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Is money velocity pro-cyclical? The case of India

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Abstract

Monetary targeting served as a useful tool for conducting monetary policy until 1980s, but the instability in the relationship between money and nominal income led to its abandonment by most economies. One way of measuring this relationship is money velocity, defined as the ratio of nominal income to money. The purpose of the present study is to show that if short-run cyclical factors are accounted for, money velocity function becomes stable and thus any change in monetary aggregates will lead to predictable change in nominal income and therefore inflation. In such a scenario, monetary targeting can serve as a useful tool in the conduct of monetary policy. The study utilizes quarterly data from 1996:Q2 to 2020:Q1 and time series methodology to conduct empirical analysis. Findings show that money velocity and all its identified determinants exhibit pro-cyclical behaviour. After accounting for these determinants, money velocity has been found to be stable. The direction of causality runs from money velocity to rate of interest to investment to GDP. Thus, when formulating monetary and fiscal policies, policymakers can monitor the short-term cyclical patterns in money velocity as an indicator of forthcoming expansionary or contractionary conditions in the economy to design effective policies.

Keywords: Macroeconomics, Monetary policy, Money velocity, Business cycle, Money

1 Introduction

Monetary targeting served as a useful tool for conducting monetary policy until the 1980s, but the instability in the relationship between money and nominal income led to abandonment of monetary targeting by most economies. However, literature shows that if appropriate factors are accounted for, the relationship between money and nominal income becomes stable (Bordo and Jonung 1987, 1989; Grilli 1989; Howlader and Khan 1990; Arrau et al. 1995; Lee and Chien 2008; Yu and Gan 2009; Rami 2010; Gill 2010; Pattanaik and Subhadhra 2011; Akinlo 2012; Lucas and Nicolini 2015; Nampewo and Opolot 2016; Folarin and Asongu 2019; Adil et al. 2020). Thereby, any change in monetary aggregates will lead to a predictable change in nominal income and therefore inflation. In such a scenario monetary aggregates can be useful in designing and implementing monetary policy to ensure price stability.

Literature suggests that most of the studies conducted to assess the stability in the relationship between money and nominal income examine the money demand function (Goldfeld et al. 1976; Darrat 1986; Poole 1988; Friedman and Kuttner 1992; Hoffman et al. 1995; Lütkepohl et. al., 1999; Bahmani-Oskooee and Barry 2000; Akinlo 2006; Singh and Pandey 2009; Jiranyakul and Opiela 2014; Lucas and Nicolini 2015; Aggarwal 2016; Asongu et al.; 2019; Folarin and Asongu 2019; Benati et. al., 2021). However, the present study provides an alternate perspective by examining the money velocity function. Money velocity defined as the ratio of nominal income to money, is also the inverse of the money demand defined as the ratio of the money to nominal income. As pointed out by Friedman and Schwartz (1982) "an analysis of the behaviour of velocity is an analysis of the demand for money". Further as pointed out by Jung (2017) "the velocity of money provides a complementary perspective on money demand, thereby allowing policymakers to cross-check the information gained from money demand models".

At the outset, there are empirical traditions which do not consider the importance of cyclical influences on money velocity. Traditionally money velocity was considered to be constant by the classical economists, even in the short-run. This belief rested on the presumption that money velocity is mainly impacted by technological improvements in terms of institutional changes which remain more or less constant in the short-run (Fisher 1911; Edgmand et al. 1996; Mitra and Abhilasha 2012; Dimand 2013; Canto 2018; Doan 2020). Friedman (1956) developed a theory of money demand which focused on the factors that impact money demand. One peculiarity of Friedman's theory was that it used permanent income instead of income as a factor determining money demand. Since permanent income is less volatile during economic cycles in comparison to income, one important conclusion of Friedman's theory was that money demand was stable over the cycles, i.e. it will not show pronounced cyclical tendencies.

This stability in money demand led to an important implication that money velocity will also not vary much with economic cycles and therefore will be stable. In other words, although money velocity will exhibit pro-cyclical behaviour (as a result of some pro-cyclicality in permanent income), but the amplitude of cyclicality is going to be relatively much lesser for money velocity in comparison to actual income.31 Thus, although monetarists acknowledge the pro-cyclical behaviour of money velocity, they argue that money velocity tends to be more stable in the long run but can exhibit short-term fluctuations in response to changes in economic conditions. Monetarists focus on the relationship between money supply and nominal GDP, with changes in money velocity playing a role in adjusting the impact of changes in the money supply on economic activity (Bridges and Thomas 2012; Jahan and Papageorgiou 2014; Viitanen 2022).

The post-Keynesian monetary theory emphasizes the endogenous nature of money. It states that money supply is not exogenously determined, but it is the demand of the real economy which determines the amount of money supply in an economy. In periods of economic recovery there is positive expectation regarding investments for production led activities which leads to rise in demand for credit. At this time if the rate of interest conditions in the economy are not favourable (i.e. not low enough to provide adequate supply of credit by banks to fulfil the demand for credit), there will be pressure on money velocity to rise (Kaldor 1970; Padhi 2018).

Money velocity has been observed to follow a pro-cyclical pattern in various economies around the world (Leão, 2005; Mishkin 2004; Shirvani and Wilbratte

2008; Benk et al. 2009; Patrick 2010; Mishkin 2004). This pro-cyclicality arises because of many reasons. Firstly, during economic expansions or booms, businesses and consumers tend to increase their spending as confidence rises and income levels improve. This increased economic activity leads to higher money velocity as money changes hands more frequently to facilitate transactions. Secondly, during periods of economic growth, investment and consumption typically increase. Firms invest in new projects, expand production capacity, and hire more workers, while consumers spend more on discretionary items. This heightened investment and consumption result in higher money velocity as money is used more actively to finance these activities. Thirdly, economic expansions are often accompanied by increased lending and credit creation by banks. As borrowing activity rises, the money supply expands, leading to more money in circulation. This influx of money fuels higher spending and economic activity, contributing to the pro-cyclical nature of money velocity.

The present study argues that the short-run instability in money velocity is mainly caused due to cyclical factors (Rich 2003; Mishkin 2004; Shirvani and Wilbratte 2008; Patrick 2010). Thus, if cyclical factors are accounted for, money velocity can be shown to be stable. In this context, the present study aims at examining the cyclical nature of money velocity in India by assessing the cyclical determinants of money velocity. It aims to estimate a money velocity model and examine its stability. It further aims to identify the direction of causality between money velocity and its short-run determinants.

The originality of this study lies in its focus on the money velocity function as a means to understand monetary stability, rather than the more commonly examined money demand function. By analysing the cyclical determinants of money velocity in India, this research offers a unique perspective on the pro-cyclical behaviour of money velocity and its short-term fluctuations. The study aims to provide empirical evidence that, when accounting for cyclical factors, money velocity can be shown to be stable. This approach not only complements existing literature by cross-verifying findings from money demand models, but also offers new insights into the relationship between money velocity and economic cycles, particularly within the context of an emerging economy like India. By identifying the direction of causality between money velocity and its short-run determinants, the study enhances our understanding of how monetary aggregates can be utilized in designing and implementing effective monetary policies to ensure price stability.

The study is organized as follows. First, evolution of monetary policy in India has been discussed. Second, cyclical nature of money velocity has been examined. Third, cyclical determinants of money velocity have been identified from theory and literature. Fourth, business cycles have been identified using quarterly data for log of real GDP. Fifth, cyclical components of money velocity and the identified determinants have been extracted. Sixth, cyclical components of money velocity and the identified determinants are analysed using correlation analysis and graphical analysis. Seventh, an ARDL regression model has been estimated to assess the significance of short-run determinants of money velocity and its stability has been examined. Ninth, direction of causality is identified amongst money velocity and its short-run determinants. Lastly, summary and conclusion are spelt out.

2 Evolution of monetary policy in India

Understanding the dynamics of monetary policy in India is important against the backdrop of changing monetary regimes and evolving institutional framework over the past many decades. The main objective of RBI's monetary policy is to stabilize inflation. Once inflation is stable, RBI may focus on the objective of promoting growth (Das 2020).[1]

The Reserve Bank of India (RBI) adopted 'Monetary Targeting with Feedback' in 1985. Given the reasonable stability in money demand function (Rangarajan 1997), the annual growth in broad money (M3) was used as an intermediate target of monetary policy to achieve its final objectives.[2] Monetary management involved working out M3 growth consistent with projected growth of GDP which corresponds to a tolerable level of inflation, adjusted for any change in money velocity. However, an important prerequisite for monetary targeting in any economy is a stable, reliable and predictable relationship between the targeted monetary aggregate, inflation and output. In India, the stability of these relationships declined due to fluctuations in money velocity caused by increased financial innovations, swings in capital flows, financial deregulations and global contagion factors (Mohanty and Mitra 1999). As pointed out by Goyal (2011, p. 35) "deregulation and liberalization of the financial markets combined with the increasing openness of the economy in 1990s made money demand more unstable, and money supply more endogenous". Further as pointed out by Reddy (2002), the RBI itself noted monetary policy based on demand function of money, in these circumstances, was expected to lack precision. Thus, by late 1990s, it became apparent that the relationship between M3, inflation and nominal income decreased, which lead RBI to abandon monetary targeting in 1998.

RBI abandoned Monetary Targeting and switched over to Multiple Indicators Approach in 1998.[3] In this approach, the RBI shifted its monetary instrument from monetary aggregates to interest rate. As explained by Jalan (2001), RBI moved towards using the interest as an instrument, basing its actions on a number of indicators of monetary conditions. Further explained by Goyal (2011), RBI moved towards using the repo rate instead of monetary aggregates as the instrument of monetary policy after 2002. Thus, although RBI did not announce any explicit nominal anchor during this regime, it continued to provide money supply projections (along with projections of other macroeconomic variables) which served as an important information variable to make the resource balance in the economy consistent with the credit needs of the government and the private sector (Mohanty 2010).

The multiple indicators approach performed well from its adoption in 1998 until the commencement of global financial crisis in 2008 with relatively high growth rate coupled with stable inflation. However, in the post-global financial crisis era, Indian economy experienced low growth rate coupled with rising inflation. Along with the domestic issues a number of international issues, such as tapering talks of the United States in

[1] Under the Reserve Bank of India, Act, 1934 (RBI Act,1934) (as amended in 2016).

[2] As per RBI the primary objective of monetary policy in India is to maintain price stability while keeping in mind the objective of growth since price stability is a necessary precondition to sustainable growth.

[3] Besides monetary aggregates, a host of forward-looking indicators such as credit, output, inflation, trade, capital flows, exchange rate, returns in different markets and fiscal performance constituted the basis of information set used for monetary policy formulation (Das 2020).

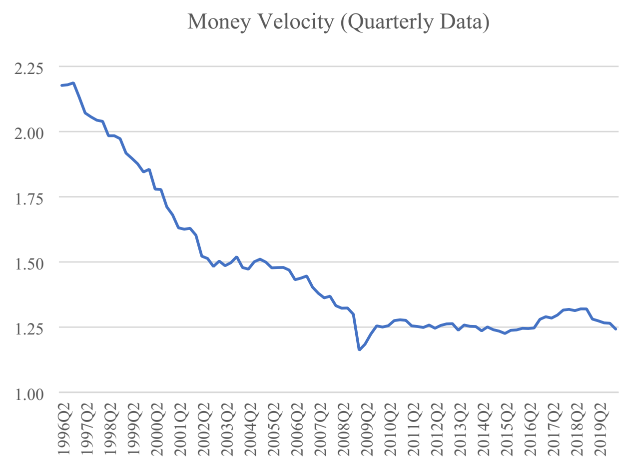

Fig. 1 Money velocity (quarterly data). The graph of broad money velocity

mid-2013[4] also destabilized the Indian economy. At this time the multiple indicators approach was considered inadequate to stabilize the economy as it was argued that a single nominal anchor is more effective than a large number of economic indicators to conduct the monetary policy.

In light of this argument, Flexible Inflation Targeting was adopted by the RBI in 2016.[5] Under this framework, the RBI uses various monetary policy tools, such as the repo rate, reverse repo rate, and other liquidity management measures, to achieve its inflation target. The Monetary Policy Committee (MPC), constituted by the government, decides on these policy rates. The MPC assesses various economic indicators and data, including inflation projections, growth forecasts, and global economic conditions, to make informed decisions on monetary policy.

Inflation targeting aims to provide transparency and predictability to monetary policy decisions, anchoring inflation expectations and fostering macroeconomic stability. However, the effectiveness of this framework depends on various factors, including the credibility of the central bank, fiscal discipline, and external economic shocks.

3 Cyclicality in money velocity

Money velocity has been observed to follow a pro-cyclical pattern in India. As shown by Pattanaik and Subhadhra (2011), although money velocity has been observed to follow a downward trend in India, it fell more steeply in periods of economic downturns such as in the south east Asia crisis in the late 1990s and in the global financial crisis in 2008. Figure 1 shows graph of quarterly data on money velocity from 1996–97 to 2020–21. It may be observed that there is steep decline in money velocity from 1996Q2 to 2002Q4 representing the southeast Asia crisis and again from 2008Q3 to 2009Q1 representing global financial crisis.

[4] Tapering is an economic technique whereby a central bank phases out quantitative easing which was rolled out for the purpose of economic recovery.

[5] In May 2016, the RBI Act, 1934 was amended to provide a statutory basis for the implementation of the flexible inflation targeting framework.

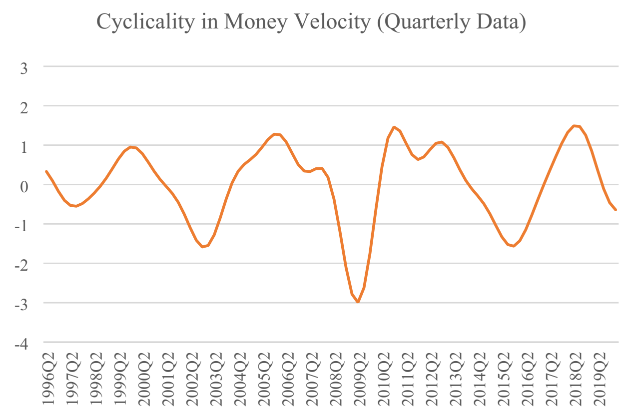

Fig. 2 Cyclicality in money velocity (quarterly data). The cyclical component of broad money velocity extracted using Full Sample Asymmetric Christiano–Fitzgerald filter

The figure clearly shows that money velocity is not stable during the period of study. Following Kumar et al. (2020),[6] the cyclical component of money velocity has been extracted by applying Full Sample Asymmetric Christiano–Fitzgerald filter (2003). Quarterly money velocity is presented in Fig. 1. The figure shows that money velocity exhibits a downward trend till 2008–2009 conforming to the fact that India is in the first phase of economic development. Post that, money velocity has a relatively flat (stable) curve. The cyclical component of log of quarterly money velocity is presented in Fig. 2.

4 Data

Quarterly data from 1996Q2 to 2020Q1 have been used for empirical analysis.[7] The data have been mainly collected from handbook of statistics on Indian economy published by Reserve Bank of India. The variables utilized in the analysis, along with their respective sources, are detailed in Table 1.

4.1 Determinants of cyclicality in money velocity

The cyclical determinants of money velocity have been identified as follows:

4.1.1 Real GDP

The variable lgdp denotes the natural logarithm of real GDP and is used as a scale variable. This variable is expected to enter the short-run money velocity model with either a positive sign or a negative sign. If real income elasticity of money demand is greater than one (i.e. for every one per cent increase in real income money demand increases by greater than one percent), then the real income elasticity of money velocity will be negative (Rami 2010).

However, if real income elasticity of money demand is less than one, then the real income elasticity of money velocity will be positive. Rao and Kumar (2009) pointed

[6] The paper uses frequency filter technique of Christiano–Fitzgerald to extract cyclicality in real GDP, credit to GDP ratio, real house prices, real equity prices and real effective exchange rate to examine the interdependence in business cycle and financial cycle in India during 1996Q1–2018Q3.

[7] Data after 2020Q2 has not been used due to COVID-19 impact.

Table 1 Data description. Source: International Financial Statistics published by International Monetary Fund and Handbook of Statistics on Indian Economy published by Reserve Bank of India

S. no.	Variable	Description	Source
1	Broad money velocity	Broad money velocity has been estimated by taking the ratio of quarterly nominal GDP and quarterly broad money supply. Quarterly broad money supply is estimated using monthly broad money supply	1. Gross Domestic Product, Nominal, Seasonally Adjusted, Domestic Currency taken from International Financial Statistics published by International Monetary Fund 2. Broad money velocity taken from Table 163: Components of Money Stock taken from Handbook of Statistics published by RBI, India
2	Real GDP	Gross Domestic Product at constant prices	Gross Domestic Product, Nominal, Seasonally Adjusted, Domestic Currency taken from International Financial Statistics published by International Monetary Fund
3	Rate of interest	Money market rate has been used for rate of interest	Financial, Interest Rates, Money Market, Percent per annum taken from International Financial Statistics published by International Monetary Fund
4	Investment	Real gross fixed capital formation has been used for investment	Table 156: Quarterly Estimates of Gross Domestic Product (At Constant Prices) from Handbook of Statistics published by RBI, India
5	Bank credit	Bank credit has been taken as the sum of food credit and non-food credit by banks	Table 169: Scheduled Commercial Banks—Select Aggregates from Handbook of Statistics published by RBI, India

out that income elasticity for money demand is close to/greater than one for developing countries, whereas it is less than one for developed countries. Since India is an emerging economy with fast paced development in the estimation period from 1996–97 to 2019–2020, the income elasticity of money demand is expected to be less than one and thus the income elasticity of money velocity is expected to be positive. In other words, the expected sign of coefficient of real GDP is positive.

The time series plot of the natural logarithm of real GDP for the estimation period 1996Q2 to 2020Q1 is presented in Fig. 3.

4.1.2 Rate of interest

The variable roi denotes rate of interest and is estimated as $[(1+r/100)*100]$. It is used as an opportunity cost variable. This variable is expected to enter the short-run money velocity model with a positive sign (Bordo and Jonung 1987; Silkos 1993; Dreger and Wolters 2009; El-Shagi and Giesen 2010; Rami 2010; Pattnaik and Subhadra 2011; Akinlo 2012; Okafor et al., 2013; Nunes et al. 2018). An increase in rate of interest will lead to rise in opportunity cost of holding money leading to fall in demand for money and thereby rise in money velocity. The literature confirms positive coefficient for rate of interest in money velocity function.

The time series plot of money market rate (estimated as $([1+r/100]*100)$) for the estimation period 1996Q2 to 2020Q1 is presented in Fig. 4.

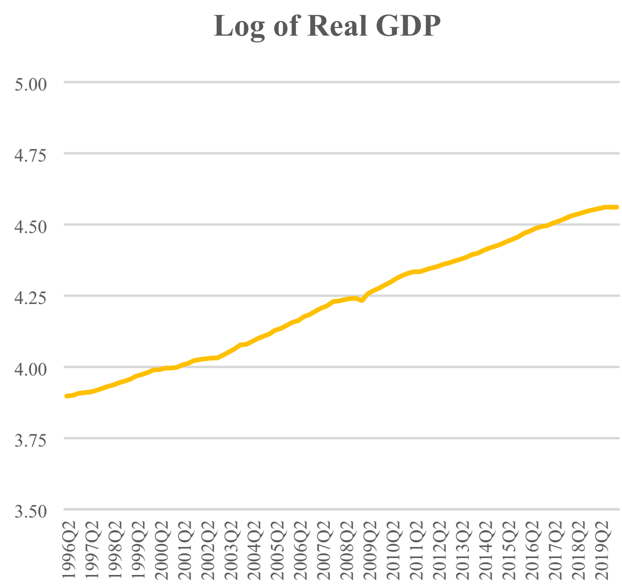

Fig. 3 Log of real GDP

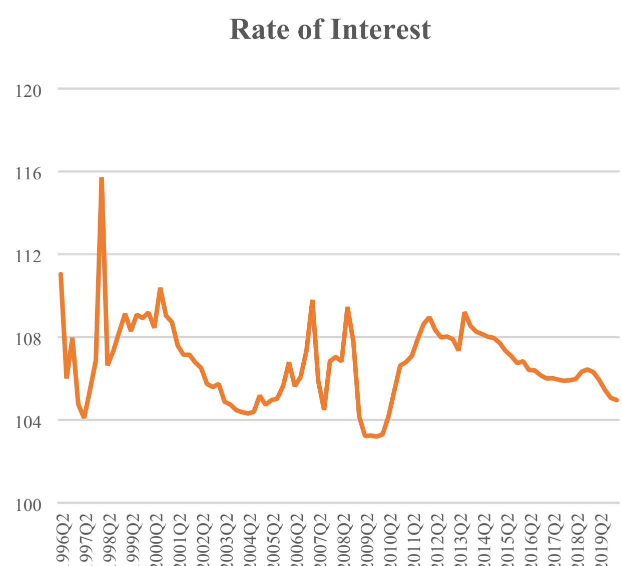

Fig. 4 Rate of interest

4.1.3 Investment

The variable linv denotes the natural logarithm of real investment. This variable is expected to enter the short-run money velocity model with a positive sign. In periods of economic expansions (contractions) investment exhibits a rising (falling) trend and so does money velocity (Leão, 2005). Wen and Arias (2014) explain that a decrease in interest rates coupled with decrease in money velocity is also accompanied by readjustment of portfolios towards liquid money, thereby leading to fall in investment.

The time series plot of the natural logarithm of real investment for the estimation period 1996Q2 to 2020Q1 is presented in Fig. 5.

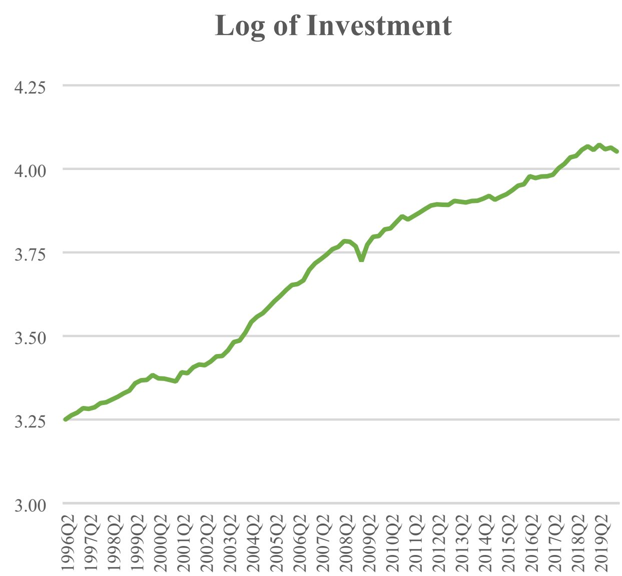

Fig. 5 Log of investment

4.1.4 Bank credit

The variable lbc denotes the natural logarithm of bank credit to private sector. The expected sign of this variable in the short-run money velocity model may be positive or negative. In periods of economic expansions (contractions) demand for credit rises (falls). In case of favourable interest rate conditions (i.e. low interest rate) in the economy, bank credit will rise in economic expansions. However, if interest rate conditions are not favourable (for example in case of contractionary monetary policy with high interest rate), bank credit may fall in times of economic expansions (Kaldor 1970; Padhi 2018).

The time series plot of the natural logarithm of bank credit for the estimation period 1996Q2 to 2020Q1 is presented in Fig. 6.

4.2 Descriptive statistics and cross-correlations of the variables

Tables 2 and 3 present the descriptive statistics and cross-correlation of the variables included in the model for the estimation period 1996Q2 to 2020Q1.

5 Cyclicality in money velocity and its determinants

5.1 Identification of business cycles

The business cycles have been identified by using quarterly data for log of real GDP. The cyclical component has been extracted by applying Full Sample Asymmetric Christiano–Fitzgerald filter. As given by Pandey et al. (2017), following NBER, the cycle period has been taken as two to eight years. Harding and Pagan (2002) dating algorithm has been used to date the business cycles by using standardized cyclical component of log of real GDP. The results are presented in Fig. 7 and Table 4.

The results obtained in Table 4 are majorly in line with Pandey et al. (2017) who estimated the dating of business cycles in India from 1996 to 2014. Table 4 shows that

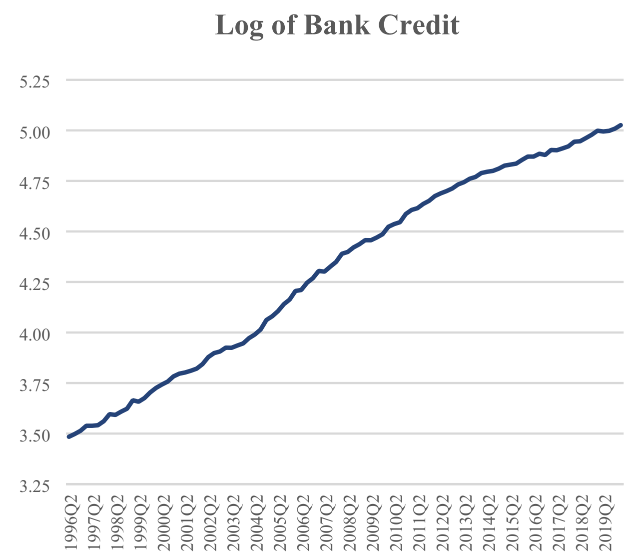

Fig. 6 Log of bank credit

Table 2 Descriptive statistics (billions)

	MV	GDPCO	ROI	INV	BC
Mean	1.47	18,811.82	6.75	5795.90	35,355.06
Median	1.33	17,065.40	6.69	5795.80	24,779.61
Maximum	2.23	36,394.60	15.72	11,813.40	106,169.30
Minimum	1.16	7902.80	3.20	1780.10	3048.54
Std. Dev	0.28	8903.36	1.93	3105.50	31,442.65
Skewness	1.20	0.53	1.01	0.30	0.70
Kurtosis	3.24	2.03	6.53	1.84	2.15
Jarque–Bera	23.19	8.36	66.10	6.82	10.78
Probability	0.00	0.02	0.00	0.03	0.00

The dependent variables are broad money velocity, real GDP, rate of interest, investment and bank credit

Table 3 Cross-correlation

	MV	GDPCO	ROI	INV	BC
MV	1.00	− 0.74	0.28	− 0.78	− 0.68
GDPCO	− 0.74	1.00	− 0.14	0.99	0.99
ROI	0.28	− 0.14	1.00	− 0.14	− 0.09
INV	− 0.78	0.99	− 0.14	1.00	0.98
BC	− 0.68	0.99	− 0.09	0.98	1.00

The dependent variables are broad money velocity, real GDP, rate of interest, investment and bank credit

the Indian economy witnessed two major recessions from 1999Q4 to 2003Q1 with a duration of 13 quarters and from 2007Q3 to 2009Q2 with a duration of 7 quarters, for which the amplitude and duration of the deceleration phase is comparatively higher than the other deceleration phases. The deceleration witnessed from 2010Q4 to 2013Q3 also has high amplitude with a duration of 11 quarters. After this the

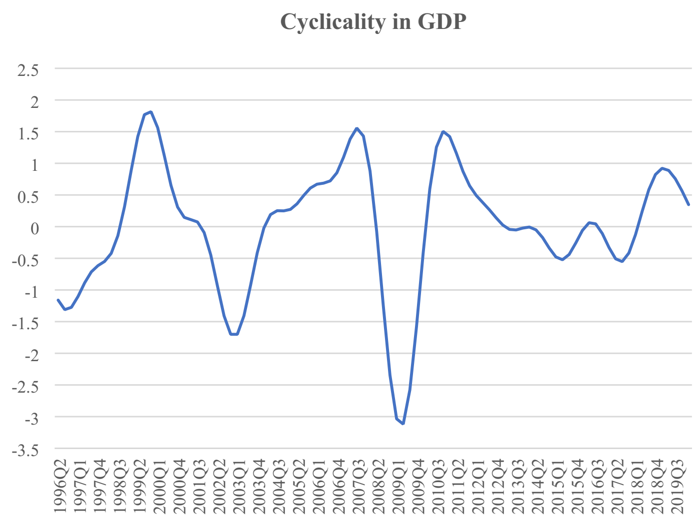

Fig. 7 Cyclicality in GDP. The cycles have been estimated for real GDP velocity extracted using Full Sample Asymmetric Christiano–Fitzgerald filter

Table 4 Dates of cyclical changes in GDP

Phase	Start	End	Duration	Amplitude
Deceleration	1999q4	2003q1	13	− 3.52
Acceleration	2003q1	2007q3	18	3.26
Deceleration	2007q3	2009q2	7	− 4.68
Acceleration	2009q2	2010q4	6	4.62
Deceleration	2010q4	2013q3	11	− 1.56
Acceleration	2013q3	2014q1	2	0.05
Deceleration	2014q1	2015q2	5	− 0.52
Acceleration	2015q2	2016q2	4	0.58
Deceleration	2016q2	2017Q3	5	− 0.61
Acceleration	2017Q3	2019Q1	6	1.47
	Average acceleration		**7.2**	**2.00**
	Average deceleration		**8.2**	**− 2.18**

Bold values indicate the duration and amplitude of average acceleration and average deceleration

The cycles have been estimated for real GDP

Indian economy faced two deceleration phases, but the amplitude and duration both are small.

The Indian economy witnessed two major accelerations from 2003Q1 to 2007Q3 with a duration of 18 quarters and from 2009Q2 to 2010Q4 with a duration of 6 quarters, for which the amplitude of the acceleration phase is comparatively higher than the other acceleration phases. The acceleration witnessed from 2017Q3 to 2019Q1 also has high amplitude and a duration of 6 quarters. Other than these the Indian economy faced two acceleration phases, but the amplitude and duration both are small.

5.2 Extraction of cyclicality in money velocity and its determinants

The cyclical components of all the variables included in the study have been extracted by applying Full Sample Asymmetric Christiano–Fitzgerald filter. After this the cyclical

Table 5 Standardized cyclical amplitudes of real GDP, money velocity, rate of interest, investment and bank credit

Phase	Start	End	Duration	Amplitude				
				GDP	MV	ROI	INV	BC
Deceleration	1999q4	2003q1	13	− 3.52	− 2.50	− 0.10	− 3.22	− 1.12
Acceleration	2003q1	2007q3	18	3.26	1.95	0.95	2.80	1.36
Deceleration	2007q3	2009q2	7	− 4.68	− 3.40	− 2.26	− 4.15	− 2.19
Acceleration	2009q2	2010q4	6	4.62	4.45	1.54	2.93	0.25
Deceleration	2010q4	2013q3	11	− 1.56	− 1.09	0.82	0.26	1.95
Acceleration	2013q3	2014q1	2	0.05	− 0.49	− 0.32	− 0.41	− 0.13
Deceleration	2014q1	2015q2	5	− 0.52	− 1.21	− 0.81	− 1.13	− 0.85
Acceleration	2015q2	2016q2	4	0.58	0.18	− 0.78	0.79	− 0.46
Deceleration	2016q2	2017Q3	5	− 0.61	1.85	0.63	− 0.58	− 1.03
Acceleration	2017Q3	2019Q1	6	1.47	0.15	2.74	2.47	1.85
	Average Acceleration		**7.2**	**2.00**	**1.25**	**0.83**	**1.72**	**0.57**
	Average Deceleration		**8.2**	**− 2.18**	**− 1.27**	**− 0.34**	**− 1.76**	**− 0.65**

The cycles have been estimated for real GDP, broad money velocity, rate of interest, investment and bank credit velocity extracted using Full Sample Asymmetric Christiano–Fitzgerald filter

Table 6 Correlation analysis (standardized cyclical components)

	Money velocity	Real GDP	Rate of interest	Investment	Bank credit
Money velocity	1.0000	0.7865	0.4899	0.8052	0.2254
Real GDP	0.7865	1.0000	0.5487	0.8381	0.3098
Rate of interest	0.4899	0.5487	1.0000	0.5569	0.6277
Investment	0.8052	0.8381	0.5569	1.0000	0.4304
Bank credit	0.2254	0.3098	0.6277	0.4304	1.0000

The correlation has been estimated for the standardized cyclical components of real GDP, broad money velocity, rate of interest, investment and bank credit

components have been standardized to facilitate comparison amongst different variables. Table 5 provides the standardized cyclical amplitude of all the variables included in the study.

6 Relationship between cyclicality in money velocity and its determinants

6.1 Correlation analysis

Correlation analysis has been undertaken to compare the cyclicality in money velocity and its determinants by calculating the correlation coefficient between the standardized cyclical component of money velocity and standardized cyclical component of the determinants. The results are presented in Table 6.

The results show that there is strong positive correlation between standardized cyclical component of money velocity and standardized cyclical component of real GDP and investment. Also, there is positive correlation between standardized cyclical component of money velocity and standardized cyclical component of interest rate. However, the correlation between standardized cyclical component of money velocity and standardized cyclical component of bank credit is weak. Thus, it may be concluded from correlation analysis that there is pro-cyclicality between money velocity and real GDP, investment and rate of interest.

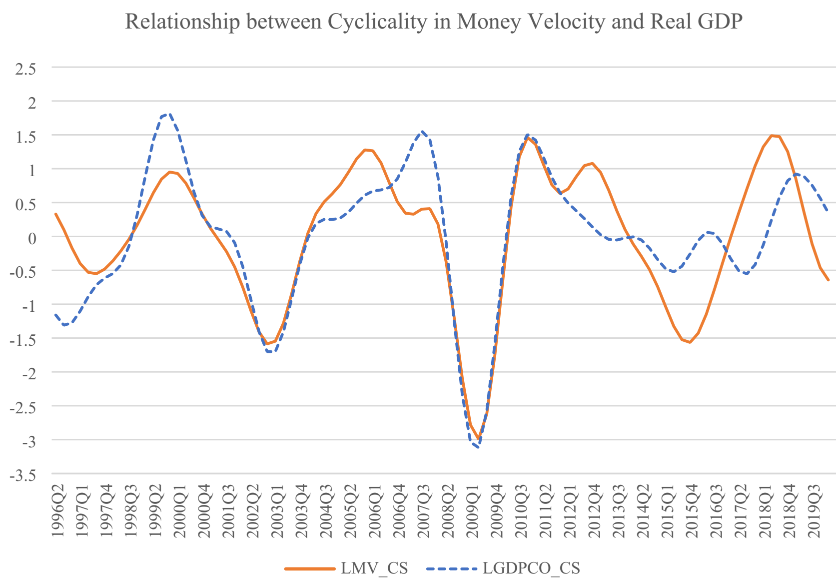

Fig. 8 Relationship between cyclicality in money velocity and real GDP. The relationship has been shown for the cyclical components of broad money velocity and real GDP

6.2 Graphical analysis

The cyclicality of money velocity with other determinants has been analysed as follows.

6.2.1 Cyclicality in money velocity and real GDP

Figure 8 presents the standardized cyclical components of log of real GDP and log of money velocity. It may be seen that money velocity clearly exhibits pro-cyclicality especially when the amplitude of cyclicality in real GDP was high spanning from 1997Q2 to 2011Q4. After 2013Q3 the amplitude and duration of cyclicality in real GDP is much smaller. During this time money velocity is not following the same cyclical pattern as real GDP.

6.2.2 Cyclicality in money velocity and rate of interest

Figure 9 presents the standardized cyclical components of rate of interest and log of money velocity. It may be seen that money velocity and rate of interest both are following a similar pro-cyclical pattern after 2003Q2. There is a clear lead lag relationship between the two variables. The cyclical component of money velocity precedes the cyclical component of rate of interest. It may be concluded that there is a short-run causality running from money velocity to rate of interest.

6.2.3 Cyclicality in money velocity and investment

Figure 10 presents the standardized cyclical components of log of real investment and log of money velocity. It may be seen that the cyclical components of money velocity and real investment move together over time. It may be seen that the cyclical components of real investment and money velocity are showing similar movement till

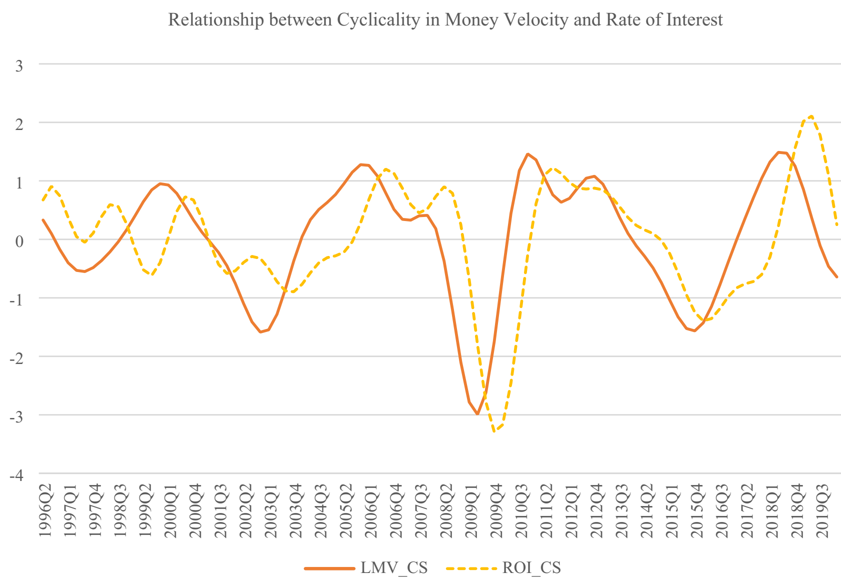

Fig. 9 Relationship between cyclicality in money velocity and rate of interest. The relationship has been shown for the cyclical components of broad money velocity and rate of interest

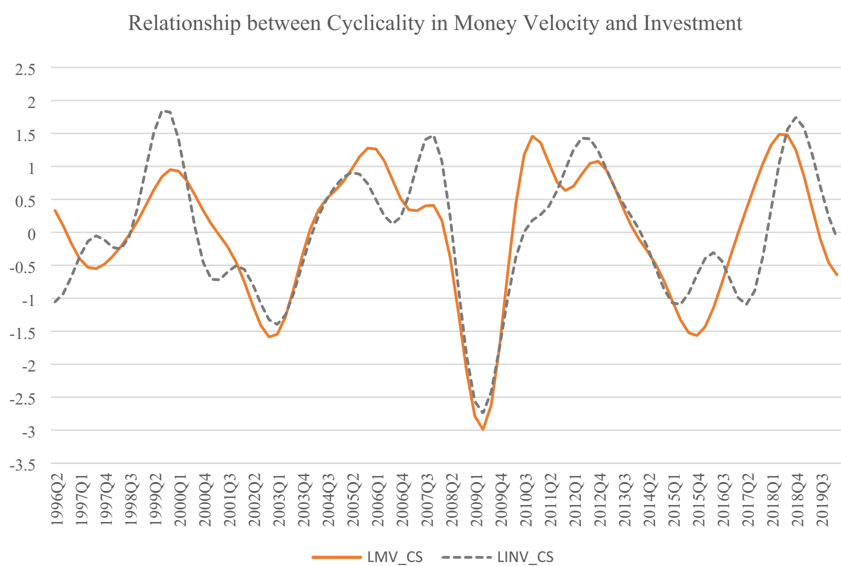

Fig. 10 Relationship between cyclicality in money velocity and investment. The relationship has been shown for the cyclical components of broad money velocity and investment

2015Q1. They show slightly different cyclical patterns from 2015Q2 to 2016Q4. After this again there is similar cyclical pattern, but with some lag in investment.

6.2.4 Cyclicality in money velocity and bank credit

Figure 11 presents the standardized cyclical components of log of bank credit and log of money velocity. It may be seen that money velocity and bank credit both are following a pro-cyclical pattern, but there is a lead lag relationship between the two. The cyclical component of money velocity precedes the cyclical component of bank credit with some

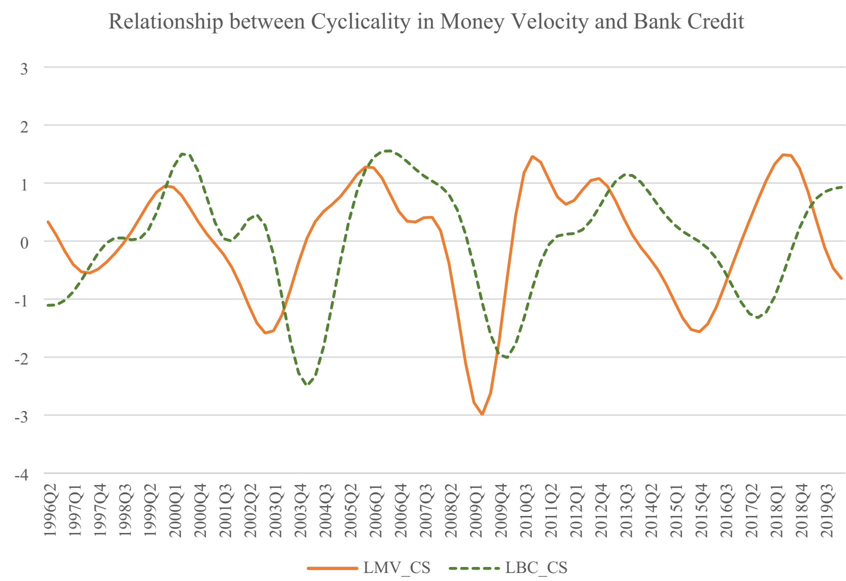

Fig. 11 Relationship between cyclicality in money velocity and bank credit. The relationship has been shown for the cyclical components of broad money velocity and bank credit

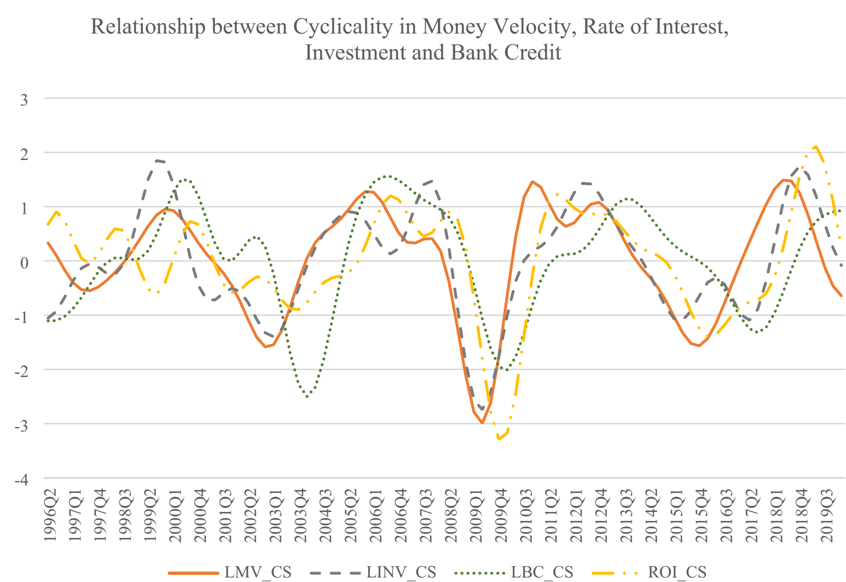

Fig. 12 Relationship between cyclicality in money velocity, rate of interest, investment and bank credit. The relationship has been shown for the cyclical components of broad money velocity, real GDP, rate of interest, investment and bank credit

lag. It may be concluded that there is a short-run causality running from money velocity to bank credit.

Figure 12 presents the standardized cyclical components of log of money velocity, rate of interest, log of real investment and log of bank credit together in one graph.

The above analysis shows that there is pro-cyclicality in all the variables included in the study. Money velocity exhibits closest cyclical movement with investment followed by GDP. There is a lead lag relationship between cyclicality in money velocity and rate of interest and money velocity and bank credit. It may be concluded that short-run causality runs from money velocity to rate of interest and from money velocity to bank credit. Therefore, it may be concluded that money velocity is an important policy variable.

6.3 Regression analysis

Regression analysis has been undertaken to examine the short-run determinants of money velocity and assess the causality amongst such variables.

6.3.1 Unit root testing

To finalize the methodology to be used for estimating the regression model, augmented Dickey–Fuller test and Phillips–Perron test have been performed to test for unit roots. If all the variables are found to be stationary or in other words integrated of order zero then simple linear regression model would have been the appropriate methodology. If instead all the variables are found to be non-stationary at levels but stationary at first difference or in other words integrated of order one, then error correction model would have been the appropriate methodology. However, if the variables are a mix of I(0) and I(1) the appropriate methodology is ARDL.

The results of the ADF test and PP test are presented in Table 7. The results of the ADF test show that the null hypothesis of unit root is rejected for roi. Hence, roi variable is stationary, i.e. I(0). For the variables lmv, lgdp, linv and lbc the ADF test fails to reject the null hypothesis for unit root at 5 per cent level of significance. Further, the ADF test for the first difference of these variables indicates that null hypothesis of unit root is rejected at 1 per cent level of significance and thus they are all stationary at first difference, i.e. I(1).

The results of the PP test show that the null hypothesis of unit root is rejected for roi at 1 per cent level of significance. Hence, the variable roi is stationary, i.e. I(0). For the variables lmv, lgdp, linv and lbc the PP test fails to reject the null hypothesis for unit root at 5 per cent level of significance. Further, the PP test for the first difference of these variables indicates that null hypothesis of unit root is rejected at 1 per cent level of significance and thus they are all stationary at first difference, i.e. I(1).

Both the test results indicate that the variables included in the study are a mixture of I(0) and I(1) variables. Therefore, ARDL methodology has been utilized for conducting regression analysis.

6.3.2 Structural break

The next step has been to test for any structural breaks in the dependent variable money velocity. If structural breaks present in the dependent variable are not accounted for, the model may suffer from the problem of structural instability. For this purpose, Chow test, Quandt–Andrews unknown breakpoint test and Bai–Perron multiple breakpoint test have been conducted. The results are presented in Table 8.

All three tests indicate that there is a structural break in money velocity at 2002Q2. A dummy variable *dummy* is added to the model to account for this break which takes the value 0 before 2002Q2 and 1 from this date onwards.

Table 7 Unit root tests

Variable		Drift only	Drift and trend	Order of Integration
Augmented Dickey–Fuller test				
LMV	Level	− 4.7102***	− 1.6203	I(1)
	First difference	− 7.7018***	− 9.1001***	
LGDP	Level	0.6344	− 2.5153	I(1)
	First difference	− 8.6602***	− 8.6289***	
ROI	Level	− 3.4273**	− 3.4236*	I(0)
	First difference	− 9.9003***	− 9.8545***	
LINV	Level	− 1.5634	− 0.2072	I(1)
	First difference	− 9.6032***	− 10.0226***	
LBC	Level	− 2.4464	0.3112	I(1)
	First difference	− 7.8272***	− 8.3214***	
Phillips–Perron test				
LMV	Level	− 4.6071***	− 1.6203	I(1)
	First difference	− 7.8954***	− 9.1001***	
LGDP	Level	0.5091	− 2.6708	I(1)
	First difference	− 8.7510***	− 8.7229***	
ROI	Level	− 3.6287***	− 3.6257**	I(0)
	First difference	− 11.0461***	− 11.0239***	
LINV	Level	− 1.566	− 0.1557	I(1)
	First difference	− 9.6162***	− 10.0200***	
LBC	Level	− 2.2282	0.1623	I(1)
	First difference	− 7.8595***	− 8.2736***	

*** 1%, ** 5%, *** 10%, test statistic for ADF test for drift and trend at 1%, 5% and 10% are − 4.0586, − 3.4583 and − 3.1152, t-statistic for drift only at 1%, 5% and 10% are − 3.5014, − 2.8925 and 2.5834

Test statistic for PP test for drift and trend at 1%, 5% and 10% are − 4.0597, − 3.4589 and − 3.1555, t-statistic for drift only at 1%, 5% and 10% are − 3.5022, − 2.8929 and − 2.5835

Table 8 Structural breaks test

Chow breakpoint test at 2002Q2			
F-statistic	**331.0989**	**Prob. F(2,46)**	**0**
Log likelihood ratio	144.1499	Prob. Chi-Square(2)	0
Quandt–Andrews unknown breakpoint test (number of breaks compared: 66)			
Statistic	**Value**	**Prob.****	
Maximum LR F-statistic (2002Q2)	331.0989	0	
Maximum Wald F-statistic (2002Q2)	331.0989	0	
Bai-Perron multiple breakpoint tests			
Break test	**F-statistic**	**Scaled F-statistic**	**Critical value*****
0 vs. 1	331.0989	331.0989	8.58
1 vs. 2	104.1655	104.1655	10.13
2 vs. 3	2.4658	2.4658	11.14
Break dates	**Sequential**	**Repartition**	
1	**2002Q2**	2000Q4	
2	2007Q3	2007Q3	

** represent probabilities calculated using Hansen's (1997) method, *** represent Bai–Perron critical values

Table 9 ARDL bounds test for co-integration

Test statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.5676***	10%	2.2	3.09
k	4	5%	2.56	3.49
		1%	3.29	4.37

*** 1%, ** 5%, * 10%. The asymptotic critical values reported in the table are based on the critical values suggested by Pesaran et al. (2001)

6.3.3 ARDL bounds test

Since the variables are found to be a combination of I(0) and (1) the study adopted the ARDL framework given by Pesaran and Shin (1995, 1999) and Pesaran et al. (2001) to conduct the empirical analysis.

To examine the short-run dynamics amongst the variables included in the model within the ARDL framework, firstly bounds test for co-integration has been applied to assess if there is any long-run relationship amongst the variables. For this purpose, the conditional error correction (EC) version of the ARDL model has been estimated using ordinary least squares and an F-test has been conducted for testing the joint significance of the coefficients of the lagged levels of the variables (Pesaran et al. 2001). The model is specified in Eq. (1):

$$\begin{aligned}\Delta \mathrm{lmv}_t = {} & \alpha + \beta_1 \Delta \mathrm{lmv}_{t-1} + \beta_2 \Delta \mathrm{lgdp}_{t-1} + \beta_3 \Delta \mathrm{roi}_{t-1} \\ & + \beta_4 \Delta \mathrm{linv}_{t-1} + \beta_5 \Delta \mathrm{lbc}_{t-1} + \sum \gamma_{1i} \Delta \mathrm{lmv}_{t-i} + \sum \gamma_{2i} \Delta \mathrm{lgdp}_{t-i} \\ & + \sum \gamma_{3i} \Delta \mathrm{roi}_{t-i} + \sum \gamma_{4i} \Delta \mathrm{linv}_{t-i} + \sum \gamma_{5i} \Delta \mathrm{lbc}_{t-i} + e_t,\end{aligned} \quad (1)$$

where mv is money velocity, lgdp is log of real GDP, roi is call money rate, linv is log of investment and lbc is log of bank credit.

The null and alternate hypotheses for the bounds test are given as follows:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ against the alternative.

H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$.

The F-statistic obtained from this test will refer to the critical values which consist of a lower bound as well as an upper bound. If the F-statistic exceeds (lower than) the upper bound, the null hypothesis is rejected (accepted), and the test is significant (insignificant). If the F-statistic falls between the bounds, the test is inconclusive (Pesaran et al 2001). The calculated F-statistic for the model is displayed in Table 9.

The results show that the calculated F-statistic value of 4.5676 exceeds the upper bound at 1 percent level of significance, therefore, the null hypothesis of no co-integration is rejected. Thus, the test result suggests that there is a long-run relationship amongst money velocity, real GDP, rate of interest, investment and bank credit at 1 percent level of significance.

6.3.4 ARDL-ECM model

Following the co-integration bounds test, the error correction term (ECT) is estimated. The ARDL-ECM (4,1,2,1,1) is chosen using AIC lag selection criteria. The results are presented in Table 10.

Table 10 ARDL-ECM (4,1,2,1,1)

Variable	Coefficient	Prob
D(LMV(-1))	0.1052	0.1764
D(LMV(-2))	− 0.0035	0.9615
D(LMV(-3))	− 0.1860	0.0109**
D(LGDPCO)	0.8051	0.0000***
D(ROI)	0.0028	0.0028***
D(ROI(− 1))	0.0017	0.0353**
D(LINV)	0.1603	0.006***
D(LBC)	− 0.1994	0.0004***
DUMMY	− 0.0049	0.0865*
ECT(− 1)[a]	− 0.0609	0.0000***
R-squared	**0.6146**	
Adjusted R-squared	**0.5723**	

*** 1%, ** 5%, *** 10%, ECT is the error correction term

[a] The error correction term (ECT) represents the speed at which the variables in the model return to equilibrium after a shock or disturbance. It is a measure of the long-run relationship between the variables in the model

The first part of the results shows the estimated coefficients of short-run dynamics and the second part shows the estimate of the error correction term (ECT) that measures the speed of adjustment whereby short-run dynamics converge to the long-run equilibrium path in the model.

The short-run coefficient of real GDP is positive and highly significant at 1 per cent level of significance. This result is in line with a priori expectation. The results indicate that the real income elasticity of money demand is less than 1 in India.

Both the short-run coefficients of rate of interest are positive and significant at 1 per cent and 5 per cent level of significance, respectively. This result is in line with a priori expectation. A positive coefficient indicates that as rate of interest rises, opportunity cost of holding money also rises, leading to fall in money demand and rise in money velocity.

The short-run coefficient of investment is positive and highly significant at 1 per cent level of significance. This result is in line with a priori expectation since both the variables are expected to exhibit pro-cyclical behaviour.

The short-run coefficient of bank credit is negative and highly significant at 1 per cent level of significance. A negative coefficient indicates that in Indian economy interest rate conditions are generally not favourable in times of economic expansions. A high rate of interest during economic expansions leads to lower bank credit thereby leading to a negative coefficient for bank credit in money velocity model (since money velocity exhibits pro-cyclical behaviour).

The coefficient of dummy variable for structural break in 2002Q2 is negative and significant at 10 per cent level of significance indicating that there was a structural break in money velocity in 2002Q2. The rate of decline in money velocity was high from 1996Q2 to 2002Q1. Although money velocity continued to follow a decreasing trend from 2002Q2, the rate of decline has been lesser. After 2009Q1, money velocity is seen to become stable.

The error correction term is negative and highly significant at 1 per cent level of significance. This result is in line with the result of the bounds test in Table 7 which also

Table 11 Diagnostic tests

Test name	Statistic [p-value]
BG serial correlation LM test	0.3995 [0.6720]
BPG heteroskedasticity test	19.161 [0.1182]
Jarque–Bera test	13.6243 [0.0011]
RESET test	1.5976 [0.1141]

Diagnostic tests for model with dependent variable broad money velocity and independent variables real GDP, rate of interest, investment and bank credit

indicated that all the variables in this model are co-integrated. The coefficient of adjustment of − 0.06 indicates the rate of convergence to equilibrium. The estimated value of the coefficient implies that about 6 per cent of the disequilibrium in money velocity caused in the previous time period is offset by the short-run adjustment in the current time period. This rate is low since the model estimated mainly comprises short-run or cyclical determinants of money velocity. The adjusted R-squared for the model is 57.2 per cent signifying that 57.2 per cent of the variation in money velocity is explained by the model.

6.3.5 Diagnostic tests

The results are further subjected to several diagnostic tests. The econometric tools employed included Breusch–Godfrey serial correlation LM test for serial correlation, Breusch–Pagan–Godfrey test for heteroscedasticity, Jarque–Bera test for normality and Ramsey RESET test for specification errors, respectively (Greene 2008; Gujarati and Sangeetha 2007). The results are presented in Table 11.

The results imply that there is no higher order serial correlation in the models and they are free from presence of heteroscedasticity. The RAMSEY test for misspecification did not reject the null hypothesis of no misspecification. Thus, the functional form of the models is appropriate. However, the residuals are not normally distributed. This may not constitute a problem since the data set comprises 100 observations.

6.3.6 Stability of money velocity model

The model is tested for structural stability by applying CUSUM and CUSUMSQ tests. The results are presented in Fig. 13. The model is structurally stable since both CUSUM and CUSUMSQ do not fall outside the 5 percent significance boundaries.

6.3.7 Actual, fitted and residual

The estimated ARDL-ECM Model is fitted against the money velocity historical data. The plot of actual, fitted and residual values is presented in Fig. 14. The model performs well in terms of tracking the long-run and short-run movement of money velocity in India.[8]

[8] The spike in residuals in 2016 corresponds to the demonetization in November 2016.

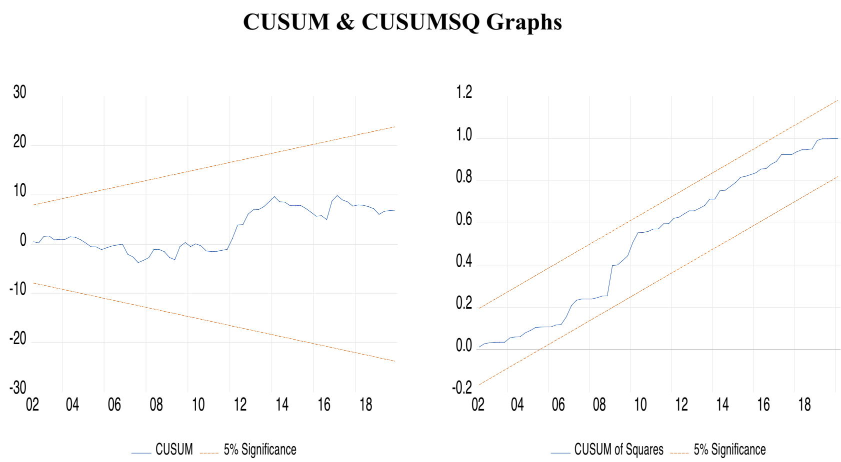

Fig. 13 CUSUM and CUSUMSQ Graphs. CUSUM and CUSUM square for model with dependent variable broad money velocity and independent variables real GDP, rate of interest, investment and bank credit

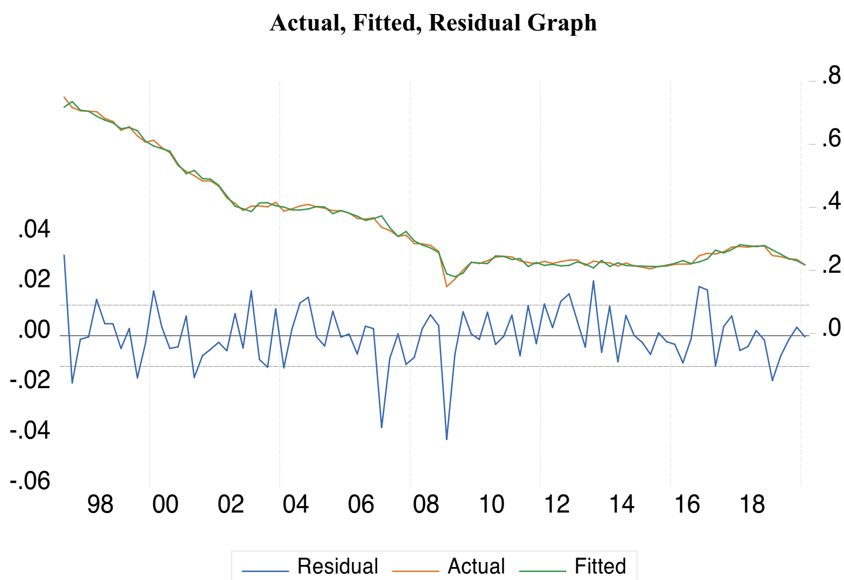

Fig. 14 Actual, fitted, residual graph. Actual, fitted, residual graph for model with dependent variable broad money velocity and independent variables real GDP, rate of interest, investment and bank credit

6.3.8 Toda–Yamamoto–Granger causality analysis

Co-integration of the variables in the money velocity model indicates that there may be a causal relationship amongst these variables. Toda and Yamamoto (1995) developed a technique to examine Granger causality amongst variables that have different order of integration. The method comprises estimation of augmented VAR model with (p + d) lags, where p is the optimal lag for the VAR model with levels data and d is the maximum order of integration of the variables included in the model.

The results of Toda–Yamamoto–Granger causality test are presented in Table 12. The results may be summarized as follows:

Table 12 Toda–Yamamoto–Granger causality test

Excluded	Chi-sq	df	Prob.	Direction of causality
Dependent variable: LMV				
LGDPCO	4.82	5	0.438	
ROI	10.14	5	0.0715*	
LINV	3.85	5	0.5709	
LBC	2.53	5	0.7722	
All	30.12	20	0.0679*	
Dependent variable: ROI				
LMV	19.20	5	0.0018***	LMV- > ROI
LGDPCO	7.22	5	0.205	
LINV	3.26	5	0.6607	
LBC	8.30	5	0.1404	
All	37.49	20	0.0102**	
Dependent variable: LINV				
LMV	12.53	5	0.0283**	LMV- > LINV
LGDPCO	6.01	5	0.3057	
ROI	12.13	5	0.0331**	ROI- > LINV
LBC	5.48	5	0.3607	
All	37.41	20	0.0104**	
Dependent variable: LBC				
LMV	4.94	5	0.4228	
LGDPCO	4.95	5	0.4223	
ROI	5.29	5	0.381	
LINV	7.39	5	0.1929	
All	38.26	20	0.0082	
Dependent variable: LGDPCO				
LMV	15.01	5	0.0103**	LMV- > LGDPCO
ROI	16.68	5	0.0051***	ROI- > LGDPCO
LINV	7.64	5	0.1773	
LBC	12.18	5	0.0324**	LBC- > LGDPCO
All	43.75	20	0.0016***	

***1%, **5%, ***10%

Toda–Yamamoto–Granger Causality test for model with dependent variable broad money velocity and independent variables real GDP, rate of interest, investment and bank credit

1. Money velocity Granger causes rate of interest at 1 per cent level of significance.
2. Rate of interest and money velocity Granger causes investment at 5 per cent level of significance.
3. Rate of interest, money velocity and investment Granger causes real GDP at 5 per cent level of significance.

Thus, it may be concluded that the direction of causality runs from money velocity to rate of interest to investment to real GDP. Bank credit does not play any significant role in the causal analysis.

This result leads to a very important conclusion that it is money velocity that causes rate of interest and not rate of interest that causes money velocity in the short-run. Similar result has been obtained from the graphical analysis in Fig. 10, which showed that there is a lead lag relationship between the cyclical components of money velocity and rate of interest whereby the direction of causality runs from money velocity to rate of interest.

7 Summary and conclusion

The study examines the cyclical nature of money velocity and assesses its cyclical determinants using correlation analysis, graphical analysis and regression analysis. The chapter further examines the direction of causality amongst the variables included in the model. The empirical analysis has been conducted using quarterly data from 1996Q2 to 2020Q1.

The study establishes that when short-run cyclical factors are accounted for, money velocity function becomes stable and therefore monetary aggregates can be used to conduct effective monetary policy. The study further reveals that money velocity exhibits pro-cyclical behaviour, and the direction of causality among its cyclical determinants follows a sequence from money velocity to interest rate to investment to real GDP.

Thus, an upward trend in cyclical money velocity suggests a potential increase in investment and real GDP, indicating the onset of an expansionary phase. Conversely, a downward trend in cyclical money velocity suggests a potential decrease in investment and real GDP, indicating the onset of a contractionary phase. Thus, one important implication of the present study is that while formulating monetary and fiscal policies, policymakers can monitor the short-term cyclical patterns in money velocity as an indicator of forthcoming expansionary or contractionary conditions in the economy to design effective policies.

Abbreviations

ADF	Augmented Dickey–Fuller
AIC	Akaike information criteria
ARDL	Auto-regressive distributive lag
ARDL-ECM	Auto-regressive distributive lag error correction model
CUSUM	Cumulative sum
CUSUMSQ	Cumulative sum of squares
ECM	Error correction model
ECT	Error correction term
GDP	Gross domestic product
LM	Lagrange multiplier
NBER	National Bureau of Economic Research
PP	Phillips–Perron
RESET	Regression equation specification error test
VAR	Vector auto-regressive

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Data availability
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Declarations

Competing interests

The author has no competing interests to declare that are relevant to the content of the present study.

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