Relationship between Money, Output and Price Level in India: A Granger Causality Approach

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ABSTRACT

The relationship between money supply, income and prices is still a contentious concern mostly between the Keynesians and Monetarists. The Keynesians emphasise that a change in income reflects changes in money through demand for money, which means that there exists a unidirectional causality from income to money without any criticism. The Monetarists claim that money is the most important cause leading to changes in income and prices. Therefore, the direction of causation runs from money to income and prices without any feedback. This article studies the association between these macroeconomic aggregates using time series method of pair wise Granger causality test on annual data of the Indian economy over the period 1950-51 to 2012-13. Lag length is favoured by using standard criteria through VAR estimation. The Monetarists view is strongly supported by the result of this study. It is understood from the paper that the monetary policy has a force on the Indian macroeconomic variables as there is a casual relationship between money supply to inflation and income. Nevertheless, these relationships of variables are sensitive to lag length selections.

Keywords: Pair wise Granger causality; VAR lag order selection criteria; Augmented Dickey Fuller (ADF) test; Phillips-Perron (PP) test.

1.0 Introduction

Causality movement and strength of association between money, output and prices has always been a frequently deliberate topic between policy makers and economic researchers. This concern justifies this interest because it reveals allegiance of monetary policy.

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The Keynesians argue that money supply does not play any significant role in changing output and prices. They are of the view that output change causes changes in money supply through demand for money, which implies a unidirectional causality from output to money. They argue further that structural factors are responsible for changes in the price level.

The monetarists state that changes in money supply have an effect on output and prices. On the other hand, it can be affirmed that changes in output and price in an economy are essentially because of the changes in money supply. Hence, the trend of causation runs from money supply to output and prices with no reaction. It infers that nominal income and prices can be proscribed through money supply. The emphasis is that there is unidirectional causality running from money to output and prices. These theoretical frameworks have provided a justification for empirical investigations that shift argument away from theoretical debate to that of empirical question. This paper objects to reconsider the causality association between money, output and prices in the Indian perspective. Causality relationship between money, output and price has been the most explore subject in different period and nations. A comprehensive literature reviews supports our article.

The studies of Srivastava and Sexana (1968), Sims (1972), Fiebig and Pierce(1974) Nachane and Nadkarni (1985), Ramachandra (1986), Khan and Siddiqui (1990), Sharma (1991), Paul and Pradhan (1982), Das (1992), Masil and Masih (1994) and Salam (1995) have recognized that money do affect the prices in the economy and the causation is unidirectional from money to prices.

On the other hand, the studies by Komura (1982), Ramachandra(1983), Sharma (1985), Joshi and Joshi(1985), Bhattacharya and Sharma(1985), Singh(1989), Patil And Ramanathan(1989), Thacker(1992), Singh(1995), Biswas and Sanders(1990) and Mishra et al., (2010) have brought out feedback relationship between money and prices and confirmed bidirectional causation between them.

The lessons made by Rangarajan and Arif (1990), Dhanasekaran (1996), Sarma(1991),Mishra(2002), Bhattacharya and Mitra(1997) and Bhalla(1997) have shown that both the money supply and income influence price but only the study of Rugmani Bai (2000) confirmed bidirectional causation between income and price level. The studies by Friedman and Kuttner (1992), Mukherjee(1979), Joshi and Joshi (1985), Patil and Ramanathan(1989), Paul and Bhanumurthy(1999), Ashra et al. (2004), Dave and Rami (2010) and Medhavin and Rami (2008) have revealed that money supply influences both price and output. However, the studies by Chowdury (1986), Fickler and Rogers (1995), Coleman (1996), Cover (1992), Mishkin (1995), Mishra (2002),
Ramathilagam and Amudha (2004) and Sharma (2008) have shown that money supply influences only output.

The studies made by Gupta (1987), Lee and Li (1983) have indicated that bidirectional causation exists between income and money supply. The studies made by Sainai (1982), Ray and Namboodiri (1987) and Verma and Kumar (1994) have demonstrated that price is influenced only by non-monetary factors and not by money supply.

Table 1 shows that correlation exist between real GDP, Money and WPI. This correlation matrix deals with the two-way relation amid the state variables. It indicates high correlation between variables pairwise. The highest correlation emerges between GDP and WPI. The magnitude of the correlation is almost (0.99).

Table 1: Correlation Matrix between BM, GDP and WPI 1950-2013

| VARIABLES | BM | GDP | WPI |
|-----------|----|-----|-----|
| BM        | 1  | 0.95| 0.91|
| GDP       |    | 1   | 0.99|
| WPI       |    |     | 1   |

Source: Compiled by the authors.

2.0 Methodology and Framework

The major objective of this paper is to test the specific relationship between the three macroeconomic variables under study namely money supply, GDP and price. Thus, this paper sets the hypotheses in a form of three questions:

1. Is it the money supply that causes price movements or is it the price movements that grounds money supply for the Indian economy?
2. Is it money supply that grounds the GDP or is it the GDP that causes money supply for the Indian economy?
3. Is it GDP that causes the price or is it the price that causes GDP for the Indian economy?

In this paper, we have examine the issues of causality between money supply Broad money (M3) defined by RBI, price level (Wholesale Price Index), Output as measured by GDP at factor cost. The data were collected from (1) Annual Reports of Reserve Bank of India, We have taken annual data for M3, GDP at factor cost and WPI for the time period covering 63 years 1950 to 2013. To begin with, we convert all the variables into natural logarithmic form for reducing variations in them. In the second
step, a time series is stationary if its mean and variance is constant over time. This means that the sequence do not have an upward or downward trend over time. Standard estimation procedures cannot be applied to the model that contains a non-stationary variable. Also, the non-stationary time series has the likelihood of spurious regression. Therefore, we should test if a series is stationary or not before using it in a model (Kim et al 2003). Then we transform non-stationary series by taking the first differences, or the number of differencing operation it takes to make the series stationary. The stationarity of variables included in the analysis was tested by a Unit Root test. In this background, the Augmented Dickey Fuller (ADF) test is employed to check the stationarity of the selected variables was used and three models were estimated.

Model I (without any constant and trend)

\[
\Delta Y_t = \theta Y_{t-1} + \gamma \sum_{i=1}^{b} \Delta Y_{t-i} + \varepsilon_t 
\]

\[\text{………1.1}\]

Model II (with constant but no trend)

\[
\Delta Y_t = \beta_1 + \theta Y_{t-1} + \gamma \sum_{i=1}^{b} \Delta Y_{t-i} + \varepsilon_t 
\]

\[\text{………1.2}\]

Model III (with constant and trend).

\[
\Delta Y_t = \beta_1 + \beta_2 t + \theta Y_{t-1} + \gamma \sum_{i=1}^{b} \Delta Y_{t-i} + \varepsilon_t 
\]

\[\text{………1.3}\]

The Phillips-Perron (PP) test is engaged to test the stationarity of the chosen variables and the three models, given below, were projected. Moreover, Phillips-Perron test was used to test the occurrence of unit root since it also takes care of serial correlation in the error terms by using the non-parametric statistical method without addition of lagged difference terms. The Phillip-Perron test is based on the following model:

Model I (without any constant and trend)

\[
\Delta K = \rho K_{t-1} + \phi \left[ t - \frac{T}{2} \right] + \sum_{i=1}^{m} \lambda_i \Delta k_{t-i} + v_t 
\]

\[\text{………2.1}\]

Model II (with constant but no trend)

\[
\Delta K = \alpha_1 + \rho K_{t-1} + \phi \left[ t - \frac{T}{2} \right] + \sum_{i=1}^{m} \lambda_i \Delta k_{t-i} + v_t 
\]

\[\text{………2.2}\]

Model III (with constant and trend)

\[
\Delta K = \alpha_1 + \beta_2 t + \rho K_{t-1} + \phi \left[ t - \frac{T}{2} \right] + \sum_{i=1}^{m} \lambda_i \Delta k_{t-i} + v_t 
\]

\[\text{………2.3}\]
Both ADF and PP test represents the first difference operator. $Y_t$ and $K_t$ are the time series under examination where $\alpha_1$ and $\beta_1$ is intercept. $t$ is linear time trend. $p$ and $m$ is the number of lagged first differences. $\epsilon_t$ and $\nu_t$ is a pure white noise. The null hypothesis is unit root and the alternative hypothesis is level stationarity. The null hypothesis of unit root is tested using the $t$-statistic with critical values calculated by Mackinnon. If the coefficient of the lag of $Y_{t-1}(\theta)$ and $K_{t-1}(\rho)$ is significantly different from zero, then the null hypothesis is rejected. The equations 1.1 and 2.1 consists of without any drift and trend whereas the equations 1.2 and 2.2 includes only drift and the equations 1.3 and 2.3 includes both drift and a deterministic trend. All three models were tested with Unit Root test in both methods (i) First Difference when the value of ADF and PP is statistically significant, is measured as stationarity of series. The observed test encompass been carried out using the Eviews 7 econometrics package.

The tests were carried out with the null hypothesis of non stationarity (unit root) for each data series and the results indicate all the three data series are at the non-stationary level and become stationary after first-order difference. It is obvious that the no null hypothesis of unit roots for all the time series are rejected at their first differences since the ADF test and PP test statistic values are less than the significant values at 10%, 5% and 1% levels of significances. Therefore, the variables are stationary and incorporated of same order, i.e., $I(1)$. Then, the assortment of suitable lag order has been carried out by using five different criteria viz. LR (Sequential modified Likelihood Ratio test statistic (each test at 5% level), FPE (Final Prediction Error), AIC, SC and HQ (Hannan-Quinn Information Criterion). For the lag order therefore chosen, pair-wise Granger Causality test has been appropriate with a pair of above-mentioned Null Hypotheses. Based upon the values of $F$-statistic and the related significance levels, the proper winding up has been drawn.

3.0 Result and Discussion

ADF test and PP test have been used for stationary along with AIC and SBC criteria. Table 2 shows the results of stationarity of the W.P.I series derived by using various test statistics. The Augmented Dicky-Fuller (ADF) test and Phillips-Perron (PP) test statistics in level (logarithmic) reveals presence of unit root in WPI (level). Intercept coefficient is statistically significant while ADF is insignificant. Intercept with trend coefficient is statistically insignificant while ADF is significant. Phillips-Perron (PP) test also suggests the same result. Hence, it may be concluded that the series in not stationary.
### Table 2: Stationarity of W.P.I for the Annual Series from 1950-51 to 2012-13 (Base 2004-05= 100)

| WPI LEVEL     | ADF(t-test) | AIC    | SBC    | Remark                                      |
|---------------|-------------|--------|--------|---------------------------------------------|
| None          | 4.1146      | -2.8597| -2.7905|                                             |
| Intercept     | 1.1800      | -2.8870| -2.8184| Intercept coefficient is not statistically significant |
| Intercept With Trend | -4.3022 | -3.1453| -3.0069| Intercept and trend coefficient is not statistically significant |
| WPI(First Difference) |           |        |        |                                             |
| None          | -0.1028     | -3.3170| -3.0615|                                             |
| Intercept     | -6.0538*    | -2.9028| -2.8336| Intercept coefficient is statistically significant |
| Intercept With Trend | -5.2660 | -3.0660| -2.9267| Intercept and trend coefficient is not statistically significant |
| WPI(LEVEL)    | PP(adj t-test) | AIC    | SBC    |                                             |
| None          | 6.1958      | -2.8288| -2.7945|                                             |
| Intercept     | 0.9382      | -2.8870| -2.8870| Intercept coefficient is not statistically significant |
| Intercept with trend | 0.0433 | -3.0717| -2.9687| Intercept and trend coefficient is not statistically significant |
| WPI(first difference) |           |        |        |                                             |
| None          | -3.5093     | -2.6402| -2.6056|                                             |
| Intercept     | -6.0875*    | -2.9028| -2.8336| Intercept coefficient is statistically significant |
| Intercept with trend | -6.2664 | -2.8969| -2.7931| Intercept and trend coefficient is not statistically significant |

*significant at 1 percent level

Result: Wholesale price index (WPI) stationary at first difference with intercept, statistically significant therefore we concluded that series only stationary at intercept.

It is found that when considered W.P.I (first difference) series, both ADF and intercept coefficient statistic are statistically significant indicating absence of unit root. Phillips- Perron test makes the confirmation of the result suggested. Hence, It may be concluded that the series is stationary. We have used ADF test and PP test for stationary along with AIC and SBC criteria.

Table 3 shows the results of stationarity of the GDP derived by using various test statistics. The Augmented Dicky-Fuller (ADF) test and Phillips-Perron (PP) test statistics in level (logarithmic) reveals presence of unit root in GDP (level). Intercept coefficient is statistically significant while ADF is insignificant. On the other hand, both
intercept with trend coefficient and ADF is statistically insignificant. When the trend is included with intercept, coefficient value becomes statistically insignificant and ADF is also statistically insignificant. Phillips-Perron (PP) test also suggests the same result. Hence, it may be concluded that the series in not stationary. It is found that when considered GDP (first difference) series, both ADF and intercept coefficient statistic are statistically significant indicating absence of unit root. Phillips- parron test makes the confirmation of the result suggested and hence, It may be concluded that the series is stationary.

Table 3: Stationarity of GDP Annual Series from 1950-51-2012-13 (Base 2004-05= 100)

| GDP(LEVEL) | ADF    | AIC    | SBC    | Remark                                           |
|------------|--------|--------|--------|--------------------------------------------------|
| None       | 13.3936| -4.2384| -4.2041|                                                  |
| Intercept  | 3.7263 | -4.3040| -4.2354| Intercept coefficient is not statistically significant |
| Intercept With Trend | 0.2378 | -4.2734| -4.1704| Intercept and trend coefficient is not statistically not significant |
| GDP(FirstDifference) | None       | -0.8308| -3.9733| -3.8677                                         |
| Intercept  | -7.6932*| -4.0898| -4.0206| Intercept coefficient is statistically significant |
| Intercept With Trend | -9.5505| -4.3075| -4.2037| Intercept and trend coefficient is not statistically significant |
| GDP(LEVEL) | PP(adj t-test) | AIC | SBC   |
| None       | 13.8889| -4.2384| -4.2041|                                                  |
| Intercept  | 5.6455 | -4.3040| -4.2354| Intercept coefficient is not statistically significant |
| Intercept With Trend | 0.7641 | -4.2734| -4.1704| Intercept and trend coefficient is not statistically not significant |
| GDP(First Difference) | None       | -2.9381| -3.5756| -3.5410                                         |
| Intercept  | -7.7809*| -4.0898| -4.0206| Intercept and trend coefficient is not statistically significant |
| Intercept With Trend | -9.6796| -4.3075| -4.2037| Intercept and trend coefficient is not statistically not significant |

Note: *significant at 1 percent level

Result: Gross Domestic Product (GDP) stationary at first difference with intercept

Table 4 shows the results of stationarity of the M₃ series derived by using various test statistics. The Augmented Dicky-Fuller (ADF) test and Phillips-Perron (PP)
test statistics in level (logarithmic) reveals presence of unit root in $M_3$ (level). Intercept coefficient is statistically significant while ADF is insignificant. Intercept with trend coefficient is statistically insignificant while ADF is significant. Phillips-Perron (PP) test also suggests the same result. Hence, it may be concluded that the series is not stationary. It is found that when considered $M_3$ (first difference) series, both ADF and intercept coefficient statistic are statistically significant indicating absence of unit root. Phillips- parron test makes the confirmation of the result suggested and hence, It may be concluded that the series is stationary.

### Table 4: Stationary of BROAD MONEY Annual Series: 1950-51-2012-13

| M$_3$ (LEVEL) | ADF | AIC  | SBC  | Remark                                      |
|--------------|-----|------|------|---------------------------------------------|
| None         | 2.2711 | -4.0138 | -3.9901 |                                              |
| Intercept    | 1.9822 | -4.1987 | -4.0949 | Intercept coefficient is not statistically significant |
| Intercept With Trend | -7.5533 | -4.1564 | -4.0535 | Intercept and trend coefficient is not statistically significant |
| M$_3$ (First Difference) |       |       |      |                                              |
| None         | -0.3971 | -3.9605 | -3.8907 |                                              |
| Intercept    | -5.2411* | -4.1660 | -4.0968 | Intercept coefficient is statistically significant |
| Intercept With Trend | -5.6212 | -4.2219 | -4.1181 | Intercept and trend coefficient is not statistically significant |

| M$_3$(LEVEL) | PP(adj t-test) | AIC  | SBC  | Remark                                      |
|--------------|---------------|------|------|---------------------------------------------|
| None         | 12.1483 | -3.2346 | -3.2003 |                                              |
| Intercept    | 3.4792 | -3.3926 | -3.3240 | Intercept coefficient is not statistically significant |
| Intercept With Trend | -6.1706 | -4.1564 | -4.0535 | Intercept and trend coefficient is not statistically significant |
| M$_3$(First Difference) |       |       |      |                                              |
| None         | -0.7250 | -3.8184 | -3.7838 |                                              |
| Intercept    | -5.3944* | -4.1660 | -4.0968 | Intercept coefficient is statistically significant |
| Intercept With Trend | -5.6469 | -4.2219 | -4.1181 | Intercept and trend coefficient is not statistically significant |

Note: *significant at 1 percent level

Result: Broad Money Supply ($M_3$) stationary at first difference with intercept

### 3.1 Granger causality: Annual data

Even though regression analysis deals with the dependence of one changeable on other variables, it does not necessarily imply causation. In other words, the existence of a
relationship between variables does not prove causality or the direction of influence. But in regressions involving time series data, the situation may be somewhat different because time does not run backward. That is, if event A happens before event B, then it is possible that A is causing B. However, it is not possible that B is causing A. In other words, events in the past can cause events to happen today. Future events cannot. This is roughly the idea behind the so-called Granger causality test. But it should be noted clearly that the question of causality is deeply philosophical with all kinds of controversies. At one extreme are people who believe that “everything causes everything,” and at the other extreme are people who deny the existence of causation whatsoever. The econometrician Edward Leamer prefers the term precedence over causality. Francis Diebold prefers the term predictive causality. As he writes: “The statement “yi causes yj” is just shorthand for the more precise, but long-winded, statement, “yi contains useful information for predicting yj (in the linear least squares sense), over and above the past histories of the other variables in the system.” To save space, we simply say that yi causes yj.

The Granger Test, developed by Nobel Laureate econometrician C W J Granger (1969) is applicable only to econometric models where there is a lead-lag relationship between two variables. In terms of the St. Louis equation, we are to test whether M3 grange causes Inflation and whether M3 granger causes economic growth.

**Case 1: Causality between BM and WPI**

According to Granger, the time series BMt (broad Money) fails to Granger cause WPIt. If in a regression of WPIt on lagged WPI values and lagged broad Money, the estimated coefficients of the latter are not statistically significant from zero.

Similarly the dependent variable BMt is regressed on the lagged values of BMt as well as the lagged values of WPI and if the estimated coefficients of the lagged values of WPI are found to be statistically insignificant then it may be concluded that WPI does not Granger cause BM.

The Granger Test for the St. Louis equation engages the evaluation of the following pairs of equations:

\[
\text{wpi}_t = \sum_{i=0}^{m} \delta_i \text{BM}_{t-i} + \sum_{j=0}^{m} \gamma_j \text{wpi}_{t-j} + u_{1t} \quad \text{...........(3.1)}
\]

\[
\text{BM}_t = \sum_{i=0}^{n} \lambda_i \text{BM}_{t-i} + \sum_{j=0}^{m} \phi j \text{wpi}_{t-j} + u_{2t} \quad \text{...........(3.2)}
\]

where, it is assumed that both \(u_{1t}\) and \(u_{2t}\) are uncorrelated white noise error terms.
Unidirectional causality from BM to WPI is indicated if the estimated coefficients on the lagged BM in Eq. (3.1) are statistically different from zero as a group and the set of estimated coefficients on the lagged WPI in Eq. (3.2) is not statistically different from zero. Conversely, unidirectional causality from WPI to BM exists if the set of lagged BM coefficients in Eq. (3.1) is not statistically different from zero and the set of lagged WPI coefficients in Eq. (3.2) is statistically different from zero. Bi-directional causality is indicated if in both equations 3.1 and 3.2 the respective null hypotheses are rejected. Bilateral causality, is suggested when the sets of BM and WPI coefficients are statistically significantly different from zero in both regressions.

**Case 2: Causality between BM and GDP**

Here also, the test for Granger causality (unidirectional of bidirectional) is done exactly in the same way as in case (1), only replacing WPI by GDP.

\[ GDP_t = \sum_{i=0}^{n} \delta_i BM_{t-i} + \sum_{j=0}^{m} \gamma_j GDP_{t-j} + u_{1t} \]  
\[ BM_t = \sum_{i=0}^{n} \lambda_i BM_{t-i} + \sum_{j=0}^{m} \phi_j GDP_{t-j} + u_{2t} \]

where, it is assumed that both \( u_{1t} \) and \( u_{2t} \) are uncorrelated white noise error terms.

**Case 3: Causality between GDP and WPI**

The test for Granger causality is on the similar line in which we estimate the following equations:

\[ WPI_t = \sum_{i=0}^{n} \delta_i GDP_{t-i} + \sum_{j=0}^{m} \gamma_j WPI_{t-j} + u_{1t} \]  
\[ GDP_t = \sum_{i=0}^{n} \lambda_i GDP_{t-i} + \sum_{j=0}^{m} \phi_j WPI_{t-j} + u_{2t} \]

where, it is assumed that both \( u_{1t} \) and \( u_{2t} \) are uncorrelated white noise error terms.

### 3.2 Lag order selection

The significant lag values have been determined by using five different criteria namely, (i) LR : sequential modified LR test statistic (each test at 5% level) (ii) FPE : Final prediction error (iii) AIC : Akaike information criterion (iv) SC : Schwarz information criterion (v) HQ : Hannan-Quinn information criterion.
3.3 Causality between $M_3$ and GDP

Table 5 shows the values of various lag order selection criteria. It is seen from Table 5 that two criteria (FPE and AIC) out of five criteria indicate log order of 9. The other two criteria (SC and HQ) indicate lag order 1 and only one criteria (LR) indicate lag order 5. The results obtained from the granger causality test between broad money supply ($M_3$) and GDP on the basis of the selected lag order have been given in Tables 6, 7 and 8.

**Table 5: VAR Lag Order Selection Criteria**

| Lag | logL   | LR         | FPE       | AIC       | SC       | HQ        |
|-----|--------|------------|-----------|-----------|----------|-----------|
| 0   | 211.9143 | NA        | 1.07e-06  | -8.073627 | -7.998579 | -8.044855 |
| 1   | 224.7265 | 24.14605  | 7.61e-07  | -8.412557 | -8.187414 | -8.326242 |
| 2   | 227.3046 | 4.660462  | 8.05e-07  | -8.357870 | -7.982631 | -8.214012 |
| 3   | 229.3955 | 3.618858  | 8.68e-07  | -8.284443 | -7.759108 | -8.083042 |
| 4   | 234.8852 | 9.079078  | 8.23e-07  | -8.341738 | -7.666307 | -8.082794 |
| 5   | 241.5071 | 10.44232* | 7.48e-07  | -8.442582 | -7.617056 | -8.126095 |
| 6   | 244.0244 | 3.775906  | 7.99e-07  | -8.385554 | -7.409932 | -8.011524 |
| 7   | 248.8495 | 6.866527  | 7.84e-07  | -8.417290 | -7.291572 | -7.985716 |
| 8   | 252.4543 | 4.852630  | 8.09e-07  | -8.402090 | -7.126277 | -7.912974 |
| 9   | 259.4860 | 8.924827  | 7.35e-07  | -8.518694 | -7.092785 | -7.972034 |
| 10  | 259.9890 | 0.599647  | 8.63e-07  | -8.384191 | -6.808186 | -7.779988 |

*Note: * indicates lag order selected by the criterion

**Table 6: Pair wise Granger Causality Tests: Lags: 1**

| Null hypothesis: | Obs | F-statistic | Probability |
|------------------|-----|-------------|-------------|
| $M_3$ does not granger cause GDP | 61  | 2.75498     | 0.1023      |
| GDP does not granger cause $M_3$ | 3.26536 | 0.0759      |

*Note: $M_3$ stationary at first difference with intercept; GDP stationary at first difference with intercept*

**Table 7: Pair wise Granger Causality Tests: Lags: 5**

| Null hypothesis: | Obs | F-statistic | Probability |
|------------------|-----|-------------|-------------|
| $M_3$ does not granger cause GDP | 57  | 1.81169     | 0.1293      |
| GDP does not granger cause $M_3$ | 2.17459 | 0.0733      |

*Note: $M_3$ stationary at first difference with intercept; GDP stationary at first difference with intercept*
### Table 8: Pair wise Granger Causality Tests: Lags: 9

| Null hypothesis:                  | Obs | F-statistic | Probability |
|-----------------------------------|-----|-------------|-------------|
| M₃ does not granger cause GDP     | 53  | 2.93432     | 0.0110      |
| GDP does not granger cause M₃     | 1.89808 | 0.0860      |

Note: M₃ stationary at first difference with intercept; GDP stationary at first difference with intercept

In cases above two out of three indicate the rejection of causality relationship between broad money and GDP and only one case unidirectional causality running from M₃ to GDP indicate the significance at 0.01 level. As argued by the monetarists, analysis further suggests that one-way causation exists from broad money to GDP and broad money supply has probably played major role in the growth of national income of India during the reference period.

#### 3.4 Causality between M₃ and WPI

Table 9 shows the values of the test statistics and the significance of various criteria. Table 9 shows that five out of five criteria LR, FPE, AIC, SC and HQ point out the selection of lag order 2. Table 10 shows the result of granger causality test between broad money supply (M₃) and WPI. In this case, bidirectional causality running each other from M₃ to WPI is indicated at one per cent level of significant. This means that the growth in the general price level is affected each other by increase in broad money supply. Hence, In India during the reference period, one of the chief factors affecting the increase in price level is money supply.

### Table 9: VAR Lag Order Selection Criteria

| Lag | logL   | LR        | FPE       | AIC       | SC        | HQ        |
|-----|--------|-----------|-----------|-----------|-----------|-----------|
| 0   | 189.4471 | NA        | 2.54e-06  | -7.209505 | -7.134458 | -7.180734 |
| 1   | 209.0746 | 36.99022  | 1.39e-06  | -7.810562 | -7.585418 | -7.724247 |
| 2   | 218.6011 | **17.22095** | **1.13e-06** | **-8.023119** | **-7.647879** | **-7.879261** |
| 3   | 220.2341 | 2.826383  | 1.23e-06  | -7.932081 | -7.406746 | -7.730680 |
| 4   | 223.6985 | 5.729524  | 1.27e-06  | -7.911480 | -7.236049 | -7.652535 |
| 5   | 226.5687 | 4.526162  | 1.33e-06  | -7.868028 | -7.042501 | -7.551540 |
| 6   | 229.6644 | 4.643557  | 1.39e-06  | -7.833247 | -6.857625 | -7.459217 |
| 7   | 230.7715 | 1.575516  | 1.57e-06  | -7.721982 | -6.596265 | -7.290409 |
| 8   | 231.3633 | 0.796569  | 1.82e-06  | -7.590895 | -6.315082 | -7.101779 |
| 9   | 233.1523 | 2.270713  | 2.02e-06  | -7.505859 | -6.079950 | -6.959199 |
| 10  | 236.1316 | 3.552157  | 2.16e-06  | -7.466598 | -5.890594 | -6.862395 |

* indicates lag order selected by the criterion
Table 10: Pair wise Granger Causality Tests: Lags: 2

| Null hypothesis:                      | Obs | F-statistic | Probability |
|---------------------------------------|-----|-------------|-------------|
| $M_3$ does not granger cause WPI      | 60  | 5.41902     | 0.0071      |
| WPI does not granger cause $M_3$      |     | 4.64406     | 0.0137      |

Note: $M_3$ stationary at first difference with intercept; WPI stationary at first difference with intercept

3.5 Causality between GDP and WPI

Table 11 shows the value of various lag order selection criteria. Taking this lag order 3 suggested by the LR criterion, the results are given in Table 12. The results show that there is almost unidirectional granger causality running from GDP to WPI. Here it is important to note that the significance level is slightly more (0.06) than the standard significance level of 0.05.

The other two criteria’s FPE and AIC suggest the lag order 6. By using the suggested lag order, the granger causality test was administrated and the results are given in Table 13. The result indicates that there is unidirectional causality running from WPI to GDP for both the sets of criteria.

Table 11: VAR Lag Order Selection Criteria

| Lag | logL     | LR  | FPE    | AIC    | SC     | HQ     |
|-----|----------|-----|--------|--------|--------|--------|
| 0   | 194.4027 | NA  | 2.10e-06 | -7.400105* | -7.325057* | -7.371333* |
| 1   | 199.3263 | 9.279053 | 2.02e-06 | -7.435627 | -7.210484 | -7.349312 |
| 2   | 202.4903 | 5.719582 | 2.09e-06 | -7.403474 | -7.028235 | -7.259616 |
| 3   | 209.2390 | 11.68038* | 1.88e-06 | -7.509192 | -6.983857 | -7.307791 |
| 4   | 212.4158 | 5.253905 | 1.95e-06 | -7.477530 | -6.802099 | -7.218586 |
| 5   | 218.2120 | 9.140170 | 1.83e-06 | -7.546614 | -6.721088 | -7.230127 |
| 6   | 223.4297 | 7.826563 | 1.76e-06* | -7.593449* | -6.721088 | -7.219419 |
| 7   | 224.0987 | 0.951994 | 2.03e-06 | -7.465333 | -6.339615 | -7.033759 |
| 8   | 228.4231 | 5.821383 | 2.04e-06 | -7.477812 | -6.201999 | -6.988695 |
| 9   | 232.4292 | 5.084632 | 2.08e-06 | -7.478045 | -6.052137 | -6.931386 |
| 10  | 234.3469 | 2.286547 | 2.31e-06 | -7.397959 | -5.821954 | -6.793756 |

Note: * indicates lag order selected by the criterion

Table 12: Pair wise Granger Causality Tests: Lags: 3

| Null hypothesis:                      | Obs | F-statistic | Probability |
|---------------------------------------|-----|-------------|-------------|
| GDP does not granger cause WPI        | 59  | 2.58946     | 0.0627      |
| WPI does not granger cause GDP        |     | 1.09168     | 0.3609      |

Note: GDP stationary at first difference with intercept; WPI stationary at first difference with intercept
Table 13: Pair wise Granger Causality Tests: Lags: 6

| Null hypothesis                         | Obs | F-statistic | Probability |
|----------------------------------------|-----|-------------|-------------|
| GDP does not granger cause WPI          | 56  | 1.36816     | 0.2492      |
| WPI does not granger cause GDP         | 2.55567 | 0.0332     |

Note: GDP stationary at first difference with intercept; WPI stationary at first difference with intercept

4.0 Conclusion

The association among money supply, general price level and output of Indian economy for the period 1950-2013 has been examined in this study. The data properties are investigate to institute the stationarity of time series using the Augmented Dickey-Fuller unit root test and The Phillips-Perron Test. The two tests indicate that all the three variables are incorporated of order one I (1). Unit root test is approved out to avoid spurious regression and the Granger Causality test is administrated by using stationarity data to find out causality relationship between variables. The consequences from correlation analysis indicate that there is well-built correlation among the three variables pairwise. The Granger causality test make known that the bidirectional causality exists stuck between the money supply and price movement. The causation runs from money supply to prices as well as price to money supply. Therefore, it is to say that the supply of money is the most important factor that determines the spending on goods and services and it causes the movement in prices.

In addition, Granger causality test signify that there is unidirectional causality running from money supply to GDP and consequently, it is accomplished that the money supply have a propensity to increase in the production of the economy. This we consider as a piece of experiential evidence behind the monetarist claim. On the other hand, it is exposed that the money supply development results in the slender increase in the production while much raise in price level. Consequently, it can be said that the outcome of money supply on price and output will be governed based on the lag structure considered. Granger causality Test has to be suspiciously used since it is very perceptive to the length of lag used in the model. In the particular study, the statistically significant lagged terms as suggested by various lag order selection criteria have been worn and it may be changed by altering the length of the lag order.

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