



Nexus Between Indian Financial Markets and Macro-economic Shocks: A VAR Approach

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Abstract

This paper studies the nexus between asset returns volatility in six major segments of Indian financial markets (viz. money, equity, gsec, forex, equity and banking stocks) and macro-economic shocks (viz. GDP, Inflation, Current Account Deficit, market capitalisation to GDP ratio, US Treasury Yield and Foreign Portfolio Investment). The period of study is from April 2002 to March 2021, a period covering four instances of significant economic and financial market stress. Findings of the study are generally aligned to economic theory, except for the case of gsec market. Besides, macro-variables were found to be exerting greater impact when they are in their weaker/unstable state and the behaviour of US treasury yield and FPI flows were found to be more significant factors during stress periods and recovery immediately thereafter. Therefore, there is a need to focus on maintaining macroeconomic stability as a policy to foster financial market stability. Besides, there is a need to monitor a customized and dynamic list of macroeconomic variables in respect of each of the financial market segments to decide on the timing, type and quantum of policy and regulatory responses from time to time. This study contributed towards financial markets public policy, particularly during periods of uncertainties.

Keywords Macro economic factors · Financial markets · Volatility · VAR · Regulation

1 Background

The fundamental function of financial markets is to price and re-price the financial assets based on all publicly available information, on a real-time basis. It is through this role of being able to price the risk weighted returns associated with various financial assets that financial markets facilitate a more efficient allocation of financial resources to alternative economic activities. At a macro level, given

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the available investible funds, information on real sector activities in the economy, to which financial markets allocate resources, forms the very basis for pricing of instruments in the financial markets. Hence, both pricing and price driven allocation of resources, by financial markets, themselves are derived from the developments in the real sector of the economy. Therefore, naturally there is a strong nexus between the financial markets and real sector activities. Accordingly, systemic macroeconomic real sector factors like prices, output and position on external account of the economy, etc. can play an important role on the overall outlook of financial markets.

As far as the response of asset prices to new information is concerned, accordingly to the efficient market hypothesis, (Fama, 1971), asset prices should incorporate new information on a real time basis. Ross (1989) also argues that the volatility of prices should capture new information in an efficient market within an arbitrage-free economy. Therefore, other things remaining same, arrival of new public news is supposed to increase price volatility (Foster & Viswanathan, 1993 and Pasquariello & Vega, 2007).

Additionally, the way financial markets could respond to such macroeconomic factors would also depend on the depth of the financial markets themselves. For instance, a large and liquid financial market segment is expected to absorb the news of a macro development better than a relatively shallow and illiquid market segment. In a globalized world, cross-border flow of information and investments are also expected to play an important role in shaping the outlook of the financial markets. In addition, there are also certain exogenous developments, like change in government policy or strike of a catastrophe or onset of a crisis like situations, which can have sudden and significant influence on the financial markets, that too without much advance notice.

Theoretically, any development in real economy having impact on the credit, liquid or market risk or a combination of them in an asset class and therefore on the expected returns from the asset class, would lead to revision in pricing of such assets. Under uncertainty prices of such assets could become even more volatile leading to further uncertainty and at times herd behaviour, creating a self-fulfilling loop of volatility.

An analysis by IMF (2020)¹ infers that “if the level of macroprudential regulation is low, an increase in global risk aversion (proxied by the Chicago Board Option Exchange Volatility Index (VIX)) or an outflow of foreign capital considerably reduces economic growth in emerging markets. For example, a 60 percent spike in the VIX—about half of what we experienced in the first quarter of 2020 as a result of the COVID-19 pandemic—or a capital outflow equal to 2 percent of GDP in a quarter can push a typical emerging market into a recession”. Accordingly, given that macro-economic shocks transmit to real economies via the financial markets, monitoring and managing of financial market volatility becomes very crucial, more so during periods of stress and uncertainty.

¹ <https://blogs.imf.org/2020/05/19/dampening-the-impact-of-global-financial-shocks-on-emerging-market-economies/>

In this backdrop, this paper seeks to empirically test the response of financial market volatility in India to a set of macro-economic variables in terms of their direction, extent and duration of impact. This paper seeks to add to the literature by:

- (i) Including all six major segments of Indian financial markets, unlike majority of earlier studies on the subject focusing on the nexus between macroeconomic variables vs. one or two segments of financial market;
- (ii) also considering new macro-economic variables representing global macro-economic shocks and depth of Indian financial market; and
- (iii) considering a long study period covering multiple macro-economic shocks viz. dotcom bubble bust in late 1990s to global financial crisis during 2007–08 to Eurozone debt crisis during 2009–13 to US Fed tape tantrum during 2013 to Covid 19 led shocks most recently.

2 Literature Review

2.1 Macro-Economic Factors and Money Market

As far money market rates are concerned, they are predominantly driven by prevailing liquidity in the financial system. Liquidity as such depends on multiple factors such as structural factors, (viz. GDP growth, inflation, capital flows, forex market intervention, credit to deposit ratio), frictional factors (viz., seasonal demand for cash vs. cash balances of government maintained with the Central Bank) and most importantly the policy induced factors viz. change in policy rates, advance tax payments and Open Market Operations (OMO).

In this light, a study on the effect of structural and frictional liquidity shocks on call money rates and the pattern of volatility (Singh, 2020) suggests that among the key exogenous liquidity shocks impacting call money rates in India, there is strong evidence of currency demand, forex inflows and movements in government's cash balances with the RBI as principal drivers. Given the significant currency-GDP ratio in India, movements in currency demand result in sudden changes in money market liquidity. A key structural driver of liquidity demand in money markets is also the credit to deposit growth of the banking system. Forex inflows, particularly led by portfolio inflows, are more volatile in nature as these are strongly influenced by foreign investors' expectations and risk-taking behaviour. As far government's cash balance is concerned, while tax revenues are relatively predictable, expenditures are uneven, causing unanticipated liquidity demand/supply and hence higher volatility in money market rates. On the other hand, Ramchander et al. (2003) find that yield variability in money market is fundamentally linked to the release of macroeconomic news that conveys important information on inflation.

2.2 Macro-economic Factors and Forex Market

Exchange rate stability is one of the crucial factors for macroeconomic stability. Typically, exchange rate volatility arises due to macro-economic fundamentals like growth, trade, price level, interest rate, foreign exchange reserve etc. and short-term speculation. For instance, exchange rate volatility in India, post the taper talk reached its peak in August 2013 when the exchange rate depreciated by 10% in just one month. This kind of volatility in exchange rate to a significant extent also due to the then prevailing high current deficit and weaker macroeconomic health of India. RBI had to intervene swiftly to stabilize the situation.

In the empirical literature, the findings of researchers on the impact of macro-economic factors on exchange rate is mixed. In the short run particularly, market participants do not in fact use a commonly agreed model for evaluating the outlook of the foreign exchange market and do not all share the same expectations at any point of time” (Frankel et. al., 1996). Macroeconomic fundamentals are barely useful in predicting the rate movement in the short-run, particularly after the introduction of on-line trading systems that made the tick-by-tick (high frequency) data available (Sarno & Taylor, 2001). More than macroeconomic fundamentals, the dealers consider other variables that are micro in nature (Lyons, 1995). The micro variables are bid-ask spreads, trading volume, own volatility, nonsynchronous trading, information (both private and public), inventory cost, etc. Moreover, the macro models to forecast exchange rate lost its allure post the seminal conclusion by the work of Meese and Rogoff (1983) that “forecasts based on monetary approach to exchange rate determination could not out-perform the random walk forecasts”. Many studies thereafter corroborated that, fundamentals cannot provide best forecasts for the exchange rate movement (see Mark Nelson, 1995; Mark & Sul, 2001; Cheng et al., 2002; and Chinn & Meese, 1995, Evans & Lyons, 1999).

On the other hand, there are also several macro models in the international economics literature dealing with exchange rate determination (Gandolfo, 2001) which shows that exchange rates are driven by a gamut of economic, political, and psychological factors that are highly correlated and interactive in a very complex way (Alagidede & Ibrahim, 2017; Huang et al., 2004; Yu et al., 2010). In the context of India, Mishra and Yadav (2012) found that money supply and inflation rate have the most notable effect on exchange rate. Saha and Biswas (2014) found that export, interest rate, foreign exchange reserve and economic growth have appreciating effect whereas import and inflation have depreciating effect on exchange rate. Another study by Khushboo and Syeedun (2019) found that foreign exchange reserve, money supply and interest rate have a significant influence on exchange rate in India while current account deficit have a non- significant influence on exchange rate.

2.3 Macro-economic Factors and Stock Market

As far as the empirical literature on macroeconomic development and stock market volatility is concerned, the findings here too are mixed. Schwert (1989) finds that macroeconomic variables play significant role in prediction of stock market volatility and their impact has been more during the period of depression. From the theoretical perspective, the dividend discount model (DDM) and arbitrage pricing theory (APT) provide the theoretical framework through which the behaviour of macroeconomic fundamentals can be linked to the stock market volatility (see Chen et al., 2007). These models emphasize that any expected or unexpected arrival of new information and policy decisions regarding macroeconomic variables such as gross domestic product (GDP), money supply, inflation, interest rates, exchange rates and foreign institutional investments (FIIs) will change the equity prices and further the volatility of stocks via change in the future cash flows and expected dividends. Intuitively, the essence of the theoretical link between the macroeconomic fundamentals and equity market volatility is that any change or shock in the macroeconomic variables will raise the source of systematic and idiosyncratic risk of the market portfolio, irrespective of how well the portfolio is diversified (Chowdhury and Rahman, 2004). Diebold and Yilmaz (2008) empirically investigate the issue taking sample of 45 markets including developed and emerging and suggest a significant positive relationship between volatility of stock returns and GDP volatility. On the other hand, using the VAR framework, Morelli (2002) empirically tested the issue in the UK stock market and documented no significant explanatory power of macroeconomic volatility in determining the stock market volatility.

The literature on the relationship between macroeconomic factors and stock returns volatility in India largely emphasizes on the long run causal links and long run co-movements of the variables. For instance, Darrat and Mukherjee (1986), and Mukherjee and Naka (1995) examine the long run relationships and co-movements of the macroeconomic fundamentals and stock returns. The study has demonstrated the absence of the long run co-movements among the variables. However, Naka et al. (1998) find a long run relationship among the variables. Panda and Kamiah (2001) further estimate the causal and dynamic linkages among the monetary policy variables and volatility and conclude that macroeconomic factors cause the volatility in the market. More recently, Manel et al. (2021) investigated the dynamic connectedness between stock indices and the effect of economic policy uncertainty (EPU) in eight countries where COVID-19 was most widespread (China, Italy, France, Germany, Spain, Russia, the US, and the UK) and found that the direction of the EPU effect on net connectedness changed during the pandemic onset, indicating that information spillovers from a given market may signal either good or bad news for other markets, depending on the prevailing economic situation.

2.4 Macro-economic Factors and Bond Market

Empirical literature on macro economy and bond market nexus supports that “macroeconomic news is most important for Govt. bond markets” (Macqueen and Roley,

1993). In the context of 10-year US Treasury Bonds, macroeconomic news has a strong impact on the dynamics of bond market volatility. News on employment situation and inflation are especially influential at the intermediate and long end of the yield curve, while monetary policy seems to affect the short-term volatility (de Goeij and Marquering 2006). Das (2002) and Piazzesi (2003) show that the Federal Open Market Committee (FOMC) release on its target rate can explain the jump behaviour of interest rates. Brenner et al. (2009) studied the impact of the release of surprise U.S. macroeconomic information on U.S. stock, Treasury, and corporate bond markets volatilities and co-movements of their returns by applying several extensions of the parsimonious multivariate GARCH-DCC model of Engle (2002). This study found that both the process of price formation in each of these financial markets and co-movement of their returns appear to be driven by fundamentals. Inflation rate, terms of trade and the exchange rate of domestic currency influence government bond yields. Inflation rate has a positive effect on yield. Haque et al. (1996) find that the prices of government bonds in developing countries are affected by the ratio of reserves to total imports, the ratio of the balance of payments to GDP, economic growth and inflation. Therefore, macroeconomic factors exhibit a significant relationship with volatility in all the bond markets, more specifically in the emerging bond markets. Thenmozhi (2012) found that past lags explain bond volatility in India, Brazil, USA, UK and Japan, which reasserts that the assumptions of random walk hypothesis does not hold true and bond markets are predictable in the long run.

With regard to various risks and consequent yield volatility associated with corporate bonds, Gemmill and Keswani (2011) found that corporate bond yield spreads are mostly caused by default losses. Liquidity risk, however, is important to the corporate credit risk and expected corporate bond returns, more particularly during stress periods (Lin et. al., 2011). Acharya and Pedersen (2005) found that the expected returns of bonds depend on the expected liquidity, the covariance of the returns and market liquidity. A broad overview of the literature on factors affecting yields on corporate bonds, therefore, include the Treasury market variables (e.g., Longstaff and Schwartz (1995)), liquidity (Longstaff et al., 2005), equity market variables (e.g., Collin-Dufresne et al. (2001), and macro-economic variables (e.g., Jean and Kleiman (1997), Greg and Stein (2002) and the monetary policy stance shaped by a multitude of macro factors (Smolyansky and Suarez (2021)).

2.5 Macro-economic Factors and Banking Sector

In literature studies on the relationship between macroeconomic factors and individual bank risk are relatively rare (e.g., Buch et al., 2007; Wedow, 2006, Baele et al., 2004). Most of the existing theoretical and empirical research rather focus the relationship between macro-economic variables and stock market returns. The major empirical findings with regard to the macro factors impacting returns on bank stock in particular, inter alia, comprise of variables such as GDP, inflation rate, interest rate and exchange rate (Acaravci & Çalim, 2013; Jara-Bertin et al., 2014; Menicucci & Paolucci, 2016; Pasiouras & Kosmidou, 2007). The study by

Paul and Mallik (2003) found that, as per Australian experience, the interest rate has a negative effect, whereas GDP growth has a positive effect on bank and finance stock prices and Inflation has no significant effect on stock prices. Another study by Lucey, Lucey et al. (2008) investigate the relationship between macroeconomic surprises and returns of stock exchanges in developed countries viz., Canada, France, Germany, Hong Kong, Italy, Singapore and UK. Applying GARCH model on the monthly data of 1999–2007, this study found that unexpected news of macroeconomic factors had significant impact on the returns of Stock Exchanges. Al-Homaidi et al., (2018) find that macroeconomic factor such as GDP, inflation rate, interest rate and exchange rate negatively impact on Indian commercial banks profitability. Joaqui-Barandica et al. (2021) identified three main macroeconomic factors underlying banking profitability: the financial burden of households and economic activity; household income and net worth and, in the case of ROA and ROE, corporate indebtedness.

3 Variables and Data

In order to capture the effect of selected macro-economic developments or shocks on financial market volatility in India, the current study uses one representative indicators for each of the six segments of Indian financial markets, namely, MIBOR to represent money market, USD INR to represent foreign exchange market, 10-year Gsec yield to represent GSEC market, CRISIL Corporate Bond Composite Index to represent corporate bond market, NSE 500 to represent broader equity market and NSE Bank Nifty to represent the banking sector in India. The macroeconomic variables considered for assessing their impact on the six financial market segments of India include the ratio of Equity Market Capitalisation to Gross Domestic Product (EMCGDP) to represent financial market depth; Gross Domestic Growth rate (GDPG), Consumer Price Index (CPI) and Current Account Deficit (CAD) to represent the macro fundamentals of the economy; Foreign Portfolio Investment (FPI) in India and the US Treasury Bill rate (USTB) to represent respectively the domestic and global economic sentiments.

The period of study is from April 2002 to March 2021, with 218 number of monthly observations. Further the whole period has been divided into sub sample periods based on structural breaks through Chow break point and the NBER business cycle as well as the consideration of having adequate data sample size for undertaking empirical estimations for each sub sample periods. The study considers five sub periods along with the whole time period such as Sample Period I (Apr 2002–Nov 2007), Sample Period II (Dec 2007–Dec 2013), Sample Period III (Jul 2009–Dec 2013), Sample Period IV (Jan 2014–Feb 2020), and Sample Period V (Jan 2014–Mar 2021). All data have been sourced from respective secondary sources, including Bloomberg.

4 Methodology

The study has converted all raw data into natural log returns using the formula:

$$l_n \left(\frac{P_t}{P_{t-1}} \right) * 100 \tag{1}$$

where P_t refers to today’s price, and P_{t-1} refers to yesterday’s price. Furthermore, in order to transform the GSEC and MIBOR yields into monthly returns, such that the time frame of all sectors, and market would be matched, the following calculation is used:

$$R_{f(monthly)} = (1 + R_{f(annual)})^{1/12} - 1 \tag{2}$$

where R_f represents the risk-free rates, while c and t characterize specific country and time of the return respectively, while the denominator (12) is the average number of months annually in the respective segment.

The precondition to applying any econometrics model including VAR is to ensure the stationarity of the variables. The study performs the stationarity of the variables through Augmented Dickey-Fuller (ADF), and Zivot Andrews test. We found that all data are stationary at the level and have applied Vector Auto Regression (VAR) to capture the dependencies among the variables and segments under considerations. Further to run VAR, we need to first select the lag length. In this study we have used the following:

4.1 Vector Auto Regression (VAR)

The simple univariate Autoregressive (AR) model is represented by

$$Y_t = \alpha + \beta Y_{t-1} + e_t \tag{3}$$

Here, the present value of variable y is dependent on its initial lag, where α is parameter coefficient, and the lag is written as subscript. It is called autoregressive of order one as it contains only one lagged value or AR (1). However, the order can easily be increased by adding more lags, that is, AR(p). Here, e_t is the error term which is assumed to be normally distributed with mean zero and variance is equal to σ^2 . A VAR is in a sense, a systems regression model, where there are multiple dependent variables. Simplest case is a bivariate VAR, which can be written as equations iv and v , where $U(it)$ is an independent and identically distributed term with $E(Uit) = 0$, $i = 1, 2$; and $E(U1t U2t) = 0$.

$$Y_{1t} = \beta_{10} + \beta_{11}Y_{1t-1} + \dots + \beta_{1k}Y_{1t-k} + \alpha_{11}Y_{2t-1} + \dots + \alpha_{1k}Y_{2t-k} + u_{1t} \tag{4}$$

$$Y_{2t} = \beta_{20} + \beta_{21}Y_{2t-1} + \dots + \beta_{2k}Y_{2t-k} + \alpha_{21}Y_{1t-1} + \dots + \alpha_{2k}Y_{1t-k} + u_{2t} \tag{5}$$

The symmetric covariance matrices of standard VAR models show the relation correlation between endogenous variables. The premise behind VAR is that each of the time arrangements in the framework impacts one another; that is, we can foresee the arrangement with past estimations of itself alongside different arrangements in the framework.

4.2 Impulse Response function

VAR models are often tough to interpret. One solution is to construct the impulse responses and variance decompositions. Impulse response analysis is an important step in econometric analysis, which utilizes vector autoregressive models. Their fundamental reason is to describe the development of a model's variables in response to a shock in one or more variables. This element helps tracing the transmission of a single shock in an otherwise noisy system of equations, therefore making it a very useful tool in the calculation of economic policies. A common method to recognize the shocks of a VAR model is by using orthogonal impulse response (OIR). The objective here is to decompose the variance–covariance matrix, therefore $\Sigma = PP'$, where P is a lower triangular matrix with positive diagonal elements, that is mostly obtained by a cholesky decomposition.

4.3 Variance Decomposition

Variance decompositions suggests a somewhat different technique of examining VAR dynamics. They give the proportion of the movements in the dependent variables that are due to their “own” shocks, versus shocks from the other variables. This would be done by determining how much of the s-step ahead forecast error variance for each variable is explained innovation to each explanatory variable ($s = 1, 2, \dots$). The variance decomposition gives information about the relative importance of each shock to the variables in the VAR.

5 Discussion of Empirical Results

5.1 Diagnostic Tests

For the post diagnostic tests, we check the autocorrelation through Portmanteau test, Heteroscedasticity through ARCH test and normality through Jarque–Bera test. All the tests confirmed that models under considerations are good fit and none of the equations are violating the diagnostic tests (Tables 1, 2, 3 and 4).

Table 1 Descriptive statistics

	CAD	COBBOND	CPI	EMCGDP	FPI	GDPG
Mean	0.00	0.00	0.01	0.01	0.02	1.02
Median	0.00	0.00	0.00	0.01	0.00	-0.11
Maximum	0.44	0.01	0.66	0.37	1.02	69.53
Minimum	-0.32	-0.01	-0.51	-0.38	-0.45	-12.14
Std. Dev	0.08	0.00	0.15	0.08	0.18	8.14
Skewness	0.94	0.32	0.62	-0.56	1.06	6.23
Kurtosis	12.79	11.32	5.22	8.41	7.50	47.52
Jarque-Bera	889.61	624.25	58.00	273.09	221.84	19,145.63
Probability	0.00	0.00	0.00	0.00	0.00	0.00
	LTY	MIBOR	NSE500	NSEBN	USDINR	USTB
Mean	0.00	0.20	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.00	0.00	0.00	0.00
Maximum	0.19	31.37	0.03	0.04	0.02	0.23
Minimum	-0.26	-0.94	-0.04	-0.04	-0.02	-0.42
Std. Dev	0.04	2.26	0.01	0.01	0.01	0.08
Skewness	-0.43	12.71	-0.66	-0.34	0.38	-0.81
Kurtosis	11.81	172.02	6.84	5.72	4.95	7.11
Jarque-Bera	702.73	261,705.30	147.20	70.69	39.23	175.25
Probability	0.00	0.00	0.00	0.00	0.00	0.00

Table 2 Correlation matrix

	COB	LTY	MIBOR	NSE500	NSEBN	USDINR
CAD	0.07	-0.04	0.00	0.06	0.09	-0.07
CPI	0.06	-0.04	-0.03	0.08	0.08	-0.02
EMCGDP	0.16	-0.01	-0.04	0.94	0.83	-0.51
FPI	0.12	-0.13	-0.08	0.11	0.20	-0.16
GDPG	0.00	0.06	-0.03	0.00	0.01	-0.02
USTB	-0.26	0.21	-0.05	0.08	0.04	-0.02

Table 3 Stationarity test

	ADF	Z/A
COBBOND	-13.27***	-7.26***
LTY	-9.47***	-9.81***
MIBOR	-15.09***	-7.48***
NSE 500	-12.80***	-13.52***
NSEBN	-13.98***	-14.46**
USDINR	-13.27***	-5.39*
EMCGDP	-13.00***	-13.62***
GDPG	-5.20***	-6.02***
CPI	-11.11***	-9.76***
CAD	-12.30***	-12.60***
FPI	-11.57***	-11.75**
USTB	-10.66***	-10.84*

Table 4 Lag included in the VAR model through AIC

Sl. No	Segment	Period	Number of lags
1	Corporate bond	2002–2021	1
2		2002–2007	2
3		2007–2013	5
4		2009–2013	4
5		2014–2020	5
6		2014–2021	5
1	GSEC	2002–2021	4
2		2002–2007	4
3		2007–2013	4
4		2009–2013	3
5		2014–2020	5
6		2014–2021	5
1	Money market	2002–2021	1
2		2002–2007	4
3		2007–2013	5
4		2009–2013	3
5		2014–2020	5
6		2014–2021	5
1	Equity	2002–2021	1
2		2002–2007	4
3		2007–2013	4
4		2009–2013	4
5		2014–2020	5
6		2014–2021	5
1	Banking	2002–2021	1
2		2002–2007	3
3		2007–2013	4
4		2009–2013	4
5		2014–2020	5
6		2014–2021	5
1	Foreign exchange	2002–2021	1
2		2002–2007	4
3		2007–2013	5
4		2009–2013	3
5		2014–2020	5
6		2014–2021	3

Pursuant to the diagnostic tests, estimations have been done to see the impact of selected macro-economic shocks for each of the financial market indicators for each different sample periods, not only to see the impact of shocks but also to see how they behave in different sample periods, representing different scenarios.

5.2 Impulse Response Plots

The impact of macro-economic shocks on financial market indicators have been estimated using the change in macro-variables on the return on financial market indicators. The impacts have been captured by computing the Impulse Response Plot (IRP), based separately on the data sample for each sample periods considered in this study. The impulse response function indicates the transmission effect of innovations in one variable to the shock of another variable.

Illustratively, the impulse response plot for the full sample period may be referred to in Figs. 1, 2, 3, 4, 5 and 6 below:

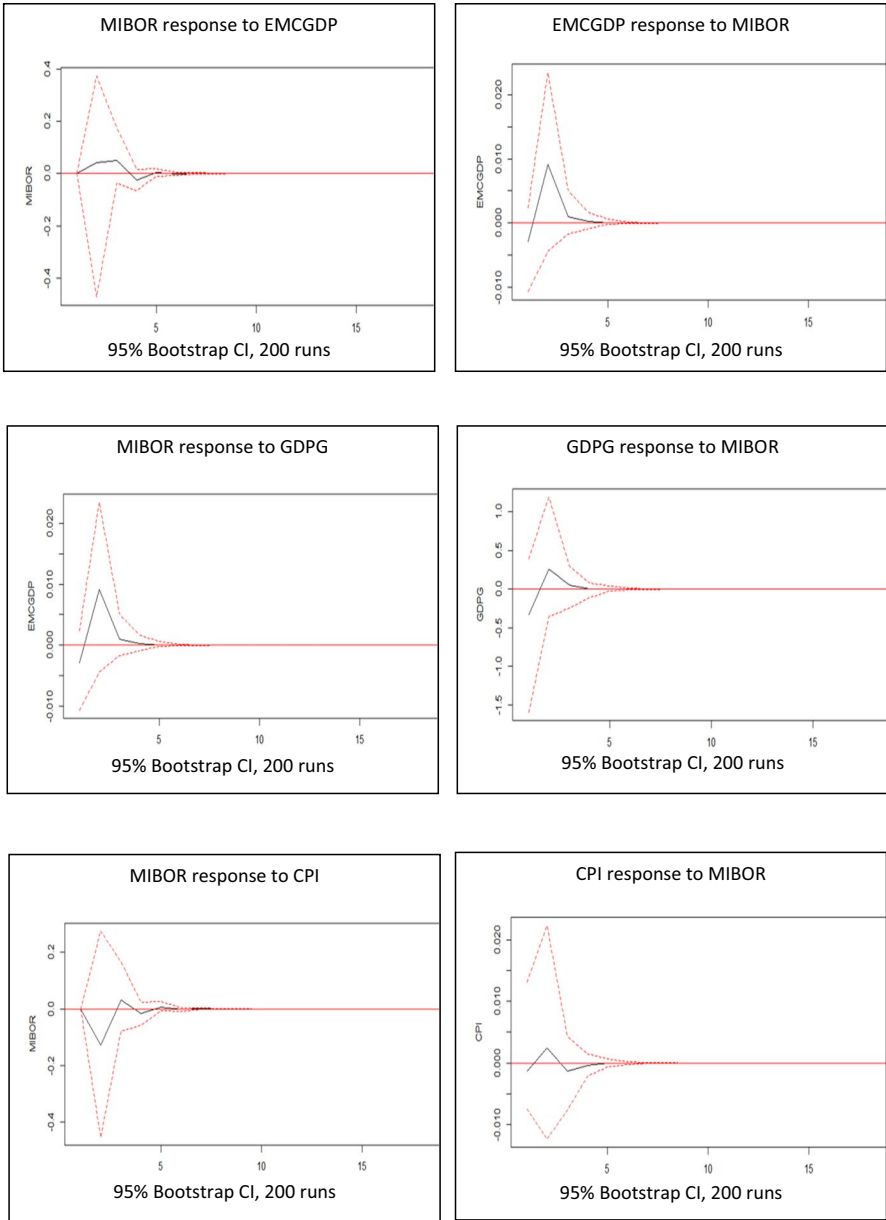


Fig. 1 Impulse Plot for MIBOR–Full Sample Period (2002–21)

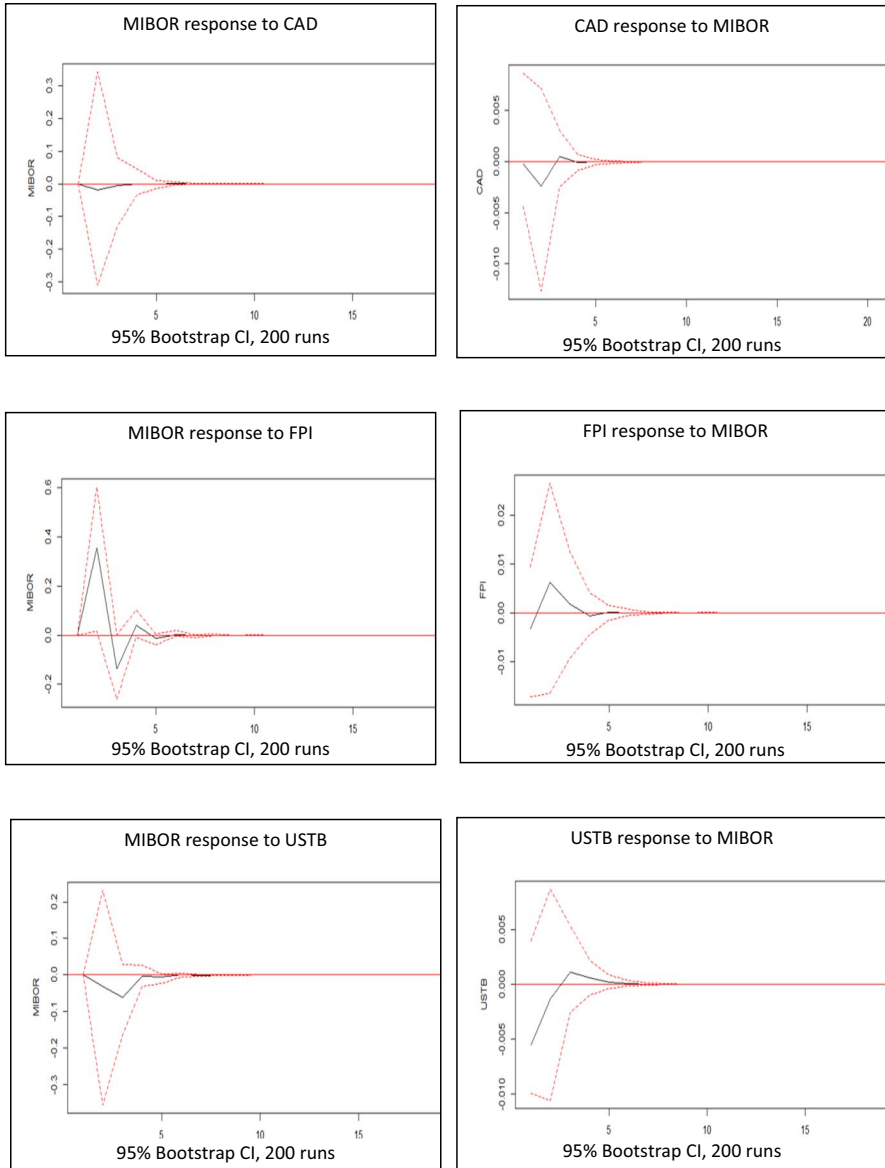


Fig. 1 (continued)

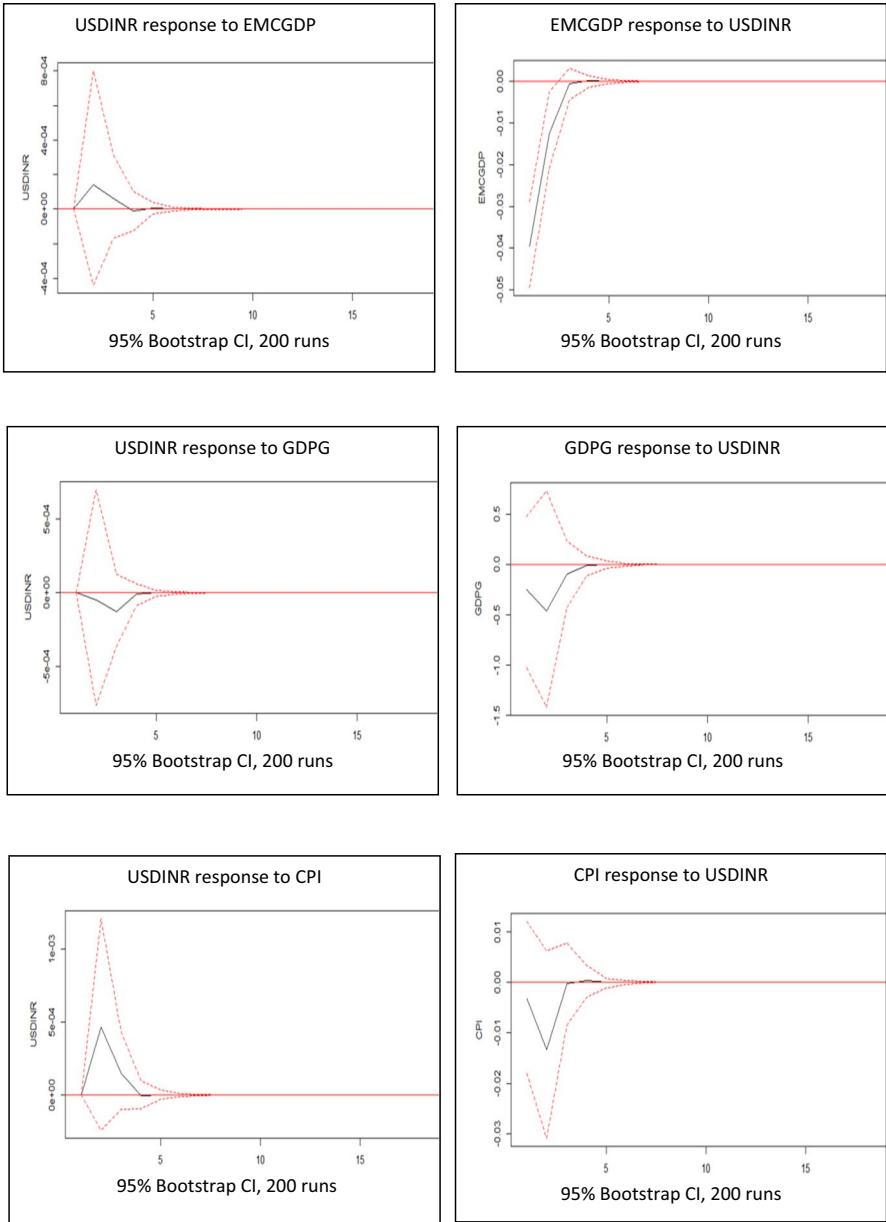


Fig. 2 Impulse Plot for USD-INR–Full Sample Period (2002–21)

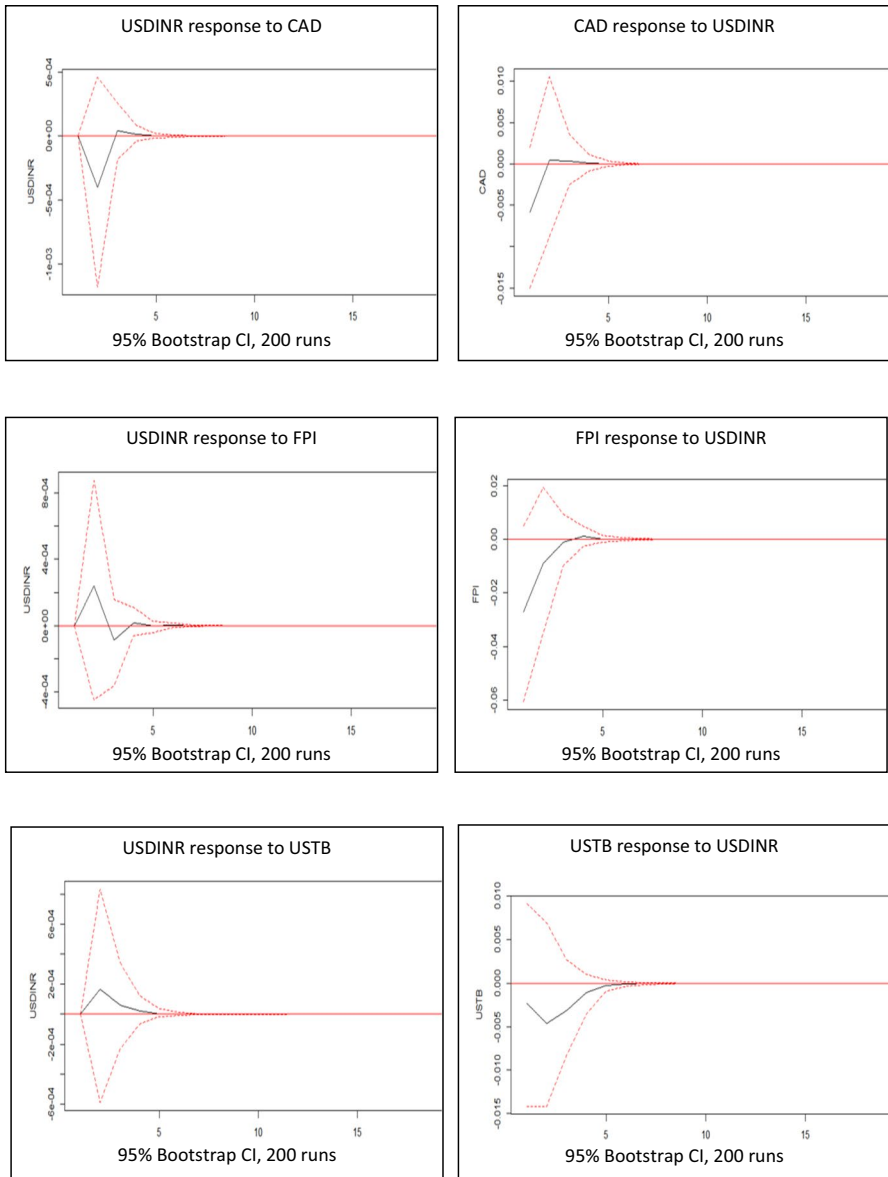


Fig. 2 (continued)

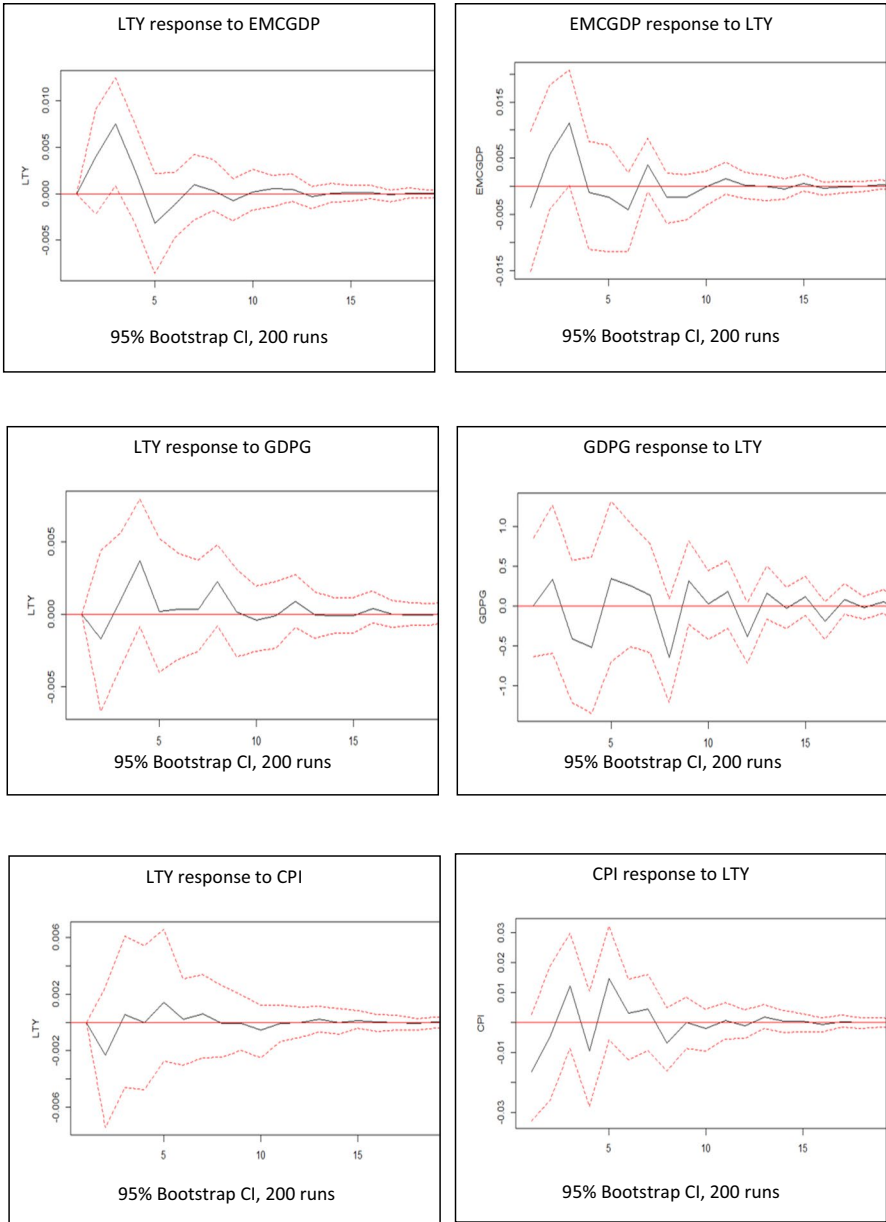


Fig. 3 Impulse plot for LTY–full sample period (2002–21)

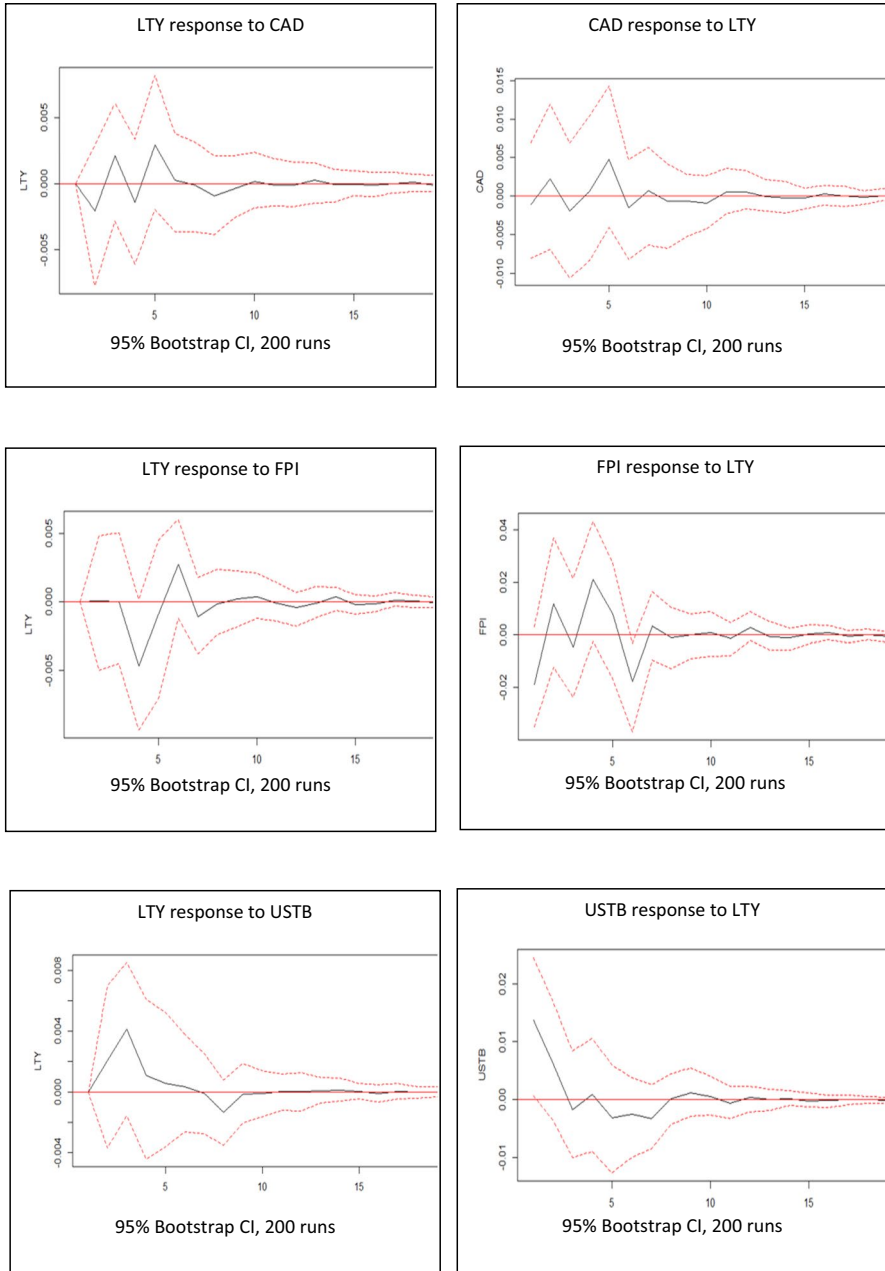


Fig. 3 (continued)

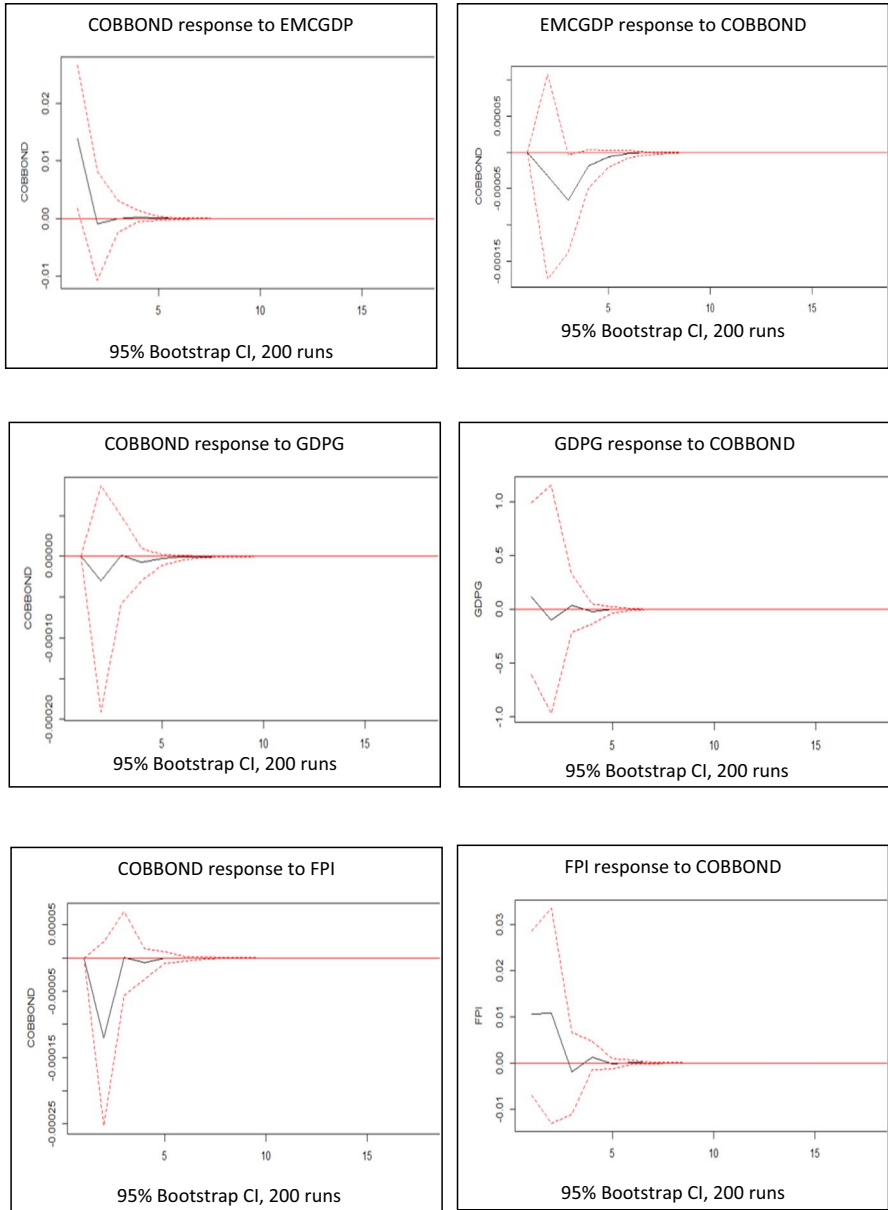


Fig. 4 Impulse plot for COB–full sample period (2002–21)

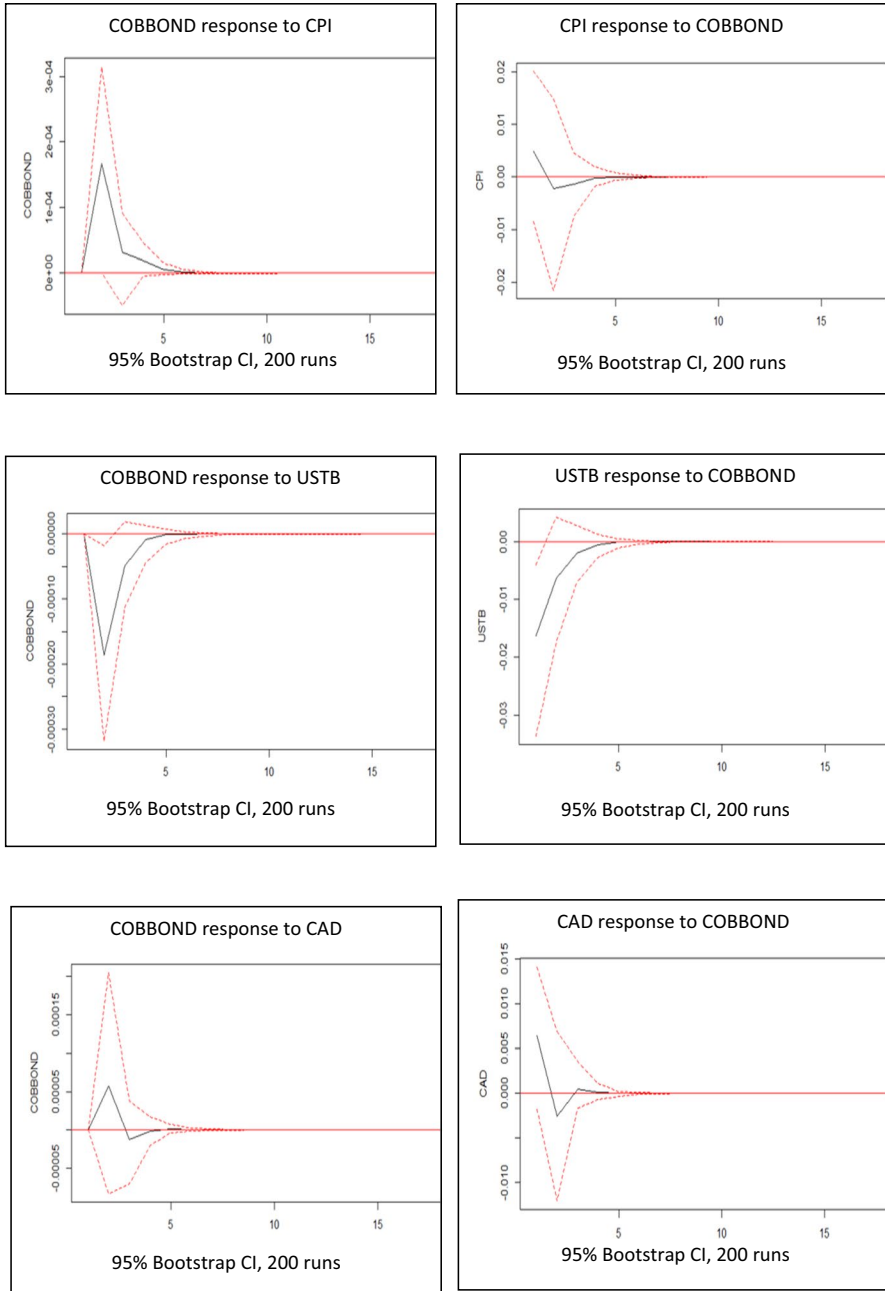


Fig. 4 (continued)

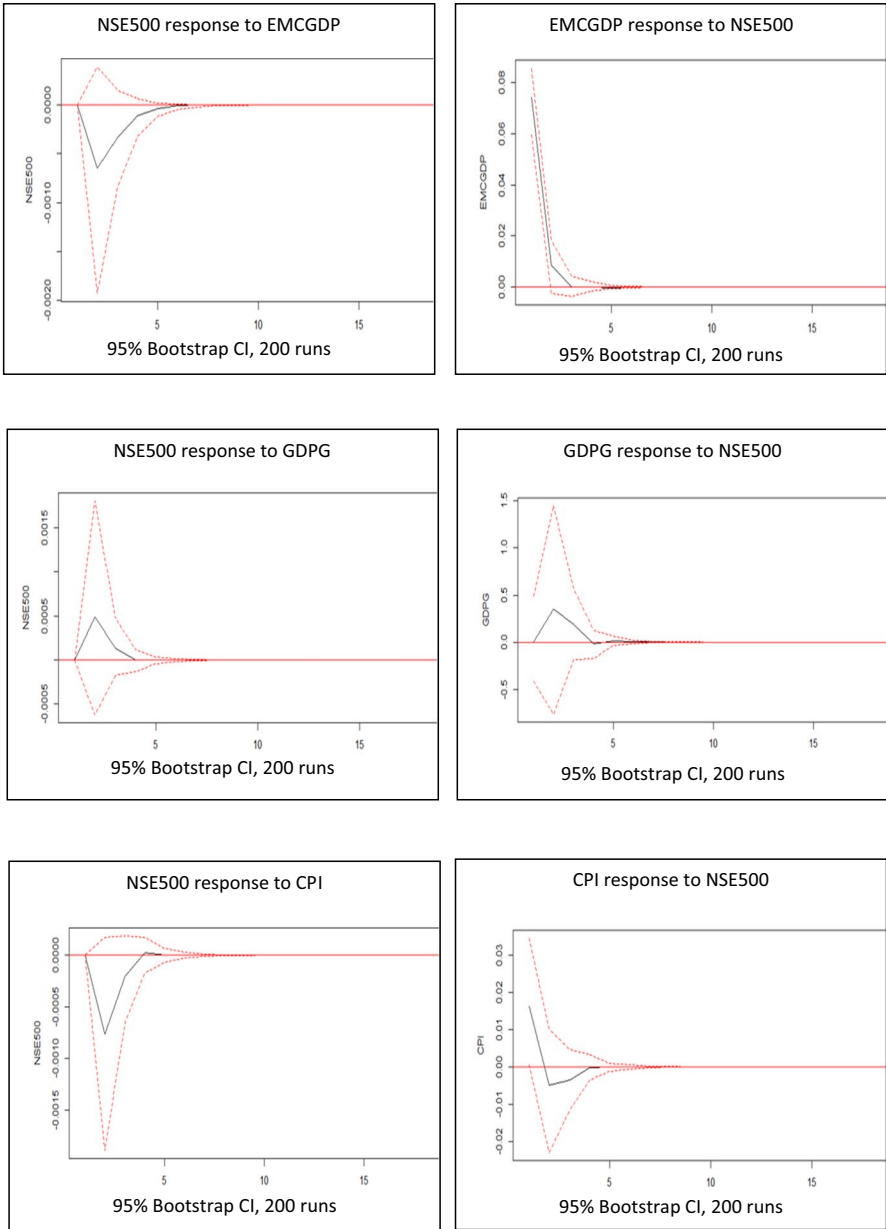


Fig. 5 Impulse plot for NSE500–full sample period (2002–21)

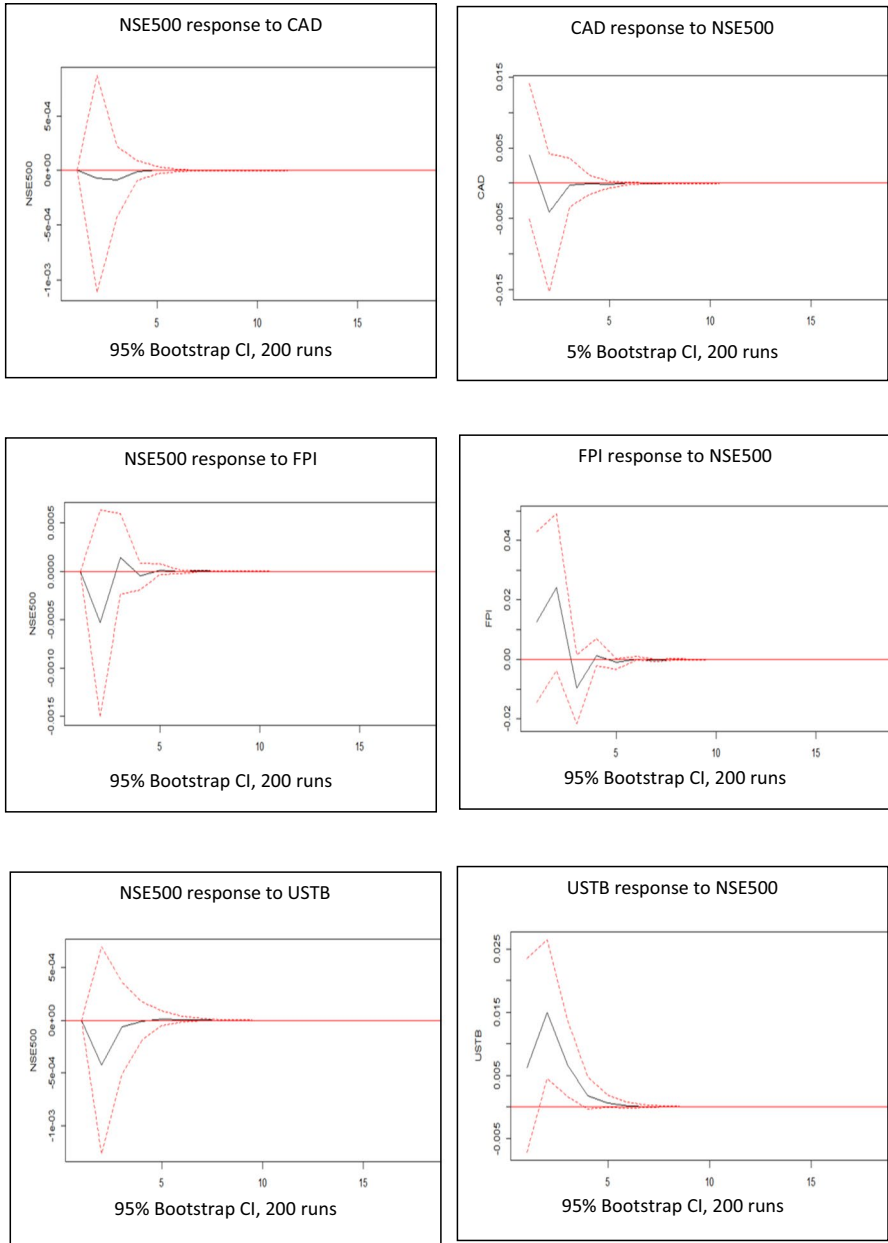


Fig. 5 (continued)

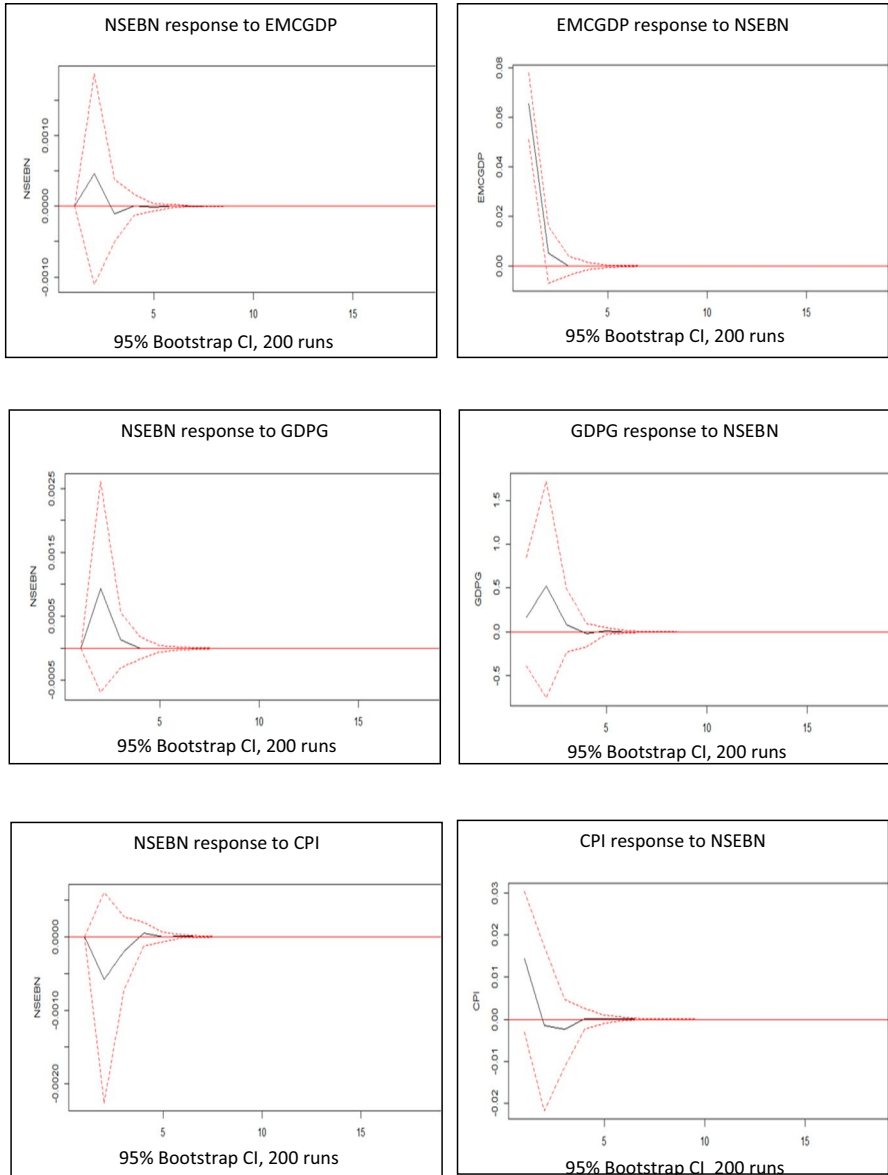


Fig. 6 Impulse plot for NSEBN–full sample period (2002–21)

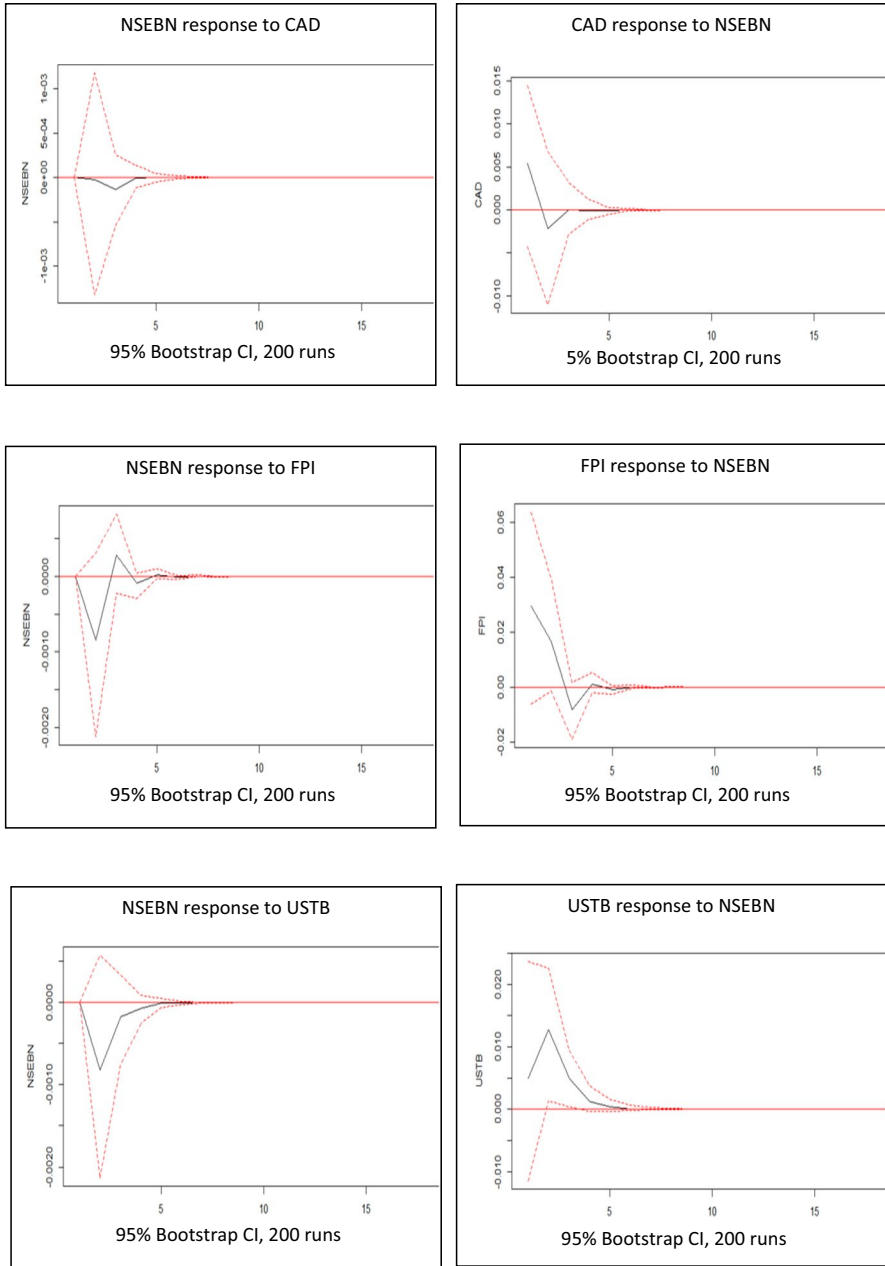


Fig. 6 (continued)

It was found that the response of MIBOR to macro-economic shocks are in accordance with theory e.g., negative to Inflation, CAD and US Treasury Yields. On the other hand, the response of MIBOR is positive to GDP growth signifying higher demand for money. Response of MIBOR to FPI flows becomes positive and then turn negative, before converging to steady state. This kind of trend seems to be a response to use of Market Stabilisation Scheme (MSS) by the Reserve Bank of India (RBI) to sterilize the enhanced foreign liquidity coming through FPIs. An increase in financial market depth, represented by market cap to GDP ratio is also a positive for MIBOR. Further, the response of MIBOR dies down in three to five months of the impulses coming from the macro-economic shocks.

As far as the response of USD INR rate to macro-economic shocks is concerned, the response will come from the impact of such shocks on the expectations regarding the underlying net demand for USD. With an increase in inflation and CAD, for instance, the demand for USD will go up, as both these shocks means net increase in demand for foreign goods and services, and therefore, more domestic demand for USD to service imports. On the other hand, an increase in USD treasury yield would mean net outflow or lower net inflow of USD through FPIs, thereby adversely impacting the net supply of USD. Therefore, as expected, the response of USD INR rate to shocks in inflation, current account deficits and USD treasury yields is positive, indicating weakening of rupee and potential depreciation of Indian currency. On the other hand, the response is negative to shocks in GDP growth rate and market cap to GDP, indicating strengthening of forex inflows and consequent exchange rate appreciations. The positive response of USD-INR exchange rate to FPI flows i.e., appreciation of rupee following capital inflows is also theoretically intuitive, as with FPI flows the exchange rate can potentially appreciate. Further, the response of USD-INR dies down in three to five months of the impulses coming from the macro-economic shocks.

The response of Gsec Yield to GDP growth, Inflation and CAD, after becoming negative then turns to have a general positive bias before returning to steady state. This kind of a behavior seems to be reflecting the dominant role of monetary policy and over-all political economy in India in shaping the yields on Gsec. As expected, however, the response of Gsec yield to US Treasury Yields is positive. On the other hand, the response of Gsec yield to FPI flows and market cap to GDP have been negative, as a higher of these variables reflect positive trends and increasing likely interest of investors in equity markets and consequent addition to liquidity in the system. Another important pattern observed is that the response of Gsec yield to macro shocks persists for longer period, ranging from 10 months to more than 20 months, before the response dies down to respective impulses coming from the macro-economic shocks.

In case of corporate bonds, their interest rate risks are driven by their underlying financial strength. The better are these companies' balance sheets, cash balances, and underlying business trends, the less likely they are to default (miss a payment of principal or interest). They, therefore, tend to react differently to macro-economic shocks than a Gsec per se. In our analysis, the response of corporate bond is negative to GDP growth and US Treasury yield shocks, while they are positive to Inflation and CAD. On the other hand, the response

of corporate bonds, similar to Gsec yield, have been negative to FPI flows and market cap to GDP. The response of corporate bonds dies down in two to five months of the impulses coming from the macro-economic shocks. The response of corporate bonds to macro variables are more aligned to theory as compared to their Gsec counterpart.

The response of NSE 500 to macro-economic shocks are in accordance with theory e.g., positive to GDP growth, negative to Inflation, CAD and US Treasury Yields. On the other hand, the response of NSE 500 to FPI flows and market cap to GDP has been negative, implying, respectively, the immediate profit bookings mentality of domestic investors and stickiness of market capitalization to GDP in India. The similar pattern is also visible in NIFTY Bank Index, except response to market cap to GDP, which is positive in this case, implying banking stocks reacting positively to increased stock market depth. The response of equity market dies down in three to five months of the impulses coming from the macro-economic shocks.

Another important observation is regarding the time it takes in various sub-periods, to reach back to the steady state, post the macro-economic shocks. For the full sample period, the response of financial market indicators, except for Gsec yields, normally takes dies down between 2 to 5 days. However, when seen for different sub—periods, it took longer times in each of those sub-periods to reach steady states in financial market variables following a shock in the macro-economic indicators. Another general observation has been that, in the sample periods, which also includes the time period of general market revival following the crises e.g., GFC (2009 to 2013) and COVID (2014 to 2021), the response functions themselves have been more volatile, reflecting shaky sentiments in such periods.

Moreover, it may be highlighted that the response of broader equity index to an impulse from FPI flows, an indicator signifying investors' confidence, has been negative for the entire sample period. However, it is observed from the impulse response for different sample periods that, during the sample period from 2009 to 2013 and sample period from 2014 to 2021, the response of equity market to FPI follows have been positive. This may be explained by the fact that, as economy recovers from crises, FPI inflows signifies an immediate positive sentiment about the market, leading to overall bullishness and recovery in the equity market.

5.3 Variance Decomposition Analysis (VDA)

When we forecast for N periods, the forecast error variance decomposition indicates how much a variable's own past movements explain its own variation and to what extent other variables, included in the analysis, explain its variation. Put simply, it shows as to how much of own shocks and how much other variables shocks are impacting one particular variable. Generally, own shock becomes predominant in this analysis.

5.4 VDA of MIBOR

In the case of MIBOR the variance decomposition analysis (VDA) for the entire sample period from 2002 to 2021 revealed that, apart from its own lags, which explains 97% of its variations, FPI flows explains the rest 3% of variations in MIBOR. During sample period I, the lags of MIBOR explain at least 70% of its variation, followed by FPI flows upto 9%, CAD about 6% and CPI about 5%. During sample period II, its own lags explain at least 57% of variations in MIBOR, followed by upto 11% by Market Capitalization to GDP, upto 10% by CAD and upto 6% each by FPI, CPI and GDP Growth. In sample period III, at least 37% of variations in MIBOR is explained by its own lags, followed by CAD upto 24%, GDP growth upto 15%, US treasury yields upto 11% and FPI flows upto 9%. This is the sample period which represents the Eurozone crisis and taper tantrum by US Fed at a time of higher CAD, slowing GDP growth and overall fiscal imbalance domestically in India. In sample period IV, at least 57% of variations in MIBOR is explained by its own lags, followed by CAD upto 15%, CPI upto 8% and FPI flows upto 7%. In sample period V, at least 63% of variations in MIBOR is explained by its own lags, followed by CAD upto 18% and FPI flows upto 7%. This period also includes the post Covid period of general negative shock to global economy, indicating potential decline in exports.

5.5 VDA of USD-INR Rate

In the case of USD-INR, apart from its own lags which explain at least 98% of its variations, only CPI explains the balance for the full sample period. During sample period I, the lags of USD-INR explain at least 54% its variations, followed by upto 19% by CPI, upto 11% by market capitalization to GDP ratio and upto 6% each by CAD, FPI and USTB. During sample period II, at least 60% of variations in USD-INR is explained by its own lags, followed by USTB upto 12%, EMCGDP 9%, FPI flows upto 7%, CAD upto 5% and CPI and GDP growth rate upto 4% each. During sample period III, at least 73% variations in USD-INR is explained by itself, followed by upto 13% by USTB, upto 4% by EMCGDP, upto 3% each by CPI, FPI and GDP growth and upto 2% by CAD. This is the sample period which represents the Eurozone crisis and taper tantrum on global fronts, combined with higher CAD, slowing GDP growth and overall fiscal imbalance domestically in India. In sample period IV, at least 53% of variations in USD-INR is explained by its own lags, followed by CPI upto 12%, CAD and USTB upto 9%, EMCGDP upto 7%, FPI upto 6% and GDP growth upto 5%. In sample period V, at least 76% of variations in USD-INR is explained by its own lags, followed by CPI upto 10% and FPI upto 7%, CAD upto 3%, EMCGDP and GDP growth upto 2% and upto 1% by USTB. This period also includes the post Covid period of general negative shock to global economy.

5.6 VDA of LTY

The VDA results of LTY i.e. 10 year Gsec yield for the full sample period shows that, for LTY, its own lags explain at least 90% of its variations, followed by upto 0.5% by EMCGDP, upto 2% by FPI and 1% by GDP Growth and CAD. During sample period I, the lags of LTY explain at least 67% its variations, followed by upto 6% each by EMCGDP, CPI, CAD; upto 5% each by FPI, GDP Growth and USTB. During sample period II, at least 71% variations in LTY is explained by itself, followed by upto 14% by EMCGDP, upto 5% by CAD, upto 4% by USTB, upto 3% by CPI and upto 2% each by FPI and GDP growth. During sample period III, the variation in LTY is explained by its own lags upto 57% followed by upto 15% by CAD, upto 9% by USTB, upto 5% each by EMCGDP, GDP Growth and FPI and upto 4% by CPI. This is the sample period which represents the Eurozone crisis and taper tantrum on global fronts, combined with higher CAD, slowing GDP growth and overall fiscal imbalance domestically in India. In sample period IV, at least 54% of variations in LTY is explained by its own lags, followed by FPI upto 12%, GDP Growth upto 11%, EMCGDP upto 9%, CPI upto 6%, CAD upto 5% and USTB upto 4%. In sample period V, at least 54% of variations in LTY is explained by its own lags, followed by FPI flow upto 16%, GDP growth upto 10%, USTB upto 8%, EMCGDP upto 6%, CAD upto 4% and CPI upto 3%. This period includes the post Covid period of general negative shock to global economy. As can be seen, sentiment indicators like FPI and USTB and economic revival represented by GDP growth had major influence on Gsec yield or LTY during this period.

5.7 VDA of COB

For corporate bond, its own lags explain at least 94% of its variations, followed by upto 2% each by CPI and USTB and 1% by FPI during the full sample period. During the sample period I, the lags of corporate bond explain at least 78% its variations, followed by upto 10% by USTB, upto 6% by CAD; upto 4% by FPI and upto 1% by GDP Growth, CPI and EMCGDP. During sample period II, at least 67% variations in corporate bond is explained by itself, followed by upto 11% by CPI, upto 9% by EMCGDP, upto 5% by USTB, upto 3% each by FPI and CAD and upto 2% by GDP growth. During sample period III, the variation in corporate bond is explained by its own lags upto 46% followed by upto 23% by CPI, upto 17% by USTB, upto 6% by GDP growth, upto 5% by EMCGDP and upto 2% each by FPI and CAD. This is the sample period which represents the Eurozone crisis and taper tantrum on global fronts, combined with higher CAD, slowing GDP growth and overall fiscal imbalance domestically in India. In sample period IV, at least 58% of variations in corporate bond is explained by its own lags, followed by GDP growth upto 10%, EMCGDP and CAD each upto 8%, FPI upto 6% and CPI and USTB upto 5% each. In sample period V, at least 48% of variations in corporate bond is explained by its own lags, followed by USTB upto 13%, GDP growth upto 12%, FPI upto 10%, CAD upto 9%, EMCGDP upto 6%, CPI upto 4%. This period includes the post Covid period of general negative shock to global economy. As can be seen, sentiment

indicators like FPI and USTB and economic revival represented by GDP growth had major influence on corporate bonds during this period.

5.8 VDA of NIFTY500

VDA of NIFTY500 for the full sample period shows that, for NSE500, its own lags explain at least 97% of its variations, followed by upto 1% each by EMCGDP and CPI. In sample period I, the lags of NSE500 explain at least 48% its variations, followed by upto 18% by EMCGDP, upto 10% by CAD; upto 7% each by GDP growth and CPI, upto 5% each by CAD and USTB. During sample period II, at least 70% variations in NSE500 is explained by itself, followed by upto 14% by USTB, upto 5% each by FPI and CPI, upto 4% by EMCGDP, upto 2% by CAD and upto 1% by GDP growth. This period includes the period of GFC and hence a significant impact of USTB. During sample period III, the variation in NSE500 is explained by its own lags at least 37% followed by upto 35% by USTB, upto 14% by FPI, upto 11% by CPI and upto 3% each by EMCGDP, GDP growth and CAD. This is the sample period which represents the Eurozone crisis and taper tantrum on global fronts, combined with higher CAD, slowing GDP growth and overall fiscal imbalance domestically in India. In sample period IV, at least 59% of variations in NSE500 is explained by its own lags, followed by CPI upto 12%, GDP growth upto 10%, CAD upto 7%, EMCGDP upto 6%, FPI upto 4% and USTB upto 3%. In sample period V, at least 67% of variations in NSE500 is explained by its own lags, followed by GDP growth upto 9%, CAD upto 7%, CPI upto 6%, FPI and EMCGDP each upto 4% and USTB upto 3%. This period includes the post Covid period of general negative shock to global economy.

5.9 VDA of NSEBN

VDA of NSEBN for the full sample period shows that, for NSEBN, its own lags explain at least 97% of its variations, followed by upto 1% each by GDP growth and USTB. In sample period I, the lags of NSEBN explain at least 53% its variations, followed by upto 16% by CPI, upto 13% by EMCGDP, upto 7% by CAD; upto 5% by GDP growth, upto 4% by USTB and upto 2% by FPI. During sample period II, at least 64% variations in NSEBN is explained by itself, followed by upto 20% by USTB, upto 6% each by CPI, upto 4% by EMCGDP, upto 3% by FPI, and upto 2% each by CAD and GDP growth. This period includes the period of GFC and hence a significant impact of USTB. During sample period III, the variation in NSEBN is explained by its own lags at least 36% followed by upto 33% by USTB, upto 11% by EMCGDP, upto 8% by CPI, upto 6% by FPI and upto 4% each by growth and upto 2% by CAD. This is the sample period which represents the Eurozone crisis and taper tantrum on global fronts, combined with higher CAD, slowing GDP growth, high inflation and overall fiscal imbalance domestically in India. In sample period IV, at least 49% of variations in NSE500 is explained by its own lags, followed by CPI upto 19%, CAD upto 15%, EMCGDP upto 7%, GDP growth upto 6%, USTB upto 4% and FPI upto 2%. In sample period V,

at least 56% of variations in NSEBN500 is explained by its own lags, followed by upto 11% by CAD, upto 10% by GDP growth, upto 9% by EMCGDP, upto 8% by CPI and upto 3% each by FPI and USTB. This period includes the post Covid period of general negative shock to global economy.

6 Summary of Findings

The direction and extent of response by financial market variables are generally aligned to economic theory. Corporate bonds, however, tend to react differently to macro-economic shocks than a government bond. It takes at least 3–5 months for the impact of macro-economic shocks on financial markets to die down. In case of Gsec market, though, such impacts are more persistent and less aligned to economic theory, indicating a possible strong influence of monetary policy actions and larger political economy in shaping Gsec yields. It is also observed that as economy recovers from crises, the response of financial markets to macro-economic developments becomes even more volatile, reflecting shaky sentiments during such periods. During such periods, FPI inflows seems to signify an immediate positive sentiment about the market, leading to overall bullishness and recovery in the equity market.

FPI flow, current account deficit (CAD), inflation (CPI) and economic growth are predominant macro factors influencing money market and exchange rates. During uncertain times, USTB also significantly shapes the trajectory of MIBOR and exchange rates. CAD and CPI have significant impact on Gsec yield. A higher market capitalization to GDP ratio, representing higher financial market depth, is a big positive for Gsec yields. USTB and FPI impact Gsec yields more during uncertain periods. USTB has a significant impact on corporate bonds, more particularly in uncertain times, reflecting the fact that global sentiment has a role to play in assessing the corporate sector performance in India.

In times of global uncertainty, USTB and FPI flows have significant impact in forecasting equity market returns. Both these indicators represent market sentiments. Secondly, domestic macro-economic variables, in their weaker state, tend to influence the equity market more. CPI has a significant impact on bank stocks and corporate bonds, given that CPI is the harbinger of interest rate expectations and consequent business and profitability of banks.

7 Policy Lessons

The type and extent of the impact of macro-economic factors varies across financial market segments. The nexus depends on how macro-indicators impact valuation of expected returns from different asset classes. Secondly, macro-variables, when they are in their weaker state, tend to exert greater impact. For example, news on CAD, when CAD is already high, is likely to impact the expected return of the asset class more. Therefore, there is a need to focus on maintaining macroeconomic stability as a policy to foster financial market stability. Thirdly, sentiments play a significant role in financial markets, particularly during periods

of global uncertainty. Therefore, the behaviour of indicators like US treasury yield and FPI flows needs to be watched more closely during stress periods to assess financial markets volatility and to decide on the timing, type and quantum of response domestically. Fourthly, a deeper equity market, by providing for an alternative platform for fund raising, is positive for bond market volatility. Finally, given that nexus between macro factors and financial markets is subject to change with time and circumstance in the short-run as well as economic and market structures in the long run, there is an unavoidable need to monitor a customized and dynamic list of macroeconomic variables in respect of each of the financial market segments for early detection of trend reversals so as to decide on the timing, type and quantum of policy and regulatory responses from time to time.

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