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Dating business cycles in India

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Abstract

Purpose – This paper aims to present a chronology of Indian business cycles in the post-reform period. In India, earlier, macroeconomic shocks were about droughts and oil prices. Economic reforms have led to an interplay of a market economy, financial globalisation and decisions of private firms to undertake investment and hold inventory. This has changed the working of the business cycle and has raised concerns about business-cycle stabilisation. In the backdrop of these developments, the macroeconomics research agenda requires foundations of measurement about business-cycle phenomena. One element of this is the identification of dates of business-cycle turning points.

Design/methodology/approach – This paper uses the growth-cycle approach to present the chronology of business cycles. The paper uses the Christiano–Fitzgerald (CF) filter to extract the cyclical component and shows the robustness of the findings to the contemporary methods of cycle extraction. It then applies the Bry–Boschan algorithm to identify the dates of peaks and troughs.

Findings – The paper finds three periods of recession. The first recession was from 1999-Q4 to 2003-Q1; the second recession was from 2007-Q2 to 2009-Q3; and the third recession ran from 2011-Q2 till 2012-Q4. These results are robust to the choice of filter and to the choice of the business-cycle indicator. These dates suggest that, on average, expansions in India are 12 quarters in length and recessions run for 9 quarters. The paper offers evidence of change in the nature of cycles.

Originality/value – Dates of business-cycle turning points are a critical input for academic and policy work in macroeconomics. The paper offers robust estimation of the business-cycle turning points in the post-reform period using contemporary techniques of cycle extraction. This work helps lay the foundations for downstream macroeconomics research by academicians and policymakers.

Keywords Business cycles, growth cycles, stabilisation

Paper type Research paper

1. Introduction

Stabilising business cycles is a key objective of the macroeconomic policy. The analysis of past experiences of the economy requires an agreed-upon chronology of business-cycle turning points. In the USA, the National Bureau of Economic Research (NBER) performs this role. All researchers and policymakers use the NBER dates. Most graphs of macroeconomic series in the USA use shaded bars to represent the periods of recession based on dates identified by the NBER. Similarly, the CEPR Euro Area Business Cycle Dating Committee establishes the chronology of recessions and expansions of euro area member countries.

As a developing country becomes more market-dominated, the working of the macroeconomy changes substantially. In India, earlier, macroeconomic shocks were about droughts and oil prices. The economic reforms have led to an interplay of market economy, financial globalisation and decisions of private firms to undertake investment and hold inventory. This has changed the workings of the business cycle (Shah, 2008; Shah and Patnaik, 2010; Ghate *et al.*, 2013)[1].

This has given fresh salience to concerns about business-cycle stabilisation and has shaped the institutions of macroeconomic policy. In 2015, India established an inflation

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target as the objective of monetary policy and in 2016 shifted the power for rate setting to a Monetary Policy Committee. These developments call for a commensurate development of a macroeconomics literature. This research agenda, in turn, requires foundations of measurement about business cycle phenomena. One element of this is the identification of dates of business cycle turning points.

The existing literature on business-cycle measurement in India has been grounded in three approaches – the classical business cycle (Dua and Banerji, 2012), the growth cycle (Chitre, 1982, 2004; Mall, 1999) and the growth rate cycle (Dua and Banerji, 2012)[2]. Hatekar (1994) presents business-cycle stylised facts using annual data from 1951 to 1985 using 64 different time series. Mall (1999) uses filtered output to examine the cyclical behaviour of the Indian economy since the 1950s. The author identifies six sets of turning points in IIP-Manufacturing as the peaks and troughs of the cycle in the period.

These papers have largely worked on the pre-1991 period, and their results are less useful in the contemporary setting. Few papers have examined the post-1991 period (Mohanty *et al.*, 2003; Dua and Banerji, 2006). The OECD (2016) has applied its standard methods for India. For the purpose of contemporary macroeconomic research in academics and policy, there is a need to establish a robust set of dates, using contemporary techniques of business-cycle measurement, with careful evaluation of every decision in the modelling process. The release of quarterly data for GDP only began in 1996, and in this paper, for the first time, we are able to subject 72 observations of quarterly GDP data to this analysis.

In the post-1991 period, we have not seen an actual fall in output, as was seen in the pre-1991 years. Hence, the classical approach is not appropriate for identifying business-cycle turning points. For the post-reform period in India, the growth cycle or growth rate cycle approaches are more appropriate (Patnaik and Sharma, 2002; Mohanty *et al.*, 2003; Dua and Banerji, 1999, 2006). When identification of business-cycle dates is desired, rather than monitoring and forecasting cycles in real time, the growth-cycle approach is appropriate (Boschan and Banerji, 1990).

In this paper, we use the growth-cycle approach to identify the turning points for the Indian business cycle in the post-reform period using quarterly GDP series. This work runs in three steps. The first step is seasonal adjustment where we use our previous work (Bhattacharya *et al.*, 2016).

The next step is the extraction of the cyclical component. Most of the existing literature on Indian business-cycle measurement has used filter of Hodrick and Prescott (1997) (HP). In the past 20 years, many concerns have been expressed about this filter (Hamilton, 2016). We use the Christiano–Fitzgerald filter (CF) to separate the trend and the cyclical component of output (Christiano and Fitzgerald, 2003) at the NBER-defined business-cycle periodicity of 2-8 years. Hamilton (2016) offers an attractive alternative approach to extracting the de-trended series. We find these results broadly concur with those from the CF filter. We also use multiple different reference series and establish a robust result.

The third step is to identify dates in the cyclical component series. We do this using Bry and Boschan (1971) and Harding and Pagan (2002).

When we apply this three-part process to the 1996-2014 period[3], we find three episodes of recession: the first recession was from 1999-Q4 to 2003-Q1; the second recession was from 2007-Q2 to 2009-Q3; and the third recession ran from 2011-Q2 till 2012-Q4. These results are robust to the choice of filter and to the choice of the measure of the business-cycle indicator. These dates suggest that, on average, expansions in India are 12 quarters in length and recessions run for 9 quarters.

India's experience, with the changed nature of the business cycle in the post-1991 period, is not unique. A number of emerging economies have undergone changes in the policy

environment resulting in structural transformation of the economy. One strand of the business-cycle literature examines the changes in stylised facts in response to structural transformation (Kim *et al.*, 2003; Alp *et al.*, 2012; Ghate *et al.*, 2013). This paper contributes to this thinking by offering evidence of change in the average duration of a cycle. Drawing on the analysis by Plessis (2006) and Hall and McDermott (2009), we supplement the descriptive analysis by reporting the coefficient of variation (CV) in amplitude and duration across expansions and recessions. We find that the phases of expansion and recession have become more diverse in the post-reform period.

The contribution of this paper lies in the following elements. The paper offers robust estimation of the business-cycle turning points in the post-reform period. It uses contemporary techniques and examines robustness to alternative reference series. It further offers evidence of change in the nature of the Indian business cycle before and after 1991.

In the interests of reproducible research, all the data and the software used in this paper are freely available on the Web[4]. This makes it possible for other researchers to use this work and build on it. The results of this work, i.e. the dates, would be updated on the Web in the years to come.

The rest of the paper is organised as follows. Section 2 outlines our methodology for detection of turning points, Section 3 presents the empirical analysis and our findings on growth-cycle turning points. Section 4 assesses the robustness of our findings on business-cycle chronology to the choice of the filter and to the choice of the reference series. Section 5 concludes the paper and outlines areas for future research. The technical details and related analysis are placed in the Appendix. In the Appendix, the Indian business cycles present an overview of the changes in the economy in the post-reform period. Business-cycle turning points identified in the literature present a snapshot of trough and peak dates identified in the Indian business-cycle literature. Detrending techniques present technical details of the detrending methodologies. The Bry – Boschan algorithm is used for detection of turning points. Description of recessions and expansions presents a brief description of the macroeconomic conditions during the phases of expansion and recession identified using the dating methodology.

2. 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, the occasional real decline in economic activity in major industrial economies gave way to slowdowns in the pace of expansion. Acceleration and slowdown in growth rather than expansion and contraction in the levels of variables became a prominent feature of business cycles. This led to the concept of a growth cycle (Mintz, 1974): the ups and downs in the deviations of the actual growth rate of the economy from the long-run trend growth rate.

In the Indian data, we do not see an absolute decline in levels in the post-1991 period. Hence, the growth-cycle approach is suitable for the present analysis.

2.1 Seasonal adjustment and adjustment for outliers

The first step is to adjust the series for seasonal fluctuations. In India, the official statistics do not feature seasonal adjustment. We use the methods developed by Bhattacharya *et al.* (2016). This involves a stylised model selection procedure. There are concerns about errors

in the official Indian GDP data. Hence, we use robust statistics in the seasonal adjustment process[5].

2.2 Extraction of cycles

The next step is the extraction of the cyclical component. The seasonally adjusted series is filtered to extract the cyclical component.

One tool that is widely used for this purpose is the HP filter. In recent years, it has become increasingly clear that this filter, while elegant and readily implemented, has important shortcomings. The business-cycle facts that emerge from HP-filtered data are sensitive to the different values of the smoothing parameter (λ) (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.

OECD (2016) addresses this limitation by aligning the λ parameter to the frequency domain framework. This is done to filter out cycles in a certain frequency range with the help of the transformation into the frequency domain. They apply the HP filter twice to achieve a smoothed de-trended cycle (referred to as the double HP filter). First, they remove the long-term trend by setting λ to a high value, to preserve the business-cycle frequencies and the high-frequency components. Second, they apply the HP filter with a smaller λ to preserve the trend part of the filter. The first step de-trends the series and the second step smooths the series. This is a relatively unusual approach which diverges from the mainstream literature.

Hamilton (2016) shows that the HP filtered series produces spurious dynamic relations that have no relation with the underlying data-generating process. The literature has increasingly come to rely on alternatives to the HP filter.

The workhorses of the literature are the band pass filters proposed by Baxter and King (1999) and Christiano and Fitzgerald (2003). Band pass filters eliminate slow-moving trend components and high-frequency components while retaining the intermediate business-cycle fluctuations. These filters approach the detrending and smoothing problem in the frequency domain.

In a recent advance, Hamilton (2016) proposes a simple and robust estimator of the cyclical component. This is based on an estimate of an OLS regression of y_{t+h} on a constant and the four most recent values of y as of date t. Hamilton (2016) shows that the residual from this regression provides a reasonable de-trended approximation for a broad class of underlying processes. The residuals from the following OLS regressions are the cyclical component of the series:

$$y_{t+h} = \beta_0 + \beta_1 y_t + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \beta_4 y_{t-3} + v_{t+h}$$

$$\hat{v}_{t+h} = y_{t+h} - \hat{\beta}_0 - \hat{\beta}_1 y_t - \hat{\beta}_2 y_{t-1} - \hat{\beta}_3 y_{t-2} - \hat{\beta}_4 y_{t-3}$$

In our work, we first use the asymmetric CF filter to isolate the trend and cyclical component. The NBER defines business cycles as fluctuations having periodicity ranging between 8 to 32 quarters. We use this definition. The cyclical component is standardised before the application of the dating algorithm[6].

In addition, we also use the methods of Hamilton (2016). Figure 1 superposes the cycles extracted from the CF filter and the Hamilton (2016) methodology. We will apply all the steps of the dating procedures through these two methods.

2.3 The 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 improved by Harding and Pagan (2002).

An alternative approach to identifying turning points applies the parametric dynamic factor time model. This approach characterises expansion and recession phases as unobserved regime shifts in the mean of the common factor. This common factor is modelled as following a Markov switching model by Hamilton (1989). This model endogenously estimates the timing of regime shifts in the parameters of a time series model. This model, further developed by Chauvet (1998), estimates the probability of an economy being in either recession or expansion at any point in time. These probabilities can be used to establish turning point dates using an algorithm for converting probabilities into a binary-state variable that defines the business-cycle phase at any particular time (Chauvet and Hamilton, 2006).

Chauvet and Piger (2008) apply these two approaches to a real-time data set of four coincident indicators identified by the NBER. The authors' analysis suggests that both approaches are capable of identifying turning points in real time with reasonable accuracy. The turning points identified through both methods are close to the official chronology established by the NBER. Hence, in this paper, we do not pursue this line of thought further. It can be carried forward in future research.

3. Empirical analysis

We use the quarterly GDP series (base year 2004-2005) to identify the chronology of business-cycle turning points[7]. This series is available from 1996-Q2 (April-June) to 2014-Q3 (July-September).

3.1 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).

Figure 2 and Table I show three episodes of recession in the economy during the period 1996-2014. Using GDP as the reference series, the first episode of recession was in the period: 1999-Q4 to 2003-Q1, the second recession was in the period 2007-Q2 to 2009-Q3, and the third recession in the period 2011-Q2 to 2012-Q4.

Table II shows the average amplitude and duration of phases (recession and expansion) extracted from these dates. The average duration of expansion is 12 quarters and the average duration of recession is 9 quarters. The average amplitude of expansion is seen to

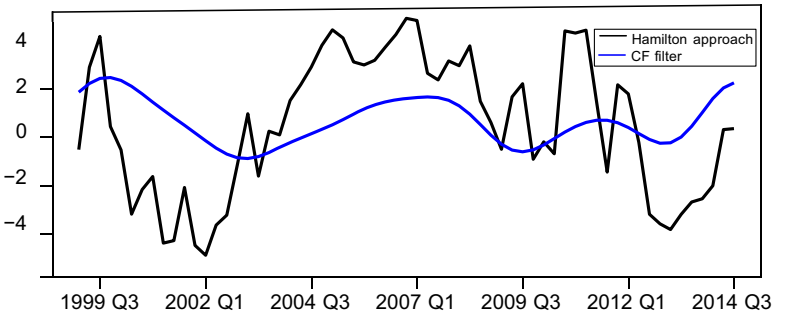
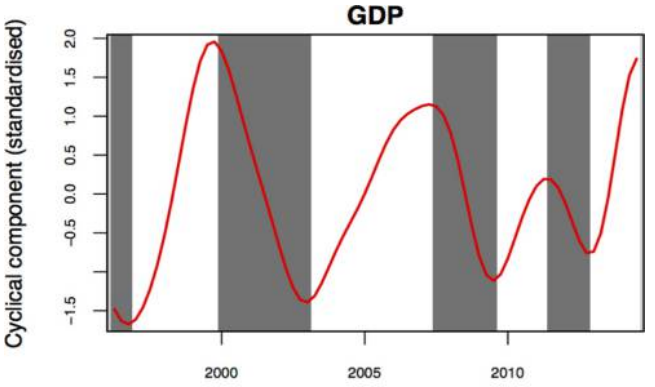


Figure 1.
GDP cyclical component: CF filter and Hamilton method



Notes: 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 year

Figure 2. Turning points in GDP

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

Note: This table shows the chronology of turning points using GDP as the reference series

Table I. Dates of turning points in GDP

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

Notes: This table shows the summary statistics of growth-cycle turning points; it reports the figures for average duration and amplitude and the measure of diversity in duration and amplitude across expansions and recessions

Table II. Summary statistics of GDP growth cycles

be 2.5 per cent, while the average amplitude of recession is 2.2 per cent. In addition to reporting the average numbers for duration and amplitude of phases, Table II also reports coefficient of variation (CV) which is a measure of diversity in duration (C V_D) and amplitude (CV_A) of expansion and recession phases (Plessis, 2006; Hall and McDermott, 2009). This measure shows how diverse the duration and amplitude of expansion and recession phases are across specific cycles. A higher value of the coefficient indicates greater diversity across cycles. The diversity in the 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:

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

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

Where:

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

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

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

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

Where:

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

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

Table II shows that the diversity in duration of recessions and expansions is similar, 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 be longer than the duration reported by the earlier literature (Mohanty *et al.*, 2003; Rand and Tarp, 2002; Dua and Banerji, 2012) (See Table III). Mohanty *et al.* (2003) apply the growth-cycle approach to IIP and identify 13 growth cycles during the period from 1970-1971 to 2001-2002. The authors find that the average duration of expansion is four quarters. Recessions are characterised by relatively longer durations of five quarters. Dua and Banerji (2012) using the growth rate-cycle approach for the period 1960-2010 and find that the average duration of speed-up is five quarters, and the average duration of slowdown is six quarters. One plausible

explanation for relatively shorter durations of phases in earlier studies could be that these studies cover the pre-1991 period. In the pre-1991 period, the fluctuations were driven by short-lived weather and oil price shocks. Inventory-investment fluctuations which are central to a conventional business cycle did not play a prominent role[8].

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

Do the characteristics of business cycles change over time? 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 literature is that emerging economy cycles have changed in the post-1991 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 countries[9] spanning the period 1960-1996. Because 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-1991 period. The authors find that post-1991, 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' business cycle, 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 the business cycle has changed over time. This analysis cannot be performed using GDP, as the quarterly series is available only from 1996. 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: a pre-reform phase from 1971 to 1990 and a post-reform phase from 1992 to 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 two to eight 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 IV shows the average duration of expansions and recessions in the two sub-periods. The table shows that while expansions have become longer, recessions have

Paper	Reference time period	Average duration of expansion	Average duration of recession
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

Notes: 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

Table III.
Changing nature of Indian business cycle: evidence from the literature

become shorter in the post-reform period. As an outcome, cycles have become longer. This analysis shows that over time, the duration of cycles has changed.

Table V reports the CV in duration and amplitude of phases across different cycles in the pre- and post-1991 period. The 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, whereas 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 the pre- and post-1991 period. Our analysis points to interesting features about the Indian business cycles. Although 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.

What could explain the increase in the average duration of cycle in the post-reform period? One possible reason could be the changing nature of shocks that affect the economy. In the pre-reform period, good and bad times were determined by monsoons. These changes played out over a short time-frame. Output fluctuations in the pre-reform period reflected a series of uncorrelated monsoon shocks (Shah, 2008). In the post-reform period, agricultural shocks mattered less. This is evident from the decline in the volatility of aggregate GDP in the post-reform period as shown by Ghate *et al.* (2013). Further, the authors show that the cyclical components of key macroeconomic variables have become more persistent in the post-reform period.

As an example, the authors show that the persistence of output for India is higher than the average of that for developing economies. The persistence is even higher when non-agricultural GDP is taken as the aggregate measure of business-cycle activity. Price levels are also significantly persistent. Persistence in key series is a reflection of a more stable business cycle.

Further, the decline in the average duration of recession shows the interplay of macro-stabilisation measures. With the onset of the 2008 crisis, the Central Government announced

Table IV.
Average duration in quarters: Evidence from pre- and post-IIP

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

Note: This table presents a comparison of the average duration of expansion, recession and overall cycle between the pre- and post-reform periods

Table V.
Have the phases of cycles become more diverse over time?

	CV_D		CV_A	
Phase	Expansion	Recession	Expansion	Recession
1971-1990	0.28	0.32	0.61	0.59
1992-2014	0.43	0.46	0.74	0.71

Note: This table shows the CV in duration and amplitude of expansion and recession identified using the cyclical component of IIP

a series of fiscal stimulus packages in the form of additional plan spending and cut in duties to fuel growth (Kumar and Soumya, 2010). This manifested in an increase in the fiscal-deficit to GDP ratio from 2.5 per cent in 2007-2008 to 6 per cent in 2008-2009 and further to 6.46 per cent in 2009-2010. This was also a period of monetary expansion characterised by easing of the monetary policy instruments[10]. The 2011-2012 recessionary period also witnessed an increase in deficit from 4.8 to 5.73 per cent. The fiscal-monetary stimulus cushioned the slowdown in growth and prevented a much sharper fall in GDP growth during the identified periods of slowdown.

However, the individual phases of business cycles have become more diverse in the post-reform period. This could be attributed to two defining features of the Indian economy in the post-reform period:

(1) *Investment-inventory fluctuations*: In the post-reform period, fluctuations in the economy are driven by fluctuations in investment and inventory. In the pre-reform period, a prominent source of investment was government investment in the form of plan expenditure, which did not show any cyclical fluctuations. In the present environment with eased controls on capacity creation and dismantling of trade barriers, private sector investment as a share of GDP has shown a significant rise. The dramatic changes in private corporate sector investment have led to sharp upswings and downswings in GDP (Shah, 2008). The greater correlation between the cyclical components of investment and GDP in the post-reform period also indicate that investment fluctuations drive output fluctuations in the post-reform period (Ghate *et al.*, 2013).

(2) *Current and capital account integration*: Another potential source of diversity in business cycles in the post-reform period could be the sharp increase in India's integration on both current and capital accounts (Figure 3). The figure shows a sharp surge in capital flows post 2000. This coincided with a period of business cycle expansion in the USA[11]. Emerging economies experience a sharp surge in net capital flows when the U.S is in expansion than when it is in recession (Reinhart *et al.*, 2001). A sharp surge in flows has implications for business-cycle volatility in emerging economies. A significant strand of literature has analysed the association between greater trade and financial openness and business-cycle volatility. These show a differential impact of trade and financial openness on business cycles through the impact on consumption and investment (Razin and Rose, 1992; Buch *et al.*, 2005).

We present a description of the characteristics of the business-cycle turning points in the post-reform period. Using seasonally adjusted quarterly GDP from 1996-Q2 to 2014-Q3, we

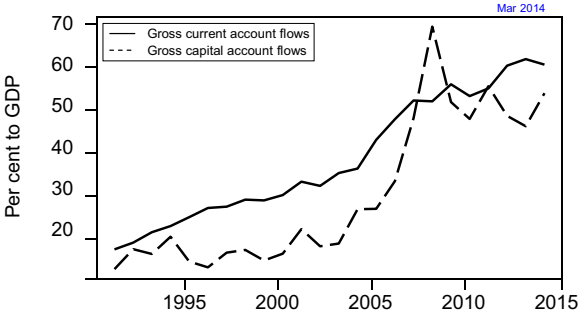


Figure 3.
Gross flows on current and capital account (as per cent to GDP)

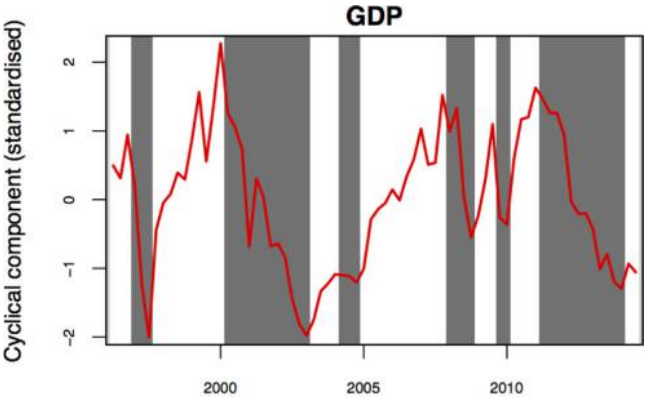
identify three episodes of recession: 1999-Q4 to 2003-Q1, 2007-Q2 to 2009-Q3 and 2011-Q2 to 2012-Q4. The average duration of expansion is seen to be 12 quarters, whereas the average duration of recession is seen to be 9.3 quarters. We also report CV – a measure of diversity of amplitude and duration of expansion and recession across specific cycles. We find that while the duration of both expansion and recession is 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.

4. Robustness of these results

In this section, we present robustness checks to examine the sensitivity of our findings on business-cycle chronology to the choice of the filter and to the choice of the reference variable. We perform two sets of robustness checks. First, we check the sensitivity of our results to the detrending procedures. To do this, we use the HP filter in place of the CF filter to extract the cyclical component. We perform this check to test whether cyclical components derived from different detrending procedures yield similar turning points. We also check the robustness of our findings with Hamilton's cycle extraction technique. 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 proxies for analysing business-cycle chronology to test if the chronology of turning points is sensitive to the choice of the reference series.

4.1 Robustness check I: using different detrending procedures

In this section, we report the sensitivity of our findings to the choice of filter to detrend the series. Figure 4 and Table VI show 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



Notes: 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 1,600

Figure 4.
Dates of turning points in GDP using HP filter

set *a priori* to 1,600. We test the robustness of our findings with the default value of the smoothing parameter (λ). With this value of smoothing parameter, the HP filter defines the cyclical component as fluctuations with a period less than eight years[12].

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 HP filter. A comparison of Tables I and VI shows that the application of HP filter to extract cyclical component yields more number of cycles. This is attributed to the property of the 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 the 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 filter (Figures 2 and 4).

Figure 5 and Table VII show the turning points in the cyclical component of GDP extracted using the Hamilton filter. Three episodes of recession are identified: 1999Q3-2002Q1, 2006Q4-2009Q4 and 2011Q1-2013Q1. The second and the third phases of recession identified using the cycle extracted through the Hamilton filter broadly concur with the phases of recession identified using our baseline CF filter.

4.2 Robustness check II: 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-cycle chronology. We exclude agriculture, as 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 owing 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, as they follow very different accounting concepts. We also exclude oil companies, as their balance sheets experience large changes owing to the 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

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

Note: This table shows the business cycle chronology using the HP filter

Table VI. Dates of turning points in GDP using HP filter

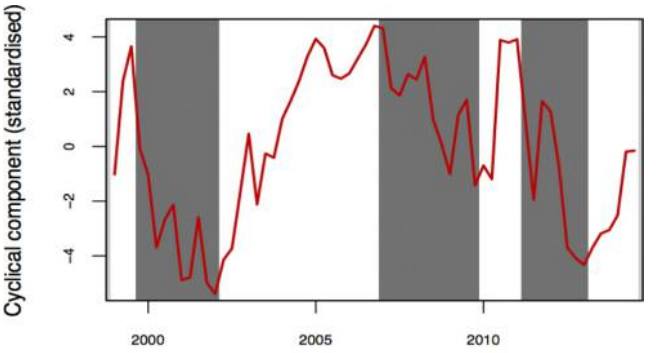


Figure 5.
Dates of turning points in GDP using Hamilton filter

Notes: This figure shows the turning points in the cyclical component of GDP; here, the cyclical component is extracted using the Hamilton method
Source: Hamilton (2016)

Table VII.
Dates of turning points in GDP using Hamilton filter

Phase	Start	End	Duration	Amplitude
Recession	1999-Q3	2002-Q1	10	9
Expansion	2002-Q1	2006-Q4	19	9.8
Recession	2006-Q4	2009-Q4	12	5.8
Expansion	2009-Q4	2011-Q1	5	5.3
Recession	2011-Q1	2013-Q1	8	8.2

Note: This table shows the business cycle chronology using the Hamilton filter

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.

Following our baseline methodology, we use the CF filter to extract the cyclical component and then apply the Bry–Boschan algorithm. Tables VIII, IX and X 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

Table VIII.
Dates of turning points in IIP

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

Note: This table shows the business-cycle chronology using IIP as the reference series

three series are broadly divided 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 to 2002-Q4, 2007-Q4 to 2009-Q3 and 2011-Q2 to 2013-Q4. These are broadly in conformity with the recession periods identified using GDP as the reference series.

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

Note: This table shows the chronology of business-cycle turning points using GDP excluding agriculture and government as the reference series

Table IX. Dates of turning points in GDP (excluding agriculture and government)

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

Note: This table shows the chronology of business-cycle turning points using firms' net sales as the reference series

Table X. Dates of turning points in firms' net sales

Year	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

Notes: 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

Table XI. Sectoral share (expressed as a % to GDP)

On the whole, the robustness checks show that our findings regarding the three phases of recession are broadly robust to the choice of the filter and to the choice of the reference series. With HP filter, we do get some additional short cycles. These are attributed to the property of the filter.

5. Conclusion

India has become a more market-oriented economy. This has brought fresh impulses upon academic and policy work in macroeconomics. In both dimensions, certain pillars of measurement are required to embark on the analysis. The first pillar concerns the procedures of seasonal adjustment. This was undertaken in our previous work (Bhattacharya *et al.*, 2016). The second pillar of measurement concerns the dates of turning points of the business cycle. This work has been done in this paper.

Prior to this work, the OECD dates were the best source of dates for the Indian business cycle. However, the OECD work uses a somewhat unusual double-HP filtering. Our work is more consistent with the standard approach followed in the literature, as in Christiano and Fitzgerald (2003) and Hamilton (2016). The OECD uses the index of industrial production. However, business-cycle fluctuations should be viewed through GDP data, which we use. We undertake robustness checks at every step of the way, and we release the full source code, so as to contribute a robust building block to this emerging literature.

A natural next step would be to apply the findings about the nature of the Indian business cycles to construct and validate theoretical business cycle models. Some progress in the field of building theoretical models to explain the key stylised features of the Indian business cycle is visible in a study by Ghate *et al.* (2016). Emerging economies have counter-cyclical real interest rates. Ghate *et al.* (2016) build a small open economy real business cycle model with a role for fiscal policy. Incorporating fiscal policy makes the real interest rate less counter-cyclical or even procyclical at times.

In a model featuring credit constraints and shocks to trend growth, Bhattacharya *et al.* (2016) explain the high relative volatility of consumption in the presence of financial development. Building and extending this theoretical literature to understand the propagation of shocks in an emerging market setting would be a subject of future research.

Notes

1. Appendix presents an overview of changes in the Indian economy in the post-reform period.
2. The "classical approach" uses levels of output to identify turning points. The "growth cycle" approach uses deviation of output from its long-term trend, i.e. the cyclical component, to identify periods of peaks and troughs in the business cycle. Finally, the "growth rate cycle" approach identifies turning points based on the growth rate of output.
3. This is the period for which the quarterly GDP series is available.
4. These materials are available at: http://macrofinance.nipfp.org.in/releases/PPS2016_india_dating.html
5. We seasonally adjust the series using the x-13-arima-seats seasonal adjustment programme. The seasonal adjustment program also extracts the seasonally adjusted series adjusted for extreme values (outliers). The programme provides a set of regression variables to deal with these outliers. These are additive outliers (AOs), temporary change outliers (TCs) and level shifts (LSs), seasonal outliers (SOs) and ramps. Adjustment for outliers along with seasonal adjustment enables us to get a relatively smoother series for trend-cycle decomposition. For more details on the treatment of outliers, see the programme's reference manual: www.census.gov/ts/x13as/docX13AS.pdf
6. For a detailed analysis of the detrending techniques, see Appendix.

7. The Central Statistical Organisation revised the GDP series with a new base year of 2011-2012. The revised series is available only from 2011-Q2. Hence, we stick to the series with the old base year for our analysis.
8. We cannot compare the findings on coefficient of variation as this statistic is not reported in earlier studies.
9. The authors study Indonesia, Korea, Malaysia, The Philippines, Singapore, Taiwan and Thailand.
10. From October 2008 to April 2009, the repo rate was reduced six times by a total of 425 basis points. CRR was also eased during this period.
11. The NBER Business Cycle Dating Committee identified November 2001 to December 2007 as the period of business cycle expansion in the USA.
12. OECD (2016) also use the HP filter, but they modify the default smoothing parameter to align it to the frequency domain sphere.

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Appendix

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. 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 has changed (Ghate *et al.*, 2013; Shah and Patnaik, 2010). The share of agriculture has declined and the share of services has increased (Table XI). 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 hand, 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 downswings. The first plot in Figure A1 shows the time series of private corporate gross fixed capital formation (GFCF) expressed as a percentage to GDP. In the mid-1990s, private corporate GFCF increased from 5 per cent of GDP in 1991-1992 to 9 per cent of GDP. This fell dramatically in the business cycle downturn of 2000-2003 and hovered around 5 per cent of GDP. It again surged to 12-14 per cent of GDP in the period 2005-2007 before moderating in the recent years. Investment-inventory fluctuations are today central to understand the emergence of business cycles in India. This is also reflected in the performance of firms. The second plot in Figure A1 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).

Business-cycle turning points identified in the literature

Table AI shows the dates of troughs and peaks identified in the literature on Indian business cycle.

Detrending techniques

Cycle extraction is a crucial step in the growth-cycle approach. The class of band pass filters translates the series in a frequency domain framework. In the frequency domain, we can treat the series as a construction of sine waves of different wavelengths. The trend part of the series comprises the low-frequency (high wavelength) sine waves, whereas the noise is formed by a set of high-frequency sine waves (OECD, 2016).

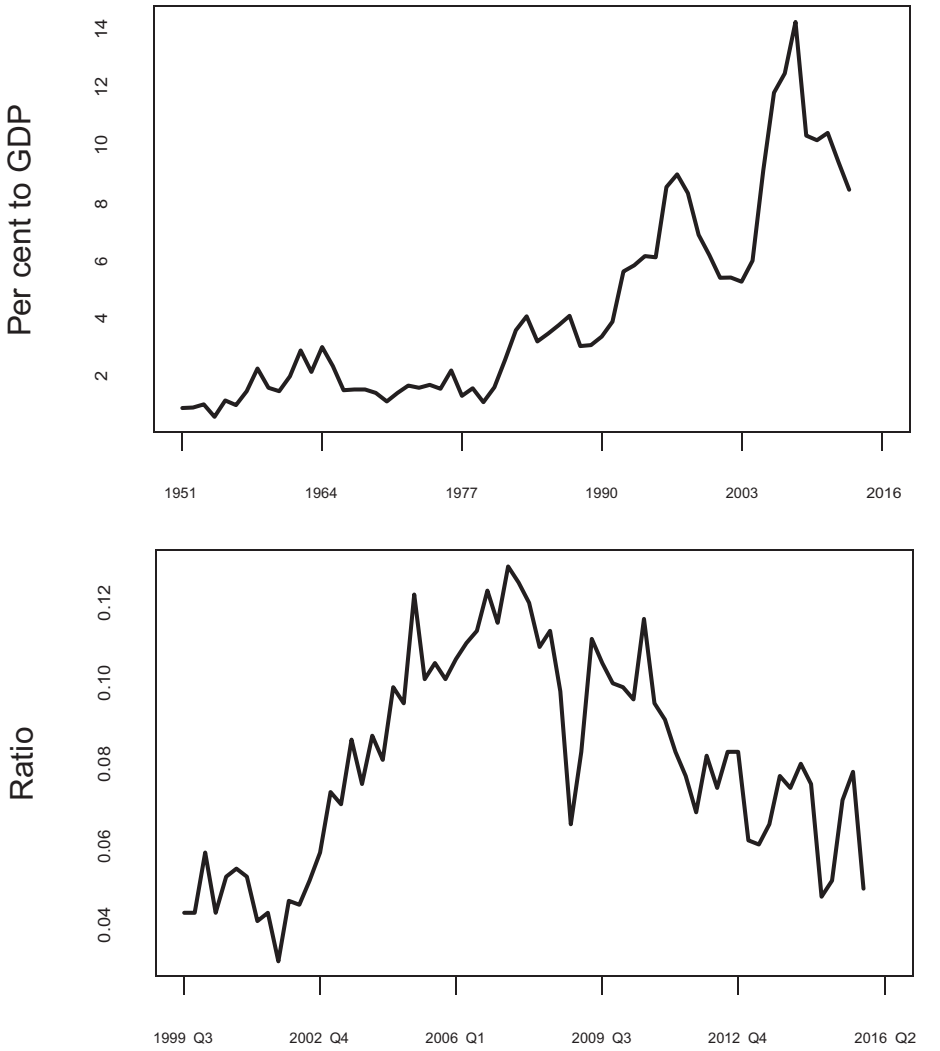


Figure A1.
Private corporate gross fixed capital formation and net profit margin of firms

Notes: The figure on the top shows the private corporate gross fixed capital formation expressed as a percentage to GDP; the figure on the bottom shows fluctuations in the net profit margin of firms; the fluctuations indicate the emergence of conventional business cycles

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

Trough	Peak
Mall (1999), growth cycle approach	
	1951-1952
1953-1954	1956-1957
1959-1960	1964-1965
1967-1968	1969-1970
1974-1975	1978-1979
1980-1981	1989-1990
1992-1993	1995-1996
Patnaik and Sharma (2002), classical approach	
	1956-1957
1957-1958	1963-1964
1965-1966	1978-1979
1979-1980	1990-1991
1991-1992	
Mohanty et al. (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	

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

Table AI.
Trough and peak dates in literature

The cyclical component in CF filter is calculated as follows:

$$c_t = B_o y_t + B_1 y_{t+1} + \cdots + B_{T-1-t} y_{T-1} + \tilde{B}_{T-t} y_T + B_1 y_{t-1} + \cdots + B_{t-2} y_{t-2} + \tilde{B}_{t-1} y_1$$

Where $B_j = \frac{\sin(jb)-\sin(ja)}{\pi j}$, $j \geq 1$ and $B_0 = \frac{b-a}{\pi}$, $a = \frac{2\pi}{p_u}$, $b = \frac{2\pi}{p_l}$

$$\tilde{B}_k = -\frac{1}{2}B_0 - \sum_{j=1}^{k-1} B_j$$

Where the parameters p_u and p_l are the cut-off cycle length and c_t is the cyclical component.

We use the asymmetric CF filter. The asymmetric filter varies with time. The alternative methodology is through the application of symmetric filters. Symmetric approximation assumes no phase-shifts in the resulting filtered series. However, symmetric approximation requires pruning of series. Depending on the extent of pruning, a certain number of observations at the end of the series cannot be filtered. Baxter–King filter, another filter in the class of band pass filters, is a symmetric filter.

The HP filter:

$$y_t = \tau_t + c_t$$

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

The initial y_t series is decomposed into λ_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 HP filter into frequency domain. The literature uses 1,600 as the value of λ for a 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).

Algorithm for detection of turning points

The Bry–Boschan (BB) and Harding–Pagan (HP) algorithms find the turning points as follows:

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

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

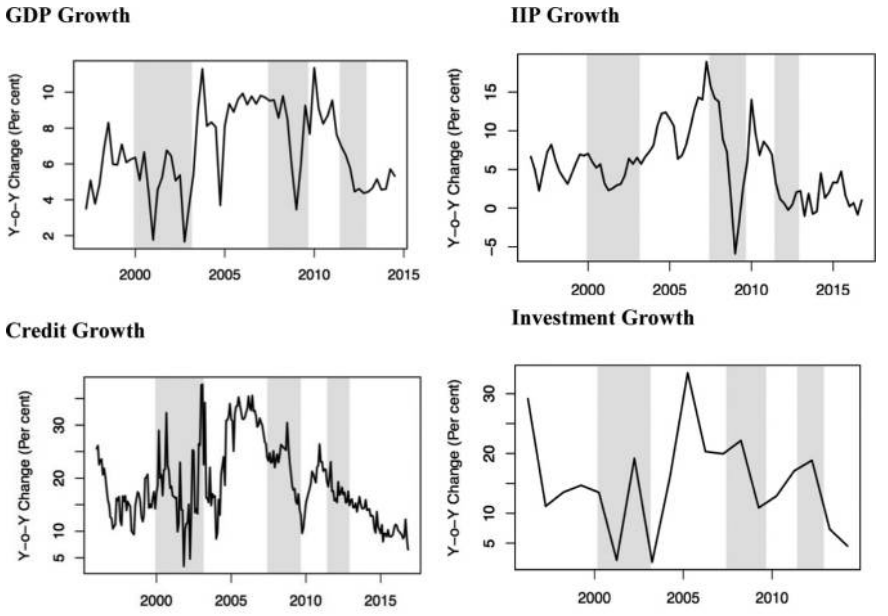
- The first rule states that the peaks and troughs must alternate.
- The second step involves the identification of local minima (troughs) and local maxima (peaks) in a single time series, or in y_t after a log transformation.
- Peaks are found where y_s is larger than k values of y_t in both directions.
- Troughs are identified where y_s is smaller than k values of y_t in both 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 a minimum duration of phase (from peak to 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.
- The identification of turning points is avoided at extreme points.

The dating algorithm does not define double-dip recession. Two periods of contraction can be either two separate recessions or parts of the same recession. The determination in the algorithm is based on the duration and strength of the upturn after the initial trough.

Description of recessions and expansions

Figure A2 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



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

Figure A2.
Slowdown in macro-economic variables during the identified periods of recession

periods of recession. A 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.

The decade of 1990s: The decade of the 1990s saw far-reaching changes in economic policy. The balance of payments crisis in the early 1990s triggered wide-ranging reforms towards a market-oriented economy. These led to a spurt in economic growth in the first half of the nineties. Some of the key reforms introduced in the early 1990s were:

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

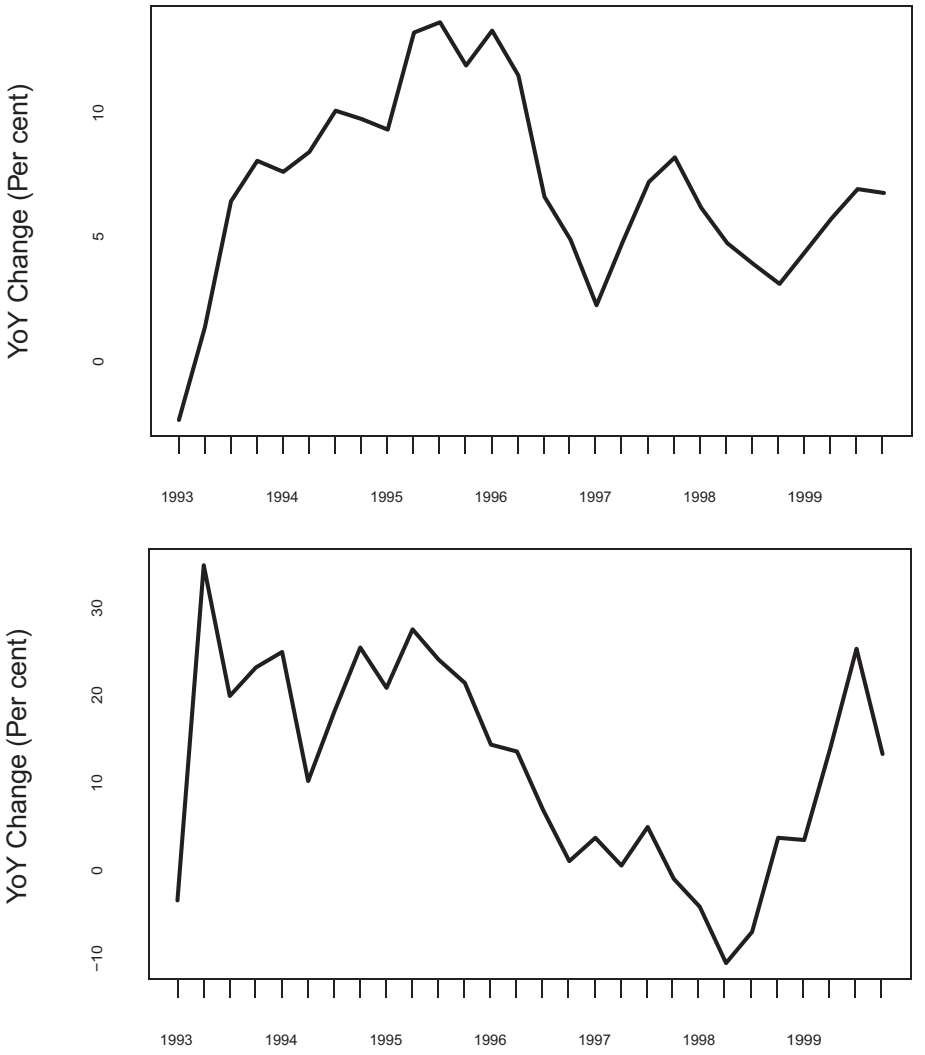
Against the backdrop of these reforms, the external and real sector witnessed a sharp turnaround. Table AII shows a spurt in growth in GDP and its components in the initial post crisis years. Figure A3 shows a sharp growth in industrial production and exports during the initial years of the 1990s. The initial post-crisis years saw a sharp growth in IIP, with growth peaking at 13.7 per cent in mid-1995. Export growth surged to 20 per cent in 1993-1994. The external debt indicators also witnessed an improvement (Table AIII). The external debt stock-to-GDP ratio improved from 38.7 per cent in 1991-1992 to 30.8 per cent in 1994-1995 and further to 22 per cent in 1999-2000. The ratio of short-term debt to total debt declined from 8.3 per cent in 1991-1992 to 4.3 per cent in 1994-1995 to 4 per cent in 1999-2000. The ratio of foreign exchange reserves to total debt and the ratio of short-term debt to foreign exchange reserves also witnessed an improvement in the 1990s.

Aggregate savings and investments were also buoyant during the first half of the nineties. Gross domestic savings as a percentage to GDP rose from 21.3 per cent in 1991-92 to 24.15 per cent in 1997-1998. Similarly, gross domestic capital formation rose from 22.5 per cent in 1991-1992 to reach a peak of 26.1 per cent in 1995-96 before slowing down to 22 per cent in 1996-1997.

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

Table AII.
Growth rate in GDP and its sectors

Notes: This table shows the growth rate in GDP and its sectors in the 1990s; the table shows a pick up in the growth rate during the initial post-crisis years from 1992 to 1996; since 1997, a broad-based moderation is seen in the growth rates for overall GDP, agriculture and industrial GDP



Notes: 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 1990s before moderating from 1996-1997 onwards

Figure A3.
Industrial production and exports in the nineties

From 1997 onwards, we see a deceleration in India's growth story (Acharya, 2012). GDP growth moderated to 4.3 per cent in 1997-1998 from 8 per cent in 1996-1997. Agriculture and industrial growth also slowed down in 1997-1998. The growth in manufacturing fell sharply to less than 1 per cent in 1997-1998 from 9.5 per cent in the previous year. Figure A3 shows a slump in industrial production and exports in 1997. The moderation in growth from 1997-1998 onwards could be

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
1991-1992	38.7	8.3	10.8	76.7
1992-1993	37.5	7.0	10.9	64.5
1993-1994	33.8	3.9	20.8	18.8
1994-1995	30.8	4.3	25.4	16.9
1995-1996	27.0	5.4	23.1	23.2
1996-1997	24.6	7.2	28.3	25.5
1997-1998	24.3	5.4	31.4	17.2
1998-1999	23.6	4.4	33.5	13.2
1999-2000	22.0	4.0	38.7	10.3

Table AIII.
External debt indicators in the nineties

Notes: This table shows the key external debt indicators in the 1990s; one of the outcomes of the reform measures introduced in the 1990s was the improvement in the external debt indicators
Source: India's external debt: A status report 2014-2015

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 that 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.

End 1999 to 2003 Q1 recession. Table AIV shows the performance of key macro-economic indicators during the period 2000-2003. GDP growth slowed down from 7.6 per cent in 1999-2000 to 4.3 per cent in 2000-2001. 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 dot-com 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.

Variable	1999-2000	2000-2001	2001-2002	2002-2003
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

Table AIV.
Key macro-economic conditions in 2000-2003

Notes: This table shows the growth rate in GDP, gross fixed investment as a ratio to GDP and savings as a ratio to GDP during 2000-2003 period; we see a moderation in GDP growth rate; broadly, the savings rate exceeded the investment rate in this period

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 A2 shows a surge in credit growth between 2004 to 2007. The credit growth reached a peak of 40 per cent during this period. GDP growth remained strong at 8-10 per cent 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 2008-2009 (see the first graph of Figure A4).

Mid-2009 to mid-2011 expansion. We saw a business cycle upswing in 2009. GDP growth recovered to 8.6 per cent in 2009-2010 from 6.72 per cent in 2008-2009. The growth further strengthened to 8.9 per cent in 2010-2011. The upswing was an outcome of a coordinated monetary and fiscal policy stimulus packages announced in 2008-2009. 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 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 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 per cent in 2011-2012 and further to 4.47 per cent in 2012-2013. 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).

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 per cent in the year ending March 2012. The current account as a percentage to GDP also rose beyond comfort levels to 4.17 per cent for the year ending March 2012. High domestic inflation and negative real interest rates on deposits encouraged gold imports thus adding to CAD pressures (Figure A5).

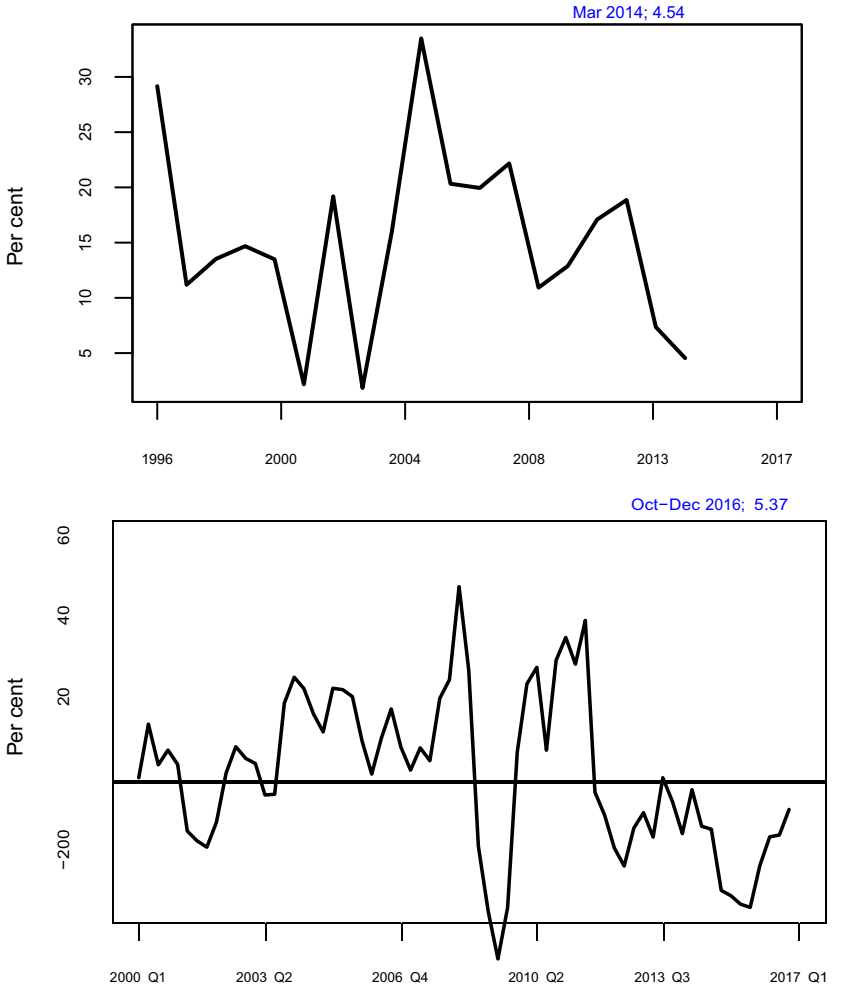


Figure A4.
Slowdown in investment and exports in 2008-2009

Notes: This figure shows the slowdown in investment and exports growth during the 2008-2009 period; the first graph shows the year-on-year growth in investment and the second graph shows the year-on-year growth in exports

Data sources

Variables Sources:

- GDP base year: 2004-2005: Central Statistical Organisation.
- IIP: Central Statistical Organisation.
- GDP (Excluding Agriculture and Government): CSO, authors' calculations.
- Firms Net Sales Index: CMIE Prowess and authors' calculations.
- Non-food credit: RBI.

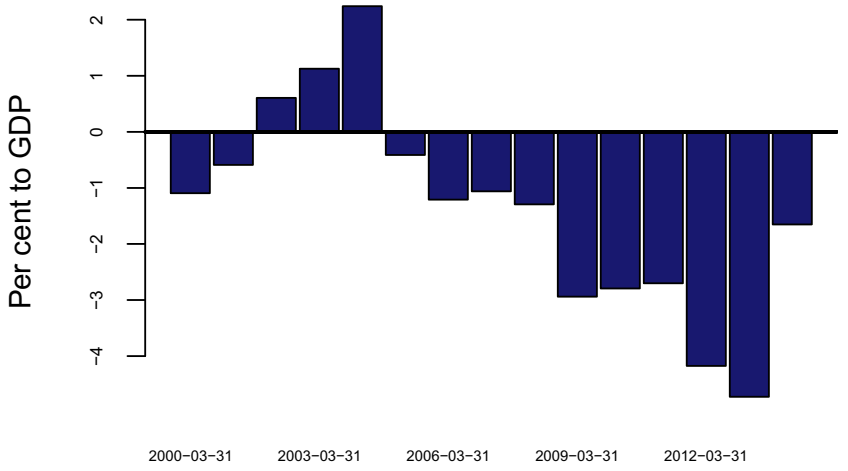


Figure A5.
Surge in current account deficit as a ratio to GDP during 2011-2012

- Gross fixed capital formation (investment): CSO.
- Gross domestic savings: CSO.
- Exports: Ministry of Commerce & Industry.
- Current account deficit: RBI.
- Fiscal deficit: Ministry of Finance.

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