

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Radhika Pandey, is
Consultant, NIPFP

email:
radhika.pandey@nipfp.org.in

Ila Patnaik, is
Professor, NIPFP

email:
ila.patnaik@nipfp.org.in

Ajay Shah, is
Professor, NIPFP

email: ajay.shah@nipfp.org.in

National Institute of Public Finance and Policy,
18/2, Satsang Vihar Marg,
Special Institutional Area (Near JNU),
New Delhi 110067
Tel. No. 26569303, 26569780, 26569784
Fax: 91-11-26852548
www.nipfp.org.in