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Empirical Evidence on Money-Price Relationship in India: Cointegration and Causality Approach

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Abstract: In recent years, the study of the causal relationship between money supply and price level has attracted the attention of economists, researchers, and policy makers. This study shall be significant in deciding whether price stability is the primary objective of monetary policy in India. Using the sample data on consumer price index and broad money supply for the period 1950-51 to 2015-16, this study provides the evidence of long-run equilibrium relationship between money and general price level. It further suggests the existence of unidirectional causality running between money supply to general price level in the long-run. And, also confirms the presence of bidirectional causal relationship between money and price in the short-run. But it is very interesting. The causality from money supply to price is positive whereas in the reverse direction it is negative. Thus, any increase in money supply would raise the rate of inflation and hence, price stability should be considered as the primary objective of monetary policy in India. On the contrary, rising inflation can be controlled through curtailed money supply implementation of appropriate monetary policy in the country.

Keywords: Money Supply, Price, Cointegration, Granger Causality, Error Correction Model

JEL Classification Code: C32, E31, E40, E51

INTRODUCTION

In recent years, the empirical study of the dynamics of short- and long-run relationships between money supply and price level in the context of developing countries has attracted the attention of economists, researchers, and policy makers due to the fact that maintaining price level stability is now considered the foremost objective of the central bank of a country. Over the past few decades, policy makers have become more aware of the socio-economic costs of inflation, and thus, more concerned with the price level stability. Price level stability is desirable because a rise in price level creates uncertainly in the economy, and leads to lower economic growth (Fisher, 1993). The Reserve Bank of India can effectively contribute to the maintenance of price stability provided it understands the empirical robustness of the dynamic relationship between money and prices (Barma & Mukhopadhyay, 2009).

In the macro-economic literature, the relationship between money and price has been widely studied from different aspects. And, it starts with the most fundamental Quantity Theory of Money (QTM). The QTM postulates a direct and proportional relationship between money supply and price level. Classical quantity theorists maintain that the causal relationship between money and prices runs from the former to the latter. They define two channels through which money influences price level, viz., the direct and indirect channels. The direct mechanism relies on the disequilibrium between actual and desired real balances to induce the spending that ultimately causes prices to change in proportion to the monetary expansion. On the other hand, the indirect mechanism refers to the process by which a monetary change influences spending and prices indirectly via a prior effect on the interest rate. In this way, the proportionality result between money and prices in ensured in the long-run. The classical view of the role of money in determining the price level dominated the macro-economic literature till 1930s. After that, however, it encountered heavy criticism from Keynesians. Keynesian views on money and price relationship are summarized in the Phillips curve. The Phillips curve envisages that money has effects both on price level and output (unemployment). The Phillips curve posits a trade-off between money wage inflation and unemployment. Increasing money supply (money wage) helps to increase inflation and reduce unemployment. With the increase in money supply, employment opportunities, output and prices rise. Keynesians, therefore, assume a direct but not necessarily proportional relationship between money and prices.

The major response to the Keynesian criticism of the classical quantity theory came from Friedman (1956) who restated the quantity theory in terms of the demand for money function. Milton Friedman argued that the Phillips curve exists only in the short-run, but not in the long-run. This means that the Phillips curve is vertical in the long-run which again means there is a direct and proportional relationship between money supply and prices in the long-run. Friedman's analysis, therefore, distinguishes, as the classical quantity theory does, between short-run and long-run effects of an increase in the money supply. Only in the short-run, where there exists unanticipated inflation, will there be any effect on output and employment as well as on prices. In the long-run, however, when unanticipated inflation is eliminated, output and employment return to their natural rates and only prices rise. The Rational Expectation Hypothesis **(**REH) postulates that Phillips curve does not exit even in the short-run. So, any increase or decrease in money supply has a direct bearing on prices. The REH assumes that real variables including output are determined independent of monetary factors. Hence, money and prices have a direct and proportional relationship.

The empirical literature, however, provides the conflicting evidence on the direction of causality between money and prices and thus, the issue has long been a matter of controversy. In this context, this paper is an attempt to reinvestigate the causal relationship between money supply and price level in a developing country like India. Such a study would keep much relevance for economists, researchers, and policy makers of the country may be due to one or two reasons. First, currently the Indian economy is experiencing rising inflation, and thus, price stability should be the main objective of Reserve Bank of India. And, to comply this goal, the money supply should be manipulated which requires the investigation of the money-price relationship. Second, India has accelerated economic reforms since the early 1990s with outward orientation of the economy, and hence, it is important to ascertain the structural shift of money-price relationship during the study period. It is with this backdrop, the rest of the paper is structured as follows: Section 2 reviews the related literature; Section 3 discusses the data and methodology of the study; Section 4 makes the empirical analysis; and Section 5 concludes.

LITERATURE REVIEW

In view of the existing contradictions about the money-price relationship in the macro-economic literature, researchers have undertaken empirical studies on this issue across time and space. The empirical literature provides the evidence of at least four strands of relationship between money supply and the price level. The first is the money supply leading to price level change; second is the price level leading to money supply change; third is the feedback relationship; and fourth is the no relationship between them. We present here time period wise review of extant literature so as to understand the development of the concept, gravity of the issue and also methodological improvements.

In a seminal study, Brillembourg & Khan (1979) tested the money-price causality for U.S over the period 1870-1975. The study used the methodology developed by Sims (1972). The test consists of regressing money (prices) on past, present and future values of prices (money). If money causes prices then the coefficients of all future values of money should be approximately equal to zero in the regression. The results showed unidirectional causation from money to prices. The results confirm the basic long-run monetarist proposition of Friedman & Schwartz (1963) that money causes prices. Latter, Sharma (1984) investigated the causality between price level and money supply (M_1 and M_2) using Granger (1969) and Sims (1972) statistical techniques for the period 1962-1980 and established a bidirectional causality between M_1 and Price level as well as between M_2 and Price level. Although the study found the causality from M_1 to price level was much stronger than the reverse causality between prices to M_1. Parikh (1984) examined the relationship between money supply and prices for Indonesia, and the hypothesis of any causality is rejected by both Granger and Sims tests. Nachane & Nadkarni (1985) found unidirectional causality from money stock to prices based on the study over the period 1960-1961 to 1981-1982. In the study the causality results between real income and money stock remained inconclusive. Darrat (1986) examined the direction of causation between money and prices for Morocco, Tunisia and Libya over the period 1960:Q1 and 1980:Q2. The results show a unidirectional causation running from money to prices without feedback for all the three countries concerned. Darrat (1986) concluded that the results support the monetarist view of money causes inflation. Jones (1989) examined the causality between money and prices for US over the period 1959:Q1 to 1986:Q2. The results, however, show feedback relationship between the measures of money growth (M_1 and M_2) and inflation (CPI and WPI). Singh (1989) using data on broad money (M_3) and movements in the wholesale price index, questioned the proposition that changes in the price level are primarily the result of changes in the rate of growth of money supply in India. This study revealed comparatively less significant causality from money supply to prices. Biswas & Saunders (1990) found bidirectional causality or feedback between money supply (M_1, M_2) and price level (WPI) by using quarterly data for two periods: 1962-1980 and 1957-1986. The study used Hsiao's (1981) lag selection criteria and contradicted findings of Sharma (1984) of comparatively weaker reverse causality between M_1 to Price level. Sharma (1991) re-examined the issue using Granger's causality test and found that there exists unidirectional causal flow from narrow money to price level, on the one hand and on the other hand, there exists unidirectional causal flow from broad money to price level for the period 1954 to 1985. Masih & Masih (1994) examined the causality between money and prices in the context of India. Consistent with the view of the monetarist, but contrary to that of the structuralists, the study tends to suggest that the money supply is the leading variable and price is the lagging variable in the case of India for period 1961 through 1990. In another study, Masih & Masih (1997) re-examined the issue of causality between money and prices both in the bi-variate and multivariate context of a small developing economy, based on an improved methodology. Pakistan was used as a case study. The study tends to suggest rather strongly that in the case of Pakistan during the period under consideration (1970-71 to 1993-94), contrary to earlier findings, it is price that is the leading variable as the structuralists maintain, and not the other way around as the monetarist maintain. Masih & Masih (1998) further investigated the causality between money (M_1 and M_2) and prices for four South-East Asian developing countries, namely Thailand, Malaysia, Singapore, and the Philippines over the period 1961 to 1990. The study found that money supply leads to price which is in agreement with the monetarist view. Pradhan & Subramanian (1998) examined the long-run relationship between supply of money and prices in India and using the cointegration test it provides the evidence of stable relationship between the variables in the long-run.

The NRB (2001) in a study found that there is a feedback interaction between money supply and price in Nepal over1975:Q3 through 1999:Q2. Pinga & Nelson (2001) examined the relationship between money supply and aggregate prices for 26 countries, and found no causal relationship between prices and money (M_1 and M_2) in Malaysia. The study also found that aggregate prices cause money supply in Chile and Sri Lanka, which are in agreement with the structuralists view. Evidence of money supply exogeneity was also found to be strongest in Kuwait, Paraguay, and US. Most countries exhibited mixed evidence of money supply endogeneity, with bi-directional causation between money supply and aggregate prices a common result. Das (2003) examined the long-run relationship between money and prices in India and provides the evidence of no long-run relationship between variables on the basis of cointegration test, but using VARMA model suggests the existence of short-run bidirectional causality between them. Tang (2004) by using the modified Wald test examined the causality between money (M_2) and prices in Malaysia for the period 1970 to 1998 and found that there is unidirectional causality running from money to prices, and it supports the monetarist view. Benbouziane & Benamar (2004) for three Maghreb countries found that there is unidirectional causation from money to prices in the case of Morocco and Tunisia, supports the findings of Darrat (1986). On the other hand, the results also show the apparent absence of causality between money and prices in the case of Algeria, which is not easy to explain. Ashra *et al.* (2004) established the bidirectional causality between price (GDP deflator) and M_3 for India. Ghazali *et al.* (2008) examined the relationship between money and prices for Malaysia using Toda-Yamamoto causality tests and found that there is unidirectional causality running from money supply to CPI. Therefore, the empirical evidence for Malaysia supports the Quantity Theorist's view. Barma & Mukhopadhyay (2009) using VECM provides the evidence that there exists unidirectional Granger causality running from money supply to prices and in the economy of Maldives. Mishra *et al.* (2010) in the context of India found the evidence of bidirectional causality between money supply and output, and unidirectional causality running from price level to money supply as well as from price level to output in the long-run. And, it is also found that short-run bidirectional causality exists between money supply and price level. Ahmed & Suliman (2011) provides the evidence of unidirectional causal relationship running from money supply to prices in the context of Sudan for the sample period 1960-2005. Singh *et al.* (2015) provides the evidence of the feedback relationship between money and prices in India, and such relationship depends on the choice of variable and time frame. Therefore, it is inferred from the review of the above mentioned related literature that the issue of the causal relationship between money and prices is still a moot point and hence, requires further attention. It is with this impression in mind, this paper proceeds to make an empirical reinvestigation of the said debate for an emerging market economy like India.

DATA AND METHODOLOGY

The objective of this paper is to reinvestigate the dynamics of the causal relationship between money and price in India for the sample period spanning from 1950-11 to 2015-16. In this study the variables are money supply and consumer price index (*CPI*). Money supply is measured in terms of broad money (M_3) which consists of currency with the public, other deposits with Reserve Bank of India and demand deposits of banks and time deposits. Similarly, the proxy for price level is CPI. The annual data on consumer price index are obtained from International Financial Statistics database of International Monetary Fund. All other annual data are obtained from the Handbook of Statistics on Indian Economy published by Reserve Bank of India. All the variables are taken in their natural logarithms to avoid the likely problems of heteroscedasticity. The estimation methodology employed in this study has four steps. In the first step, we test the stationary properties of the time series under consideration. In the second step, we examine the equilibrium relationship between variables. In the third step, we estimate the vector error correction model to assess the long-run relationship between money and price level. In the last step, we focus on the short-run relationship between them. All these four steps are discussed as follows.

The time series econometric methodology, first examines the stationarity properties of each time series of consideration. The present study uses Augmented Dickey-Fuller (ADF) unit root test to examine the stationarity of the data series. It 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:

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

The additional lagged terms are included 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. Rejection of the null hypothesis implies stationarity. Precisely, the null hypothesis is that the variable Y_t is a non-stationary series (H_0: $\alpha_2 = 0$) and is rejected when α_2 is significantly negative (H_a: $\alpha_2 < 0$). If the calculated value of ADF statistic is higher than McKinnon's critical values, then the null hypothesis (H_a) is not rejected and the series is non-stationary or not integrated of order zero, I(0). Alternatively, rejection of the null hypothesis implies stationarity. 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. If the time series (variables) are non-stationary in their levels, they can be integrated with I(1), when their first differences are stationary.

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. Cointegration analysis is important because if two non-stationary variables are cointegrated, a VAR model in the first difference is misspecified due to the effects of a common trend. If cointegration relationship is identified, the model should include residuals from the vectors (lagged one period) in the dynamic VECM system. In this stage, Johansen's cointegration test is used to identify cointegrating relationship among the variables. The Johansen method applies the maximum likelihood procedure to determine the presence of cointegrated 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. In the Johansen framework, the first step is the estimation of an unrestricted, closed p^{th} order VAR in k variables. The VAR model as considered in this study is:

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_p Y_{t-p} + BX_t + \varepsilon_t \tag{2}$$

Here Y_t is a k-vector of non-stationary I(1) endogenous variables, X_t is a d-vector of exogenous deterministic variables, $A_1 \ldots\ldots\ldots A_p$ and B are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables. Since most economic time series are non-stationary, the above stated VAR model is generally estimated in its first-difference form as:

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + BX_t + \varepsilon_t \tag{3}$$

Where, $$\Pi = \sum_{i=1}^{p} A_i - I, \quad and \quad \Gamma_i = -\sum_{j=i+1}^{p} A_j$$

Granger's representation theorem asserts that if the coefficient matrix Π has reduced rank $r < k$, then there exist $k \times r$ matrices α and β each with rank r such that $\Pi = \alpha\beta'$ *and* $\beta' Y_t$ is I(0). r is the number of co-integrating relations (the *co-integrating rank*) and each column of β is the co-integrating vector. α is the matrix of error correction parameters that measure the speed of adjustments in ΔY_t. The Johansen approach to cointegration test is based on two test statistics, viz., the trace test statistic, and the maximum eigenvalue test statistic. The trace test statistic can be specified as: $\tau_{trace} = -T \sum_{i=r+1}^{k} \log(1-\lambda_i)$, where λ_i is the *ith* largest eigenvalue of matrix Π and T is the number of observations. In the trace test, the null hypothesis is that the number of distinct cointegrating vector(s) is less than or equal to the number of cointegration relations (r). The maximum eigenvalue test examines the null hypothesis of exactly r cointegrating relations against the alternative of $r + 1$ cointegrating relations with the test statistic: $\tau_{\max} = -T \log(1-\lambda_{r+1})$, where λ_{r+1} is the $(r + 1)^{th}$ largest squared eigenvalue. In the trace test, the null hypothesis of $r = 0$ is tested against the alternative of $r + 1$ cointegrating vectors. It is well known that Johansen's cointegration test is very sensitive to the choice of lag length. So first a VAR model is fitted to the time series data in order to find an appropriate lag structure. The Akaie Information Criterion (AIC), Schwarz Criterion (SC) and the Likelihood Ratio (LR) test are used to select the number of lags required in the cointegration test.

Once the cointegration is confirmed to exist between variables, then the third step requires the construction of error correction mechanism to model dynamic relationship. The purpose of the error correction model is to indicate the speed of adjustment from the short-run equilibrium to the long-run equilibrium state. A Vector Error Correction Model (VECM) is a restricted VAR designed for use with non-stationary series that are known to be cointegrated. Once the equilibrium conditions are imposed, the VECM describes how the examined model is adjusting in each time period towards its long-run equilibrium state. Since the variables are supposed to be cointegrated, then in the short-run, deviations from this long-run equilibrium will feedback on the changes in the dependent variables in order to force their movements towards the long-run equilibrium state. Hence, the cointegrated vectors from which the error correction terms are derived are each indicating an independent direction where a stable meaningful long-run equilibrium state exists. The VECM has cointegration relations built into the specification so that it restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationship while allowing for short-run adjustment dynamics. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. The dynamic specification of the VECM allows the deletion of the insignificant variables, while the error correction term is retained. The size of the error correction term indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium state. In this study the error correction model as suggested by Hendry (1986) has been used. The general form of the VECM is as follows:

$$\Delta X_t = \alpha_0 + \lambda_1 EC^1{}_{t-1} + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \sum_{j=1}^{n} \alpha_j \Delta \mathrm{Y}_{t-j} + \varepsilon_{1t} \tag{4}$$

$$\Delta \mathrm{Y}_t = \beta_0 + \lambda_2 EC^2{}_{t-1} + \sum_{i=1}^{m} \beta_i \Delta \mathrm{Y}_{t-i} + \sum_{j=1}^{n} \beta_j \Delta X_{t-j} + \varepsilon_{2t} \tag{5}$$

Here Δ is the first difference operator; EC_{t-1} is the error correction term lagged one period; λ is the short-run coefficient of the error correction term (–1 < λ < 0); and ε is the white noise. The error correction coefficient (λ) is very important in this error correction estimation as greater the co-efficient indicates higher speed of adjustment of the model from the short-run to the long-run. The error correction term represents the long-run relationship. A negative and significant coefficient of the error correction term indicates the presence of long-run causal relationship. If both the coefficients of error correction terms in both the equations are negative and significant, this will suggest the bi-directional causality. If only λ_1 is negative and significant, this will suggest a unidirectional causality from Y to X, implying that Y drives X towards long-run equilibrium but not the other way around. Similarly, if λ_2 is negative and significant, this will suggest a unidirectional causality from X to Y, implying that X drives Y towards long-run equilibrium but not the other way around. On the other hand, the lagged terms of ΔX_t and ΔY_t appeared as explanatory variables, indicate short-run cause and effect relationship between the two variables. Thus, if the lagged coefficients of ΔX_t appear to be significant in the regression of ΔY_t, this will mean that X causes Y. Similarly, if the lagged coefficients of ΔY_t appear to be significant in the regression of ΔX_t, this will mean that Y causes X. In the last step, we have employed Granger causality test so as to confirm the short-run dynamics of the relationship between money and price level.

EMPIRICAL ANALYSIS

At the outset, the Pearson's correlation coefficient between Broad Money (M_3) and Consumer Price Index (CPI) has been calculated over the sample period and its significance has been tested by the t-test. The value of Pearson's correlation coefficient (r) between these two time series over the sample period is 0.99. It shows that Broad Money (M_3) and Consumer Price Index (CPI) are positively related in India and that to a very high degree of correlation is evident between these two variables. To test whether this value of 'r' shows a significant relationship between two time series, student's t-test has been used. The null hypothesis of the test is $r = 0$ against the alternative of $r \neq 0$. Since the t-statistic at 65 degrees of freedom is 15.61 and the critical value of 't' at 5% level of significance is less than it, the null hypothesis is rejected. So, it can be said that the correlation between Broad Money (M_3) and Consumer Price Index (CPI) is statistically significant. Correlation, however, does not say anything about long-run relationship and thus, leaves unsettled the debate concerning the long-run relationship between Broad Money (M_3) and Consumer Price Index (CPI).

Table 1
Results of ADF Unit Roots Test

Variables	*ADF Statistic at level with trend and Intercept*	*p-value*	*ADF Statistic at 1st Difference with trend and Intercept*	*p-values*
$ICPI_t$	1.118	0.997	-5.351	0.000*
$LM3_t$	1.168	0.997	-5.256	0.000*

Source: Authors' Own Estimation * significant at 1% level;

Before proceeding with the time series analysis, it is required to determine the order of integration for each of the two variables used in this analysis. The Augmented Dickey-Fuller unit root test has been used for this purpose, and the results of such test are reported in Table 1. It is clear that the null hypothesis of no unit roots for both the time series are rejected at their first differences since the ADF test statistic values are less than the critical values at 10%, 5% and 1% levels of significances. Thus, the variables are stationary and integrated of same order, i.e., I(1).

In the next step, the cointegration between the stationary variables has been tested by the Johansen's Trace and Maximum Eigenvalue tests. The results of these tests are shown in Table-2. The Trace test indicates the existence of one cointegrating equation at 5% level of significance. And, the maximum eigenvalue test makes the confirmation of this result. Thus, the two variables of the study have long-run equilibrium relationship between them. But in the short-run there may be deviations from this equilibrium and we have to verify whether such disequilibrium converges to the long-run equilibrium or not. And, Vector Error Correction Model can be used to generate this short-run dynamics. Error correction mechanism provides a means whereby a proportion of the disequilibrium is corrected in the next period. Thus, error correction mechanism is a means to reconcile the short-run and long-run behaviour.

Table 2
Results of Johansen's Cointegration Test

Hypothesized Number of Cointegrating Equations	*Eigen Value*	*Trace Statistics*	*Critical Value at 5%(p-value)*	*Maximum Eigen statistics*	*Critical Value at 5%(p-value)*
None*	0.2981	29.0388	20.261(0.002)	22.3011	15.892(0.004)
At Most 1	0.1014	6.7377	9.164(0.141)	6.7377	9.164(0.0141)

Source: Authors' Own Estimation * denotes rejection of the hypothesis at the 0.05 level

Table 3
Results of VECM Estimation

Independent Variable	$\Delta LCPI_t$	$\Delta LM3_t$
EC_{t-1} [t-statistic] (p-value)	-0.0795*** [-1.8128](0.0724)	0.1362 [4.8775](0.0000)
$\Delta LCPI_{t-1}$ [t-statistic] (p-value)	0.4755*[3.5451](0.0006)	-0.1812*[-2.1218](0.0360)
$\Delta LCPI_{t-2}$ [t-statistic] (p-value)	-0.1337[-1.0797](0.2825)	0.0575[0.7289](0.4675)
$\Delta LM3_{t-1}$ [t-statistic] (p-value)	0.6293*[3.3638](0.0010)	0.3271*[2.7465](0.0070)
$\Delta LM3_{t-2}$ [t-statistic] (p-value)	-0.0628[-0.3566](0.7220)	0.3160*[2.8183](0.0057)

Source: Authors' Own Estimation * significant at 1% level; *** significant at 10% level.

The estimation of a Vector Error Correction Model (VECM) requires the selection of an appropriate lag length. The number of lags in the model has been determined according to Schwarz Information Criterion (SIC). The lag length that minimizes the SIC is 2. Then an error correction model with the computed t-values of the regression coefficients is estimated and the results are reported in Table-3. The estimated coefficient of error-correction term in the LCPI equation is statistically significant and has a negative sign, which confirms that there is not only any problem in the long-run equilibrium relation between the independent and dependent variables in 5% level of significance, but its relative value (-0.0795) for India shows the rate of convergence to the equilibrium state per year. Precisely, the speed of adjustment of any disequilibrium towards a long-run equilibrium is that about 7.95 percent of the disequilibrium in consumer price index is corrected each year. Furthermore, the negative and statistically significant value of error correction coefficient indicates the existence of a long-run causality between the variables of the study. And, this causality is unidirectional in our model being running from the broad money to consumer price index. In other words, the changes in consumer prices can be explained by broad money supply.

The existence of Cointegration implies the existence of Granger causality at least in one direction (Granger, 1988). The long-run causality test from the VECM indicates that causality runs from money supply to consumer prices, since the coefficient of the error term in LCPI equation is statistically significant and negative based on standard t-test which means that the error correction term contributes in explaining the changes in consumer prices. However, the coefficient of the error correction term in the LM_3 equation is positive which means that the error term does not contribute in explaining the changes in money supply, even if it is statistically significant. Therefore, there is unidirectional causality running from the money supply to price level.

The coefficient of the first difference of LCPI lagged one period in LCPI equation is positive and significant which indicates that the past values of price level has power to forecast the future values of it. In addition to this finding, the coefficient of the first difference of LM_3 lagged one period in LCPI equation is statistically significant which indicates the presence of short-run causality from money supply to price level based on VECM estimates. Furthermore, the coefficient of the first difference of LCPI lagged one period in LM_3 equation is negative and statistically significant which indicates the presence of short-run causality from price to money supply in India. And, the negative sign of the coefficient means the forecast of decline in money supply if the price level would rise. In order to confirm this result of the short-run causality between the LCPI and the LM_3 based on VECM estimates, a standard Granger causality test has

Table 4
Results of Granger Causality Test

Null Hypothesis	*F-Statistic*	*Probability*	*Decision*
ΔLM_3 does not Granger Cause $\Delta LCPI$	5.641	0.005	Rejected at 5% level of significance
$\Delta LCPI$ does not Granger Cause ΔLM_3	2.691	0.076	Rejected at 5% level of significance

Source: Authors' Own Estimation (Number of lags = 2)

been performed based on F-statistics taking the variables in their first difference form. The results are presented in Table-4. It is clear that both the null hypotheses are statistically rejected at 5% level of significance. It means there is the presence of bidirectional or feedback relationship between money and price in the short-run. In other words, both the variables contain power to forecast each other in the short-run. This finding supports the previous results obtained from VECM for the short-run.

CONCLUSION

In this paper, the relationship between money supply and price in a developing country like India has been investigated using popular time series methodologies. The data properties are analyzed to determine the stationarity of time series using the Augmented Dickey-Fuller unit root test which indicates that the two series are I(1). The results of the Cointegration test based on Johansen's procedure indicate the existence of the Cointegration between money supply and price. Therefore, the two variables have a long-run equilibrium relationship exists, although they may be in disequilibrium in the short-run. The vector error correction model based on VAR indicates that about 7.95% of disequilibrium is corrected each year. In addition, the negative and significant error correction term in LCPI equation supports the existence of a long-run equilibrium relationship between money supply and price. Furthermore, the estimates of the VECM indicate the existence of a unidirectional causality running from money supply to price in the long-run. The Granger causality test indicates that there is a bidirectional causal relationship between money supply and price in the short-run. However, the causality running from money supply to price is positive and that of from price to money supply is negative. It means increase in money supply would result in increase in the general price level. A closer look reveals that money supply affects the price level after one year. Hence, it is the money supply that takes the lead in increasing the rate of inflation in India. On the other hand, the negative causal relationship from price to money supply indicates that increase in price level would forecast a decline in money supply. These findings are very significant from the policy point of view. One of the policy implications is that the monetary authorities and policy makers are required to device prudential norms so as to manipulate the money supply for the price stability in the long-run which in turn would contribute to the sustainable development of the country. Another policy implication is that rise in price level or inflation can be curbed by reducing the money supply in the economy through appropriate monetary policies.

REFERENCES

Ahmed, A.E.M., & Suliman, S.Z. (2011), The Long-Run Relationship between Money Supply, Real GDP, and Price Level: Empirical Evidence from Sudan, *Journal of Business Studies Quarterly*, 2(2): 68-79

Ahmed, M. (2003), Money-Income and Money Price Causality in Selected SAARC Countries: Some Econometric Exercises, *The Indian Economic Journal*, 50(1): 54-76

Ashra, S., Chattopadhyay, S. and Chaudhuri, K. (2004), Deficit, Money and Price: The Indian Experience, *Journal of Policy Modelling*, 26(3): 289-299.

Barma, S. C. and Mukhopadhyay, C. K. (2009), Money and Price Relationship in the Economy of Maldives – An econometric Study, *The Indian Journal of Economics*, 90(356): 47-72.

Benbouziane, M. & Benamar, A. (2004), The Relationship between Money and Prices in the Maghreb Countries: A Cointegration Analysis, *The 11th Annual Conference of the Economic Research Forum (ERF),* Beirut – Lebanon –December, 16-28.

Biswas, B., & Saunders, P. J. (1990), Money and Price Level in India: An Empirical Analysis, *Indian Economic Journal*, 35: 103–113.

Brahmananda P. R. and Nagaraju G. (2003), Quantity Theory of Money in the Indian Empirical Setting, *The Indian Economic Journal*, 50(1): 88-94

Brillembourg, A. and Khan, M.S. (1979), The Relationship between Money, Income and prices: Has Money Mattered Historically, *Journal of Money, credit and Banking*, 11: 358-65.

Darrat, A.F. (1986), Money, Inflation and Causality in the North African Countries: An Empirical Investigation, *Journal of Macroeconomics,* 8(1): 87-103.

Das, S. (2003), Modelling Money, Price and Output in India: A Vector Autoregressive and Moving Average (VARMA) Approach, *Applied Economics*, 35(10): 1219-1225

Dickey, D.A and W.A. Fuller (1981), Likelihood Ratio Statistics for Autoregressive Time Series, *Econometrica*, 49(4): 1057-1072.

Dickey, D.A. and W.A. Fuller (1979), Distribution for Estimators for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Society,* 74(366): 427-431.

Engle, R.F. and Granger, C.W.J. (1987), Cointegration and Error Correction: Representation, Estimation and Testing, *Econometrica*, 55(2): 251-76.

Fisher, S., (1993), The role of Macroeconomic Factors in Growth, *Journal of Monetary Economics,* 32(3): 485-512.

Friedman, M. (1956), The Quantity theory of Money, in *Studies in the Quantity Theory of Money*, (eds.) M. Friedman, University of Chicago Press, Chicago

Friedman, M. and Shwartz, A.J. (1963), The Definition of Money: Net wealth and neutrality as criteria, *Journal of Money, Credit and Banking*, 1(1): 1-14.

Friedman, Milton, (1968), The Role of Monetary Policy, *American Economic Review,* 58(1): 1-17.

Ghazali, M. F., Amin, H., Muhammad, M. Z. and Samsu, S. H. (2008), Linkage between Money and Prices: A Causality Analysis for Malaysia, *International Business Research*, 1(4): 82-87

Granger C. W. G. (1969), Investigating Causal Relationships by Economic Models and Cross Spectral Models, *Econometrica*, 37(3): 424-438

Granger C. W. J. (1988), Some Recent Development in a Concept of Causality *Journal of Econometrics*, 39(1/2): 199-211.

Granger, C.W.J. (1986), Developments of the Study in Cointegrated Variables, *Oxford Bulletin of Economics and Statistics,* 48(3): 213-228.

Jha R. and Donde K. (2002), The Real Effects of Anticipated and Unanticipated Money: A Test of the Barro Proposition in the Indian Context, *The Indian Economic Journal*, 49(1): 21-30

Johansen, S. (1988), Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control*, 12(2/3): 231-254.

Johansen, S. (1989), The Power of the Likelihood Ratio Test for Cointegration, *Institute of Mathematical Statistics, University of Copenhagen*, (Mimeographed).

Johansen, S. (1991), Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models, *Econometrics*, 59(6): 1551-1580.

Johansen, S. (1992), Cointegration in Partial Systems and the Efficiency of Single Equation Analysis, *Journal of Econometrics,* 52(3): 389-402.

Johansen, S. (1995), *Likelihood-Based Inference in Cointegrated Vector Autoregressive Models.* Oxford: Oxford University Press.

Johansen, S., and K. Jusellius (1990), Maximum Likelihood Estimation and Inference on Cointegration - with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics*, 52(2): 169-210.

Jones, J. D. (1989), A Comparison of Lag Length Selection Techniques in Tests of Granger Causality between Money Growth and Inflation, *Applied Economics*, 21(6): 809-822.

Masih, A. M. M. and R. Masih (1994), Temporal Causality between Money and Prices in LDCs and the Error-Correction Approach: New Evidence from India, *Indian Economic Review*, 29(1): 33-55.

Masih, Abul M. M. and Masih, Rumi, (1998), Does Money Cause Prices, or the Other Way Around? - Multi-Country Econometric Evidence Including Error-Correction Modelling from South-East Asia", *Journal of Economic Studies*, 25(3): 138 – 160

Masih, A. M. M. and R. Masih, (1997), Bivariate and Multivariate Tests of Money-Price causality: Robust Evidence from a Small Developing Country, *Journal of International Development*, 9(6): 803-825.

Mishra, P. K., U. S. Mishra, and S. K. Mishra (2010), Money, Price and Output: A Causality Test for India, *International Research Journal of Finance and Economics,* 53: 26-36

Nachane, D. M., & Nadkarni, R. M. (1985), Empirical Tests of Certain Monetarist Propositions via Causality Theory, *Indian Economic Journal*, 33(1): 13-41.

NRB (2001), Money and Price Relationship in Nepal: A Revisit, *Economic Review: Occasional paper No.13*, Nepal Rastra Bank, pp. 50-65.

Parikh, A (1984), Causality between Money and Prices in Indonesia, *Empirical Economics*, 9(4): 217-232

Pinga, V. E. B. and Nelson, G. C. (2001), Money, Prices and Causality: Monetarist Vs. Structuralists Explanation Using Pooled Country Evidence, *Applied Economics*, 33(10): 1271-1281

Pradhan, B. K. and Subramanian, A (1998), Money and Prices: Some Evidence from India, *Applied Economics*, 30(6): 821-827.

Sharma R. L. (1991), Causality between Money and Price Level Revisited, *Artha Vijnana*, 33(2): 126-41

Sharma, R. (1984), Causality between Money and Price Level in India, *Indian Economic Review*, 19(2): 213-21.

Sims, C. (1972), Money, Income, and Causality, *American Economic Review*, 62(4): 540-552.

Singh, B. (1989), Money Supply- Price Causality Revisited, *Economic and Political Weekly*, 24(47): 1613-1615.

Singh, C., Das, R., & Baig, J. (2015), Money, Output and Prices in India, *IIMB Working Paper No.497*, Indian Institute of Management Bangalore, Bangalore, India

Tang, T. C. (2004), Causality between Money and Price in Malaysia: A Revisit, *Labuan Bulletin of International Business and Finance*, 2(1): 71-81.