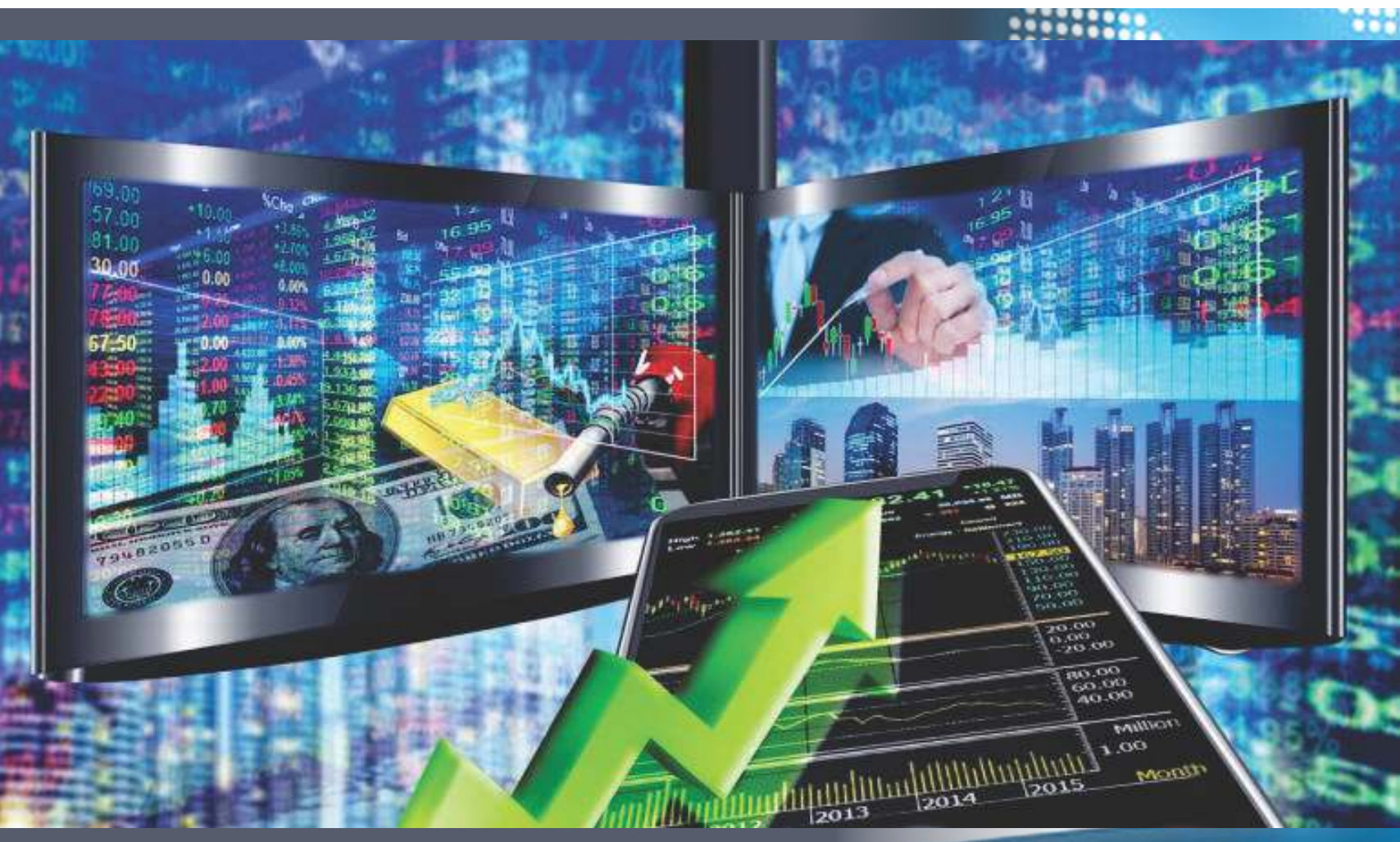


Causal Interactions between Macroeconomic Variables and Stock Market Returns in India with Special Reference to NSE

*Prof. Swami Prasad Saxena, **Dr. Sonam Bhadauriya



ABSTRACT

Stock market is one of the main variables of economic development of any economy, on the other hand, variations in stock market are also caused by the fluctuations in the various macroeconomic indicators. These stock market variations influence the behaviour of investors; so, the modeling of stock market returns and macroeconomic indicators is one of the key areas of financial researches. The present paper intends at identifying causal interactions between stock market returns and various macroeconomic variables.

Keywords: Stock market returns, Macroeconomic variables, Granger Causality, Causal loop diagram

[†] Professor, Dayal Bagh Educational Institute, Agra, India

^{**} Asst. Professor, Himalayan School of Management, Dehradun, India



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|------|--|-------|---|--------|
| CTMX | | 0.45 | ▲ | +0.45 |
| FTR | | -0.23 | ▼ | -2.34% |
| CSCO | | -1.01 | ▼ | -1.89% |
| CHK | | 0.02 | ▲ | +0.21 |
| AAPL | | +2.59 | | |
| PRTO | | -0.12 | | |
| AMZN | | | | |
| TSLA | | | | |

INTRODUCTION

Understanding the stock market dynamics has long been a topic of considerable interest by the market practitioners and investors which is a formidable challenge for them. The volatility of stock market indicators goes beyond anyone's reasonable explanations where the industry performances, economic and political changes are among the major factors that can affect the stock market (Goonatilake and Herath, 2007). The stock price movements are mainly caused by fundamentals and news about company, industry and economy. Fundamentals and news about company and industry e.g. results announcement, industry performance, business cycle, financial leverage, product launch, etc. are micro variables and the performance and news about economy, e.g. national income, interest rates, budget announcement, nuclear power testing, inflation etc. are known as macro variables.

From stock market point of view, the impact of macroeconomic variables is more important because stock performance of a particular company is influenced by micro it was variables but the macro variables drop impact on the whole stock market behavior. On any one day, there would be good stock-specific news for a few companies and bad stock-specific news for others. The news that is common to all stocks is news about macro economy. In this way, stock markets are barometers of the economy. It is expected that the markets and their indicators, in the form of indices, reflect the potential of the corporate listed on them, and, in the process, the direction and health of the economy. If a country's economy is performing well and expected to grow at a healthy rate, the markets usually reflect that. Stock prices reveal the expectations about future corporate performance; these generally reflect the level of economic activities and the underlying fundamentals. Accordingly, the causal relations and dynamic interactions between macroeconomic variables and stock prices are very important for the market practitioner.



LITERATURE REVIEW

The relationship between macroeconomic variables and stock market returns is, by now, well-documented in the literature. Maysami, Howe and Hamzah (2004) examined the long-term equilibrium relationships between selected macroeconomic variables and the Singapore stock market index and concluded that the causal relations and dynamic interactions among macroeconomic determinants of the economy and stock prices are important in the formulation of the nation's macroeconomic policy. Leblebicioglu and Aksoy (2004) successfully implemented a rule based fuzzy logic model to forecast the monthly return of the ISE100 Index by combining technical analysis, financial analysis and

macroeconomic analysis.

Chowdhury, Mollik and Akhter (2006) examined how the macroeconomic risk associated with industrial production, inflation, and exchange rate is related and reflected in the stock market returns in the context of Bangladesh. They concluded that there is relation between stock market dynamics and macroeconomic volatility. Engle and Rangel (2006) developed a model that allows long horizon forecasts of volatility to depend on macroeconomic developments, and delivers estimates of the volatility to be anticipated in a newly opened market. Humpe and Macmillan (2007) examined whether selected macroeconomic variables influenced stock prices in the US and Japan.

Adam and Tweneboah (2008) observed that there is co-integration between macroeconomic variables and Stock prices in Ghana indicating long run relationship. Kumar (2009) investigated the relationship between macroeconomic parameters like Exchange rate and foreign institutional investment with stock returns in India, in particular at National Stock Exchange. By using Granger causality test he found that exchange rate and stock returns had no causality from either of the sides whereas stock return was found to be Granger cause of FII series. Ali et al. (2010) also investigated the causal relationship between macroeconomic indicators and stock exchange prices. They found co-integration between industrial production index and stock prices, and no causal relationship between macroeconomic indicators and the stock prices in Pakistan.

Tripathi and Seth (2014) examined the causal relationships between the stock market performances and select macroeconomic variables in India and found a significant correlation between stock market indicators and macroeconomic factors. Gurloveleen and Bhatia (2015) investigated the impact of macro-economic variables on the functioning of Indian Stock Market. Kotha and Sahu (2016) examined long and short run relations between selected macroeconomic indicators and stock market returns with reference to India. Khalid and Khan (2017) investigated the effects of interest rate, exchange rate and inflation rate on stock market performance of Pakistan by using annual time series data covering the 1991-2017 period.



NEED OF THE STUDY

Stock market of any economy provides ample opportunities to investors to earn profits and enhance their investments worth. It plays an important role in the mobilization of capital from the domestic as well as from foreign investors. The importance of this research stems from the crucial role played by the Indian stock market in developing Indian economy. Many academic researchers, financial and industry analysts and practitioners have tried to envisage the relationship between macroeconomic variables and stock market movements from the past decades. They have done several empirical and descriptive studies to check the effect of macroeconomic variables on stock prices or vice-versa using various statistical, mathematical and econometrical models.

In the linkage the present research is contributing to the identification of causal interactions between stock market returns and various macroeconomic variables.



RESEARCH OBJECTIVES AND METHODOLOGY

Research Objectives

This paper is dedicated to the identification of causal interactions between stock market returns and various macroeconomic variables. First of all statistical causal interaction are identified and on the basis statistical interactions and conceptual knowledge causal loop interactions are recognized. Thus, the objectives of the research paper are:

1. To find out statistical causal interactions between macroeconomic variables and stock market returns via Granger Causality Test.
2. To draw causal loop interactions between macroeconomic variables and stock market returns via causal loop diagramming.

The Variables

Keeping above mentioned objectives in mind, the researchers extensively reviewed available literature and identified 14 key macroeconomic variables of stock market vulnerability. These are Gross Domestic Product (GDP), Index of Industrial Production (IIP), Wholesale Price Index (WPI), Balance of Payments (BOP), Foreign Exchange Reserves (FXRE), Foreign Exchange Rate (FXRA), Repo Rate (RPR), Treasury Bills Rate (TBR), Prime Lending Rate (PLR), Foreign Institutional Investments (FII), Trading Volume (TRV), Market Capitalization (MCP), Crude Oil Prices (CRO) and Gold Prices (GLD). The supported research works of the selection of these variables are mentioned in Table 1. Stock market returns (SMR) of National Stock Exchange of India Ltd. is selected as the indicator of the Indian stock market. Monthly Data of twelve financial years from FY 2002-03 to FY 2013-14 has been collected through official government websites. The detailed description of the variables is provided in Table 2.

Research Technique 1: Granger Causality test

Granger Causality test is a test for determining whether one-time series is useful in forecasting another or not. Granger proposed that if causal relationship exists between variables, they can be used to predict each other. In general, it is a F-test on lagged values of a time series X including the lagged values of Y (Madalla, 2001). The mathematical presentation of Granger Causality test for a model of two variables X and Y is:

Where, p is the maximum length of the lagged observations, A is the matrix that contains the coefficients of the model

$$\begin{aligned}
 X(t) &= \sum_{j=1}^p A_{1,j} X(t-j) + \sum_{j=1}^p A_{2,j} Y(t-j) + \varepsilon_1(t) \\
 Y(t) &= \sum_{j=1}^p A_{21,j} X(t-j) + \sum_{j=1}^p A_{22,j} Y(t-j) + \varepsilon_2(t)
 \end{aligned}$$

(containing of each lagged values of both the variables), and ε_1 and ε_2 are the prediction errors. The magnitude of a G-causality interaction can be estimated by the logarithm of the corresponding F-statistic (Geweke, 1982). Granger Causality test can be extended to the n variables. If the hypotheses (X does not Granger cause Y) rejects, it means X has causality impact on Y or (Y does not Granger cause X) rejects, it means Y has causality impact on X, and so the causality inference is unidirectional. If both the hypotheses reject, then it should be interpreted as the bidirectional causality or feedback.

Research Technique 1: Causal Loop Diagram

Causal Loop Diagrams (CLDs) are abstract and simplified representations of relevant factors of any system and the causal relationships between them (Cioni, 2009). The CLDs consist two items, the first are the factors or variables and second are the links connecting the factors. Any link has annotations about its polarity and delay. The polarity tells whether the dependency has positive polarity (if the cause increases, the effect will also increase compared with the situation where the cause did not change) or negative polarity (if the cause increases, the effect will decrease compared with the situation where the cause did not change) (Binder et al., 2004). CLDs represent only the structure; the dynamics of events have been abstracted away. Basically, these indicate what happens between events or variables as cause and effect. The sources of information may be mental (primary information with every human being), written/spoken (previous research works) and numerical (quantitative database). The diagramming is done in Vensim PLE V6.0 software using mental (researchers' conceptual knowledge), written/spoken (reviewed research papers) and numerical information (results of Granger Causality test).



RESULTS AND DISCUSSION

Granger Causality Test

To explore the existence of causality between stock market and selected macroeconomic variables, the Granger Causality Test has been applied and the F-statistics along with their significance values are shown in Table 3. Results of Granger causality test established only three causal relationship (i) SMR Granger cause to BOP, (ii) SMR Granger Cause to RPR and (iii) MCP Granger Cause to SMR. Rest all the hypotheses are not rejected at 5% level of significance. Only the results of Granger causality are not able to develop a comprehensive causal interacted structure between stock market and the selected macroeconomic variables.

Causal Loop Diagramming

Results explored by the Granger Causality test for SMR with all the fifteen explanatory variables do not show much significant outcomes as only few of the Granger cause hypotheses are rejected and rest proved valid. As researcher did not find remarkable results from the Granger Causality test, and has also considered written and published literature available on

stock market interactions with macroeconomic indicators by scrutinized review of researches for diagramming the CLD, the developed causal framework has been presented in the Figure 1. In this figure, the polarity of the causal loops is indicated by blue color at the top of the arrows. The logical description of causal relationships between selected variables is as follows:

SMR has three positive causal links (i.e., positive polarities) to FII, TRV and MCP. As FII, TRV and MCP are the indicators from stock market, they are directly affected by changes in SMR. It indicates that a rise in stock market indices boosts the number of investors, trading volume and the market capitalization. Further, SMR is positively affected by GDP, IIP, FII, TRV, MCP, CRO, and GLD; and negatively by PLR. GDP has a massive positive impact on almost all the sectors of the country. Reduced consumer spending leads to lower demand situation, which results in cutting down the production by the producers. Low industrial production results in lower corporate sales and profits, which directly affects the stock prices. So, there is a direct impact of weak IIP on sudden fall in stock prices. Increased consumer spending leads to higher demand of all products including financial products, thus inflation has positive impact on market behavior. FII, TRV and MCP have bidirectional causal relationship. Rising prices of crude oil and gold indicate sound purchasing power people of the country.

GDP has six positive causal links to SMR, IIP, WPI, TRV, FII and MCP. It shows that growth in GDP leads to increased production opportunities, investments and also the foreign investments. Higher GDP is a benign factor for the economy; it has overall impact on trade and industry in an economy resulting into increased trade in securities and the market capitalization of the companies. Boom in GDP may also result in the increased money supply and inflation.

IIP shows seven positive causal links to SMR, GDP, BOP, FII, TRV, MCP and CRO; and negative causal links with WPI. Relationships of IIP with stock market (TRV and MCP), and GDP are very clear as these are the outcomes of increased output, higher consumer demand, better corporate performance, increased investment and trade at stock market. Figure shows that IIP is a cause to CRO and BOP. It is due to the fact that when industrial production increases, the demand of crude oil also increases which ultimately results in to higher crude oil prices. Further, increased industrial production may result in increased international trade, favorable BOP and fall in inflation intensity.

Causalities of WPI are observed on the GDP, IIP, CRO and GLD with positive polarities. The relationship of WPI with GDP and IIP can be understood from the discussion in above paragraphs. The prices of crude oil and gold have cause and effect relationship with inflation. Thus, inflation causes an increase in demand for these commodities and the increase in demand of these commodities results into rise in inflation indices.

Increased international trade gives rise to currency flows in

the country and improves position of RBI to hold more foreign currency. The increased trade and Forex reserves also attracts foreign investors to invest in the country which again improves Forex reserves position in the country and strengthens the value of domestic currency (i.e. Rupee). Figure displays the positive causal links of BOP with FXRE and FII and negative link with FXRA.

Official Forex reserves in a country are held for transaction and precautionary motives keeping in view the aggregates of national interests. Foreign exchange reserves are important indicators of the ability of a country to repay foreign debt and for currency defence and are also used to determine credit ratings of the nations. Sound Forex reserves position of the nation brings more investments from the foreign investors and is an important instrument to maintain the exchange rate. In the figure, FXRE depicts negative causal relationship with FXRA and a positive causal link to FII.

It is commonly understood that a movement in exchange rate results in changes in relative prices of imports and exports of goods and services; so, the foreign trade and foreign investment. When US dollar appreciates against Indian Rupee, the relative prices of goods and services in the US market fall and the prices of goods and services imported from the US increase. This may result in increase in Indian exports and fall in imports depending on the degree of elasticity of demand of Indian goods and services in the US market. Any ways, the change in exchange rate has impact on production of goods and services, current account balance, BOP and the Forex reserves of the country. In the Causal Loop diagram FXRA shows negative causal link to IIP, BOP and FXRE.

RPR shows two negative causal links to IIP and WPI. It means when RBI increases repo rate, interest rates on deposits and advances also increase. This, on one hand encourages consumers to save more and reduce consumption, on the other, deters people to take loans from banks, leading to a shortage of money or liquidity in the economy. Thus, it controls inflation within limits, but retards industrial production as consumption falls and companies avoid taking new loans at higher interest rates.

Treasury Bills, highly liquid and secured promissory notes, are issued by Central Government for generating funds to finance outstanding obligations. An increase in Treasury bill rate (discount rate) leads to increased interest rates, which in turn adversely affect the industrial production and controls the intensity of inflation. Figure shows negative causal links of TBR with IIP and WPI.

Economic theory states that the interest rate channel affects demand for goods and services. Higher interest rates mean reduction in household consumption, fall in prices of both financial and real assets (e.g., shares, bonds, property etc.) and also in the present value of future returns. A rise in interest rates also makes it more expensive for firms to finance investment. If consumption and investment fall,

aggregate demand falls and lowers resource utilisation. When resource utilisation is low, prices and wages usually rise at a more modest rate. The Causal loop diagram shows negative link of PLR to SMR, GDP and IIP.

- FIIs usually pool large sums of money and invest those in securities, real property and other investment assets. As bulks of their investments are in the stock market, the inflow and outflow of money by FIIs affect stock market movement significantly and also the trading volume and the market capitalization. Since the amount of FII investment is credited in the balance of payments account, it has negative impact on the BOP. Figure 1 shows that FII has three positive causal links to SMR, TRV and MCP, and a negative causal link to BOP.
- Trading volume reflects the intensity of a stock, commodity or index. It reflects quality of a price trend and the liquidity of a security or commodity. High volume indicates greater reliance of investors in the market, positive movements in securities price, growth of the stock exchange, and its market capitalization. The Causal loop diagram indicates positive causal links of TRV to SMR and MCP.
- Market capitalization is the way to use the stock price to determine the value of a company, and to know how likely it is to grow. Investors use the figure of market capitalization to determine size of a company; normally they are attracted to the rising trend of market capitalization in a stock exchange. MCP is found to have two positive causal links with SMR and FII.
- Oil, one of the major inputs in an economy is used in most of the critical activities. When input costs of oil rise, the cost of end products also rises and results into inflation. Further, inflation causes an increase in demand for oil which results into rise in oil prices, profits of oil companies, their market performance and the growth in the stock market. Further, the hike in crude oil prices in international market results in rising bill of oil importing countries and also the rising negativity in the balance of payments account. The causal loop diagram shows three positive causal links of CRO to SMR, WPI, and GLD, and a negative link to BOP.

Investors are mostly interested in the assets with low price and high returns. When gold prices increase, investors divert their investments to stock market. This is indicated by positive causal link of GLD with SMR in causal loop Diagram.



CONCLUSION

The causal framework developed in this paper presents a logically structured framework for interrelationship between the stock market returns and the macroeconomic variables in

Indian context. Additional researches can be done using this diagram for developing non-linear modeling techniques such as multivariate GARCH, System Dynamics, Fuzzy-Neural Networks, Fuzzy Asymmetric GARCH, ANFIS, Hidden Markov Models, Wavelet Neural Networks etc.

This work would be helpful to the investors at the time of their investment decisions because they can consider all those affecting variables and take suitable actions. India has been showing remarkable interest in stock market investment in last decades. Investment in stock market is a science wherein an investor should carry out a detailed enquiry before investing. Today most young professionals earn good income but face myriad financial challenges and lose good investment opportunities. With changing time, the youngsters take participation in the programs on financial planning, safe investing, financial goal setting, etc. Further, for most of the people, the regular income comes in the form of salary and by the time of retirement, they have their income and spending patterns well established. They need to plan what they are going to do with their retirement savings to ensure that they will continue to earn a satisfying income and enjoy a comfortable lifestyle, even when they are no longer working. Stock market provides various investment avenues for the retired persons to achieve their financial goals. The research could work as an investment guide on stock market investing for them. The historical database for all the selected variables is easily available on the authentic websites any time. The investor can easily correlate the data with causal relations before making any investment decision in stock market.

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TABLE 1: VARIABLES SELECTION CRITERIA

| Dependent Variable: Stock Market Returns (SMR) | | |
|---|--|--|
| S. No. | Macroeconomic (Independent) Variables | Empirical Evidences (Justification) |
| 1. | Gross Domestic Product (GDP) | Aksoy and Leblebicioglu (2004), Maysami, Howe and Hamzah (2004), Engle and Rangle (2006), Duca (2007), Diebold and Yilmaz (2008), Oseni and Nwosa (2011), Kumar and Puja (2012), Zakaria (2012). |
| 2. | Index of Industrial Production (IIP) | Aksoy and Leblebicioglu (2004), Maysami, Howe and Hamzah (2004), Bhattacharya and Mukherjee (2006), Chowdhury, Mollik and Akhter (2006), Dopke, Hartmann and Pierdzioch (2006), Humpe and Macmillan (2007), Corradi and Distaso (2009), Engle, Ghysels and Sohn (2009), Ali et al. (2010), Paye (2011), Kumar and Puja (2012), Gurloveleen and Bhatia (2015). |
| 3. | Wholesale Price Index (WPI) | Maysami, Howe and Hamzah (2004), Bhattacharya and Mukherjee (2006), Chowdhury, Mollik and Akhter (2006), Dopke, Hartmann and Pierdzioch (2006), Engle and Rangle (2006), Flad (2006), Humpe and Macmillan (2007), Saryal (2007), Adam and Tweneboah (2008), Diebold and Yilmaz (2008), Corradi and Distaso (2009), Engle, Ghysels and Sohn (2009), Ali et al. (2010), Sharma and Mahendru (2010), Asaolu and Ogunmuyiwa (2011), Oseni and Nwosa (2011), Paye (2011), Zakaria (2012), Gurloveleen and Bhatia (2015), Kotha and Sahu (2016), Khalid and Khan (2017). |
| 4. | Balance of Payments (BOP) | Aksoy and Leblebicioglu (2004). |
| 5. | Foreign Exchange Reserves (FXRE) | Bhattacharya and Mukherjee (2001), Aksoy and Leblebicioglu (2004), Bhattacharya and Mukherjee (2006), Sharma and Mahendru (2010), Gurloveleen and Bhatia (2015), Khalid and Khan (2017). |
| 6. | Foreign Exchange Rate (FXRA) | Bhattacharya and Mukherjee (2001), Aksoy and Leblebicioglu (2004), Maysami, Howe and Hamzah (2004), Bhattacharya and Mukherjee (2006), Chowdhury, Mollik and Akhter (2006), Engle and Rangle (2006), Adam and Tweneboah (2008), Kumar (2009), Ali et al. (2010), Sharma and Mahendru (2010), Asaolu and Ogunmuyiwa (2011), Kumar and Puja (2012), Zakaria (2012), Gurloveleen and Bhatia (2015), Kotha and Sahu (2016). |
| 7. | Repo Rate (RPR) | Aksoy and Leblebicioglu (2004). |
| 8. | Treasury Bills Rate (TBR) | Aksoy and Leblebicioglu (2004), Maysami, Howe and Hamzah (2004), Dopke, Hartmann and Pierdzioch (2006), Flad (2006), Adam and Tweneboah (2008), Kotha and Sahu (2016). |
| 9. | Prime Lending Rate (PLR) | Maysami, Howe and Hamzah (2004), Humpe and Macmillan (2007), Zafar, Urooj and Durrani (2008), Oseni and Nwosa (2011), Kumar and Puja (2012), Zakaria (2012), Khalid and Khan (2017). |
| 10. | Foreign Institutional Investments (FII) | Kumar (2009), Gurloveleen and Bhatia (2015). |
| 11. | Trading Volume (TRV) | Engle, Ghysels and Sohn (2009). |
| 12. | Market Capitalization (MCP) | Oluwatoyin and Gbadeb (2009), Musebe (2014). |
| 13. | Crude Oil Prices (CRO) | Adam and Tweneboah (2008), Gurloveleen and Bhatia (2015). |
| 14. | Gold Prices (GLD) | Sharma and Mahendru (2010). |

TABLE 2: VARIABLES DESCRIPTION WITH THEIR SOURCE

| Dependent Variable | | Data Source |
|-----------------------------|--|--------------------|
| SMR | Aksoy and Leblebicioglu (2004), Maysami, Howe and Hamzah (2004), Engle and Rangle (2006), Duca (2007), Diebold and Yilmaz (2008), Oseni and Nwosa (2011), Kumar and Puja (2012), Zakaria (2012). | dbie.rbi.org.in |
| Independent Variable | | Data Source |
| GDP | Quarterly Estimates of Gross Domestic Product at Factor Cost (At Current Prices) (Base : 2004-05) (Rs.Crore) | dbie.rbi.org.in |
| IIP | Monthly Index Numbers of Industrial Production (Base : 1993-94 = 100) | dbie.rbi.org.in |
| WPI | Wholesale Price Index - Monthly Average (Base: 2004-05=100) | dbie.rbi.org.in |
| BOP | India's Overall Balance of Payments - Quarterly (Rs.Crore) | dbie.rbi.org.in |

TABLE 2: VARIABLES DESCRIPTION WITH THEIR SOURCE

| Dependent Variable | | Data Source |
|--------------------|--|-----------------|
| FXRE | Monthly Foreign Exchange Reserves (Rs.Crore) | dbie.rbi.org.in |
| FXRA | Monthly Average of Exchange Rate of the Indian Rupee (Rs.per unit of USD) | dbie.rbi.org.in |
| RPR | Repo Rate | dbie.rbi.org.in |
| TBR | Monthly Average of Implicit Yield at Cut-off Price (Per cent) on 91-Day Treasury Bills | dbie.rbi.org.in |
| PLR | Prime Lending Rate relates to State Bank of India (SBAR: State Bank Advance Rate) | dbie.rbi.org.in |
| FII | Monthly Net Investments by Foreign Institutional Investors in the Indian Capital Market (Rs.Crore) | dbie.rbi.org.in |
| TRV | Monthly Traded Volume in Corporate Debt at NSE (Amount Traded in Rs.Crore) | dbie.rbi.org.in |
| MCP | Monthly Market Capitalization-NSE (Rs.Crore) | dbie.rbi.org.in |
| CRO | Monthly Cushing, OKWTI Spot Price FOB (Dollars per Barrel) | dbie.rbi.org.in |
| GLD | Monthly Average Price of Gold in Domestic Market (Mumbai) (Rs.per 10gms.) | dbie.rbi.org.in |

TABLE 3: RESULTS OF GRANGER CAUSALITY TEST

| S. No. | Null Hypothesis | F-Statistics | P-Value | HO Not Rejected | Causality Inference |
|--------|---------------------------------|--------------|---------|-----------------------------|-------------------------------------|
| 1. | SMR does not Granger Cause GDP | 1.019 | 0.399 | H ₀ Not Rejected | No Causality |
| 2. | GDP does not Granger Cause SMR | 0.912 | 0.458 | H ₀ Not Rejected | |
| 3. | SMR does not Granger Cause IIP | 0.968 | 0.427 | H ₀ Not Rejected | No Causality |
| 4. | IIP does not Granger Cause SMR | 0.046 | 0.046 | H ₀ Not Rejected | |
| 5. | SMR does not Granger Cause WPI | 1.637 | 0.168 | H ₀ Not Rejected | No Causality |
| 6. | WPI does not Granger Cause SMR | 1.521 | 0.199 | H ₀ Not Rejected | |
| 7. | SMR does not Granger Cause BOP | 2.932 | 0.023* | H ₀ Rejected | Unidirectional Causality |
| 8. | BOP does not Granger Cause SMR | 2.372 | 0.050 | H ₀ Not Rejected | SMR BOP |
| 9. | SMR does not Granger Cause FXRE | 1.823 | 0.128 | H ₀ Not Rejected | No Causality |
| 10. | FXRE does not Granger Cause SMR | 1.316 | 0.267 | H ₀ Not Rejected | |
| 11. | SMR does not Granger Cause FXRA | 1.207 | 0.310 | H ₀ Not Rejected | No Causality |
| 12. | FXRA does not Granger Cause SMR | 1.110 | 0.354 | H ₀ Not Rejected | |
| 13. | SMR does not Granger Cause RPR | 3.702 | 0.006* | H ₀ Rejected | Unidirectional Causality SMR BOP |
| 14. | RPR does not Granger Cause SMR | 1.846 | 0.123 | H ₀ Not Rejected | |
| 15. | SMR does not Granger Cause TBR | 1.444 | 0.223 | H ₀ Not Rejected | No Causality |
| 16. | TBR does not Granger Cause SMR | 2.045 | 0.091 | H ₀ Not Rejected | |
| 17. | SMR does not Granger Cause PLR | 0.498 | 0.736 | H ₀ Not Rejected | No Causality |
| 18. | PLR does not Granger Cause SMR | 1.128 | 0.345 | H ₀ Not Rejected | |

TABLE 3: RESULTS OF GRANGER CAUSALITY TEST

| S. No. | Null Hypothesis | F-Statistics | P-Value | HO Not Rejected | Causality Inference |
|--------|--------------------------------|--------------|---------|-----------------------------|---------------------------------------|
| 19. | SMR does not Granger Cause FII | 0.649 | 0.628 | H ₀ Not Rejected | No Causality |
| 20. | FII does not Granger Cause SMR | 2.096 | 0.084 | H ₀ Not Rejected | |
| 21. | SMR does not Granger Cause TRV | 0.292 | 0.882 | H ₀ Not Rejected | No Causality |
| 22. | TRV does not Granger Cause SMR | 0.674 | 0.610 | H ₀ Not Rejected | |
| 23. | SMR does not Granger Cause MCP | 0.729 | 0.573 | H ₀ Not Rejected | Unidirectional Causality SMR → BOP |
| 24. | MCP does not Granger Cause SMR | 9.236 | 0.000* | H ₀ Rejected | |
| 25. | SMR does not Granger Cause CRO | 1.387 | 0.241 | H ₀ Rejected | No Causality |
| 26. | CRO does not Granger Cause SMR | 1.596 | 0.179 | H ₀ Not Rejected | |
| 27. | SMR does not Granger Cause GLD | 0.459 | 0.765 | H ₀ Not Rejected | No Causality |
| 28. | GLD does not Granger Cause SMR | 0.851 | 0.494 | H ₀ Not Rejected | |

Note:[*] denotes rejection of null hypothesis at 95% confidence level.

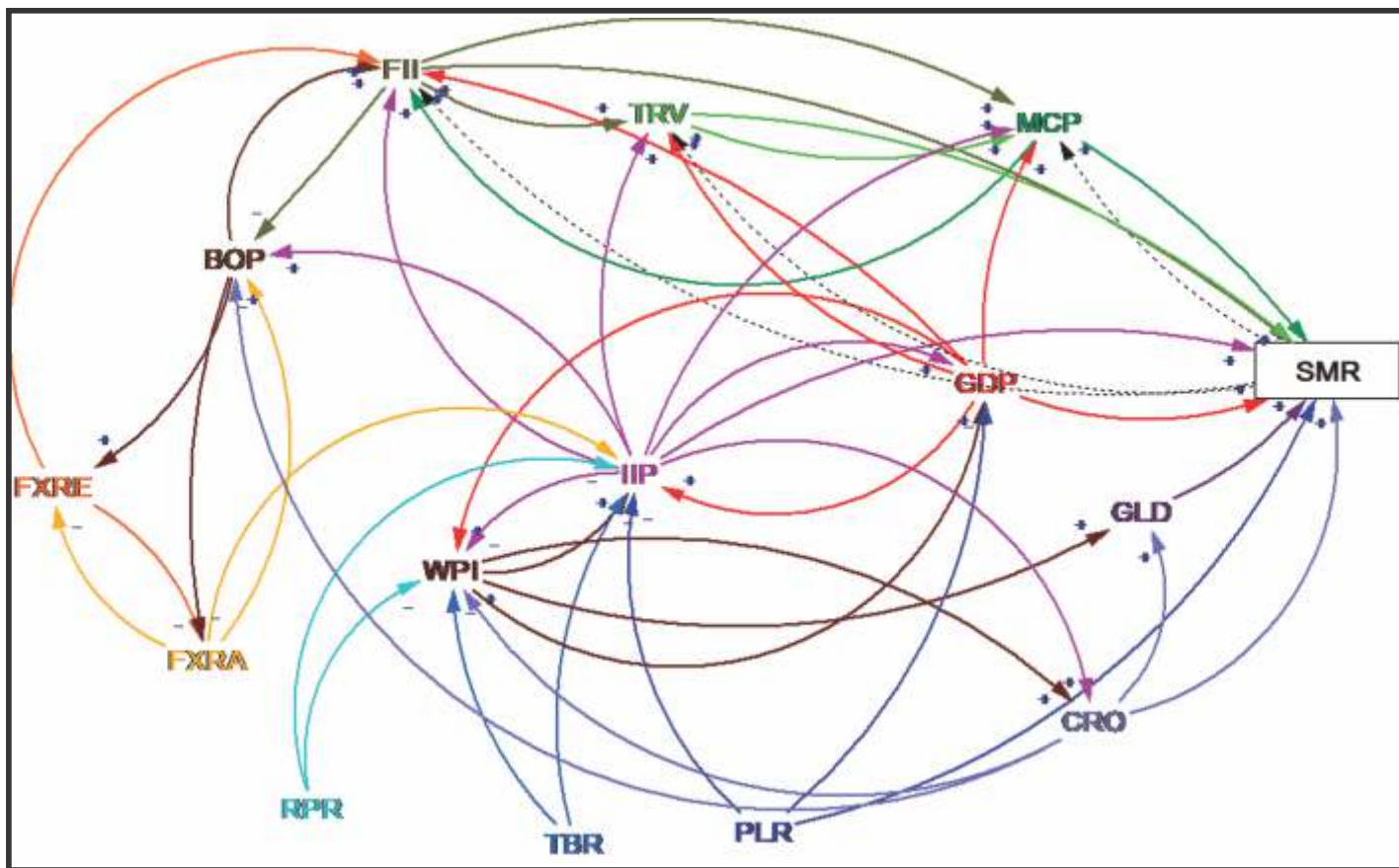


Figure 2 : Causal Loop Diagram of Macroeconomic Determinants of Stock Market Volatility