On the Temporal Causal Relationship between Macroeconomic Variables: Empirical Evidence from India

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Abstract

The present study examines the dynamic interactions among macroeconomic variables such as real output, prices, money supply, interest rate and exchange rate in India during the pre-economic crisis and economic crisis periods, using the ARDL bounds test for cointegration, Johansen and Juselius (1990) multivariate cointegration test, Granger causality/Block exogeneity Wald test based on Vector Error Correction Model, variance decomposition analysis and impulse response functions. The empirical results reveal a stronger long-run bilateral relationship between real output, price level, interest rate and exchange rate during the pre-crisis sample period. Moreover, the empirical results confirm a unidirectional short-run causality running from price level to exchange rate, interest rate to price level and real output to money supply during the pre-crisis period. Also, it is evident from the test results that there exist short-run bidirectional relationships running between real output and exchange rate, price level and interest rate in the pre-crisis era. In addition, the feedback relationship is also observed between interest rate and exchange rate variables in the short-run. Most importantly, long-run bidirectional causality is found between real output, exchange rate and interest rate during the economic crisis period. And the study results indicate short-run bidirectional causality between money supply and exchange rate, interest rate and price level and interest rate and output in India during the crisis era. Also, a short-run unidirectional causality runs from prices to real output in the crisis period.

Keywords: Macroeconomic variables, Cointegration, Causality, Variance Decomposition Analysis, Impulse Response Functions

JEL Classification: C22, E40, E50

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I. Introduction

The relationship among money supply, income and prices has long been a subject of controversy between the Keynesian and monetarist schools of thought. Different schools of economic thought have postulated various theories on relationships between macroeconomic variables. The classical school explained that a change in prices is basically due to changes in money supply. However, Keynesians criticised and rejected the proportionality between money supply and prices due to its instability in explaining the causes and remedies for the great economic debacle like Great Depression of 1930s. The Keynesians held the view that money does not play an active role in changing income and prices nor does it causes instability in the economy. They postulated that changes in income causes changes in money stock via demand for money implying that the direction of causation runs from income to money, not vice versa. Monetarists, on the other hand, argued that money plays an active role and leads to the changes in income and prices. There is unidirectional causation that runs from money to income and prices. Moreover, Fischer (1962) claimed the possibility of reverse causation and concluded that there is mutual interaction between money and other macro-variables. Friedman and Schwartz (1963) also supported this argument by stating that though the influence of money to economic activity is predominant, there is also the possibility of influences running the other way (at least in the short run). The Banking school also supported the reverse causation between money and income, thereby arguing for endogeneity of money supply (Froyen, 2004).

As a consequence of conflicting theoretical debate, the relationship has been extensively investigated in empirical literature by researchers for both developed and developing countries over different sample periods and provided the conflicting evidences on this issue. Examples include Ramachandra (1986), Miller (1991), Friedman and Kuttner (1992), Ramachandran and Kamaiah (1992), Stock and Watson (1993), Boucher and Flynn (1997), Brahmananda and Nagaraju (2003), Ramachandran (2004), Jamie (2005), Herwartz and Reimers (2006), Majid (2007), Saatcioglu and Korap (2008), Jiranyakul (2009), Rami (2010), Maitra (2011), Hossain (2011), Yadav and Lagesh (2011), Shams (2012) and Sohail et al. (2012).

One of the most important objectives of macroeconomic policy modeling is to achieve sustained output growth. Formation of effective macroeconomic policy requires examination of underlying relationship among the policy variables. With the emerging market crises of the late 2000s, the macroeconomic policies in emerging economies like India has come under intense scrutiny by academics as well as policymakers and received increased attention. Though the Indian economy experienced acceleration in growth in the early 2000s, with India's increased linkage with the world economy, India could not be expected to remain immune to the recent ongoing global economic crisis. The knock-on effect of the financial crisis was felt in all the sectors of the economy and this created disturbances in the macroeconomic environment of Indian economy. This include fluctuations in money supply, increase in price level, accelerating inflation, instability in exchange rate and affecting the aggregate output of the economy. Before the economic crisis of 2008, India recorded a average GDP growth of 8 percent per annum during 2003-07, but on the onset of global crisis with the adverse impact of demand shocks, the economic growth fell from 9.2 percent in 2007-08 to 6.7 percent and 6.5 percent in 2008-09 and 2010-11, respectively. This has significantly affected the macroeconomic relationship of monetary and real sector variables. It is worth emphasizing that the empirical issue of money, price, output, exchange rate and interest rate relationships is of crucial importance to the Indian economy given the current economic environment. The present study assumes greater significance for effective implementation of its monetary policy and achieves the desired target of growth keeping stability of prices and exchange rates. Further, since global economic crisis of 2008, no study exists in India which had examined the causal directions among macroeconomic variables in the context of recent ongoing global economic crisis. In this paper, we attempts to investigate the causal nexus between money, income, price, interest rate and the exchange rates in India during pre-global economic crisis and crisis era.

The remainder of our paper is organized as follows. Section 2 presents methodology and data of the study. The empirical results and discussion are provided in section 3 and section 4 presents concluding remarks.

II. Methodology and Data

ARDL bounds testing approach to Cointegration

The ARDL bounds testing approach was employed to investigate the long-run equilibrium relationship among the selected macroeconomic variables in India during the pre-crisis period. The ARDL modeling approach was originally introduced by Pesaran and Shin (1999) and further extended by Pesaran et al (2001). This approach estimates the short- and long-run components of the model simultaneously, removing problems associated with omitted variables and autocorrelation. Besides, the standard Wald or F-statistics used in the bounds test has a non-standard distribution under the null hypothesis of no-cointegration relationship between the examined variables, irrespective whether the underlying variables are I(0), I(1) or fractionally integrated. Moreover, once the orders of the lags in the ARDL model have been appropriately selected, we can estimate the cointegration relationship using a simple Ordinary Least Square (OLS) method. The ARDL-Unrestricted error correction model used in the present study has the following form as expressed in Equation (1):

$$\Delta InY_1 = \beta_0 + \sum_{i=1}^{m} \delta_1 \Delta InY_{2t-i} + \sum_{i=1}^{n} \delta_2 \Delta InY_{3t-i} + \sum_{i=1}^{p} \delta_3 \Delta InY_{4t-i} + \sum_{i=1}^{q} \delta_4 \Delta InY_{5t-i} + \sum_{i=1}^{r} \delta_5 \Delta InY_{1t-i} +$$
$$\beta_1 InY_{1t-i} + \beta_2 InY_{2t-i} + \beta_3 InY_{3t-i} + \beta_4 InY_{4t-i} + \beta_5 InY_{5t-i} + \varepsilon_t \quad (1)$$

$$\Delta InY_2 = \beta_0 + \sum_{i=1}^{m} \delta_1 \Delta InY_{1t-i} + \sum_{i=1}^{n} \delta_2 \Delta InY_{3t-i} + \sum_{i=1}^{p} \delta_3 \Delta InY_{4t-i} + \sum_{i=1}^{q} \delta_4 \Delta InY_{5t-i} + \sum_{i=1}^{r} \delta_5 \Delta InY_{2t-i} +$$
$$\beta_1 InY_{1t-i} + \beta_2 InY_{3t-i} + \beta_3 InY_{4t-i} + \beta_4 InY_{5t-i} + \beta_5 InY_{2t-i} + \varepsilon_t \quad (2)$$

$$\Delta InY_3 = \beta_0 + \sum_{i=1}^{m} \delta_1 \Delta InY_{1t-i} + \sum_{i=1}^{n} \delta_2 \Delta InY_{2t-i} + \sum_{i=1}^{p} \delta_3 \Delta InY_{4t-i} + \sum_{i=1}^{q} \delta_4 \Delta InY_{5t-i} + \sum_{i=1}^{r} \delta_5 \Delta InY_{3t-i} +$$
$$\beta_1 InY_{1t-i} + \beta_2 InY_{2t-i} + \beta_3 InY_{4t-i} + \beta_4 InY_{5t-i} + \beta_5 InY_{3t-i} + \varepsilon_t \quad (3)$$

$$\Delta InY_4 = \beta_0 + \sum_{i=1}^{m} \delta_1 \Delta InY_{1t-i} + \sum_{i=1}^{n} \delta_2 \Delta InY_{2t-i} + \sum_{i=1}^{p} \delta_3 \Delta InY_{3t-i} + \sum_{i=1}^{q} \delta_4 \Delta InY_{5t-i} + \sum_{i=1}^{r} \delta_5 \Delta InY_{4t-i} +$$
$$\beta_1 InY_{1t-i} + \beta_2 InY_{2t-i} + \beta_3 InY_{3t-i} + \beta_4 InY_{5t-i} + \beta_5 InY_{4t-i} + \varepsilon_t \quad (4)$$

$$\Delta InY_5 = \beta_0 + \sum_{i=1}^{m} \delta_1 \Delta InY_{1t-i} + \sum_{i=1}^{n} \delta_2 \Delta InY_{2t-i} + \sum_{i=1}^{p} \delta_3 \Delta InY_{3t-i} + \sum_{i=1}^{q} \delta_4 \Delta InY_{4t-i} + \sum_{i=1}^{r} \delta_5 \Delta InY_{5t-i} +$$

$$\beta_1 InY_{1t-i} + \beta_2 InY_{2t-i} + \beta_3 InY_{3t-i} + \beta_4 InY_{4t-i} + \beta_5 InY_{5t-i} + \varepsilon_t \quad (5)$$

where, Y_1, Y_2, Y_3, Y_4 and Y_5 represents selected macroeconomic variables for the study such as exchange rate (EXR), money supply (M3), price level (CPI), index of industrial production (IIP) and interest rate (IR), respectively. t is the time dimension and Δ denotes a first difference operator; β_0 is an intercept and ε_t is a white noise error term.

The first step in the ARDL bounds testing approach is to estimate Equations (1-5) using ordinary least squares method in order to test for existence of a long-run relationship among the variables by conducting an F-test for the joint significance of the coefficients of the lagged level variables, i.e., H_0: $\delta_1=\delta_2=\delta_3=\delta_4= \delta_5 = 0$ against the alternative H_1: $\delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq 0$, which normalize on Y_1 by $F(Y_1/Y_2, Y_3, Y_4, Y_5)$. Two sets of critical value bounds for the F-statistic are generated by Pesaran et al (2001). If the computed F-statistic falls below the lower bound critical value, the null hypothesis of no cointegration cannot be rejected. Contrary, if the computed F-statistic lies above the upper bound critical value; the null hypothesis is rejected, implying that there is a long-run cointegration relationship amongst the variables in the model. Nevertheless, if the calculated value falls within the bounds, inference is inconclusive. Similar testing procedure was followed to calculate the F-statistic when each of Y_2, Y_3, Y_4, Y_5 appear as a dependent variable and other variables are considered as explanatory variables in the specification.

Johansen and Juselius (1990) multivariate cointegration approach

Johansen and Juselius (1990) multivariate cointegration approach was employed to investigate the long-run equilibrium relationship among the selected macroeconomic variables in India during the crisis period. Before doing cointegration analysis, it is necessary to test the stationary of the series. The Augmented Dickey-Fuller (1979) test was employed to infer the stationary of the series. If the series are non-stationary in levels and stationary in differences, then there is a chance of cointegration relationship between them which reveals the long-run relationship between the series. Johansen's cointegration test has been employed to investigate the long-run relationship between the variables. Besides, the causal nexus between selected macroeconomic variables was investigated by estimating the following Vector Error Correction Model (VECM) (Johansen, 1988 and Johansen and Juselius, 1990):

$\Delta Y_t = \mu + \Gamma_i \Delta Y_{t-i} + \ldots\ldots + \Gamma_{k-1} \Delta Y_{t-k+1} + \Pi Y_{t-1} + \varepsilon_t$ (6)

where ΔY_t is (n x 1) vector of macroeconomic variables such as money, income, price, interest rate and the exchange rates in period t, μ is (n x 1) vector of constant terms, Γ_i (i = 1, …..k-1) represents the (n x n) coefficient matrix of short-run dynamics, Π is the n x n long-term impact matrix, and ε_{1t} is (n x 1) vector of error term and it is independent from all explanatory variables. When cointegration is present, we can decompose the long-term response matrix into A = $\alpha\beta'$, where α and β are n x r matrices. In other words, the expression $\beta' Y_{t-1}$ defines the stationary linear combinations (cointegration relations) of the I(1) vector Y_t, while the matrix α of the error correction terms describe how the system variables adjust to the equilibrium error from the previous period, $\beta' Y_{t-1}$.

The Johansen's cointegration proposed two test statistics through VAR model that are used to identify the number of cointegrating vectors, namely the trace test statistic and the maximum eigen-value test statistic. These test statistics can be constructed as:

$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} 1n\left(1-\hat{\lambda}_i\right)$ (7)

$\lambda_{max}(r, r+1) = -T\,1n\left(1-\hat{\lambda}_{r+i}\right)$ (8)

where $\hat{\lambda}_i$ are the eigen values obtained from the estimate of the A_k matrix and T is the number of usable observations. The λ_{trace} tests the null that there are at most r cointegrating vectors, against the alternative that the number of cointegrating vectors is greater than r and the λ_{max} tests the null that the number of cointegrating vectors is r, against the alternative of r + 1. Critical values for the λ_{trace} and λ_{max} statistics are provided by MacKinnon-Haug-Michelis (1999).

VEC Granger Causality

The Vector Error Correction Model (VECM) was employed to investigate the temporal causality between selected macroeconomic variables in India during the pre-crisis and crisis period. The Granger Representation Theorem (Engle and Granger, 1987) states that if a set of variables is cointegrated, then there exists a valid error correction representation of the data, in which the short-term dynamics of the variables in this system are influenced by the deviation from long-term equilibrium. In a VECM, short-term causal effects are indicated by changes in other differenced explanatory variables (i.e., the lagged dynamic terms in equation (6)). The long-term relationship is implied by the level of disequilibrium in the cointegration relationship, i.e., the lagged error correction term (ECT). Thus, in the cointegration model, the proposition of 'Y_k not Granger causing Y_l' in the long-term is equivalent to $\alpha_{kl} = 0$. Y_l is said to be weakly exogenous for parameter β, i.e., Y_l does not react to equilibrium errors. Besides, the proposition 'Y_k do not Granger-cause Y_l' in the short term is equivalent to Γ_{kl} (L) = 0, where L is the lag-operator. Hence, the Vector Error Correction model is useful for detecting short- and long-term Granger causality tests (Granger, 1969). The VEC Model corresponds to equation (1) can be formulated as follows:

$$\Delta Y_{1t} = \mu_1 + \gamma_1 z_{t-1} + \sum_{i=1}^{p-1}\theta_{1i}\Delta Y_{1t-i} + \sum_{i=1}^{p-1}\delta_{1i}\Delta Y_{2t-i} + \sum_{i=1}^{p-1}\xi_{1i}\Delta Y_{3t-i} + \sum_{i=1}^{p-1}\varpi_{1i}\Delta Y_{4t-i} + \sum_{i=1}^{p-1}\lambda_{1i}\Delta Y_{5t-i} + \varepsilon_{1t} \quad (9)$$

$$\Delta Y_{2t} = \mu_2 + \gamma_2 z_{t-1} + \sum_{i=1}^{p-1}\delta_{2i}\Delta Y_{2t-i} + \sum_{i=1}^{p-1}\theta_{2i}\Delta Y_{1t-i} + \sum_{i=1}^{p-1}\xi_{2i}\Delta Y_{3t-i} + \sum_{i=1}^{p-1}\varpi_{2i}\Delta Y_{4t-i} + \sum_{i=1}^{p-1}\lambda_{2i}\Delta Y_{5t-i} + \varepsilon_{1t} \quad (10)$$

$$\Delta Y_{3t} = \mu_3 + \gamma_3 z_{t-1} + \sum_{i=1}^{p-1}\xi_{3i}\Delta Y_{3t-i} + \sum_{i=1}^{p-1}\theta_{3i}\Delta Y_{1t-i} + \sum_{i=1}^{p-1}\delta_{3i}\Delta Y_{2t-i} + \sum_{i=1}^{p-1}\varpi_{3i}\Delta Y_{4t-i} + \sum_{i=1}^{p-1}\lambda_{3i}\Delta Y_{5t-i} + \varepsilon_{1t} \quad (11)$$

$$\Delta Y_{4t} = \mu_4 + \gamma_4 z_{t-1} + \sum_{i=1}^{p-1}\varpi_{4i}\Delta Y_{4t-i} + \sum_{i=1}^{p-1}\theta_{4i}\Delta Y_{1t-i} + \sum_{i=1}^{p-1}\delta_{4i}\Delta Y_{2t-i} + \sum_{i=1}^{p-1}\xi_{4i}\Delta Y_{3t-i} + \sum_{i=1}^{p-1}\lambda_{4i}\Delta Y_{5t-i} + \varepsilon_{1t} \quad (12)$$

$$\Delta Y_{5t} = \mu_5 + \gamma_5 z_{t-1} + \sum_{i=1}^{p-1}\lambda_{5i}\Delta Y_{5t-i} + \sum_{i=1}^{p-1}\theta_{5i}\Delta Y_{1t-i} + \sum_{i=1}^{p-1}\delta_{5i}\Delta Y_{2t-i} + \sum_{i=1}^{p-1}\xi_{5i}\Delta Y_{3t-i} + \sum_{i=1}^{p-1}\varpi_{5i}\Delta Y_{4t-i} + \varepsilon_{1t} \quad (13)$$

where $\gamma'_s z_{t-1}$ is the error correction term derived from the cointegrating vector. θ, δ, ξ, ϖ and λ are the short-run parameters to be estimated, p is the lag length, and ε_t are assumed to be stationary random processes with a mean of zero and constant variance.

For each equation in the VEC Model, we employ short-term Granger causality to test whether endogenous variables can be treated as exogenous by the joint significance of the coefficients of each of the other lagged endogenous variables in that equation. The short-term significance of sum of the each lagged explanatory variables (θ's, δ's, ξ's, $\mho$'s and λ's) can be exposed either through joint F or Wald χ^2 test. Besides, the long-term causality is implied by the significance of the t-tests of the lagged error correction term (ECT_{t-1}). However, the non-significance of both the t-statistics and joint F or Wald χ^2 tests in the Vector Error Correction Model indicates econometric exogeneity of the dependent variable.

Variance Decomposition Analysis and Impulse Response Function

Finally, the study employed Variance Decomposition Analysis (VDA) and Impulse Response Functions (IRFs) to assess to what extent shocks to certain macroeconomic variables are explained by other variables in the system. Variance decomposition analysis measures the proportions of forecast error variance in a variable that is explained by innovations (impulses) in it and by the other variables in the system. For example, it explains what proportions of the changes in a particular variable can be attributed to changes in the other lagged explanatory variables. In a statistical sense, if a variable explains most of its own shock, then it does not allow variances of other variables to contribute to it being explained and is therefore said to be relatively exogenous. Impulse response analysis traces out the responsiveness of the dependent variable in VECM to shocks to each of the other explanatory variables over the period of time. A shock to a variable in a VECM framework not only directly affects that variable, but also transmits its effect to all other endogenous variables in the system.

The monthly macroeconomic data used in this study consists of Index of Industrial Production (IIP), Money Supply (M3), Price (CPI), Interest Rate (IR) and Nominal Exchange Rate (EXR) from April 1994 to July 2012. The study divides the entire data set into two sample periods, i.e. the pre-economic crisis period and economic crisis period. In January 2008, the global financial crisis came into existence with sub-prime effect and it spillover into the rest of the world. Subsequently, the European sovereign debt crisis began in early 2010 and worsened the macroeconomic conditions of the Indian economy and significantly affected its economic growth. The Indian economy persistently faced retarded growth momentum and macroeconomic imbalances with high inflationary pressure as result of enduring global economic crisis. Hence, the study considered the data span from January 2008 to July 2012 as economic crisis period. Whereas the data set prior to the crisis period from April 1994 to December 2007 is considered to be the non-crisis period. The necessary data on macroeconomic variables are collected from various issues of Handbook of Statistics on Indian Economy, Reserve Bank of India, Mumbai, India. The proxy variable for money supply used is Broad money (M3), which consists of Narrow money i.e. currency with public, other deposits with Reserve Bank of India (RBI) and demand deposits of banks (M1) plus time deposits. Consumer price index (CPI), index for industrial production (IIP) and call money rate has been used as proxy variables for prices, output, and interest rate respectively.

III. Empirical Results and Discussion

A perquisite for testing cointegration between macroeconomic variables is that all variables are non-stationary. The Augmented Dickey Fuller (ADF) test is employed to check whether the variables contain a unit root or not. Table 1 report the results of ADF unit root test for the two sample periods, i.e. pre-economic crisis period and economic crisis period. For the pre-crisis period, the table results confirm that variables, prices (CPI) and interest rate (IR) are stationary at levels and are integrated of order I(0), while index of industrial production (IIP), money supply (M3) and exchange rate (EXR) are integrated of order I(1) i.e. they are non stationary at levels but stationary at first differences. For the economic crisis period, the table result reveals that all the selected macroeconomic variables are found to be stationary at their first differences and are integrated at I(1).

Table 1: Augmented Dickey-Fuller Test Results

Variables	Pre-Crisis Period		Crisis Period	
	Level	First Difference	Level	First Difference
EXR	-2.118	-9.210*	-1.859	-5.095*

IIP	0.985	-2.735***	-1.203	-9.119*
IR	-5.825*	-	-1.458	-4.741*
CPI	-4.282*	-	-0.177	-4.579*
M3	1.094	-2.765***	-0.630	-6.847*

Notes: *(***) – indicates significance at one and ten percent level, respectively. Optimal lag length is determined by the Akaike information criterion (AIC).

The ARDL Bounds test approach and the Johansen and Juselius (1990) multivariate cointegration test was performed to examine the long-run relationship between the macroeconomic variables for the pre-crisis and crisis period, respectively.

Table 2: ARDL Cointegration Bound Testing Approach for the Pre-Crises Period

Model Specification	F-statistics	Inference
F_{EXR}(EXR/M3, CPI, IIP, IR)	5.240*	Cointegration
F_{M3}(M3/EXR, CPI, IIP, IR)	1.791	No Cointegration
F_{CPI}(CPI/EXR, M3, IIP, IR)	6.759*	Cointegration
F_{IIP}(IIP/EXR, M3, CPI, IR)	12.86*	Cointegration
F_{IR}(IR/EXR, M3, CPI, IIP)	7.386*	Cointegration

Notes: * indicates computed statistic falls above the upper bound value. Asymptotic critical value bounds are obtained from Pesaran et al. 2001, p. 300; Case III: Unrestricted intercept and no trend for k=5. Lower bound I(0) = 3.416 and Upper bound I(1) = 4.681 at one percent significance level.

Table 2 presents the result of ARDL Bounds test approach for Cointegration relationship based on equations (1-5) during the pre-crisis period. The appropriate lag length was selected on the basis of Akaike Information Criterion (AIC) for the conditional ARDL-UECM. The empirical results reveal that calculated F-statistic for the equation (1) i.e. F_{EXR}(EXR/M3, CPI, IIP, IR) is found to be higher than the upper bound critical value at one percent level of significance, indicating there is a stable long-run cointegration relationship between exchange rate and other selected macroeconomic variables. Similarly, when price level is considered as a dependent variable, the calculated F-statistic is found to be statistically significant at one percent level, implying a long-run cointegration relationship among price level and other macroeconomic variables. Besides, the empirical results confirm that money supply, price and interest rate share a long-run relationship with real output. Further, there exists a long-run cointegration relation between real output, money supply, price and exchange rate when the interest rate variable is the dependent variable. However, the analysis reveals no cointegrating relationship among money supply and other macroeconomic variables when the regression is normalised on money supply.

For the crisis period, the Johansen and Juselius (1990) multivariate cointegration test was performed to examine the long-run relationship between the selected macroeconomic variables in India and the results are reported in Table 3. Both trace and maximum eigen value indicates the presence of two cointegrating vector among the selected macroeconomic variables at five percent significant level, implying that there is a well defined long-run equilibrium relationship among the variables under consideration.

Table 3: Johansen Maximum Likelihood Cointegration test for the Crises Period

Null Hypothesis	Alternative Hypothesis	Trace Statistics	5% Critical Value	Max Eigen statistics	5% Critical Value
H_0: r = 0	H_1: r = 1	97.36**	69.81	46.90**	33.87
H_0: r ≤ 1	H_1: r = 2	50.09**	47.85	28.18**	27.58
H_0 :r ≤ 2	H_1: r = 3	21.91	29.79	11.64	21.13
H_0: r ≤ 3	H_1: r = 4	10.26	15.49	10.19	14.26
H_0: r ≤ 4	H_1: r = 5	0.075	3.884	0.075	3.841

Notes: r is the number of cointegrating vector. Critical values are noted from MacKinnon-Haug-Michelis (1999), and ** - denote the significance at five percent level.

The results of the estimated multivariate Vector Error Correction Model (VECM) for both the sample periods are presented in Table 4. The long-run dynamics was examined through the effect of the lagged error correction term in the VEC model. For the pre-crisis period, the table results clearly show significant error correction terms with negative sign for real output, price level, interest rate and exchange rate. This implies that these variables are significantly adjusted to disequilibrium from the long-run relationship or the response with which the previous period's deviations in real output, price level, interest rate and exchange rate from the long-run equilibrium path are corrected in consequent period. However, the error correction coefficient for the money supply is found to be insignificant, confirming the results obtained under the ARDL bounds test of cointegration that money supply is not related to real output, exchange rate, price and interest rate in the long-run. The empirical results reveal that the selected macroeconomic variables viz. real output, price level, interest rate and exchange rate are significantly influenced by each other, suggesting a stronger long-run bilateral relationship between them in the pre-crisis sample period. However, the causality between money supply and real output, price, exchange rate and interest rate is found to be neutral in the long-run.

Table 4: Vector Error Correction Model Estimates

	ΔEXR	ΔM3	ΔCPI	ΔIIP	ΔIR
Pre-Crisis Period – April 1994 to December 2007					
Constant	-6.28E-05	9.86E-05	-0.00011	0.00016	0.00638
	(-0.062)	(0.111)	(-0.206)	(0.055)	(0.217)
ECT(-1)	-0.2543*	0.0824	-0.1217*	-1.5747*	-1.5656***
	(-3.357)	(1.225)	(-2.800)	(-7.087)	(-1.713)
Crisis Period – January 2008 to July 2012					
Constant	-0.00027	-0.00032	5.71E-05	0.00045	-0.00035
	(-0.084)	(-0.055)	(0.122)	(0.062)	(-0.030)
ECT(-1)	-0.1645***	0.2474	0.0155	-1.7794*	-1.7423*
	(-1.777)	(1.434)	(1.132)	(-8.399)	(-4.961)

Note: *, (***) - denotes the significance at one, five and ten percent level, respectively.

The coefficients of lagged error correction term show the speed of adjustment of disequilibrium in the economic crisis period of study. The error correction coefficients for the exchange rate, real output and interest rate are found to have expected negative sign and statistically significant, implying long-run bidirectional causality between exchange rate, real output and interest rate during the crisis period. However, the money supply is found to be neutral and is not influenced by the output, price, exchange rate and interest rate in the long-run. Likewise, the price variable is also not influenced by the output, money supply, exchange rate and interest rate in the long-run.

Table 5 provides the results of Granger causality/Block exogeneity Wald test based on VECM to identify the short-run causality between the selected macroeconomic variables in India during the pre-crisis and crisis periods. The empirical results for the pre-crisis sample period confirm a unidirectional short-run causality running from price level to exchange rate, interest rate to price level and real output to money supply. Also, it is evident from the test results that there exist short-run bidirectional relationships running between real output and other selected macroeconomic variables viz. exchange rate, price level and interest rate. The feedback relationship is also observed between interest rate and exchange rate variables in the short-run.

Table 5: Short-run Causality Results based on VEC Granger Causality/ Block Exogeneity Wald test

Pre-Crisis Period – April 1994 to December 2007					
Dependent Variable	**ΔEXR**	**ΔM3**	**ΔCPI**	**ΔIIP**	**ΔIR**
	Wald χ^2 Statistics				
ΔEXR	--	3.057	8.179***	9.511**	17.87*
ΔM3	5.468	--	2.978	18.90*	1.377
ΔCPI	4.085	5.489	--	26.47*	9.412**
ΔIIP	28.17**	2.918	60.02*	--	25.76*
ΔIR	26.16*	5.489	1.308	15.23*	--
Crisis Period – January 2008 to July 2012					
ΔEXR	--	5.657**	1.517	0.106	0.075
ΔM3	5.674**	--	0.008	0.902	0.062
ΔCPI	0.182	0.359	--	1.012	2.864**
ΔIIP	0.003	0.134	18.51*	--	8.313*
ΔIR	0.002	0.070	4.628**	6.255**	--

Notes: Δ implies first difference operator. Optimal lag length was determined by Akaike information criterion (AIC). *, ** and *** - denote the significance at one, five and ten percent level, respectively.

During the economic crisis period, the table results indicate short-run bidirectional causality between money supply and exchange rate, interest rate and price level and interest rate and output. Also, a short-run unidirectional causality runs from prices to real output in the crisis era.

The results of Variance Decomposition Analysis based on VECM for the selected macroeconomic variables over a 20-months horizon are presented in Table 6. The table result for the pre-crisis period shows that real output variable was 100 percent explained by its own shock on the first trading day, but it continued to reduce to 59.25 percent on the 20th month. The shock explained by changes in price variable on real output is only about 30 percent on the 20th month. Moreover, the results confirm that variables under consideration viz. money supply (86.27 percent) followed by price level (80.74 percent), interest rate (76.88 percent) and exchange rate (67.62 percent) are said to be fairly exogenous variables, as they are explained by itself for its own shock on the 20th months horizon. Furthermore, the exchange rate accounts for 28.33 percent of the shock explained by real output in the long-run.

Table 6: Variance Decomposition Analysis

Pre-Crisis Period – April 1994 to December 2007						
Variance Decomposition of ΔIIP						
Period	**S.E.**	**ΔIIP**	**ΔEXR**	**ΔCPI**	**ΔIR**	**ΔM3**
1	0.0370	100.00	0.0000	0.0000	0.0000	0.0000
2	0.0434	92.862	0.0948	5.7575	0.0999	1.1856
3	0.0488	79.531	0.0895	17.594	1.7641	1.0198
4	0.0506	74.430	0.0979	22.409	1.7889	1.2728
5	0.0524	69.783	0.7194	24.468	3.8019	1.2259
6	0.0540	65.851	1.0118	27.555	4.0845	1.4960
7	0.0545	64.744	1.1076	27.140	5.4217	1.5856
8	0.0552	63.816	1.8804	27.183	5.3910	1.7290
9	0.0561	63.482	1.8447	27.562	5.3603	1.7501
10	0.0563	63.321	1.8547	27.338	5.7415	1.7437
11	0.0565	62.876	2.0293	27.494	5.7154	1.8845
12	0.0570	62.677	2.0008	27.659	5.7073	1.9539
13	0.0571	62.443	2.0391	27.509	5.9600	2.0474
14	0.0574	61.858	2.1337	27.956	5.9499	2.1009
15	0.0578	61.319	2.1369	28.385	6.0006	2.1569
16	0.0580	60.994	2.1911	28.323	6.2477	2.2435
17	0.0583	60.321	2.3001	28.819	6.2547	2.3045
18	0.0586	60.014	2.3007	29.059	6.2479	2.3771
19	0.0587	59.738	2.3353	29.097	6.3917	2.4368
20	0.0590	59.255	2.4044	29.431	6.4019	2.5067
Variance Decomposition of ΔEXR						
Period	**S.E.**	**ΔIIP**	**ΔEXR**	**ΔCPI**	**ΔIR**	**ΔM3**
1	0.0126	6.2309	93.769	0.0000	0.0000	0.0000
2	0.0146	12.482	84.324	0.0668	2.4717	0.6547
3	0.0149	13.550	82.803	0.0934	2.5441	1.0083
4	0.0160	18.129	76.482	0.7613	3.5350	1.0919
5	0.0170	23.864	71.381	0.6714	3.1190	0.9633
6	0.0178	23.120	71.665	1.3989	2.9156	0.8993
7	0.0189	23.162	71.213	1.8375	2.8371	0.9499
8	0.0197	24.711	69.714	1.9203	2.6516	1.0013
9	0.0203	25.313	69.405	1.8381	2.4988	0.9438
10	0.0209	25.487	69.493	1.7334	2.3906	0.8953

11	0.0215	25.660	69.404	1.7567	2.3265	0.8513
12	0.0222	25.689	69.404	1.8152	2.2174	0.8734
13	0.0228	26.239	69.070	1.7326	2.0895	0.8679
14	0.0234	26.806	68.669	1.6939	1.9990	0.8305
15	0.0240	27.066	68.506	1.7049	1.9295	0.7918
16	0.0246	27.487	68.179	1.7245	1.8453	0.7624
17	0.0251	27.819	67.895	1.7563	1.7734	0.7560
18	0.0257	27.931	67.865	1.7443	1.7152	0.7429
19	0.0262	28.126	67.768	1.7190	1.6654	0.7198
20	0.0268	28.334	67.628	1.7208	1.6194	0.6969

Variance Decomposition of ΔCPI

Period	S.E.	ΔIIP	ΔEXR	ΔCPI	ΔIR	ΔM3
1	0.0072	2.6857	1.5300	95.784	0.0000	0.0000
2	0.0090	5.2424	5.2140	88.811	0.0006	0.7316
3	0.0094	7.6818	5.4822	86.018	0.1497	0.6673
4	0.0101	6.8528	4.8560	85.023	2.4015	0.8663
5	0.0108	8.1904	5.3775	82.206	3.4167	0.8086
6	0.0110	7.8456	6.0012	81.996	3.3792	0.7773
7	0.0114	7.7645	6.8580	80.722	3.8262	0.8282
8	0.0117	8.0970	7.9063	78.910	4.2887	0.7975
9	0.0119	7.7601	8.0767	78.998	4.3739	0.7902
10	0.0123	7.2900	7.9694	79.757	4.2419	0.7412
11	0.0126	6.9507	8.1347	80.119	4.0816	0.7132
12	0.0129	6.6359	8.1925	80.382	4.1058	0.6833
13	0.0134	6.2187	8.2735	80.580	4.2875	0.6399
14	0.0137	5.9366	8.4766	80.683	4.2920	0.6108
15	0.0140	5.7079	8.5492	80.840	4.3153	0.5873
16	0.0143	5.5566	8.6433	80.808	4.4284	0.5627
17	0.0145	5.4340	8.8589	80.641	4.5228	0.5426
18	0.0148	5.2428	8.9934	80.668	4.5718	0.5231
19	0.0151	5.0729	9.1107	80.716	4.5952	0.5045
20	0.0153	4.9268	9.2350	80.747	4.6012	0.4889

Variance Decomposition of ΔIR

Period	S.E.	ΔIIP	ΔEXR	ΔCPI	ΔIR	ΔM3
1	0.3661	2.6740	0.4271	2.9441	93.954	0.0000
2	0.3852	4.0679	7.4366	2.8172	85.510	0.1678
3	0.3997	5.2806	10.473	2.9172	80.391	0.9366
4	0.4187	5.2864	9.9621	2.9479	80.829	0.9744
5	0.4476	8.8280	8.9474	3.7187	77.651	0.8541
6	0.4728	8.8292	8.0179	4.0951	78.283	0.7744

7	0.4784	9.0287	8.6276	4.0314	77.534	0.7776
8	0.4981	8.5347	8.7051	7.8755	74.119	0.7654
9	0.5089	8.1921	8.4469	7.7139	74.822	0.8245
10	0.5224	8.1028	8.1823	7.3239	75.595	0.7955
11	0.5305	7.9053	8.0257	7.8226	75.461	0.7851
12	0.5381	7.6872	8.3678	7.7423	75.432	0.7705
13	0.5513	7.6220	8.1740	7.8056	75.664	0.7343
14	0.5600	7.4398	8.0692	7.8906	75.872	0.7282
15	0.5693	7.1995	8.0539	7.7553	76.275	0.7157
16	0.5781	7.1067	7.9371	7.8634	76.392	0.7004
17	0.5873	6.9455	7.9183	8.1377	76.319	0.6792
18	0.5971	6.7505	7.8464	8.0865	76.659	0.6571
19	0.6052	6.6507	7.7838	8.0788	76.846	0.6397
20	0.6133	6.4858	7.7740	8.2284	76.885	0.6264
Variance Decomposition of ΔM3						
Period	**S.E.**	**ΔIIP**	**ΔEXR**	**ΔCPI**	**ΔIR**	**ΔM3**
1	0.0112	0.3852	1.3347	0.4808	0.4244	97.374
2	0.0117	0.4779	1.8721	0.4960	0.5068	96.647
3	0.0125	4.6797	2.4859	1.4741	0.4605	90.899
4	0.0130	10.140	2.6420	1.6096	0.4394	85.168
5	0.0137	9.4058	2.9168	3.9188	0.5408	83.217
6	0.0146	8.7483	2.9113	3.6803	0.5240	84.135
7	0.0153	8.7809	2.6768	3.4345	0.8289	84.278
8	0.0157	8.3858	2.6462	3.7215	0.8857	84.360
9	0.0160	8.7743	2.5403	3.7423	0.9215	84.021
10	0.0164	8.5298	2.6801	3.9205	0.8764	83.993
11	0.0169	8.0430	2.6873	3.8562	0.8454	84.567
12	0.0173	7.8632	2.5611	3.7062	0.8034	85.065
13	0.0178	7.9332	2.4674	3.8419	0.8133	84.944
14	0.0181	7.7996	2.3802	3.8689	0.8173	85.133
15	0.0185	7.7790	2.3784	3.8214	0.7854	85.235
16	0.0189	7.6110	2.3712	3.8782	0.7839	85.355
17	0.0192	7.3781	2.2990	3.8670	0.7767	85.678
18	0.0196	7.2906	2.2380	3.7958	0.7673	85.908
19	0.0199	7.1960	2.1874	3.8054	0.7728	86.038
20	0.0203	7.0514	2.1484	3.7689	0.7580	86.273
Crisis Period – January 2008 to July 2012						
Variance Decomposition of ΔIIP						
Period	**S.E.**	**ΔIIP**	**ΔEXR**	**ΔCPI**	**ΔIR**	**ΔM3**
1	0.0546	100.00	0.0000	0.0000	0.0000	0.0000

2	0.0614	89.644	8.2826	0.2810	0.2479	1.5435
3	0.0774	66.608	6.8135	16.598	6.3565	3.6228
4	0.0811	67.597	7.0114	16.031	6.0292	3.3310
5	0.0840	63.605	8.4559	16.490	6.9744	4.4742
6	0.0878	61.348	9.2681	17.314	7.3896	4.6792
7	0.0904	61.898	9.6333	16.584	7.1986	4.6850
8	0.0926	60.445	10.578	16.531	7.4325	5.0115
9	0.0955	59.278	11.081	16.750	7.6674	5.2217
10	0.0978	59.082	11.536	16.437	7.6464	5.2963
11	0.1001	58.254	12.089	16.379	7.7826	5.4929
12	0.1025	57.568	12.513	16.386	7.8995	5.6310
13	0.1047	57.196	12.887	16.247	7.9409	5.7282
14	0.1069	56.653	13.282	16.185	8.0241	5.8542
15	0.1091	56.170	13.616	16.151	8.1016	5.9602
16	0.1112	55.805	13.922	16.073	8.1512	6.0475
17	0.1132	55.404	14.222	16.021	8.211808	6.1407
18	0.1153	55.034	14.491	15.980	8.2685	6.2241
19	0.1173	54.717	14.742	15.927	8.3144	6.2984
20	0.1192	54.400	14.981	15.884	8.3618	6.3717

Variance Decomposition of ΔEXR

Period	S.E.	ΔIIP	ΔEXR	ΔCPI	ΔIR	ΔM3
1	0.0273	11.449	88.550	0.0000	0.0000	0.0000
2	0.0373	24.947	72.925	1.3091	0.0649	0.7525
3	0.0441	24.035	71.989	2.8387	0.0827	1.0533
4	0.0499	23.927	72.551	2.4397	0.1482	0.9334
5	0.0554	24.980	71.324	2.5438	0.1204	1.0299
6	0.0603	25.083	71.035	2.7249	0.1023	1.0532
7	0.0647	25.059	71.134	2.6636	0.0995	1.0426
8	0.0689	25.366	70.809	2.6755	0.0901	1.0583
9	0.0729	25.431	70.686	2.7294	0.0819	1.0704
10	0.0767	25.469	70.665	2.7170	0.0784	1.0688
11	0.0802	25.579	70.546	2.7247	0.0737	1.0755
12	0.0837	25.629	70.477	2.7423	0.0695	1.0805
13	0.0870	25.664	70.443	2.7427	0.0667	1.0819
14	0.0901	25.718	70.385	2.7474	0.0639	1.0851
15	0.0932	25.753	70.342	2.7551	0.0614	1.0878
16	0.0962	25.781	70.312	2.7576	0.0594	1.0894
17	0.0991	25.813	70.276	2.7609	0.0575	1.0913
18	0.1019	25.838	70.247	2.7651	0.0558	1.0931
19	0.1046	25.859	70.223	2.7675	0.0543	1.0944

20	0.1072	25.881	70.199	2.7701	0.0530	1.0957
Variance Decomposition of ΔCPI						
Period	**S.E.**	**ΔIIP**	**ΔEXR**	**ΔCPI**	**ΔIR**	**ΔM3**
1	0.0033	0.9625	0.0293	99.008	0.0000	0.0000
2	0.0039	1.4705	0.0988	93.741	4.6309	0.0583
3	0.0045	1.0942	0.1878	94.553	4.01616	0.1486
4	0.0051	0.9692	0.1523	94.942	3.7225	0.2133
5	0.0056	1.1718	0.1279	94.551	3.9516	0.1965
6	0.0061	1.0383	0.1204	94.647	3.9767	0.2169
7	0.0065	1.0081	0.1108	94.791	3.8536	0.2361
8	0.0069	1.0215	0.1009	94.717	3.9283	0.2314
9	0.0073	0.9777	0.0955	94.763	3.9236	0.2397
10	0.0077	0.9582	0.0907	94.808	3.8966	0.2453
11	0.0080	0.9544	0.0856	94.802	3.9115	0.2460
12	0.0083	0.9354	0.0823	94.820	3.9120	0.2492
13	0.0087	0.9241	0.0792	94.841	3.9031	0.2521
14	0.0090	0.9177	0.0763	94.845	3.9071	0.2533
15	0.0093	0.9077	0.0740	94.856	3.9069	0.2552
16	0.0096	0.9002	0.0719	94.866	3.9040	0.2568
17	0.0098	0.8947	0.0700	94.872	3.9048	0.2579
18	0.0101	0.8884	0.0683	94.879	3.9046	0.2592
19	0.0104	0.8832	0.0668	94.886	3.9034	0.2603
20	0.0106	0.8787	0.0654	94.891	3.9035	0.2612
Variance Decomposition of ΔIR						
Period	**S.E.**	**ΔIIP**	**ΔEXR**	**ΔCPI**	**ΔIR**	**ΔM3**
1	0.0865	4.5812	0.0826	0.0911	95.245	0.0000
2	0.1304	26.346	4.0490	1.4422	63.023	5.1385
3	0.1518	24.363	5.1013	7.5391	57.187	5.8080
4	0.1701	22.071	4.7338	6.2301	61.673	5.2909
5	0.1894	23.885	5.05225	6.0000	59.574	5.4880
6	0.2050	23.746	5.2270	6.7758	58.535	5.7146
7	0.2190	23.195	5.2137	6.4745	59.497	5.6190
8	0.2333	23.569	5.2953	6.3780	59.086	5.6702
9	0.2461	23.546	5.3656	6.5504	58.797	5.7407
10	0.2582	23.398	5.3817	6.4662	59.026	5.7266
11	0.2701	23.485	5.4190	6.4341	58.912	5.7482
12	0.2813	23.481	5.4529	6.4744	58.815	5.7752
13	0.2920	23.436	5.4701	6.4491	58.865	5.7786
14	0.3024	23.458	5.4915	6.4359	58.824	5.7902
15	0.3125	23.456	5.5111	6.4448	58.784	5.8035

16	0.3222	23.441	5.5250	6.4354	58.789	5.8093
17	0.3317	23.445	5.5391	6.4292	58.769	5.8169
18	0.3409	23.443	5.5520	6.4299	58.749	5.8247
19	0.3498	23.437	5.5626	6.4255	58.743	5.8299
20	0.3586	23.438	5.5727	6.4220	58.731	5.8353

Variance Decomposition of ΔM3

Period	S.E.	ΔIIP	ΔEXR	ΔCPI	ΔIR	ΔM3
1	0.0447	1.0335	1.5684	0.1279	1.2316	96.038
2	0.0527	1.2111	3.9421	0.0957	2.2835	92.467
3	0.0626	2.2811	2.8115	0.1594	2.8593	91.888
4	0.0693	2.4824	2.4967	0.1897	2.7495	92.081
5	0.0764	2.3979	2.1325	0.1915	3.0565	92.221
6	0.0825	2.6211	1.9114	0.1684	3.1211	92.177
7	0.0882	2.6977	1.7280	0.1477	3.1442	92.282
8	0.0936	2.6953	1.6019	0.1356	3.2169	92.350
9	0.0987	2.7680	1.4904	0.1246	3.2582	92.358
10	0.1035	2.8048	1.4021	0.1135	3.2765	92.402
11	0.1081	2.8184	1.3298	0.1060	3.3101	92.435
12	0.1125	2.8498	1.2672	0.0992	3.3326	92.450
13	0.1168	2.8715	1.2137	0.0928	3.3481	92.473
14	0.1209	2.8848	1.1680	0.0877	3.3663	92.492
15	0.1249	2.9023	1.1275	0.0833	3.3809	92.505
16	0.1287	2.9164	1.0918	0.0791	3.3925	92.519
17	0.1325	2.9272	1.0604	0.0756	3.4042	92.532
18	0.1361	2.9385	1.0320	0.0724	3.4144	92.542
19	0.1397	2.9484	1.0066	0.0695	3.4231	92.552
20	0.1431	2.9568	0.9836	0.0669	3.4314	92.561

Similarly, the findings of variance decomposition analysis for the economic crisis period reveal that selected macroeconomic variables are mainly explained by its own shock in the system. The forecast error variance of real output is mainly explained by price level (15.88 percent) and exchange rate (14.98) in the long-run. Besides, the real output is the most important variable in explaining the variation in the exchange rate and interest rate in the long-run.

The impulse response functions (IRFs) in Appendix 1A and 1B illustrate the responses of the endogenous variables to an initial shock of one standard deviation in real output, price level, money supply, interest rate and exchange rate. The IRFs in Appendix 1A for the pre-crisis sample period clearly show that the real output has immediate positive response to a one-standard-deviation shock in price level and the response tend to be stable in the long-run. The exchange rate explains immediate effect to a one-standard-deviation shock in real output throughout the long-run horizon. Responses to one standard deviation in exchange rate to price tend to be small and stabilized over the time period. The IRFs in Appendix 1B for the economic crisis period shows that real output has moderate response to a one-standard deviation shock in price level and exchange rate throughout the 20 months horizon. Besides, the response to a one-standard-deviation shock in exchange rate and interest rate to price variable is tend to be stable in the long-run. By and large, the IRFs for both the sample periods appear to be consistent with the results obtained from the Variance Decomposition Analysis (VDA) discussed above.

IV. Conclusion

This study examines the dynamic interactions among macroeconomic variables such as real output, prices, money supply, interest rate and exchange rate in India during the pre-economic crisis and economic crisis periods, using the ARDL bounds test for cointegration, Johansen and Juselius (1990) multivariate cointegration test, Granger causality/Block exogeneity Wald test based on Vector Error Correction Model, variance decomposition analysis and impulse response functions. The study uses monthly data over the period from April 1994 to July 2012 and the entire data set has divided into two sample periods, i.e. the pre-economic crisis period (April 1994 to December 2007) and economic crisis period (January 2008 to July 2012).

For the pre-economic crisis period, the ARDL bound test approach indicates a stable long-run cointegration relationship between selected macroeconomic variables under consideration. However, the analysis reveals no cointegrating relationship among money supply and other macroeconomic variables when the regression is normalised on money supply. The empirical results reveal a stronger long-run bilateral relationship between real output, price level, interest rate and exchange rate in the pre-crisis sample period. While, the causality between money supply and other macroeconomic variables viz. real output, price, exchange rate and interest rate are found to be neutral in the long-run.

Moreover, the empirical results confirm a unidirectional short-run causality running from price level to exchange rate, interest rate to price level and real output to money supply during the pre-crisis sample period. Also, it is evident from the test results that there exist short-run bidirectional relationships running between real output and other selected macroeconomic variables viz. exchange rate, price level and interest rate in the pre-crisis era. The feedback relationship is also observed between interest rate and exchange rate variables in the short-run.

During the economic crisis period, the cointegration test results confirm a well defined long-run equilibrium relationship among the macroeconomic variables, viz. real output, money supply, prices, exchange rate and interest rate. The long-run bidirectional causality is observed between real output, exchange rate and interest rate during the economic crisis era. Further, the money supply and real output are found to be neutral in the long-run. The study results indicate short-run bidirectional causality between money supply and exchange rate, interest rate and price level and interest rate and output in the economic crisis period. Also, a short-run unidirectional causality runs from prices to real output in the crisis period.

To conclude, our study do not supports monetarists view for the both sample periods. Alternatively, during the pre-crisis sample period, the study findings support the Keynesian view that changes in income lead to changes in the stock of money through the demand for money in the short-run. Therefore, the direction of causation runs from income to money without any feedback. In addition, changes in price level influences the changes in exchange rate and changes in interest rate causes the changes in price level in the short-run during the pre-crisis era. Most importantly, our study shows that prices cause real output in the short-run during the economic crisis period. The study evidences suggest that the Reserve Bank of India has to concentrate on the price level as its central target variable of its monetary policy in order to achieve macroeconomic stability and to promote economic activities in the current economic crisis scenario.

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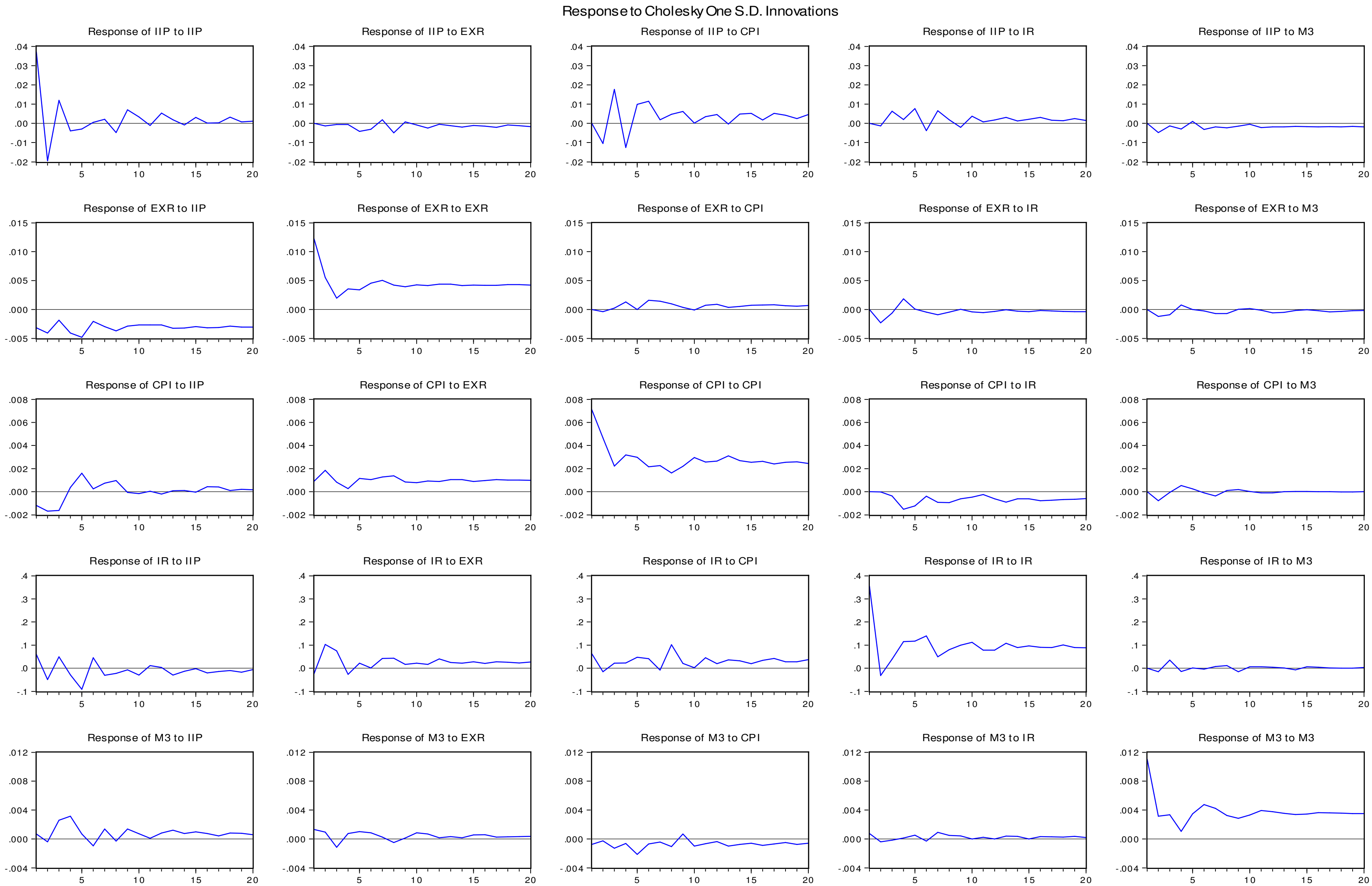
Appendix 1A: Impulse Response Function for the Pre-Crisis Sample Period (April 1994 to December 2007)



Appendix 1B: Impulse Response Function for the Crisis Sample Period (January 2008 to July 2012)