An Empirical Investigation Of The Macro Determinants Affecting India’s Stock Market Volatility: An Econometric Study

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Abstract: The motivation of this paper is to empirically test the factors basically the macro factors affecting the stock market volatility in the emerging countries like India. The macro variables that are chosen for analysis are real interest rate, real effective exchange rate, broad money supply (M3) and rate of inflation in terms of Consumer price index. The findings of the study make a clear picture about the fact that macroeconomic factors cannot be ignored. For empirical investigation various econometrics tests have run to check both association and causal relation among the concerned variable like- Unit root test for checking the stationarity of the data set, Johansen co-integration test for checking the Long run association between the variables, Vector error correction mechanism to check the both short term and long term dynamics and later on Granger causality test has been used to check the pair wise causality among the selected variables.

Key words: Stock market, Real interest rate, Exchange rate, money supply, inflation rate

1. INTRODUCTION

For any country, financial development leads to the growth of the economy which has been found in the research works of various economists like Schumpeter (1912), Gurley and Shaw (1955), McKinnon(1973) etc. Stock market being the heart of the financial system which transforms savings into financing the real sectors and augments economic growth by boosting saving as well as accelerate the both quality and quantity of investments. The stock markets can amplify the efficiency of the financial system through competition among different classes of financial instruments. Stock markets also improves the accounting as well as the tax standards as investors request more and better information in order to compare different corporations’ performance that greater discipline in the part of economic management. The official functioning of stock exchanges in India has basically started in the year 1875. Still the securities market was tolerant prior to independence. Therefore, the drive of securities market reforms has been depending on the smooth operations and effectiveness of the markets mechanism. Capital market may find it tricky to extend without the existence of efficient regulators. Later on, Securities and Exchange Board of India was established (SEBI Act) in 1992. Its main aim was to guard the wellbeing of investors in securities and to encourage the development as well as to regulate the securities market and other concerned matters. However in reality, it is very complex to capture the dynamics behind the determinant of stock markets in the developing countries like India. After the liberalization of Indian economy, the market has experienced lot of price volatility and sensitivity issues.

To meet the dynamic and complex demand structure of the modern world financing system, the Indian stock market has to develop the full fledge derivatives for future perspectives. But it is very necessary for future research to make an outline for analyzing those dynamics and to build a financial theory for identifying the determinants of stock market volatility in India. Thus this paper is motivated to identify the possible determinants that influence the stock market in context of Indian economy. Review of literature: Theoretical and Empirical Classical economic theory establishes a strong relationship between stock market performance and exchange rate performance (Dornbusch and Fisher 1980; Ross 1976; Adler and Dumas 1983; Jorion 1991). Dornbusch and Fisher (1980) advocates that movements in the stock market may be affected by exchange rate fluctuations in the economy. The flow oriented models of exchange rate determination mentions that the transmission mechanism works from the exchange rate to the stock market. In these models, currency movements change global competitiveness and the BOT (balance of trade) position of countries. Which again affect real output of countries, which in turn affect the current and future cash flows of Business and their stock price. Hence, currency appreciation (depreciation) can adversely (positively) affect stock prices. By including the stock market, Gavin (1989) illustrated that an anticipated time for fiscal expansion can guide to an expansion in output, because the anticipated expansion leads to a rise in the present stock prices through high profits in the future. In his model he mention that, if aggregate demand shocks are unpredictable, disturbances of this kind can make negative association between the stock prices and real exchange rates. However if the time between declaration and working of fiscal policy disturbances is long enough, a positive correlation between stock prices and real exchange rates be engender(Ho.Sin., & Iyke, B., 2006). Additionally, Cooley and Smith (1992) have shown that the interest rate may also influence the existence of financial markets for various reasons like when the interest rates are low, there will be inadequate incentives for economic agents to specialize, leading to the extermination of probable borrowers from specialized entrepreneurs and provide incentives for potential lenders to invest independently. While some...
studies show a negative relationship between interest rates and stock prices (Spiro 1990, Mok1993), a positive association between them also found (Shiller 1988, Barsky 1989). Spiro (1990) has also indicates that people may favour to invest in banks rather than stock markets when there is an increase in real interest rates. A number of empirical studies found on determinants of stock market development have been focused mostly on emerging markets. Using correlation analysis with secondary data (1992-2012), Yusoff & Guima (2015) tested the determinants of stock market development in Middle East and North Africa (MENA) region considering the Variables - oil rent, interest rates, exchange rates, income per capita, domestic savings and inflation were found to have had a significant impact on stock market development in the selected region. Bhattacharya and Mukherjee (2006) empirically examined the association between the Indian stock market and seven macroeconomic variables by using the vector auto regression technique and Toda and Yamamoto non-Granger causality technique by covering time period 1992 to 2001 and found no causal relation between the selected variables - stock returns and money supply, real effective exchange rate, foreign exchange reserve index of industrial production, GNP ( gross national product), and trade balance except rate of inflation. Rahman and Uddin (2009) tested the relationship between exchange rates and stock prices of Bangladesh, India and Pakistan - The three emerging countries of South Asia. They also applied Granger causality test which showed there is no causal relationship between stock prices and exchange rates in chosen countries for the study period. By covering time period 2003 to June 2008 have found no co-integrating connection between stock prices and exchange rates among the selected countries. The key objective of Barakat, M., et al., (2015) study is to study relationship between the stock market and major factors in two emerging economies - Egypt and Tunisia covering time period 1998-2014 and found a causal relationship in Egypt between market index and consumer price index (CPI), exchange rate, money supply, and interest rate. The same results for Tunisia except for CPI, which had no causal relationship with the market index. Results also revealed that the four macroeconomic are co-integrated with the stock market in both countries. Additionally, Mohanamani and Sivagnanasithi (2014) have revealed that Indian stock market is positively related to the whole sale price index (WPI), money supply and industrial productivity. Meanwhile, exchange rate and inflow of foreign institutional investment (FII) are found to be irrelevant to Indian Stock market. In the Granger Causality test results whole sale price index and industrial productivity manipulates the stock market to a great extent. Yadav and Lageesh (2011) studied interrelations among the variables of interest rate and exchange rate and real output, money, price covering the period from 1991 to 2007 with stock market. The bound test satisfies long-run relation between the selected variable. However The short-run causality test results no evidence between the selected variables. A similar kind of cointegration analysis is also applied by Humpe and Macmillan (2007) in order to check the long term relationship between the consumer price index, money supply, industrial production, interest rates and stock market prices in the countries like US and Japan. For the US, stock prices are positively related to industrial production and inversely related to both the consumer price index and interest rate. They have insignificant (although positive) association between US stock prices and the money supply. However, for Japan they have found that stock prices are influenced positively by industrial production and inversely by the money supply. Most of the studies that have been found on the determinants that have influence on India’s stock market have consider on some specific institutional factors ignoring major macro indicators. This study fills the gap in the existing literature by empirically testing role of macro factors on the volatility of India’s stock market.

**Macro Determinants of Stock market in India**

This paper is motivated to empirically identify the linkages between stock markets in India and role of some specific macroeconomic. These macro variables are- market index as proxy of stock market in India, Real effective exchange rate proxy of exchange rates as it adjusts inflation ,real interest rate as a proxy of interest rates, CPI(Consumer price index) as proxy of inflation, M3( broad money) as proxy of money supply in India.

- **Stock market index**
  Stock market indices give an overall idea about the trend of the capital markets and sensitiveness of the investors on a particular stock in a company. An index is basically made up of similar stocks depends on market capitalization, industry or company size and on selection of stocks, the index value is computed. Each stock will have a different price and price change in one stock would not be proportionately equal to the price change in another. Thus the volatility of stock market depends on various macro factors and other international & firm-specific factors as well (Khandelwal, R., 2018)

- **Real effective exchange rate (REER)**
  REER helps in neutralising the effects of inflation and it is related with the PPP hypothesis. This is a good indicator in terms of exchange rate because it includes both price differential as well as inflation (Kakoti, D., 2019). When stock prices increase, it will capture more foreign capital; and when price level reduces, it leads to liquidation of investment by overseas investors.

- **Real interest rate (RIR)**
  Abundance or scarcity of capital of a country is known by the level of interest and it has a negative relation with the outbound investment. Interest rates and concluded that both interest rates and stock markets have inverse relationship (Uddin, M., & Alam, M., 2007). For analysis we have consider real interest rate of India is negatively associate with Stock market.

- **Inflation(CPI)**
  It is defined as a condition of persistent rise in the general price level (Sikdar, S., pp. 149). In 2013, the consumer price index has taken in the place of wholesale price index (WPI) as a main measure of inflation India. The CPI measures the average change in prices over time that consumers give for a basket of goods and services, commonly known as inflation. The weighted average of the
prices of goods and services that approximates a person’s consumption patterns is used to calculate CPI. Meanwhile it can influence stock markets both positively and negatively. For illustration, when inflation rate rises, the interest rates also increases which will in turn reduces the current value of income of the company or corporate as the discount rates are increased. This phenomenon impacts stock markets unfavourably.

Money Supply (M3)

Monetary aggregates can be used as an alternative to country’s money stock (Walter, J., 1989). These can be classified as M0, M1, M2, M3, and M4 where M1 is the narrowest of all and M3 is considered as broad money. When we include time deposits with the narrow money (M1) we find the broad money, M3. Here we consider M3 as an indicator that influences stock market (Reilly, F. K.; Brown, K. C, 2003).

\[ \text{LNM3} + \text{LNINDEX} = \beta_1 \text{RIR} + \beta_2 \text{REER} + \beta_3 \text{LNCPI} + \beta_4 \text{LM3} + \epsilon \]

Where \( \epsilon \) is the disturbance term and \( \beta_1, \beta_2, \beta_3, \beta_4 \) are coefficients of independent variables. Two well-liked unit root test has been applied to check the stationarity i.e., Augmented Dicky fuller (ADF) test and Phillip-Perron (PP) test. The equation for ADF test is:

\[ \Delta y_t = \alpha + \beta_1 y_{t-1} + \beta_2 \epsilon_{t-1} + \epsilon_t \]

Where \( y \) is the selected dependent variable, i.e., Stock market, \( \epsilon \) is the white raise error term and \( \Delta \) represents one time difference term. \( \alpha \) and \( t \) indicates constant and trend term respectively. The lag length of ADF is selected on the basis of Akaike Information Criteria (AIC) Later on Phillips and Perron test is used, is a nonparametric statistical method of unit root test to check the serial correlation in the error terms without adding lagged difference terms like DF test. The Phillips-Perron (PP) test considers the following regression equation:

\[ \Delta y_t = \alpha + \beta_1 y_{t-1} + \epsilon_t \]

Where \( \epsilon_t \) is the error term and \( T = \text{Trend Term} \). When \( \pi = 0 \) time series is stationary. Later on Vector Auto-regressive model is used to check an optimal lag length of the model. For investigating the association between macroeconomic variables on stock markets, Johansen co-integration test is used. When the long-run equilibrium is established, the test generates a long-run equation with normalised co-integrating coefficients by using Vector auto regression test to examine the error correction term and the speed with which the variables will turn to bring equilibrium in the model. Then pare-wise Granger causality test is used to check the short-run causal relationship between the variables indicates lag values of a variable can help in the prediction of another variable of the model.

It estimates the subsequent pair of regressions:

\[ x_t = \sum_{i=1}^{n} \alpha_i y_{t-i} - 1 + \sum_{i=1}^{n} \beta_{ij} x_{t-i} - 1 + \epsilon_{it} \]
\[ y_t = \sum_{i=1}^{n} \alpha_i y_{t-i} + \sum_{i=1}^{n} \beta_{ij} x_{t-i} - 1 + \epsilon_{it} \]

The first equation indicates that variable X is related to the past values of itself as well as that of variable Y and the second equation assumes the similar case of Y. From the equations, the relationship has been distinguished into four cases namely, un-indirecional causality from X to Y, unindirecional causality from Y to X, Bi-lateral causality and no causality i.e. when the variable coefficients are significantly different from zero.

Findings and Discussion:

Before moving to check the association between the selected variable, testing the time series is (whether it is stationary or not) necessary. Keeping that on mind, two most likely used unit root tests are applied for this purpose – Phillip Parron test and a ADF test by taking null hypothesis (H0) as There is a presence of Unit root of the selected variables i.e., the time series under consideration is non-stationary. However if the calculated values of the variables exceeds the critical value at significance level 5% or if the p value is less than 0.05 , may leading to the rejection of (H0).

Table 1: The Macro determinants of stock market in India

<table>
<thead>
<tr>
<th>Variable</th>
<th>Proxy for each determinant</th>
<th>Data source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock market</td>
<td>Market index</td>
<td>FRED database.</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>REER (Real effective exchange rate)</td>
<td>Reserve bank of India (RBI) Bulletins, data are based on different base periods, so splicing technique is used to make it one single series and take 2005 as a base year.</td>
</tr>
<tr>
<td>Inflation</td>
<td>CPI (Consumer price index)</td>
<td>FRED database. <a href="https://fred.stlouisfed.org/series/DDOE01NA086NWDB">https://fred.stlouisfed.org/series/DDOE01NA086NWDB</a></td>
</tr>
<tr>
<td>Money supply</td>
<td>M3 (Broad money)</td>
<td>United nation conference on trade and Development(UNCTAD)</td>
</tr>
</tbody>
</table>

Source: Author’s compilation from secondary sources.

Econometrics methodology:

Table 1 shows the proxy and the data sources of the selected macro variables for study. Further, data on market index, Inflation (CPI), REER and M3 (broad money) are transformed into the natural log value so that that changes in the variables signify the relative changes or percentage changes after multiplication by 100 (Gujarati, 1998). For analysis, we consider the following model of Stock market index by considering the four influential macro factors.

\[ \text{LNINDEX} = \beta_1 \text{RIR} + \beta_2 \text{REER} + \beta_3 \text{LNCPI} + \beta_4 \text{LM3} + \epsilon \]

Where \( \epsilon \) is the disturbance term and \( \beta_1, \beta_2, \beta_3, \beta_4 \) are coefficients of independent variables. Two well-liked unit root test has been applied to check the stationarity i.e., Augmented Dicky fuller (ADF) test and Phillip-Perron (PP) test. The equation for ADF test is:

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It estimates the subsequent pair of regressions:

\[ x_t = \sum_{i=1}^{n} \alpha_i y_{t-i} - 1 + \sum_{i=1}^{n} \beta_{ij} x_{t-i} - 1 + \epsilon_{it} \]
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The first equation indicates that variable X is related to the past values of itself as well as that of variable Y and the second equation assumes the similar case of Y. From the equations, the relationship has been distinguished into four cases namely, un-indirecional causality from X to Y, unindirecional causality from Y to X, Bi-lateral causality and no causality i.e. when the variable coefficients are significantly different from zero.

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Before moving to check the association between the selected variable, testing the time series is (whether it is stationary or not) necessary. Keeping that on mind, two most likely used unit root tests are applied for this purpose – Philip Parron test and a ADF test by taking null hypothesis (H0) as There is a presence of Unit root of the selected variables i.e., the time series under consideration is non-stationary. However if the calculated values of the variables exceeds the critical value at significance level 5% or if the p value is less than 0.05 , may leading to the rejection of (H0).
In order to choose the optimal lag length of the model as a whole, the unrestricted error (FPE) values are less than 0.05 and the calculated critical values at 5 percent level (LNINDEX, LNCPI, LNM3, LNREER) are less than their values for rejection of $H_0$. Figures in the () brackets of ADF test indicate the Mackinnon (1996) one sided p-values for rejection of $H_0$. Figures in the () brackets of PP test indicate the Mackinnon (1999) test statistics. Source: Author’s calculation

Table 2 reflects that except RIR we cannot reject the null hypothesis as the estimated values of all selected variables (LNINDEX, LNCPI, LNM3, LNREER) are less than their critical values at 5 percent level of significance. Which means time series has a unit root, i.e., at levels they are non-stationary. After taking the 1st difference of each series, both ADF and PP tests show the same results except RIR, that the p-values are less than 0.05 and the calculated values are also larger than that of critical values. So may reject $H_0$ reflecting the fact that the time series for the selected variable is stationary at 1st difference. So there is no unit root. In order to choose the optimal lag length of the time series data, the unrestricted Vector auto regressive (VAR) scheme is used. The optimal lag length is determined by Akaike information criterion (AIC), Final prediction error (FPE) and Hannan and Quinn (HQ) is 2 for the model as a whole.

**Johansen Co-integration Test:**

Then Johansen test of co-integration is then used to check the co-integration among the selected variable by taking the null hypothesis as- There is no co-integration between the variables under consideration.

**Table 3:** Johansen co-integrating results Series for observation: LNINDEX RIR LNREER LNCPI LNM3 Lags interval (in first differences): 1 to 2

Unrestricted co-integration Rank test (trace)

<table>
<thead>
<tr>
<th>Hypothesised No. of CE(s)</th>
<th>Eigen value</th>
<th>Trace statistics</th>
<th>0.05 Critical values</th>
<th>Probability**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None*</td>
<td>0.913647</td>
<td>112.5949</td>
<td>69.81889</td>
<td>0.0000***</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.583605</td>
<td>51.36216</td>
<td>47.85613</td>
<td>0.0226 *</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.442077</td>
<td>29.45916</td>
<td>29.79707</td>
<td>0.0547</td>
</tr>
<tr>
<td>At most 3</td>
<td>0.382325</td>
<td>14.87079</td>
<td>15.49417</td>
<td>0.0619</td>
</tr>
<tr>
<td>At most 4</td>
<td>0.106883</td>
<td>2.825954</td>
<td>3.841466</td>
<td>0.0927</td>
</tr>
</tbody>
</table>

Note: * indicates rejection of the null hypothesis at 0.05 percent level of significance. **MacKinnon-Haug-Michelis (1999) P-values

Source: Author’s calculation

Maximum Eigen value indicates 1 co-integrating equation at 0.05 Level denotes rejection of the hypothesis at the 0.05 percent level of significance. The Tables 3 shows that there is two co-integrating vector for selected variables at significance level 5% where the trace statistics estimated value is greater than the critical value. Which indicates that stock indices of India have a
long-run co integration with the selected macroeconomic variables (lnreer, lncpi, lnM3 and rir). When we found there is two co-integrating equation between those considered variables, we use estimate the normalized co-integrating coefficients (standard error in parentheses) shown in Table 5 indicates that change in stock indices is influence negatively by RIR and LNREER. While LNCPI and LN M3 affects the change in stock indices positively. Later on CUSUM (Cumulative sum of recursive residual) graph is used to check the stability of the model (Figure 1). It is seen that the residual plot are within the area of two critical line at 5% significance level. So we consider that the selected model is stable.

Figure 1: Stability test

![Stability test graph]

Source: Authors calculation

Vector error correction mechanism (VECM)
As we have found more than two co-integrating vector, VECM (Vector Error Correction Model) is now going to be applied which adjusts short run changes in variables as well the deviations from equilibrium. Here Lag length criteria proposed two lags for testing estimating VECM. VECM model used is:

\[ \Delta Y_t = \beta_0 + \sum_{i=1}^{n} \beta_i \Delta Y_{t-1} + \sum_{i=0}^{q} \delta_i \Delta X_{t-1} + \phi Z_{t-1} + \epsilon_t \]

Where, \( \epsilon_t \) is the disturbance term. Based on the VECM estimates, the model equation is,

Table 6: Vector error correction estimates

<table>
<thead>
<tr>
<th>Error correction</th>
<th>D(LNINDEX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoinEq1</td>
<td>-0.151523</td>
</tr>
<tr>
<td>LINDEX(-1)</td>
<td>1.00000</td>
</tr>
<tr>
<td>D(LINDEX(-1))</td>
<td>0.078120</td>
</tr>
<tr>
<td>RIR(-1)</td>
<td>0.04</td>
</tr>
<tr>
<td>D(RIR(-1))</td>
<td>0.023</td>
</tr>
<tr>
<td>LNCPI(-1)</td>
<td>2.133</td>
</tr>
<tr>
<td>D(LNCPI(-1))</td>
<td>0.109</td>
</tr>
<tr>
<td>LN M3(-1)</td>
<td>-1.54</td>
</tr>
<tr>
<td>D(LNM3(-1))</td>
<td>-0.27</td>
</tr>
<tr>
<td>C</td>
<td>-49.99</td>
</tr>
<tr>
<td>C</td>
<td>11.10</td>
</tr>
</tbody>
</table>

Source: Author’s own calculations

We have estimated the error correction model (VECM) shown in table 6. The error correction term must have has a negative sign and should be significant at 5 percent level indicating the fact that estimated value of the error correction term (CoinEq1) shows that the model corrects its previous period’s level of disequilibrium by 15 percent where the p value is less than 0.05 (in our case it is 0.032).

The Granger causality test:
As we have found more than two co-integrating vectors, then a suitable inference technique is pair wise granger causality test to check the pair wise co-integration among the selected variable in the short run. The following table shows the pair wise test results.

Table 6: Granger causality test results

<table>
<thead>
<tr>
<th>Null Hypothesis is:</th>
<th>Probability</th>
<th>Reject</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIR does not granger cause LINDEX</td>
<td>0.14</td>
<td>Accept</td>
</tr>
<tr>
<td>Lnindex does not granger cause RIR</td>
<td>0.51</td>
<td>Accept</td>
</tr>
<tr>
<td>Lnreer does not granger cause LINDEX</td>
<td>0.01</td>
<td>Reject</td>
</tr>
<tr>
<td>Lnindex does not granger cause Lnreer</td>
<td>0.44</td>
<td>Accept</td>
</tr>
<tr>
<td>Lncpi does not granger cause Lnindex</td>
<td>0.24</td>
<td>Accept</td>
</tr>
<tr>
<td>Lnindex does not granger cause Lncpi</td>
<td>0.25</td>
<td>Accept</td>
</tr>
<tr>
<td>LnM3 does not granger cause Lnindex</td>
<td>0.12</td>
<td>Accept</td>
</tr>
<tr>
<td>Lnindex does not granger cause LnM3</td>
<td>0.04</td>
<td>Reject</td>
</tr>
</tbody>
</table>

Source: Author’s own calculation.

For the table 6 it is seen that except RIR and LN M3, there is no causal relationship between LNINDEX and LNCPI as well as LNREER as the Null hypothesis is accepted for the later variables that there is no causal relationship among the variable in the short run.

Impulse response function:
The impulse response function (IRF) shows how the changes in one variable impact on current and future values of the endogenous variables in the model. The impulse response functions can be used to produce the time path of the dependent variables in the VAR, to check shocks from all the explanatory variables. If the system of equations is stable, any shock should decline to zero. This also means that short-run values of the variable in question converge to the long-run equilibrium values. An unstable system would produce an explosive time path. In that sense, short-run values of the variable will diverge from its equilibrium values. Figure 2 displays the impulse response functions of the log of first differences of the variables (LNINDEX, RIR, LNREER, LNCPI, LN M3) to one standard deviation structural shocks.
The Cholesky degrees of freedom (d.f.) adjusted, which show the response to Cholesky one standard deviation innovation. Each graph as shown in plots in Figure includes a point estimation of impulse response functions as well as lower and upper bounds for a 95% confidence interval. As usual, the straight lines depict the variable percent change in response to a standard deviation of one in the respective macro variable whereas the dotted lines represent the 95% error bands. As it can be observed from the graph, the impact of the shock will first cause LNINDEX to influence up to 2 year and there after wanes and tends to decrease till the 6th year is reached. In case of other four macro variables also same case is reflected i.e., after 2\textsuperscript{nd} period, the effect of the shock is neutralised.

Conclusion:
The motivation of this paper is to empirically test the factors basically the macro factors affecting the stock market volatility in the emerging countries like India. These macro variables that are chosen for analysis are real interest rate, real effective exchange rate, broad money supply (M3) and rate of inflation in terms of Consumer price index. The findings of the study make a clear picture about the fact that macroeconomic factors cannot be ignored. It is found that LNCPI and LNM3 positively impact India’s stock market. While Real effective exchange rate and Real interest rate has negative impact on Stock market indices. Later on the error correction term (CoinEq1) shows that the model corrects its previous period’s level of disequilibrium by 15 percent where the p value is less than 0.05 (in our case it is 0.032). However the study limits its area by considering only four factor excluding GDP of India. The further research can be extended by considering the institutional factors.

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