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Examining the trade-off between price and financial stability in India

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Abstract

In recent years, many emerging economies including India have adopted inflation targeting framework. Post the global financial crisis, there is a growing debate on whether monetary policy should target financial stability. Using India as a case study, we present an empirical approach to assess whether monetary policy can target financial stability. This is done by examining the trade-off between price and financial stability for India. Using correlation between price and financial cycles, we find that a trade-off exists between price and financial stability. Our finding is robust to a series of robustness checks. Our study has implications for the conduct of monetary policy in emerging economies. Presence of a trade-off may constrain the ability of a central bank in emerging economies to target financial stability with monetary policy instrument.

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Contents

1 Introduction

The global financial crisis highlighted the importance of designing appropriate institutional and legal arrangements to address financial instability. The crisis showed that even in times of macro stability, financial instability can have a profound and prolonged impact on functioning of the real economy. Since the global financial crisis, a number of central banks have made institutional and legislative changes to incorporate financial stability as an objective of central bank ((Ingves *et al.*, 2011)).

While there is a growing consensus on the use of macro-prudential policies to safeguard stability of the financial system as a whole, there is no consensus on the precise macroprudential tools to address financial instability concerns.[1] Evidence on the transmission of macroprudential tools is sparse (Cerutti *et al.*, 2017). In pursuit of appropriate instruments to address financial stability concerns, the debate has shifted to whether monetary policy can use policy interest rate to target financial stability.

Monetary policy traditionally has the role of targeting inflation, with some banks also looking at growth (also known as flexible inflation targeting) and exchange rate stability (e.g., Hong Kong). With growing concern among central bankers and policy makers with regards to safeguarding financial stability, the key question that arises is whether it is feasible for monetary policy to target financial stability. In other words, are there trade-offs between price and financial stability or do they complement each other? One manifestation of the trade-off could be a situation where a contractionary monetary policy is used to address financial stability when prices are low and vice versa. This could imperil the objective of price stability.

Conventional wisdom has indicated a positive correlation between price and financial stability ((Schwartz, 1995), (Bordo *et al.*, 2002)). However, recent experience shows that even during times of monetary stability, there could be financial instability. Lower interest rates could trigger financial instability as investors in search for higher return invest in riskier assets. These conflicting views can have different implications for policy strategies.

While there is a discussion in the literature on whether monetary policy *should* target financial stability (Woodford, 2012; Svensson, 2010; Shirakawa, 2013; IMF, 2015; Criste and Lupu, 2014), literature is sparse on the empirical linkages between monetary policy and financial stability. Blot *et al.* (2014)

[1] See Haldane (2017) for a discussion on the range of reform measures introduced to safeguard the stability of the financial system.

use correlation analysis and dynamic correlations to test the relation between price and financial stability for the US and the EU. They reject the hypothesis that a positive relation exists between price and financial stability for the US and the EU. Kim and Mehrotra (2015) provide a framework to assess the trade off between financial and price stability by looking at the interaction between credit gap (an indicator of financial stability measured as deviation of credit-to-GDP from its long term trend) and inflation gap (measured as deviation from its target level). They look at the relationship between credit gap and inflation gap for Australia, Indonesia, Korea, New Zealand, Philippines and Thailand for the period 2000-2014. They find that periods of trade-off i.e periods of low inflation and buoyant credit growth are common. For six inflation targeting economies in the Asia-Pacific region, 12% of the country-year observations are characterised by a trade-off between price and financial stability. However the analysis is based on a limited set of countries.

Literature in this field does not distinguish between the trade-off between price and financial stability for advanced and emerging economies. Are advanced and emerging economies similar in their empirical relation between price and financial stability or do emerging economies differ? A large body of literature suggests that business cycle stylised features in emerging economies differ from those in advanced economies (Aguiar and Gopinath, 2007; Ghate *et al.*, 2013; Benczr and Rtfai, 2014). This suggests that while certain correlations may hold in advanced economies, they may not do so in emerging economies. For example, while a substantial literature has documented the counter-cyclical behaviour of the level of prices in advanced economies, the corresponding evidence on emerging economies is ambiguous (Agénor *et al.*, 2000; Rand and Tarp, 2002). Another branch of literature documents the relation between business cycle recession and financial disruptions for emerging and advanced economies (Borio, 2014a; Claessens and Ghosh, 2016). Claessens and Ghosh (2016) find that as compared to advanced economies, business cycle recessions associated with financial disruptions in emerging market countries are more costly and protracted. Thus, while the literature documents differences in business cycle stylised facts between advanced and emerging economies; in particular the relationship between business cycles and price cycles, and between business cycles and financial variables; to our knowledge there is no study examining the relationship between price and financial stability. This relationship has important implications for the conduct of monetary policy in emerging economies. In recent years, a number of emerging economies have adopted inflation targeting framework. If there are conflicts between price and financial stability, an emerging economy central bank may not be able to target financial stability along with price stability.

The relation between price and financial stability may differ depending on the nature of economic shocks (Geraats, 2010). Mohanty and Klau (2001); Kahn (2008) argue that supply side factors are important determinants of inflation in emerging economies. There could be a situation where prices fall while the output and credit gap rises. In such a case, a central bank would prefer a rate cut to stabilise inflation around the target while financial stability considerations would require raising rates. Jonsson and Moran (2014) also find that a trade-off between price and financial stability may arise if fluctuations are driven by supply shocks.

This study analyses the trade-off in the context of India as a case study of an emerging economy. We use quarterly data on non-food credit, credit-to-GDP and CPI-combined series for the purpose of our analysis. Our sample time frame is 2004 Q2 till 2018 Q3.

We analyse the interaction between price and financial stability by examining the correlation between the cyclical components of price and an indicator of financial stability. We find a significant negative correlation between price and financial stability. We check the robustness of our results through a set of robustness checks. We apply three different approaches to analyse the trade-off between price and financial stability. First we examine the interaction between credit-to-GDP gap–measured as deviation of credit to GDP ratio from its long run trend and inflation gap–measured as deviation from a target. We use 5% as the inflation target for India. Second approach relies on assessing the synchronous relationship between upswings and downswings of price cycles and financial cycles. This approach involves computing the Index of Concordance (IOC), which captures proportion of times the price and financial cycle are in the same phase i.e. both are in upswing or both are in downswing phase. Both approaches reveal a negative correlation between price and financial stability. Finally we check the robustness of our results using the Hamilton filter. Our finding of a negative relation between price and financial stability still holds.

The paper is structured as follows. Section 2 presents a review of the debate in the literature with regards to whether financial stability can be targeted using monetary policy instrument. Section 3 presents a brief discussion on recent changes in the monetary policy framework in India. Section 4 describes the data used in the analysis. Section 5 describes the empirical methodology used in the paper. Section 6 presents the main findings of the paper. Section 7 presents three robustness tests to check the robustness of our results. Finally, section 8 concludes with conjecturing some potential reasons for the existence of trade off between price and financial stability and proposes avenues for future research.

2 Monetary policy and financial stability

Policy makers and central bankers across the world are constantly grappling with the issue of designing appropriate policy responses to address financial instability. There is a growing debate on whether monetary policy *should* address financial stability (Woodford, 2012; Svensson, 2010; Shirakawa, 2013; Agnor and da Silva, 2013; IMF, 2015). Some papers argue that under certain conditions monetary policy should target financial stability (Woodford, 2012; IMF, 2015; Agnor and da Silva, 2013). Studies suggest modifying the inflation targeting framework to make interest rate policy a more effective tool for financial stability (Woodford, 2012). While financial crisis should be addressed through better supervisory capability and through new instruments of macroprudential policy such as counter-cyclical capital buffers, the existence of other instruments does not justify the complete neglect of financial stability in monetary policy deliberations.

A strand of literature argues that monetary policy should only be used to achieve financial stability if macroprudential policy and monetary policy are complements and not substitutes, i.e., a contractionary monetary policy aimed at reducing inflation should not fuel credit growth and vice versa. In situations where the central bank lacks credibility, especially in emerging markets where monetary policy is not fully developed and financial markets are weak, adding a financial stability objective to monetary policy can have implications for its credibility (Agnor and da Silva, 2013; IMF, 2015).

An alternative strand of literature argues that monetary policy should not be used to target financial stability (Svensson, 2010; Shirakawa, 2013). Papers in this field argue that financial crisis was caused by factors that had very little to do with monetary policy and hence price stability is not sufficient enough to achieve financial stability. Specific policies and instruments are needed to achieve financial stability. They suggest applying the Tinbergen's rule i.e. two independent instruments for achieving two distinct policy objectives (Svensson, 2010; Shirakawa, 2013)

The commentary by central bankers have also highlighted concerns with using monetary policy instrument to target financial stability. A number of central bankers' around the world are cautious to use monetary policy to target financial stability. Most central bankers view monetary policy as a blunt tool for addressing financial stability concerns. Many central bankers stress on applying micro and macroprudential supervision to address financial instability(Yellen, 2013; Hammond, 2009; Constancio, 2015; Mester, 2016). For a central bank pursuing monetary and financial stability, the addition of macroprudential instruments reduces the extent of the trade-off between monetary and financial stability (King, 2013).

From the discussion above, it is clear that the discourse is divided on whether monetary policy should target financial stability or not. However, there is limited empirical evidence on whether monetary policy can target financial stability. Notwithstanding the debate on whether monetary policy *should or should not* target financial stability, the paper aims to investigate whether monetary policy instrument of interest rate *can* target financial stability. The empirical literature in this field does not make a distinction between advanced and emerging economies in the relation between price and financial stability. Recent studies in the field of business cycle literature find that emerging economies have a distinct set of business cycle features (Aguiar and Gopinath, 2007; Male, 2011; Ghate *et al.*, 2013; Benczr and Rtfai, 2014). The relation between business and financial cycles also differ for advanced and emerging economies. In this paper we present an empirical strategy to investigate if there exists a trade off between price and financial stability using India as a case study of an emerging economy. In the scenario that a trade off exists between price and financial stability, it is difficult for monetary policy to target financial stability along with price stability. Alternative tools, such as macroprudential policies would be needed to address financial stability.

3 Monetary policy in India

The evolution of monetary policy in India can be analysed in two phases: pre 2016 phase and post 2016 phase. Prior to 2016, monetary policy did not have an explicit target(Subbarao, 2010). Monetary policy in India followed multiple objectives with multiple instruments with a proactive and preventive approach to financial stability rather than a reactive approach (Mohanty, 2012). Moreover, the RBI used multiple measures of inflation to communicate its inflation projections. During this period, the Reserve Bank of India (RBI) did not systematically use either the Consumer Price Index (CPI) or the Wholesale Price Index (WPI) as their inflation target. RBI preferred to look at WPI over CPI because of its availability at high frequency, national coverage and availability of disaggregated data which facilitated better analysis of inflation (Mohanty, 2010). However, around the same time, publications in official documents stated that the RBI followed a multiple indicator approach. They looked not just at the WPI numbers but CPI and a host of other indicators. For example, the Annual Policy Statement for the year 2010-11, (RBI) stated that the RBI monitors an array of measures of inflation, *"both overall and disaggregated components, in the context of the evolving macroeconomic situation to assess the underlying inflationary pressures."*

The first attempt at modernising the monetary policy framework came about with the signing of the Monetary Policy Framework Agreement between the RBI and the Government of India in February 2015. Under this agreement, the objective of monetary policy framework was to maintain price stability, while keeping in mind the objective of growth. As per the Agreement, the target for inflation was set at below 6% by January 2016 and within 4 per cent with a band of (+/-) 2 per cent for 2016-17 and all subsequent years.(Government of India, 2015).

In 2016, India statutorily adopted inflation targeting as an objective of monetary policy through an amendment of the RBI Act Government of India 2016.[2] The amendment also set up a Monetary Policy Committee to set a policy rate to pursue inflation target.

Following the MPC law, monetary policy started targeting the CPI combined series (also known as headline inflation) which is a more robust measure of true inflation that consumers face in the retail market (Patel, 2014). In this backdrop, it is important to examine the relation between price and financial stability in India to inform the conduct of a recently reformed monetary policy framework.

4 Data

We use quarterly data on non-food credit, credit-to-GDP and CPI-combined series for the purpose of our analysis. Our sample time frame is 2004 Q2 till 2018 Q3. This is because the old GDP series is available from 2004 Q2. Our sample time frame is good enough to capture both pre-crisis as well as post-crisis period. We calculate real credit by deflating nominal non-food

[2]The Preamble of the Act was amended to include the following: "And whereas the primary objective of the monetary policy is to maintain price stability while keeping in mind the objective of growth;"

credit using the CPI series.

5 Methodology

Before we delve into investigating the empirical relation between price and financial stability for India, the first step is to measure financial stability. While there is no single indicator to measure financial stability, there is a wide literature on the indicators of financial stability for various countries (Borio and Drehmann, 2009; Dumii, 2016). In this paper, we use stock of real credit as a measure of financial stability as it measures risks to financial stability in the form of build up of financial imbalances. A number of papers have shown that credit is an effective early warning indicator for banking crisis for developed as well as for emerging economies (Drehmann and Tsatsaronis, 2014; Blancher *et al.*, 2013b; Wacker *et al.*, 2014)

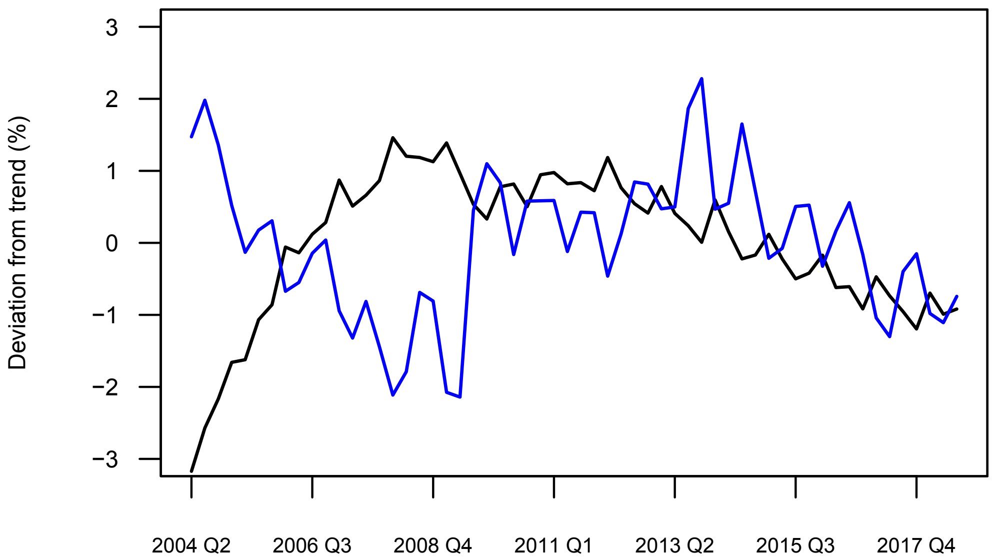
We use correlation analysis to test the trade-off between price and financial stability.[3] We use the cyclical component of real stock of credit and CPI index to calculate both contemporaneous correlation as well as lagged correlation at various lags of stock of real credit. We use the commonly used HP filter to de-trend both the CPI as well as stock of real credit series. A significant strand of literature looks at the cyclical component of credit to analyse the stylised features of financial cycles (Borio, 2014a,b; Reinhart and Rogoff, 2009; Terrones *et al.*, 2011).

We use a series of robustness checks to test the sensitivity of our findings. Drawing on the analysis by Kim and Mehrotra (2015) we examine the interaction between credit gap (measured as deviation of credit-to-GDP ratio from its long term trend) and inflation gap (measured as deviation from its target level). We also examine the synchronous relation between price and financial stability using the Index of Concordance (Harding and Pagan, 2002, 2006). We use an alternative detrending approach developed by Hamilton to check the sensitivity of our baseline findings.

[3] Blot *et al.* (2014) use correlation analysis to detect trade off between price and financial stability. Also see Canova (1998); Altissimo *et al.* (2001) on the use of correlation analysis as a robust approach to test for association between two indicators.

Figure 1 Price and financial cycles

This figure shows the price cycles superposed on the financial cycles in India. The figure shows that price and financial cycles do not follow a similar pattern. In most periods, the financial cycle appears to be a mirror image of the price cycle.



6 Baseline results

In this section, we present our main findings using correlation analysis. We look at the contemporaneous as well as lagged correlation between the cyclical components of CPI and stock of real credit at different lags to analyse if peaks and troughs in CPI coincide with those of credit. We use the Hodrick Prescott (HP) filter to de-trend the series. Unlike Blot *et al.* (2014), we analyse cyclical components as we want to see whether fluctuations in price and financial cycles are correlated with each other. A recent body of literature has analysed the core stylised features of financial cycles. They find that financial cycles have a much lower frequency than the traditional business cycle[4] (Drehmann and Tsatsaronis, 2014; Borio, 2014a). Drawing on this literature we adjust value of the smoothing parameter of the HP filter to account for the low frequency of financial cycles.

Figure 1 shows the cyclical components of CPI and real non-food credit. The

[4]Traditionally, the business cycle involves frequencies from 1 to 8 years. In contrast, the average length of the financial cycle is seen to be around 16 years.

Table 1 Correlation of CPI cyclical and real credit cyclical component

This table shows the correlation between the cyclical components of CPI and stock of real credit. The cyclical component of real credit is calculated using the standard HP filter with lambda equal to 400,000 to account for the low frequency of financial cycles. The table shows a negative correlation not only for contemporaneous time periods but also for leads and lags of CPI and credit; indicating a trade off between price and financial stability.

	Correlation
T-5	0.13
T-4	0.06
T-3	0.06
T-2	-0.04
T-1	-0.25
T	-0.36
T+1	-0.26
T+2	-0.22
T+3	-0.29
T+4	-0.30
T+5	-0.21

figure shows that the cycles are negatively correlated. Next, we compute the correlation between the cyclical components.

Table 1 shows the correlation for different leads and lags of price and financial cycles. As can be seen from the Table, the correlation between the cyclical components of CPI and real credit is negative which leads us to infer that periods of high price may coincide with periods of low credit growth. This finding provides evidence of a trade-off between price and financial stability.

7 Robustness Checks

We check the robustness of our baseline findings using a series of robustness checks. First, we present a visual inspection of interaction between inflation and credit-to-GDP gap. Second we present an alternative approach based on the Harding-Pagan Index of Concordance (IOC) to examine the synchronous relation between price and financial cycles. Finally we check whether our results are robust to an alternate detrending filter.

7.1 Visual inspection

We draw on the methodology used by Kim and Mehrotra (2015) to assess the interaction between credit to GDP gap and inflation gap.[5] We use inflation gap measured as deviation of inflation from its target, as an indicator of price stability. Most central banks target deviation of inflation from its target. Hence, we look at the gap between inflation and its target level rather than the inflation rate itself. Similarly, for financial stability, we look at credit-to-GDP gap which captures deviation of total credit-to-GDP from its long-term trend. By comparing inflation gap against credit-to-GDP gap, we can assess whether there is a trade off between price and financial stability. If both (inflation gap and credit-to-GDP gap) are positive (negative), there is no trade off. If inflation gap is positive (negative) and credit-to-GDP is negative (positive), then this indicates periods of high (low) inflation and low (high) financial instability indicating a tradeoff. In the latter case, monetary policy cannot use policy interest rate as an instrument to target financial stability.

Credit gap is calculated as deviation of credit-to-GDP from its long term trend. Kim and Mehrotra (2015) calculate the trend using the HP filter (Hodrick and Prescott, 1997) with a smoothing parameter: lambda set to 400,000 to account for the low frequency nature of financial cycle as opposed to business cycle fluctuations. We use a threshold of 6 percentage points for credit-to-GDP gap to detect periods of financial instability (Borio and Drehmann, 2009)[6]. Any deviation from trend above 6 percentage points indicates periods of high credit growth in the economy. To calculate inflation gap, we use a 5 percent inflation target. We choose 5% because before 2016, there was no clear target. It is only after 2016 that the target was set at 4% with a band of +/- 2%.

Figure 2 plots the credit gap against the inflation gap for India. Each point in the graph indicates a level of inflation gap and credit gap in a particular quarter. The vertical line is at 0 indicates when the inflation target has been met in a given quarter. Any point to the right of the vertical line indicates that inflation is above target and any point to the left of the vertical line

[5]Kim and Mehrotra (2015) provide a framework to assess the trade off between financial and price stability by looking at the interaction between the credit to GDP gap and the inflation gap (measured as deviation from its target level). The paper looks at the trade off for Australia, Indonesia, Korea, New Zealand, Philippines and Thailand for the period 2000 Q3 to 2014. The paper finds that 12 percent of the country-year observations lie in the below target inflation and high credit gap region.

[6]Borio and Drehmann (2009) show that a threshold of 6 percentage points minimises the noise-to-signal ratio for detecting financial crisis

indicates that inflation is below target. The horizontal line represents the 6 percentage point threshold for credit gap to indicate periods of financial instability. Any point above the horizontal line indicates period of high credit growth and financial instability in the economy and any point below the horizontal line indicates periods of financial stability.

The vertical and horizontal lines divide the chart into 4 different quadrants. The top right quadrant represents those periods when both credit and inflation have been high (represented by ‘triangle’ dots). The bottom left quadrant represents those periods when both credit and inflation have been low (represented by ‘plus’ dots). Together these two quadrants represent periods of no trade off as both credit-GDP gap and inflation gap move in the same direction.

The top left quadrant represents those periods when inflation has been below target and credit growth has been high and unstable (represented by ’circle’ dots). The bottom right quadrant represents those periods when inflation has been above target and credit growth has been stable (represented by ’square’ dots). Together, these two quadrants represent periods of trade off as credit-gap and inflation-gap move in opposite directions.

Figure 2 shows that proportionately greater number of quarter-observations lie in the trade off region (square dots). Very few observations lie in the no-tradeoff region indicating that in most of the quarters in our period of study (from 2004 Q2 to 2018 Q3), periods of high inflation did not coincide with periods of high credit growth.

7.2 Harding-Pagan Index of Concordance

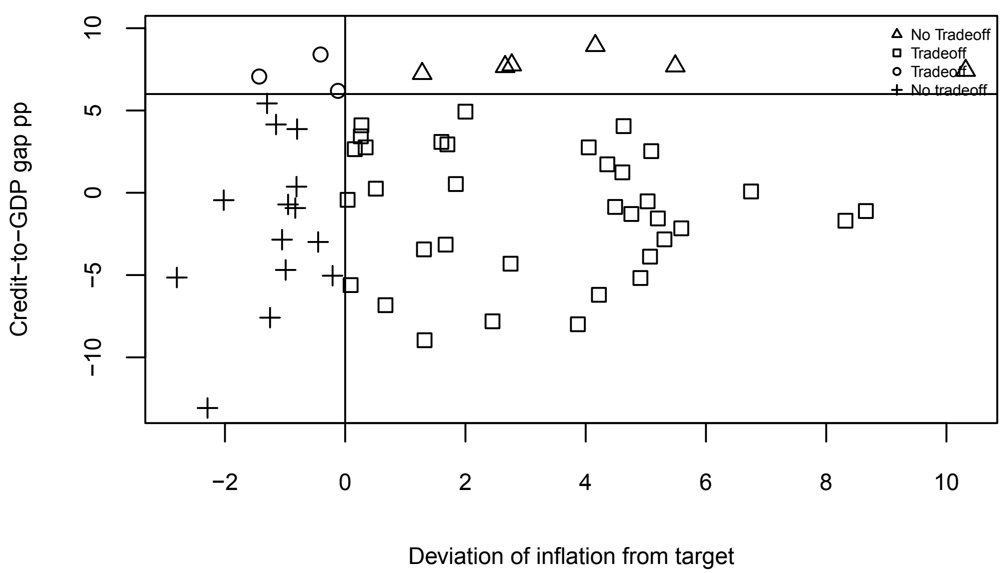
Another approach to examine the synchronous nature of two series was propounded by Harding and Pagan (2002) and Harding and Pagan (2006). Harding and Pagan (2006) determine the degree to which two cycles are in sync by measuring the percentage of time the two variables are in the same phase i.e. both the cycles are in expansion[7] or both cycles are in recession.[8] This involves identification of dates of turning points in the cyclical components of both series.

We use the dating algorithm by Bry and Boschan (1971) to identify the dates of turning points in price and financial cycles. The Bry and Boschan (1971)

[7]Expansion is defined as the phase from trough to peak.
[8]Recession is defined as the phase from peak to trough.

Figure 2 Trade off between price stability and financial stability

Clockwise: The circular dots represent periods of inflation below target and financial instability. The triangular dots represent periods of inflation above target and financial instability. The square dots indicate periods of inflation above target and financial stability and the plus dots indicate periods of inflation below target and financial stability. The circular and the square dots represent the trade-off regions while the triangle and the plus dots represent the no-tradeoff regions.
The quadrants showing trade-off have relatively greater number of quarter-observations than the quadrants showing no trade-off.



algorithm is based on a standardised set of rules that facilitate comparison of business cycle turning points across countries, regions and time-periods. The procedure was subsequently revised and quantified in a better way by Harding and Pagan (2002).[9]

Once the turning points are identified for our dataset, we construct a state variable S_t for each series. S_t is a binary variable defined as 0 when the series y_t (in our case the cyclical component) moves from peak to trough and 1 when y_t moves from trough to peak. The advantages of studying S_t over y_t are the binary definitions of recession/expansion assumed by most loss-averse agents, as well as the added ability to test for synchronisation across cycles (Harding and Pagan, 2006).

S_t can be studied in two ways. The first is the Harding-Pagan index of concordance (HP index), which measures the proportion of time the two variables are in the same state. Assuming two variables x and y over N time periods, the index of concordance between them would be I_{xy}, defined in Equation 1.

$$I_{xy} = \frac{\#[S_{xt} = 1, S_{yt} = 1] + \#[S_{xt} = 0, S_{yt} = 0]}{N} \tag{1}$$

The value of the Harding-Pagan index ranges between 0-1. An index value of close to 1 indicates perfect procyclicality while an index value of 0 indicates perfect counter-cyclicality. However, given the markov-transition probability structure of recessions ($Pr(S_{t+1} = 0, S_t = 0) \gg Pr(S_{t+1} = 0, S_t = 1)$), there is an extensive serial correlation in the S_t series (Harding and Pagan, 2006). Also, in cases where the data duration is short, the chances of a prolonged expansion or recession in one of the series skewing the value of the index of concordance are non-zero.

To correct for these flaws, through the second approach, Harding and Pagan (2006) demonstrate that the following relationship holds between the correlation coefficient ρ^{xy} between S_x and S_y and I^{xy}, which implies that the properties of ρ^{xy} are symmetric to that of I^{xy}.

$I^{xy} = 1 + 2\rho^{xy}\sigma_{Sx}\sigma_{Sy} + 2\mu_{Sx}\mu_{Sy} - \mu_{Sx} - \mu_{Sy}$

To estimate the correlation coefficient ρ^{xy}, we use the following OLS estima-

[9] See Appendix A for the rules to identify turning points.

tion:

$$\frac{S_{yt}}{\sigma_{\hat{S}_{xt}}\sigma_{\hat{S}_{yt}}} = A + \rho_{xy}\frac{S_{xt}}{\sigma_{\hat{S}_{xt}}\sigma_{\hat{S}_{yt}}} + \epsilon_t \tag{2}$$

where $\sigma_{\hat{S}_{yt}}$ denotes the sample standard deviation of S_{yt}. Given that ϵ_t inherits the serial correlation in S_t, we report p-values for the Heteroskedasticity-Autocorrelation (HAC) corrected t-statistics for $\hat{\rho_{xy}}$

The Index of Concordance is found to be 0.26 and the correlation coefficient is significant and negative at −0.515. The small value of the index of concordance and a negative correlation coefficient indicate presence of a trade-off between the price and the financial cycles for India. Table 2 and Table 3 show the dates of turning points of the financial and price cycles respectively for India. The tables show that phases of expansion and recession in the credit series do not coincide with phases of expansion and recession identified in the price series. As an example, from 2017 Q4 onward, expansion is seen in the credit cycle. However in the price cycle, this period is largely identified as a recession.

Table 2 Dates of turning points in financial cycles

This table shows the dates of turning points in the cyclical component of non-food credit. The cyclical component is arrived at using the HP filter with the value of smoothing parameter equal to 400,000 to take into account the low frequency of financial cycles. The dates of turning points are arrived at using the Bry-Boschan dating algorithm. From 2004 Q2 to 2018 Q3, four phases of expansion and three phases of recession are identified in the series. The table also shows the duration and amplitude of each phase (expansion and recession).

	Phase	Start	End	Duration	Amplitude
1	Expansion	<NA>	2008Q1	NA	NA
2	Recession	2008Q1	2009Q4	7	1.1
3	Expansion	2009Q4	2012Q1	9	0.9
4	Recession	2012Q1	2015Q3	14	1.7
5	Expansion	2015Q3	2016Q1	2	0.3
6	Recession	2016Q1	2017Q4	7	1.0
7	Expansion	2017Q4	<NA>	NA	NA

7.3 Using a different filter

Our baseline results uses the HP filter. Recent literature has pointed to some pitfalls in the HP filter(Hamilton, 2017). Hamilton (2017) points out that

Table 3 Dates of turning points in price cycles

This table shows the dates of turning points in the cyclical component of CPI. The cyclical component is arrived at using the HP filter. The dates of turning points are arrived at using the Bry-Boschan dating algorithm. During the period 2004 Q2 to 2018 Q3, seven phases of recession and six phases of expansion are identified. The table also reports the duration and amplitude of each phase.

	Phase	Start	End	Duration	Amplitude
1	Recession	<NA>	2005Q2	NA	NA
2	Expansion	2005Q2	2005Q4	2	0.4
3	Recession	2005Q4	2008Q1	9	2.4
4	Expansion	2008Q1	2008Q3	2	1.4
5	Recession	2008Q3	2009Q2	3	1.5
6	Expansion	2009Q2	2009Q4	2	3.2
7	Recession	2009Q4	2012Q1	9	1.6
8	Expansion	2012Q1	2013Q4	7	2.7
9	Recession	2013Q4	2016Q1	9	2.6
10	Expansion	2016Q1	2016Q3	2	0.9
11	Recession	2016Q3	2017Q2	3	1.9
12	Expansion	2017Q2	2017Q4	2	1.2
13	Recession	2017Q4	<NA>	NA	NA

the HP filter could introduce spurious dynamic relations in the series that have no relation with the underlying data-generating process. According to Hamilton, a regression of the variable at $t + h$ on the four most recent values as of date t offers a more robust approach to detrending.[10]

Table 4 shows the correlation between the cyclical components of prices and real credit. Here the cyclical components are arrived at using the Hamilton approach. Table reports a negative correlation between the cyclical components of price and credit.

The above analysis shows that our findings are robust to the choice of detrending filter. In summary, visual inspection, the Index of Concordance and application of the Hamilton filter reiterate presence of a negative correlation between price and financial cycles for India.

[10](See Appendix B for a description of the Hamilton approach to calculate the cyclical component of a series).

Table 4 Correlation of CPI cyclical and real credit cyclical component using Hamilton filter

This table shows the correlation between the cyclical components of CPI and stock of real credit using the Hamilton filter. The table shows negative correlation not only for contemporaneous time periods but also for leads and lags of CPI and credit. This analysis shows that our findings are robust to the choice of detrending filter.

	Correlation
T-5	-0.06
T-4	-0.12
T-3	-0.27
T-2	-0.45
T-1	-0.58
T	-0.74
T+1	-0.54
T+2	-0.36
T+3	-0.12
T+4	-0.01
T+5	0.15

8 Conclusion

In this paper, we empirically investigate whether a trade off exists between price and financial stability in the context of Indian economy as a case study of an emerging economy. We use the stock of real credit and the credit-to-GDP as measures of financial stability which are leverage-based measures.

Our results indicate that a trade-off exists between price and financial stability over the time period 2004 Q2-2018 Q3. Our results are robust to alternate approaches towards assessing the interaction between price and financial stability and to the choice of detrending filter.

Our findings have implications for the conduct of monetary policy in India. The presence of a trade-off indicates that the policy rate cannot be used as an instrument to target financial stability and alternative tools such as macroprudential policies are needed to sustain financial stability.

Our research opens a number of avenues for further research. What could be the reasons underlying the trade-off between price and financial stability? The literature provides some plausible explanations. The relation between price and financial stability may differ depending on the nature of economic shocks (Geraats, 2010). Mohanty and Klau (2001); Kahn (2008) argue that supply side factors are important determinants of inflation in emerging economies. There could be a situation where prices fall due to a supply glut while output and credit gap rises. In such a case, a central bank would prefer a rate cut to stabilise inflation around the target while financial stability considerations would require raising rates. Jonsson and Moran (2014) also find that a trade-off between price and financial stability may arise if fluctuations are driven by supply shocks. Small open economy emerging markets could face more significant trade-offs in the face of global financial integration and the reliance of domestic interest rates on global interest rates. Empirically examining the reasons for trade-off for emerging economies in general and India in particular would be a subject of future research.

A Detection of turning points

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 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.

B Hamilton filter

Our baseline results uses the HP filter. While it is a widely used filter, recently it has faced a lot of criticism. Hamilton (2017) provides a useful analysis on why one should never use the HP filter. The underlying criticism is that the HP filter calculates the cyclical component based on the future values. As a result, one might introduce autocorrelation into the cyclical component of the series, even if it is not present in the data generating process. Further, he states that while one can use a one-sided HP filter process to overcome the issue of autocorrelation; since it ignores the future values, one would be unable to capture the turning points in real time.

Hamilton (2017) redefines the cyclical component of a trending series as how different is the value at date $t+h$ from the value that we would have expected to see based on its behaviour though date t. This definition has several attractive features. First, the forecast error is stationary for a wide class of non-stationary processes. Second, cyclical factors such as whether a recession occurs over the next two years and the timing of recovery from any downturn prevents us from predicting most of the macro and financial variables at a horizon of 8 quarters.

He further states that a linear projection of y_{t+h} on a constant and the 4 most recent values of y as of date t provides a reasonable way to remove an unknown trend for a broad class of underlying process provided that fourth differences of y_t are stationary. In other words if we fit the following OLS regressions:

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

then the residuals,

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

are the cyclical component of the series.

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