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Money, Output and Prices in India

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Abstract

The dynamics of the monetary system is undergoing significant changes in India. The entire concept and flow of money; narrow, broad or base, is being influenced by measures related to financial inclusion and also behavioural changes with respect to the increase in usage of plastic money and other payment methods. Given this context, the paper aims to re-examine relationship between money supply, output and prices in the short and long-term. Different metrics for money, output and prices are used to understand the relationship between each. Variables to understand food inflation is especially used considering the fact that food prices are less income elastic and are viewed differently by citizens. The findings indicate that the relationship is sensitive to the choice of variable.

Keywords: Granger Causality, Johansen Test, Money Supply, Industrial Production, Price Indices.

Introduction

The causality, direction and strength of relationship between money, output and prices has always been a frequently debated topic among policy makers. This issue deserves this attention because it reveals implications of monetary policy. The relationship between these variables has been a debated widely among different schools of thought of economics. The Monetarists claim that money plays an important role and leads to changes in nominal income and prices. The Keynesians, on the other hand, argue that stock of money supply does not play an active role in changing the income and prices.

In terms of business cycles, there are two theories that oppose each other regarding the direction of causation between money and output. The monetary business cycle theory argues that changes in growth of the money stock cause changes in output growth. The real business cycle theory argues that the observed correlation between money and income is because of endogenous response of the money supply to fluctuations in income rather than directly causing it.

The recent growth of financial markets with technology aiding faster transactions, and diverse and growing financial services make the stability of the relationship among money, output and prices vital for devising appropriate monetary policy. These developments require investigation in the current scenario of a dynamic monetary conditions.

This paper aims to re-examine the causality relationship between money, output and prices in the Indian context. The empirical analysis will deal with metrics for monetary aggregates, prices and output. Some empirical studies in India have established Cointegration and causal relationship between money supply and prices. The hypothesis that is being investigated in this paper is, whether higher money supply is causing an increase in output and prices. The hypothesis also tests for the effect of change in output on prices and money supply and effect of change in prices on output and money supply. In brief, the relationship is being estimated between variables representing money, output and prices.

The plan of the paper is as follows. Following the section of introduction, Section II gives a brief review of the existing literature on relationship between money, output and prices in the Indian context. Section III discusses the methodology used to estimate the causal relationship between various variables from the available data used in this study. Section IV explains the variables used for the analysis, Section V presents the key results and findings related to money, output and prices. Section VI draws conclusions from the findings.

Section II: Brief Review of Literature

The link between money, output and prices has been the subject of much investigation. A detailed review of literature is presented in Singh (1999). In the case of India, Ramachandra (1983) checked for neutrality of money in India. Using annual data, he found that money causes real income and price level, price level causes real income, and nominal income causes money. Sharma (1984) checked for causality between price level, and M1 and M2 using Granger and Sims technique for the period 1962-1980 and established bidirectional causality between M1 and price level and M2 and price level. He found the causality from M1 to price level stronger than the causality from price levels to M1. An elaborate causality study on money-output-prices in India was conducted by Nachane and Nadkarni (1985). Their study spanning over the period of 1960-61 to 1981-82 found unidirectional causality from money stock to prices but, as far as money supply affecting real output was concerned, the results were inconclusive.

Singh (1990) found that causality between money supply and prices runs in both directions though the causation from wholesale price towards the money supply is much more significant as compared to the causation from the money supply towards the prices. The causality test performed using annual time series data from 1951-52 to 2000-01 by Ramachandran (2004) established an overall long term relationship between money, income and prices. The results also showed that there was a bi-directional causality between M3 and prices. Real income neither Granger caused prices and money nor was Granger caused by prices and money. Rami (2010) checked for causality between money, prices and output in India for the period 1951-2005 using the Granger approach. He found that there was unidirectional granger causality from WPI to M1 and M3, from M1 to GDP and bidirectional causality between M3 and GDP. Singh (1999) using annual data from 1951 to 1995 and quarterly data from 1971 to 1995 found that there was a feedback relationship of M1 and M3 with prices; M0, M1 and M3 Granger caused prices.

Das (2003) attempted to study the long-run and short-run causal relationship between money, output and price and found no Cointegration and therefore, no long run relationship between them. He found that money had a positive effect on price and there is a feedback between money and price and also between output and price. Mishra (2010) using the annual data from the period 1950-51 to 2008-09 found bi-directional causality between money supply and output, but unidirectional causalities from price to money supply, and price to output. He also found short-run bidirectional causality between money and price and short-run causality from output to price. Sharma, Kumar and Hatekar (2010) used a bi-variate methodology developed by Lemmens et al (2008). The authors found that there was evidence for a trade-off between money and output over the short -run, but in the long run, only money supply determined prices and not output. The results also show that output and prices did not Granger cause money supply reflecting exogenous nature of money supply.

Singh C (2015) adds another dimension to the debate by discussing the demographic pattern in different economies. A country would record a different relationship when there is a demographic transition. In a country with ageing population, the relationship would differ compared with a country having a young population.

Section III: Methodology

The study attempts to estimate relationship between money, output and prices. To estimate the relationship, Granger causality and Cointegration tests have been conducted. The following statistical tests were used.

Unit Root Test

The present study uses Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) unit root test to examine the stationarity of the data series. ADF consists of running a regression of the first difference of the series against the series lagged once, lagged difference terms and optionally, a constant and a time trend. This can be expressed as follows:

$$\Delta Y_t = \alpha_0 + \alpha_1 t + \alpha_2 Y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \varepsilon_t \qquad \ldots (1)$$

The additional lagged terms are included in the equation to ensure that the errors are uncorrelated. In this ADF procedure, the test for a unit root is conducted on the coefficient of Y_{t-1} in the regression. If the coefficient is significantly different from zero, then the hypothesis that Y_t contains a unit root is rejected.

Failure to reject the null hypothesis leads to conducting the test on the difference of the series, so further differencing is conducted until stationarity is reached and the null hypothesis is rejected. The series which is differenced only once for stationarity is said to be integrated of order 1.

The empirical distribution is always simulated under the assumption of a random walk with white noise residuals, ε ~ iid (0, σ2). In general, this is not the case, and ΔX_t is likely to have an ARMA representation. In this situation the autoregressive structure can be dealt with by augmenting the regression equation with lagged ΔX_t variables, such that $\hat{\varepsilon}_t$ in the regression model becomes white noise and the Dickey-Fuller distributions are valid. If ΔX_t contains a moving average process the situation is more complex. The augmentation is now at best viewed as an approximation. A solution is offered by Phillips and Perron (1988), who finds a non-parametric way of adjusting the estimated variance so that the tabulated distribution is valid. To test for the Unit Root hence both ADF and PP Tests are used.

Cointegration Test:

Once a unit root has been confirmed for a data series, the next step is to examine whether there exists a long-run equilibrium relationship among variables. This is called Cointegration analysis which is very significant to avoid the risk of spurious regression.

Engle and Granger's two-step procedure:

Engle and Granger (1987) formulated one of the first test of Cointegration (or common stochastic trends). In the co-integrating regression (the first step),

$$X_{1,t} = \beta_1 + \beta_2 X_{2,t} + .. + \beta_p X_{p,t} + u_t \qquad ... (2)$$

P is the number of variables in the equation. In this regression we assume that all variables are I (1) and might co-integrate to form a stationary relationship, and thus a stationary residual term $\hat{u}_t = X_{1,t} - \beta_1 - \beta_2 X_{2,t} - .. - \beta_p X_{p,t}$.

This equation represents the assumed economically meaningful (or understandable) steady state or equilibrium relationship among the variables. If the variables are co-integrating, they will share a common trend and form a stationary relationship in the long run, hence, the residuals of the regression shall be stationary.

Under the null of no Cointegration, the estimated residual is I (1) because $X_{1,t}$ is I (1), and all parameters are zero in the long run. Finding the lag length so that the residual process becomes white noise is extremely important. The empirical t-distribution is not identical to the Dickey-

Fuller, though the tests are similar. The reason is that the unit root test is now applied to a derived variable, the estimated residual from a regression. The critical values were obtained from Engle and Yoo (1987). The values obtained from the ADF and PP Test is compared with the critical values to test for Cointegration.

The Johansen test of Cointegration:

The Johansen method (J-test) applies the maximum likelihood procedure to determine the presence of co-integrated vectors in non-stationary time series. The testing hypothesis is the null of non-Cointegration against the alternative of existence of Cointegration using the Johansen maximum likelihood procedure.

To conduct J-test start with a VAR representation of the variables that are being investigated. The p-dimensional process, integrated of order d, $\{x\}_t \sim$ I(d), with the VAR representation, is as follows

$$A_k(L)x_t = \mu_0 + \Psi D_t + \varepsilon_t \qquad \dots (3)$$

The empirical VAR is formulated with lags and dummy variables so that the residuals become a white noise process. The first step is to transform all series to I(1) before setting up the VAR. By using the difference operator $\Delta = 1 - L$, or $L = 1 - \Delta$, the VAR in levels can be transformed to a vector error correction model (VECM),

$$\Delta X_t = \sum_{i=1}^{k-1} \tau_i \, \Delta X_{t-i} + \Pi X_{t-1} + \mu_0 + \Psi D_t + \varepsilon_t \qquad \dots (4)$$

The number of co-integrating vectors, are identical to the number of stationary relationships in the Π-matrix. If there is no Cointegration, all rows in Π must be filled with zeros. The rank of Π matrix determines the number independent rows in Π, and therefore also the number of co-integrating vectors. The rank of Π is given by the number of significant eigenvalues found in Π-hat. In this paper we test the null hypothesis of rank is equal to zero. If the critical value at a specific level of significance is less than the computed value then the null of no Cointegration is rejected at that level.

Granger Causality in Economics

There are various tests popularly employed to test for Granger causality in economics. These tests, surveyed in Pierce and Haugh (1977), can be basically categorized into three groups:

cross-correlation tests, cross-spectral tests and direct tests. In case of direct tests, three popular tests are given by Granger (1969), Sims (1972) and Geweke (1982). However, Guilkey and Salemi (1982) suggest that Granger's test is superior to the Sims' test, because of its computational simplicity and a smaller loss of degrees of freedom. Roberts and Nord (1985) argue that the results are sensitive to the functional form specification in a Sims' type of test. In this study the Granger's test is used to test causality.

This test is based on the procedure, not actually suggested but implicitly contained, in Granger (1969). This test is simple and therefore extensively used in empirical literature. The test can be briefly explained as follows. Let X_t and Y_t be two stationary time series with zero mean. The test then can be explained by the following model:

$$X_t = \sum_{j=1}^{m} \alpha_j X_{t-j} + \sum_{j=1}^{m} \beta_j Y_{t-j} + \varepsilon_t \qquad \ldots (5)$$

$$Y_t = \sum_{j=1}^{m} \delta_j X_{t-j} + \sum_{j=1}^{m} \gamma_j Y_{t-j} + \epsilon_t \qquad \ldots (6)$$

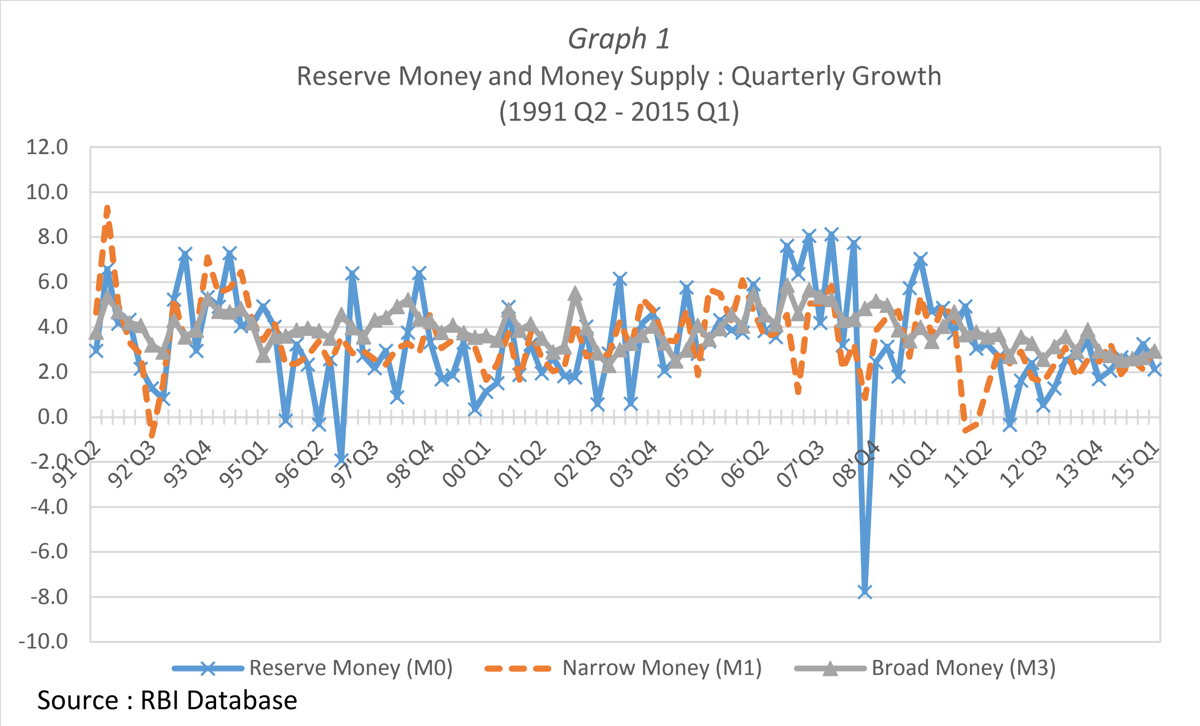
Where, the error terms, ε_t and ϵ_t are assumed to be uncorrelated. The lag term, m, is assumed to be finite and shorter than the time series. The test is sensitive to the lag length and Hsiao (1981) suggests a simple method to select the lag length. He suggests the solution to the lag selection problem through the use of Final Prediction Error (FPE) of Akaike (1969).

Section IV: Variables

Money Supply

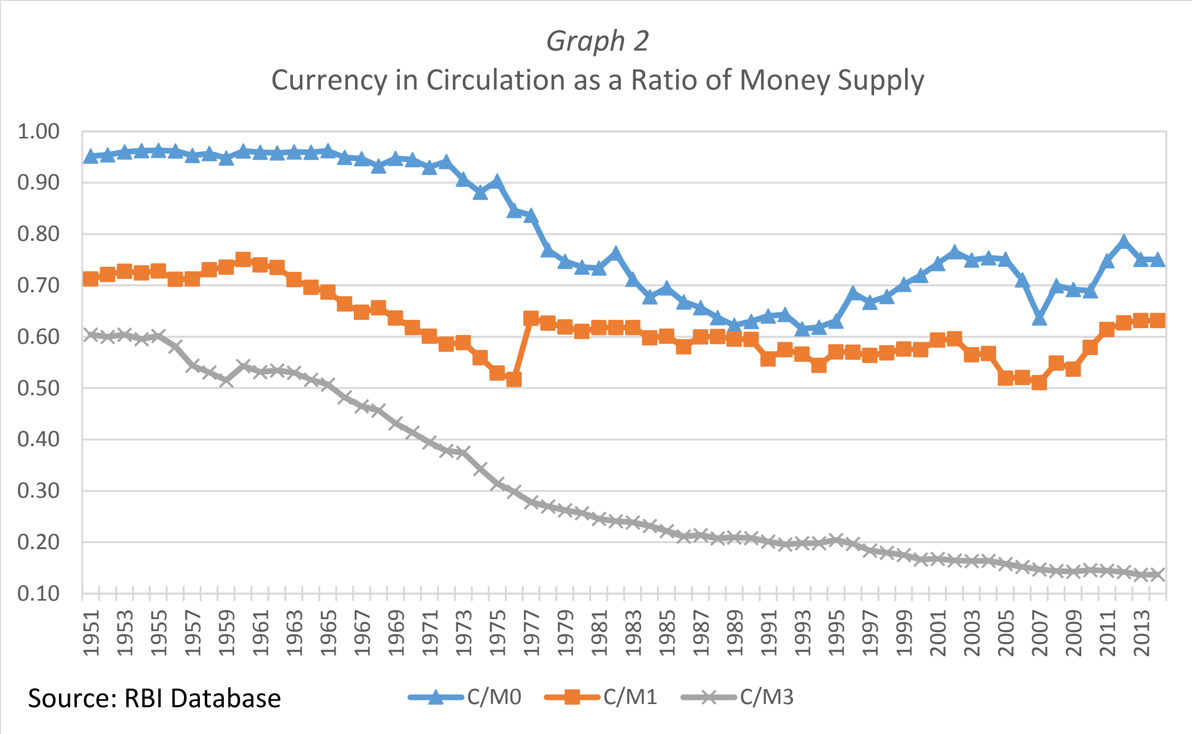
The money stock measures used in this paper are the reserve or base (M0), narrow (M1) and broad money (M3). Reserve or high-powered money constitutes of currency in circulation, Bankers' deposits with Reserve Bank of India (RBI) and 'Other' deposits with RBI. Demand deposits constitute a part of narrow money while time deposits are included in broad money. Graph 1 captures the annual growth percentage of the three measures of money supply.

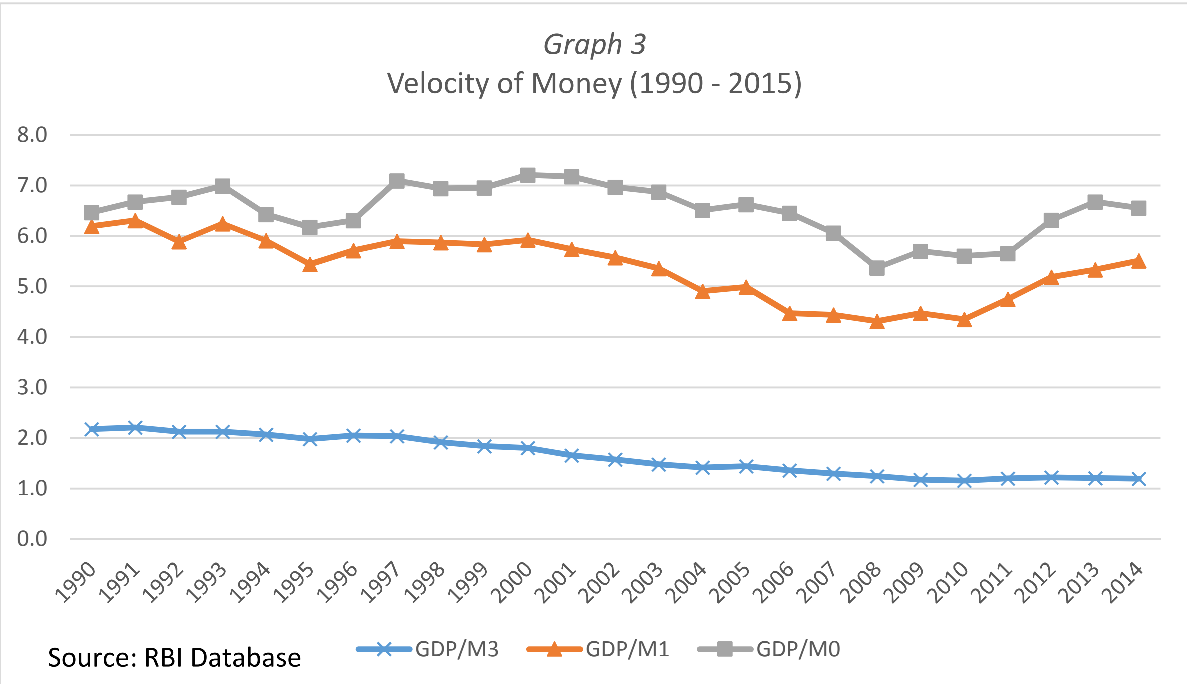
For this paper the focus has been on the post liberalization period, to avoid impact, if any, of the structural changes that were brought about in 1991 on the relationship between money supply and output.



As graph 1 shows that there is huge dip in the reserve money supply in 2008-09. Growth in reserve money during 2008-09 reflected the impact of monetary policy responses to the changing liquidity positions arising from domestic and global financial conditions. In terms of components, reserve money variation during 2008-09 was conditioned by the increase in currency in circulation and changes in cash reserve ratio (CRR) for banks. The RBI annual report specifies the need to use adjusted reserve money for analytical purposes. However, the data for adjusted reserve money is not available in the website limiting its usage for this research.

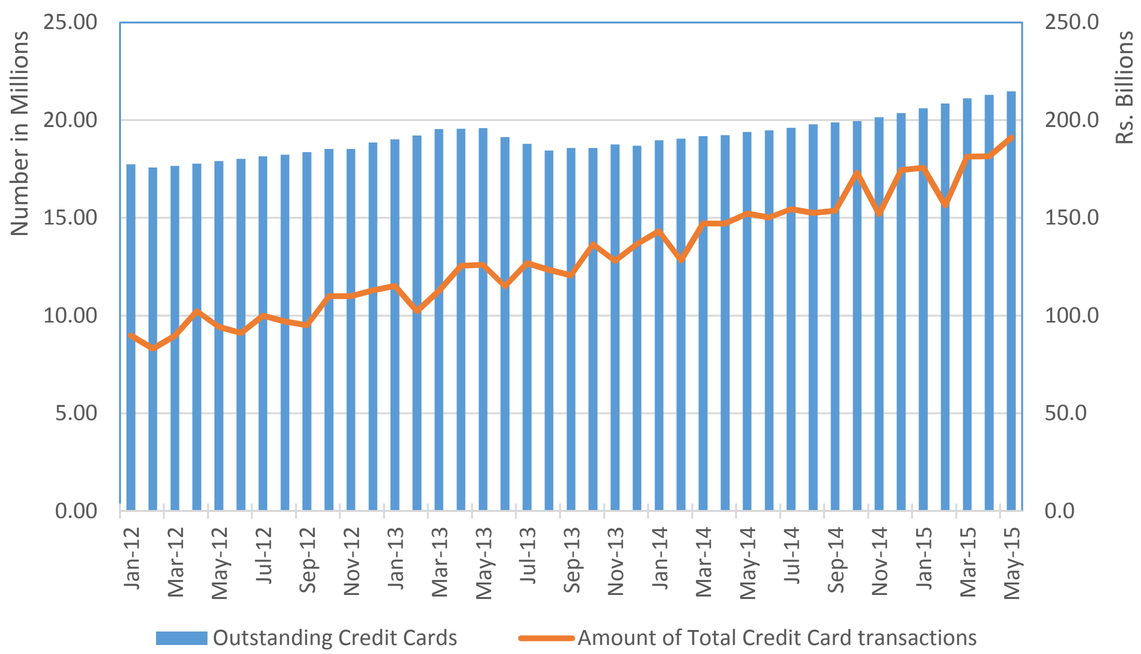
The recent explosion in credit and debit card services means that the way people are transacting have changed. It is important to explore whether it has had any significant impact on the velocity of transaction or the total currency in circulation. Graph 2 shows that the ratio of currency in circulation to narrow money or reserve money has increased in the last 7-8 years. The ratio of currency in circulation to broad money has remained almost the same for the given period. Graph 3 captures the velocity of money and it shows slight variation during the period 1990 to 2015.


Graph 2
Currency in Circulation as a Ratio of Money Supply
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
1951 1953 1955 1957 1959 1961 1963 1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013
Source: RBI Database
C/M0
C/M1
C/M3


Graph 3
Velocity of Money (1990 - 2015)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
Source: RBI Database
GDP/M3
GDP/M1
GDP/M0

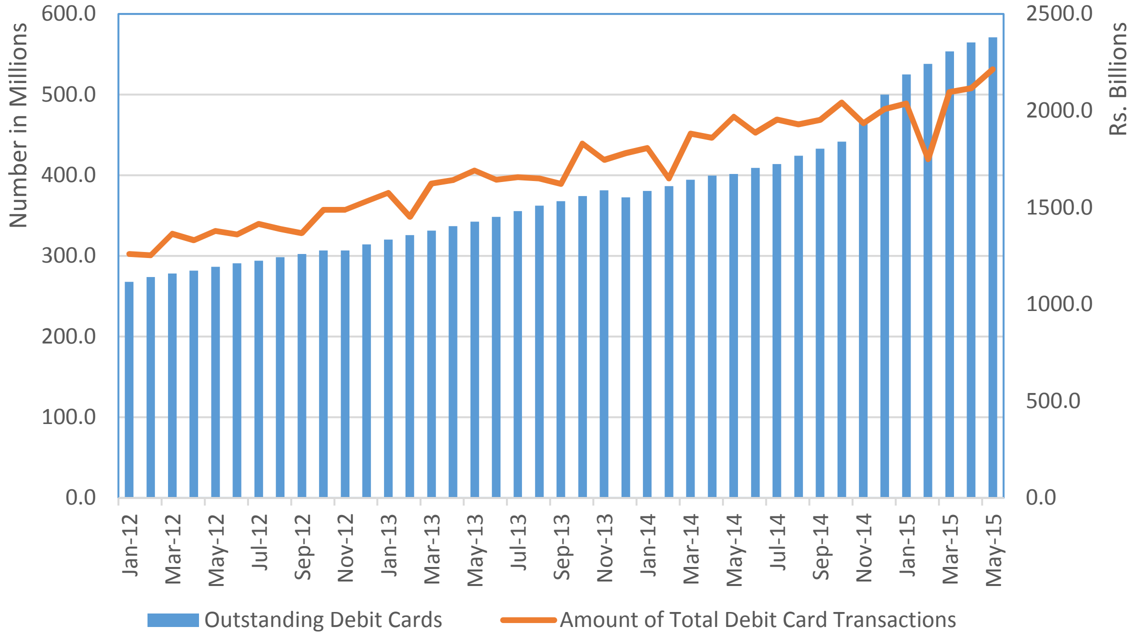
The steep growth of credit cards usage from Rs. 88 billion in January 2012 to Rs. 200 billion in May 2015 suggests that credit transactions are trending upwards. In addition, credit card transactions are estimated at approx. 2 percent of total expenditure. Therefore, credit cards could have an impact on the money multiplier and hence the total money supply. Graph 5 captures the debit card transactions during the same time period. Debit card transactions account for 20 percent of total expenditure. Though such transactions depend on the availability of cash in accompanied bank accounts, yet people have less need to carry or withdraw cash, affecting the velocity of money in circulation. However, as is apparent from Graph 3 there is no major change in velocity of money circulation.

Graph 4
Credit Cards Transactions



Source: RBI Database

Graph 5
Debit Cards Transactions

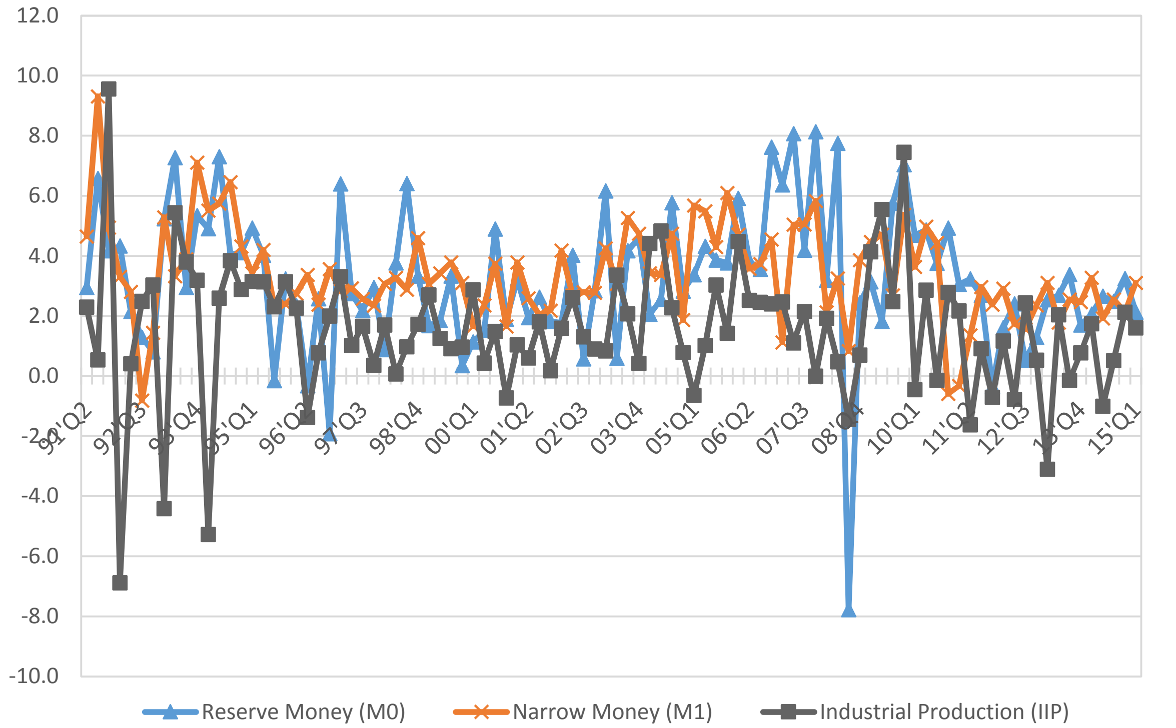


Source: RBI Database

Output

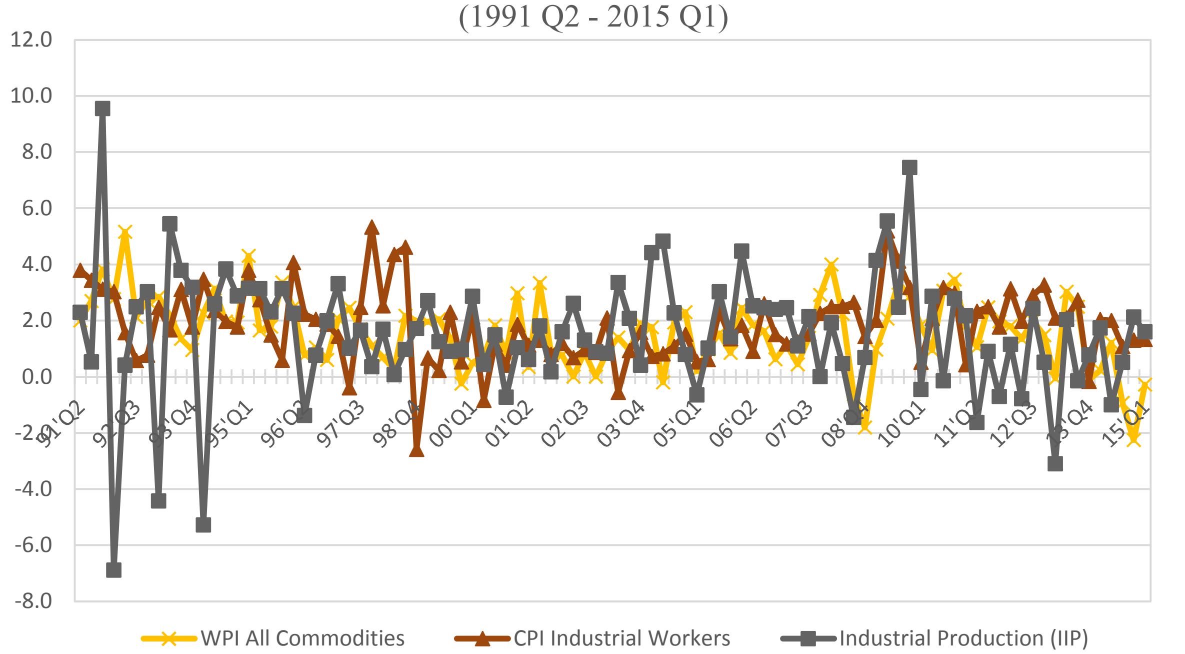
As gross domestic product (GDP) estimates are not available at a monthly level, Index of Industrial Production (IIP), compiled and published by the Central Statistical Organisation (CSO), is used as a proxy for total output. The IIP index is composed of three broad heads namely manufacturing, mining and electricity, with weights of 75.53, 14.16 and 10.32 respectively. To explore the relationship with output further, IIP manufacturing is used. Graph 6 and 7 explores the relationship between output and money, and output and prices separately. The current indices are on the base year 2004-05. The paper uses base 1993-94 for the analysis.

Graph 6
Money Supply and Industrial Production : Quarterly Growth
(1991 Q2 - 2015 Q1)



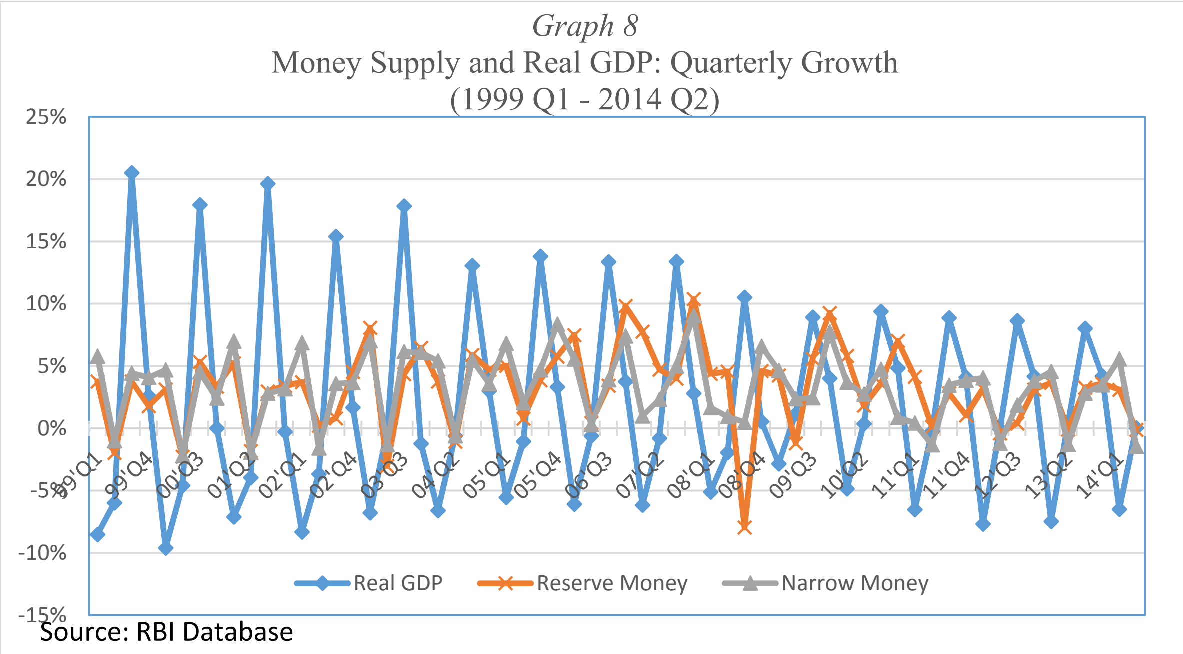
Source: RBI Database

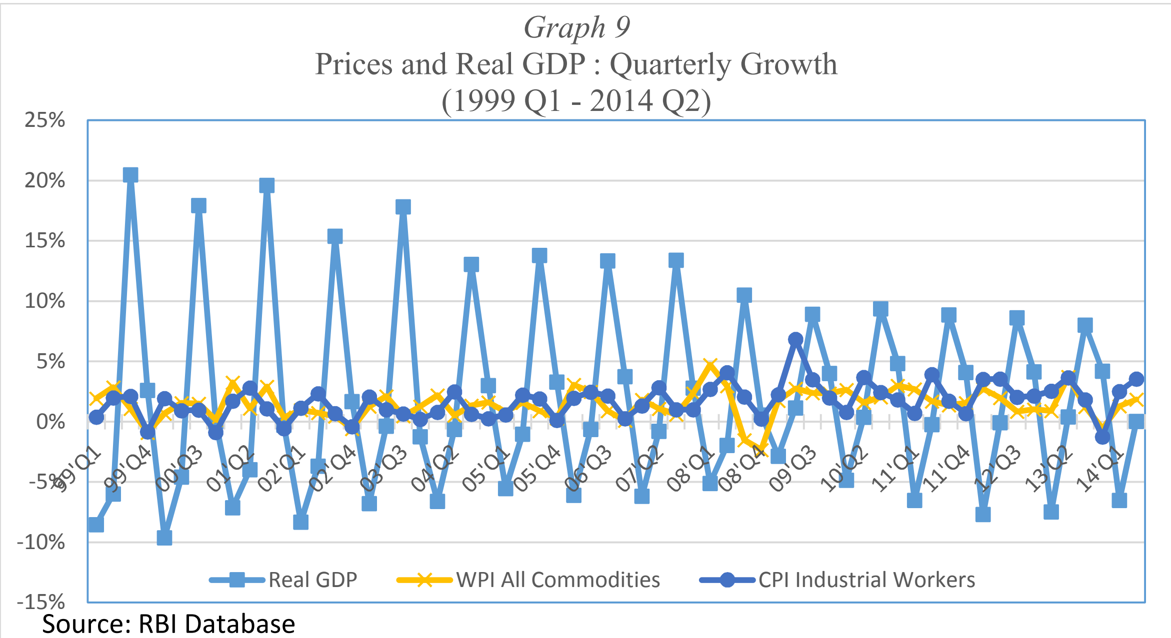
Graph 7
Prices and Industrial Production : Quarterly Growth
(1991 Q2 - 2015 Q1)



Source: RBI Database

To understand whether IIP serves as a good proxy of GDP. A comparative analysis is conducted with Quarterly Estimates of GDP.[1] The relationship with money and prices is depicted in Graphs 8 and 9.





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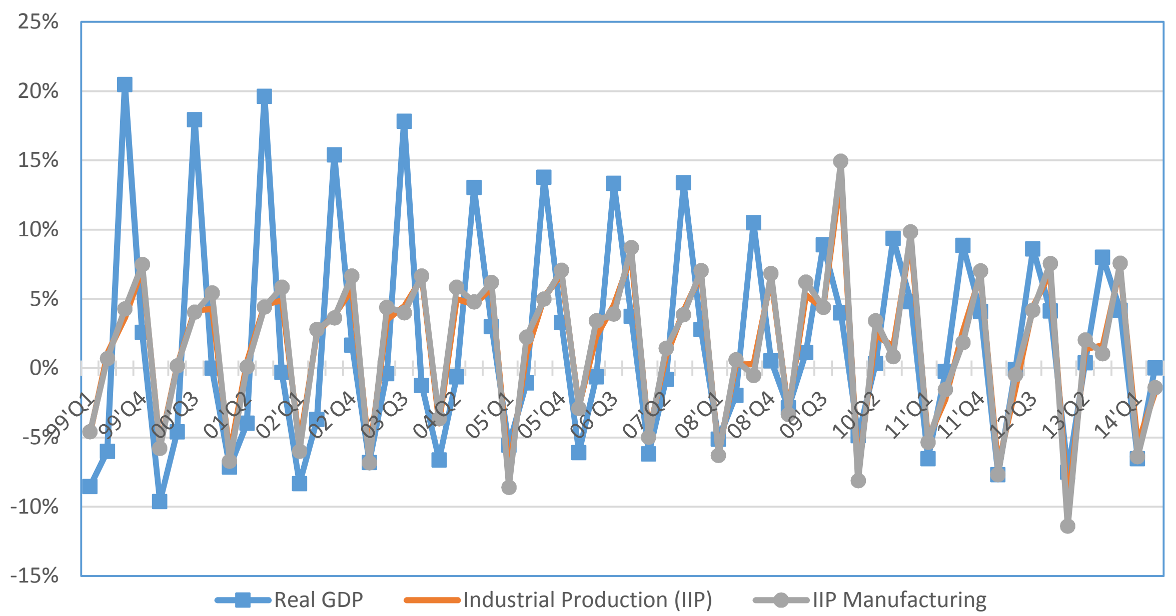
[1] The Central Statistical Organisation (CSO) introduced the quarterly estimates of Gross Domestic Product (GDP) on 30.6.1999. The estimates are available from quarter-Q4 (January-March) of financial year 1998-99, both at constant and current prices. The quarterly estimates of GDP were initially compiled through production approach. However, the quarterly estimates of GDP compiled through expenditure approach were released for the first time on 31.5.2007 and the estimates were as per the new series of national accounts from 2004-05 (base year) onwards.

The GDP data also suffers from abrupt change in methodology of estimation. From 2007 onwards the expenditure method is used instead of the production method. In the graphs 8 and 9, there is an evident change in the variance of GDP, caused due to the change in estimation technique. The IIP series has no structural breaks in comparison. This is evident in graph 10. The variation in IIP follows more closely with the variation in GDP after the expenditure method was introduced in 2007.

Graph 10

Real GDP and Industrial Production : Quarterly Growth

(1999 Q1 - 2014 Q2)



Source: RBI Database.

Prices

Price change in India is captured by consumer price index (CPI) as well as wholesale price index (WPI) measures. CPI for industrial workers (IW) is compiled and released by the Labour Bureau in the Ministry of Labour and Employment. WPI is compiled and released by the Office of the Economic Adviser in the Department of Industrial Policy and Promotion. As this paper uses both CPI as well as WPI indices to understand the relationship between variables it is meaningful to understand the difference between the two. There are conceptual and definitional differences between CPI and WPI.

WPI is based on wholesale prices for primary articles, administered prices for fuel items and ex-factory prices for manufactured products. On the other hand, CPI is based on retail prices, which include all distribution costs and taxes. CPI covers only consumer goods and consumer services while WPI covers different types of goods including intermediate goods transacted in the economy.

Target population for CPI (IW) index is working class family. The present series of CPI (IW) is on base 2001=100. The weighting diagrams for the purpose of compilation of index numbers had been derived on the basis of average monthly family expenditure of the working class as obtained from the Working Class Family Income Expenditure Survey conducted during 1999-2000.

The universe of the wholesale price index comprises of all transactions at first point of bulk sale in the domestic market. The weighting diagram for the WPI series has been derived on the basis of Gross Value of Output (GVO). The present series of WPI is on base 2004-05.

The output values at current prices, wherever available at appropriate disaggregation, have been obtained from the National Accounts Statistics (NAS), 2007 published by the Central Statistics Office (CSO), Government of India.

For this paper, the variables used for the quarterly and monthly analysis are CPI Industrial Workers (CPIIW), CPI Industrial Workers Food (CPIIWF), WPI All commodities (WPIAC), WPI Food Articles (WPIFA) and WPI Manufacturing (WPIM). The intuition behind analysing the relationship with food prices separately is that owing to the relatively low income elasticity for food expenditure with rise in income, the expenditure on non-food rise faster than food expenditure. Hence, both money as well as output interacts differently with food prices.

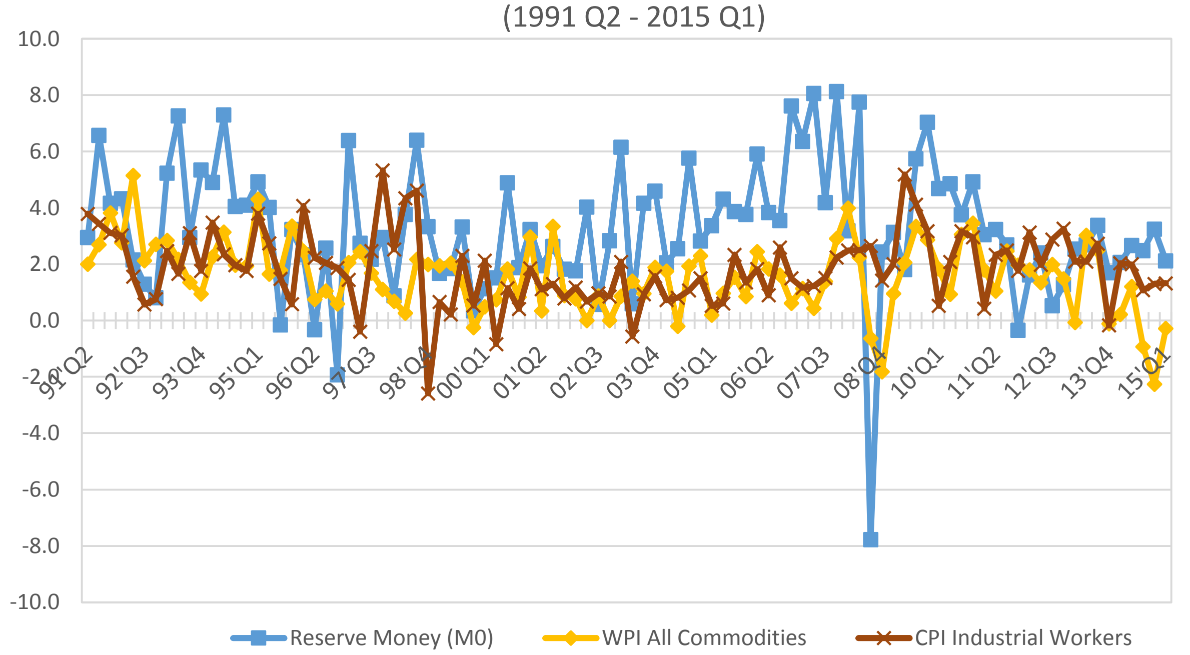
In India, numerous studies have emphasized the applicability of monetarist theory to India, whereby a rise in the money supply directly affects the price level.

Graph 10, 11 and 12 explores the relationship between prices and various measures of money supply - reserve, broad and narrow money respectively. The data used in the graphs have been deseasonalized using the ARIMA X-13 SEATS procedure developed by the United States Census Bureau.

Graph 11

Reserve Money and Prices : Quarterly Growth

(1991 Q2 - 2015 Q1)

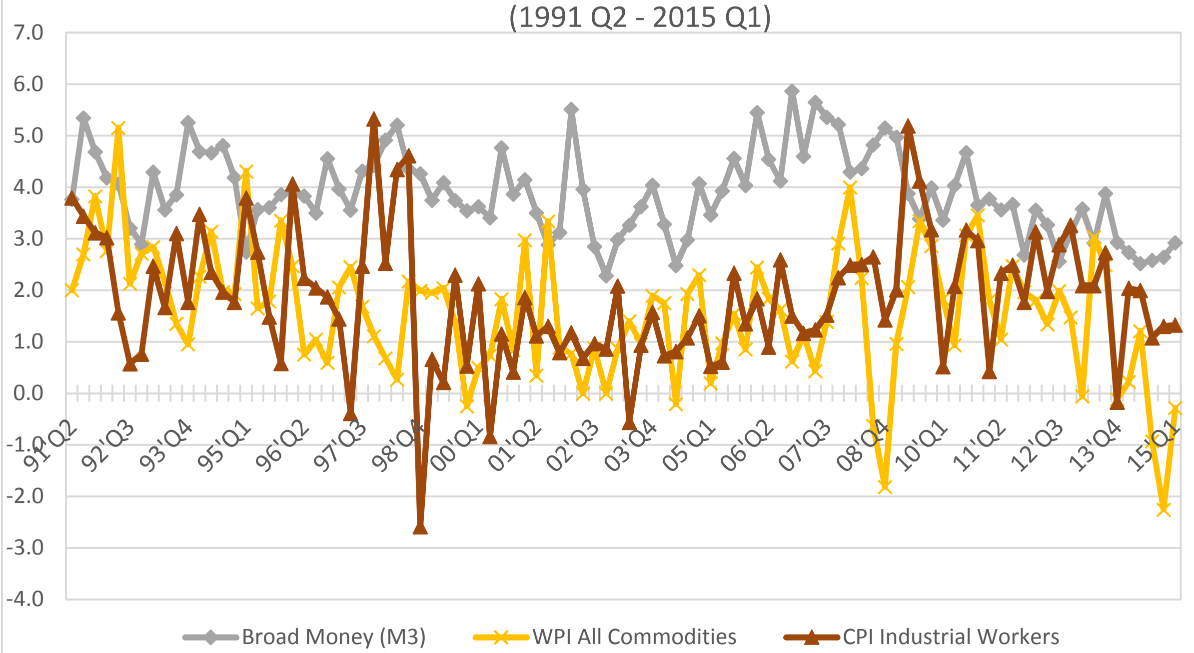


Source: RBI Database

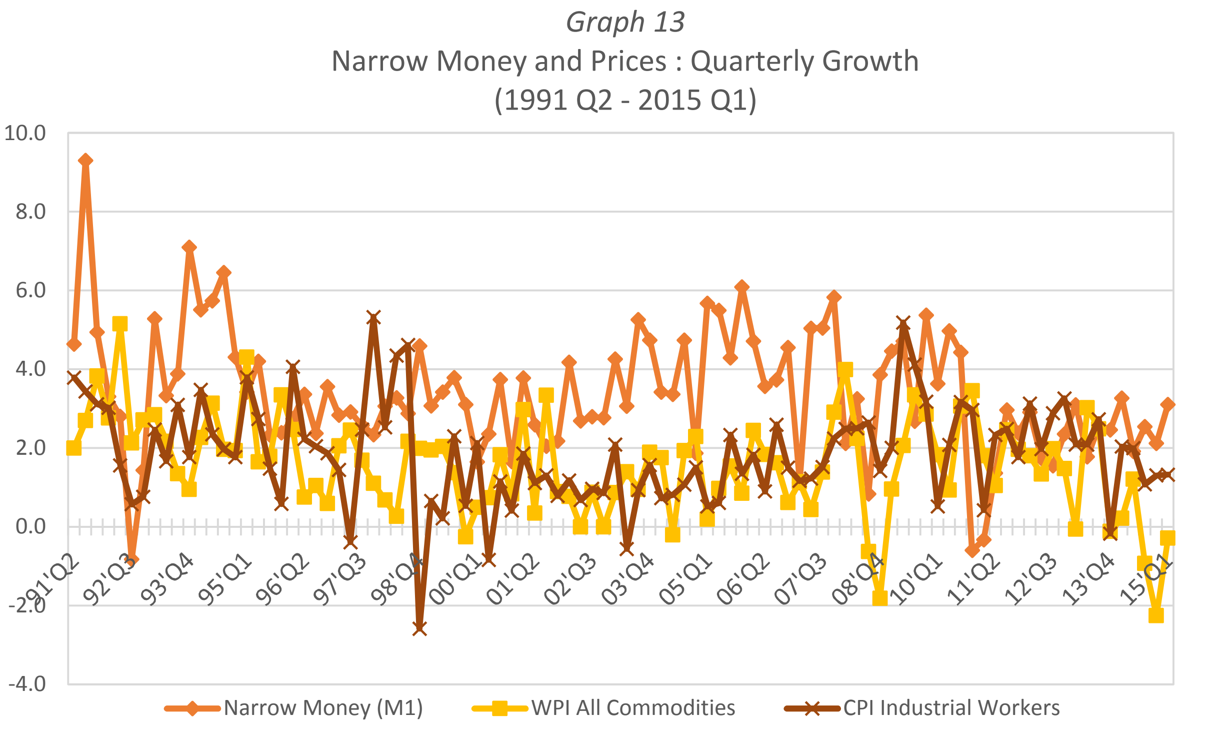
Graph 12

Broad Money and Prices : Quarterly Growth

(1991 Q2 - 2015 Q1)



Source: RBI Database



Source: RBI Database

Section V: Results and Findings

Quarterly Data Analysis

Monthly data for money supply, prices and output have been collected from RBI and Labour Bureau, Government of India. The monthly data has been deseasonalised using X-13ARIMA-SEATS developed by the United States Census Bureau. Having deseasonalized the monthly data, quarterly averages are taken. Hence, the data used is from Q1 1991-92 to Q1 2015-16. Hence, there is a total of 97 data points. The data is then log transformed.

<u>*Cointegration test for long run relationship*</u>

<u>Engle and Granger Two Step Procedure using Augmented Dickey-Fuller Test</u>: Each series is integrated of the Order 1. Table 1 records the computed value for the ADF Test of non-stationarity for the residuals of the regression between two corresponding variables. Stationarity here would indicate Cointegration. The results are the computed value for ADF test without a constant or trend as inclusion of such would skew the distribution to the left. To select the lag order Akaike information criterion (AIC) was used.

Table 1: Test values of Residuals for the ADF Test

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	-1.4334	-1.1568	-1.4418	-1.3886	-1.1315	-2.0989	-2.0818
M1	-2.0439	-0.7531	-1.9689	-1.2018	-1.2891	-3.2178	-3.2762
M3	-1.8139	-0.8251	-1.5149	-1.33	-1.1688	-2.1554	-2.2311

Phillips Perron Test: This test is robust to unspecified autocorrelation and heteroscedasticity in the disturbance process of the test equation.

Table 2: Test-values of Residuals for the Phillips Perron Test

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	-1.3626	-1.1896	-2.3117	-1.9047	-2.9173	-2.8642	-2.834
M1	-0.63113	-0.49299	-2.3005	-1.3154	-2.7523	-3.9543	-3.8725
M3	-1.0268	-0.82771	-3.045	-1.7496	-3.4807	-2.6299	-2.6508

The critical values for the ADF and PP test, for a sample size of 100, as calculated by Engle and Yoo (1987) is 3.03, 3.37 and 4.07 (ignoring the minus sign) for 10 percent, 5 percent and 1 percent level of significance, respectively.

Johansen Test: As both the ADF and PP test are non-conclusive we use the Johansen test for Cointegration analysis. This test is more robust and has greater power. The lag order for each relationship is separately estimated. The AIC and FPE criteria is used for lag selection and a maximum lag of 10 is used as it is advisable to avoid too long lag structures, since this eats up degrees of freedom and makes the underlying dynamic structure difficult to understand. The rank of the co-integrating matrix; i.e. 'r' is equal to zero when there is no Cointegration. Table 3 contains the level of significance at which the null of Cointegration is rejected.

Null Hypothesis: No-Cointegration r=0

Table 3: Level of significance if test statistic is greater than the critical value.

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	Not rejected	Not Rejected	Rejected 5pct	Not rejected	Rejected 1pct	Not rejected	Not rejected
M1	Rejected 5pct	Rejected 5pct	Rejected 5pct	Rejected 5pct	Rejected 10pct	Not rejected	Not rejected
M3	Not rejected	Not rejected	Rejected 5pct	Not rejected	Not rejected	Not rejected	Not rejected

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM
IIP	Not rejected	Not rejected	Rejected 1pct	Not rejected	Rejected 5pct
IIPM	Not rejected	Not rejected	Rejected 1pct	Not rejected	Rejected 5pct

Deductions:

a) M1 has a long run relationship with all the price variables. While M0 has a long run relationship only with WPIAC and WPIM. While M3 only has a long run relationship with WPIAC.

b) Neither of the money supply variables are co-integrated with IIP or IIPM. However, WPIAC and WPIM are co-integrated with IIP.

Granger Causality to test for short run relationship: For Granger causality tests, it is required that the series are trend and mean stationary. The log transformed deseasonalized variables are hence first differenced to make the series trend stationary and the mean value of this transformed series is then deducted to make the series zero mean stationary. The AIC and FPE are used to calculate the lag order. As is the general practice, the maximum lag order is considered to be 12 lags; i.e. 3 years. Table 4 and 5 contain the number of lags and the P-values for the Granger test. The first column lists the independent variable while the top row contains the dependent variables.

Null Hypothesis: No Granger Causality. Reported below are the number of lags for quarterly data (1991 – 2015).

Table 4 a: No of lags for the Granger Test.

→	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	1	1	2	1	3	2	1
M1	7	7	9	6	9	2	2
M3	1	1	2	2	3	1	1

Table 4 b: No. of Lags for the Granger Test.

→	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM
IIP	1	1	1	1	3
IIPM	1	1	1	1	3

Table 4 c: No. of lags for the Granger Test.

	M0	M1	M3
CPIIW	1	7	1
CPIIWF	1	7	1
WPIAC	2	9	2
WPIFA	1	6	2
WPIM	3	9	3
IIP	2	2	1
IIPM	1	2	1

Table 4 d: No. of lags for the Granger Test.

	IIP	IIPM
CPIIW	1	1
CPIIWF	1	1
WPIAC	1	1
WPIFA	1	1
WPIM	3	3

Except for the lag values for the Granger tests between prices and M1 the lag order estimated by FPE is less than or equal to 3. The lag order for M1 and WPIAC is the highest at 9.

Table 5 a: P-value of the Granger Causality Test.

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	0.477	0.418	0.175	0.928	0.301	0.267	0.068
M1	0.728	0.418	0.038	0.385	0.003	0.014	0.012
M3	0.333	0.349	0.034	0.077	0.283	0.346	0.358

Table 5 b: P-value of the Granger Causality Test.

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM
IIP	0.806	0.841	0.833	0.662	0.022
IIPM	0.740	0.767	0.800	0.560	0.013

Table 5 c: P-value of the Granger Causality Test.

⇒	M0	M1	M3
CPIIW	0.618	0.155	0.741
CPIIWF	0.440	0.134	0.491
WPIAC	0.615	0.060	0.676
WPIFA	0.840	0.340	0.851
WPIM	0.203	0.158	0.083
IIP	0.110	0.140	0.971
IIPM	0.405	0.128	0.981

Table 5 d: P-value of the Granger Causality Test.

⇒	IIP	IIPM
CPIIW	0.549	0.524
CPIIWF	0.715	0.641
WPIAC	0.382	0.328
WPIFA	0.151	0.102
WPIM	0.017	0.018

<u>Deductions:</u>

a) In the short run, narrow money Granger causes WPIAC, WPIM and IIP. Reserve money has no impact on prices while broad money affects WPIAC. This suggests the role of demand or time deposits in influencing prices.

b) Neither reserve money nor broad money granger causes output.

c) IIP granger causes only WPIM suggesting that industrial production has only an impact on prices of manufactured goods. WPIM granger causes IIPM and IIP. Hence, there is a feedback relationship between industrial production and prices of manufactured products.

d) None of the price indices Granger cause any of the money supply metrics at 5 percent level of significance. However, WPIAC Granger causes narrow money.

Quarterly Data Analysis for GDP and IIP: (Q4 1998-99 to Q2 2014-15)

To understand whether Industrial production metrics serve as a good proxy for total output a comparison of the Granger causality tests between the quarterly estimates of GDP and IIP was done. GDP at factor cost at constant price is used as the GDP estimate. As the GDP quarterly estimates are available only from 1996-97, a shorter time period was used. The time period is further shortened by two years as the initial quarterly estimates are not reliable due to the estimation method used. CSO only began publishing data from Q4 1998 onwards and this is considered to be the first quarter for the analysis.

To be consistent with the earlier analysis, the quarterly estimates for each of the variables are deseasonalized using ARIMA X-13 SEATS. However, the data is deseasonalized at a quarterly and not monthly level because GDP estimates are only available at that level. This ensures that the two variables are statistically comparable. The maximum lag order for calculating the optimal lag is as before considered 12; i.e. 3 years. FPE is, as before, used to calculate the lag order. The results are reported in Tables 6 and 7.

Table 6a: No. of lags for Granger Test.

⇒	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	M0	M1	M3
GDP	1	1	2	8	10	1	6	2
IIP	9	1	2	1	2	2	1	2
IIPM	1	1	2	1	12	2	1	2

Table 6b: No. of lags for the Granger Test.

⇒	GDP	IIP	IIPM
CPIIW	1	9	1
CPIIWF	1	1	1
WPIAC	2	2	2
WPIFA	8	1	1
WPIM	10	2	12
M0	1	2	2
M1	6	1	1
M3	2	2	2

Table 7a: P-value of the Granger Causality Test.

⇒	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	M0	M1	M3
GDP	0.388	0.467	0.040	0.438	0.076	0.001	0.168	0.037
IIP	0.004	0.942	0.523	0.520	0.438	0.005	0.373	0.482
IIPM	0.963	0.909	0.738	0.607	0.027	0.015	0.394	0.811

Table 7b: P-value of the Granger Causality Test.

⇨	GDP	IIP	IIPM
CPIIW	0.536	0.005	0.561
CPIIWF	0.971	0.263	0.320
WPIAC	0.174	0.033	0.079
WPIFA	0.111	0.900	0.962
WPIM	0.008	0.003	0.002
M0	0.071	0.399	0.284
M1	0.087	0.021	0.018
M3	0.461	0.248	0.108

Deductions:

a) From Tables 7a and 7b, it can be concluded that IIP is not necessarily, always, a good proxy for GDP when examining the relationship between output, prices and money supply.

b) GDP causes WPIAC, and WPIAC causes IIP. Hence, the two output variables have a different relationship with WPIAC.

c) In terms of the relationship between output and prices, GDP Quarterly has a unidirectional causal relationship with M0 and M3. IIP on the other hand has a unidirectional relationship with M0 only.

d) The relationship between IIP and M0 is in contrast with the earlier results. Similarly, the relationship between IIP and WPIM established earlier is found diluted.

Monthly Data Analysis

The same data as was used for the quarterly analysis has been used for the Monthly analysis. The data is deseasonalised and log transformed. The period for the analysis is April 1991 to August 2015. Hence, the total data points are 293.

Cointegration test for long run relationship

ADF Test: The ADF test is constructed on the monthly data.

Table 8: Test-values for the ADF test on the residuals for monthly data

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	-1.5114	-1.2283	-2.1441	-1.8555	-2.1318	-2.7281	-2.6335
M1	-1.2521	-0.6728	-2.0886	-1.2198	-2.2426	-3.4745	-3.6981
M3	-0.8774	-0.6926	-2.2966	-1.3597	-2.0537	-2.6271	-2.584

Phillips Perron Test: The PP test is constructed as for the monthly data.

Table 9: Test-values for the PP test on the residuals for the monthly data

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	-1.4593	-1.3357	-2.2677	-2.1073	-2.7509	-6.0164	-5.9733
M1	0.9705	-0.62101	-2.197	-1.4599	-2.5135	-6.9739	-6.8844
M3	-1.1332	-0.96335	-2.871	-1.9508	-3.1976	-4.4834	-4.6179

The critical values for the ADF and PP test, for a sample size of 100, as calculated by Engle and Yoo (1987) is 3.02, 3.37 and 4.00 (ignoring the minus sign) for 10 percent, 5 percent and 1 percent level of significance, respectively.

Johansen Test: Same as for the Quarterly data.

Null Hypothesis: No Cointegration: r=0

Table 10: Level of significance if Test statistic greater than Critical Value.

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	Not rejected	Not rejected	Rejected 10pct	Not rejected	Rejected 1pct	Not rejected	Not rejected
M1	Not Rejected	Not rejected	Rejected 1pct	Rejected 5pct	Rejected 1pct	Not rejected	Not rejected
M3	Rejected 10pct	Not rejected	Rejected 5pct	Rejected 5pct	Not Rejected	Not rejected	Not rejected

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM
IIP	Not rejected	Not rejected	Rejected 5pct	Not rejected	Rejected 1pct
IIPM	Not rejected	Not rejected	Rejected 5pct	Not rejected	Rejected 1pct

<u>Deductions:</u>

a) The Cointegration test for the monthly data mostly validates the results for the quarterly data. Reserve money is co-integrated with WPIAC and WPIM.

b) Narrow money is co-integrated with WPI, but not with the CPI indices.

c) Broad Money is co-integrated with WPIAC and has a long run relationship with WPIFA (at 5 percent) and CPIIW (at 10 percent).

d) The relationship between money supply and IIP is the same as for the quarterly analysis. The results show no long run relationship between the two.

e) WPIAC and WPIM have a long run relationship with IIP and IIPM.

<u>Granger Causality to test for short run relationship:</u> The maximum lag for the monthly data is 36, which is according to the number of lags for quarterly data; i.e. 12 quarters is equal to 36 months.

<u>Null Hypothesis:</u> No Granger Causality. Reported below are number of lags for monthly data (1991-2015).

Table 11 a:

→	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	10	14	1	2	6	2	2
M1	6	7	6	6	6	12	6
M3	6	7	6	6	6	14	14

Table 11 b: No. of lags for Granger Test.

→	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM
IIP	2	<u>2</u>	2	2	3
IIPM	2	2	2	2	3

Table 11 c: No of lags for Granger Test.

→	M0	M1	M3
CPIIW	10	6	6
CPIIWF	14	7	7
WPIAC	1	6	6
WPIFA	2	6	6
WPIM	6	6	6
IIP	2	12	14
IIPM	2	6	14

Table 11 d: No of lags for Granger Test.

	IIP	IIPM
CPIIW	2	2
CPIIWF	2	2
WPIAC	2	2
WPIFA	2	2
WPIM	3	3

The lag order as estimated by FPE varies from one month to 14 months. The average lag order is around 6. The lag order for the Granger test between reserve money and CPI indices is higher than that for M0 and WPI indicating that more significant information is contained in the higher lags for CPI than WPI.

Table 12 a: P-value of the Granger Causality Test.

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM	IIP	IIPM
M0	0.001	0.012	0.029	0.509	0.040	0.001	0.002
M1	0.200	0.088	0.095	0.175	0.069	0.013	0.005
M3	0.624	0.334	0.080	0.852	0.009	0.170	0.137

Table 12 b: P-value of the Granger Causality Test.

	CPIIW	CPIIWF	WPIAC	WPIFA	WPIM
IIP	0.926	0.278	0.100	0.220	0.076
IIPM	0.969	0.424	0.129	0.250	0.079

Table 12 c: P-value of the Granger Causality Test.

	M0	M1	M3
CPIIW	0.470	0.827	0.833
CPIIWF	0.017	0.592	0.495
WPIAC	0.164	0.684	0.515
WPIFA	0.677	0.058	0.241
WPIM	0.197	0.062	0.063
IIP	0.009	0.200	0.465
IIPM	0.007	0.233	0.624

Table 12 d: P-value of the Granger Causality Test.

→	IIP	IIPM
CPIIW	0.663	0.831
CPIIWF	0.317	0.417
WPIAC	0.887	0.878
WPIFA	0.972	0.919
WPIM	0.120	0.111

Deductions:

a) Base money Granger causes all price and output variables except WPIFA.

b) M1 continues to Granger cause WPIAC and WPIM, albeit at a low level of significance (less than 5 percent). Narrow money, also has influence over IIP and IIPM.

c) M3 only Granger causes WPIM in the monthly series.

d) None of the price indices Granger causes M0 except CPIIWF suggesting that food prices may have some influence over decisions on monthly reserve money. WPIFA Granger causes narrow money.

f) WPIM Granger causes M1 and M3 at low levels of significance (less than 5 percent).

g) Monthly IIP and IIPM Granger causes monthly M0.

h) IIP Granger causes WPI manufacturing at low levels of significance.

A summary of the results are presented in Table 13. The important results are that M1 turns out to be a significant variable granger causing prices and output. While monthly values of reserve money Granger causes output and prices, quarterly values do not. Broad Money does not turn out to be a significant variable while reserve money turns out to be influential only in the monthly time-frame.

Table 13: Summary of Conclusions : Test for Granger Causality						
No.	Null Hypothesis	Quarterly : 1991 - 2015			Monthly 1991 - 2015	
		p-value	Conclusion		p-value	Conclusion
1	RM →CPIIW	0.477	No		0.001	Yes
2	CPIIW → RM	0.618	No		0.470	No
3	RM → CPIIWF	0.418	No		0.012	Yes
4	CPIIWF → RM	0.440	No		0.017	Yes
5	RM → WPIAC	0.175	No		0.029	Yes
6	WPIAC → RM	0.615	No		0.164	No
7	RM → WPIFA	0.928	No		0.509	No
8	WPIFA → RM	0.840	No		0.677	No
9	RM → WPIM	0.301	No		0.040	Yes
10	WPIM → RM	0.203	No		0.203	No
11	RM → IIP	0.267	No		0.001	Yes
12	IIP → RM	0.110	No		0.009	Yes
13	RM → IIPM	0.068	No		0.002	Yes
14	IIPM → RM	0.405	No		0.007	Yes
15	M1 → CPIIW	0.728	No		0.200	No
16	CPIIW → M1	0.155	No		0.827	No
17	M1 → CPIIWF	0.418	No		0.088	No
18	CPIIWF → M1	0.134	No		0.592	No
19	M1 → WPIAC	0.038	Yes		0.095	No
20	WPIAC → M1	0.060	No		0.684	No
21	M1 → WPIFA	0.385	No		0.175	No
22	WPIFA → M1	0.340	No		0.058	No
23	M1 → WPIM	0.003	Yes		0.069	No
24	WPIM → M1	0.158	No		0.062	No
25	M1 → IIP	0.014	Yes		0.013	Yes
26	IIP → M1	0.140	No		0.200	No
27	M1 → IIPM	0.012	Yes		0.005	Yes
28	IIPM → M1	0.128	No		0.233	No
29	M3 → CPIIW	0.333	No		0.624	No
30	CPIIW → M3	0.741	No		0.833	No
31	M3 → CPIIWF	0.349	No		0.334	No
32	CPIIWF → M3	0.491	No		0.495	No
33	M3 → WPIAC	0.034	Yes		0.080	No
34	WPIAC → M3	0.676	No		0.515	No

No.	Null Hypothesis	Quarterly : 1991 - 2015			Monthly 1991 – 2015	
		p-value	Conclusion		p-value	Conclusion
35	M3 → WPIFA	0.077	No		0.852	No
36	WPIFA → M3	0.851	No		0.241	No
37	M3 → WPIM	0.283	No		0.009	Yes
38	WPIM → M3	0.083	No		0.063	No
39	M3 → IIP	0.346	No		0.170	No
40	IIP → M3	0.971	No		0.465	No
41	M3 → IIPM	0.358	No		0.137	No
42	IIPM → M3	0.981	No		0.624	No
43	GDP → M0	0.001	Yes			
44	M0 → GDP	0.071	No			
45	GDP → M1	0.168	No			
46	M1 → GDP	0.087	No			
47	GDP → M3	0.037	Yes			
48	M3 → GDP	0.461	No			
49	GDP → CPIIW	0.388	No			
50	CPIIW → GDP	0.536	No			
51	GDP → CPIIWF	0.467	No			
52	CPIIWF → GDP	0.971	No			
53	GDP → WPIAC	0.040	Yes			
54	WPIAC → GDP	0.174	No			
55	GDP → WPIFA	0.438	No			
56	WPIFA → GDP	0.111	No			
57	GDP → WPIM	0.076	No			
58	WPIM → GDP	0.008	Yes			

Note: The conclusion is based on 5 percent level of significance.

Depending on the choice of variable and time frame for prices and Money supply, there exists a feedback relationship between Money and Prices. Similarly, depending on the choice of variable and time frame, there exists a feedback relationship between Money Supply and output. This invokes important policy implications as influencing specific components of money can lead to better control of output and prices.

Section VI: Conclusion

The study investigates the causal relationship between money, output and prices for the post liberalization period in India. The Johansen test for Cointegration and Granger causality test were performed to test the relationship. The empirical finding indicates that the choice of variable is relevant in the understanding of relationship between money, output and prices. Narrow Money (M1) is found to be a better policy variable than reserve money (M0) or Broad Money (M3).

In the long run, on examining the relationship between money and prices, we find that quarterly M1 has a relationship with all the quarterly price metrics. M0 has a long run relationship with a few price variables. M3 has a long run relationship with prices of all commodities combined. Different components of monthly money supply have a long run relationship with different monthly price metrics. Overall, monthly WPI prices have a long run relationship with money supply, however, CPI prices have no relationship with money supply.

There is no long run relationship between either quarterly money supply and quarterly output or monthly money supply and monthly output.

The analysis between output and prices, suggest that there is a long run relationship between WPI all commodities or WPI manufacturing and output both on a month and quarter basis. CPI prices do not have a long run relationship with output indices.

In the short run, on examining the relationship between quarterly money supply and prices, we find that M1 Granger causes WPI prices. M0 has no relationship with prices. M3 Granger causes WPI All commodities combined. However, prices do not Granger cause money supply.

Monthly money supply, however, shows a different relationship between components of money and prices. M0 Granger causes both WPI and CPI prices. M1 does not Granger cause prices. M3 Granger causes WPI manufacturing. Food prices Granger cause M0 showing a feedback relationship between food prices and reserve money.

The relationship between quarterly money supply and output is unidirectional. M1 Granger causes output. M0 and M3 do not Granger cause output.

Monthly M0 has a bi-directional relationship with output, while M1 shows a unidirectional relationship. M3 has no relationship with output.

The relationship between quarterly output (IIP) and WPIM is bidirectional.

Monthly metrics show no relationship between monthly output and monthly prices.

Quarterly GDP has a unidirectional relationship with broad money and WPIAC. WPIM has a unidirectional relationship with GDP.

To conclude, monetary variables have a causal relationship with prices. In another interesting finding, food prices are having a causal relationship with monthly growth in base money. In future research, authors plan to explore the causal relationship between food prices and money supply; and the impact of demographic transition on the relationship between variables.

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