An Empirical Relationship between Exchange Rates, Interest Rates and Stock Returns

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Abstract
In this paper study aims to investigate the relationship between call money rates, exchange rates and stock returns from the perspective of India. We use monthly data for the time span of April 1992 to March 2011. This provides sufficient data set for the empirical analysis. Result from Granger causality test evidences bidirectional relationship between call money rates and exchange rates. It is also identified that call money rates and exchange rates Granger cause stock returns and did not find reverse causality from stock returns to call money and exchange rates. To explore, lead-lag interaction among the variables studied we employed VAR models. Results suggest that there is substantial lead-lag relationship from call money rates to exchange rates and stock returns. Similar relationship also found from exchange rates to call money rates and stock returns. However, there is no evidence of lead-lag causation from stock returns to call money and exchange rates. Findings of this study are useful for the investors and policy makers. In investors’ standpoint, they can utilize this historical information of call money rates and exchange rates for predicting the movements of stock returns. Similarly, policy makers can stabilize the stock market fluctuations by adopting appropriate policies towards interest rates and exchange rates for time to time.

Keywords: Direction of causality and Lead-lag interaction

1. Introduction
In the early 1990s, the financial sector reforms have been initiated in India, which ensured the relaxation of foreign investors’ restrictions and opened up domestic financial markets for the international practices. Subsequently, the Indian stock markets (Bombay Stock Exchange and National Stock Exchange) have witnessed as the most active and emerging stock markets of the world. Particularly, these stock markets have attracted the investors across the globe by expanding their horizons, which resulted in terms of listed companies, shareholders, volume of trade and market capitalization. This ‘New Economic Policy (1991)’ has helped the Indian stock markets to grow continuously and expand. Gupta and Basu (2007) provide an interesting statistics on the development of Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) over the period.

The economic theory suggests that interest rates, inflation, money supply, price level and other macro elements are important variables in understanding the deeds of stock prices and also for
predicting the movements and trends in exchange rates. Basically, there are two theoretical arguments in this regard. The first approach argues that currency depreciation will result in higher exports and this eventually raises the stock prices and then leads to higher corporate profits in the short-run. Other argument explains the relationship between exchange rates and stock prices in a portfolio adjustment path. This theory argues that whenever there is a change in stock prices will result in portfolio adjustment. If the stock prices are in the upward direction then there is high possibility that more foreign capital can inflow. In other words, if the stock prices are in downward direction will result in reduction of corporate as well as country wealth. This will lead to reduction in demand for money in the economy; in these circumstances central bank authorities will take decisions to reduce the interest rates to relieve this situation. This lower interest rate can encourage capital outflow to take over the advantages of higher interest rates in other countries. Finally, this theory suggests that a lower stock price may lead to currency depreciation (Kutty, 2010).

There has been considerable attention on whether the exchange rates and stock prices have any empirical relationship. Particularly, this issue has become more attractive among the economists, investors and policy makers after the Asian Financial Crises (1997). Empirically, it is argued that if the exchange rates and stock prices are inter-related then it is quite possible to prevent such crises by looking at the direction of causality e.g. if the causality runs from exchange rates to stock prices then the crises can be averted by implementing the appropriate policies towards controlling the exchange rate fluctuations. In other words, if the causality runs from stock prices to exchange rates then the policy makers can keep an eye on stabilizing the stock markets by enforcing the desirable economic policies. This is also an important in the investors’ point of view to know the direction of causality between exchange rates and stock prices. If the causality is identified between these variables then investors can use this historical information of one market for predicting the behavior of other market. Similarly, the relationship between interest rates and stock prices has been extensively studied by investors, policy makers and researchers. It evidences from the literature that interest rate is one of the most effective and significant factor in determining the stock prices. Theoretically, it is contended that there is an inverse relationship between interest rate and stock prices and both tend to move in an opposite directions.

Since, last three decades there are several studies have been examined the relationship between exchange rates, interest rates and stock prices. Largely, these studies have reported mixed results in nature and some other studies have drawn inconclusive results. The relationship between exchange rates and stock prices were examined by Aggarwal (1981), Giovannini and Jorion (1987), Solnik (1987) and Smith (1992). The evidences of these studies indicate that there is significant positive relationship between the variables studied. Similarly, the studies of Soenen and Hennigar (1988), Muhammad and Rasheed (2002), Bhattacharya and Mukherjee (2003), Rahman and Uddin (2009) also investigated the connection between exchange rates and stock prices and found negative relationship among the variables. Some other studies have also attempted to investigate the causal relationship between the above variables and established bidirectional relationship (Bahmani-Oskooee and Sohrabian, 1992; and Kumar, 2010) and unidirectional relationship (Abdalla and Murinde, 1997; Mishra, 2004; and Alagidede et al., 2011). Finally, Ong and Izan (1999); Nieh and Lee (2001) studies revealed that there is no empirical association between exchange rates and stock prices. Paramati and Gupta (2011) also investigated the relationship between stock prices and economic growth. Their empirical results suggest that economic growth has significant influence on stock market development.

In the same way, there are other studies have investigated the relationship between interest rate and stock prices. The empirical results of Harasty and Roulet (2000), Wong et al. (2005) studies provided evidences of long-run relationship between interest rate and stock prices. Similarly, Campbell (1987), Shanken (1990), Arango et al. (2002), Hsing (2004), Rigobon and Sack (2004), Uddin and Alam (2007), Alam and Uddin (2009) studies have established significant negative relationship between interest rate and stock prices. While some other studies have found weak causality (Farsio and Fazel, 2010) and inconclusive results (Lee, 1997) among the same variables. Overall, it is understood from the existing studies that the empirical results are mostly assorted and indeterminate. Given these
empirical and theoretical arguments, the present study will examine the empirical relationship between call money rates, exchange rates and stock returns in Indian context by using monthly data from April 1992 to March 2011.

The remainder of this study is organized as follows: Section 2 provides empirical literature review on the relationship between exchange rates, interest rates and stock prices. Section 3 presents empirical methodology for analysis. Section 4 displays nature and sources of data, variables and empirical results of the study. Finally, section 5 provides summary and conclusion.

2. Literature Review
This study has carried out a broad literature survey on both developed and emerging economies; to review, a broader theoretical and empirical literature on the connection between exchange rates, interest rates and stock prices. This understanding is very important for conducting an empirical analysis. The literature survey has been divided into two parts; part one explains the relationship between exchange rates and stock prices and, part two presents the connection between interest rates and stock prices.

2.1. The Exchange Rates and Stock Prices
A study by Aggarwal (1981) made an attempt to explore the relationship between changes in the dollar exchange rates and change in indices of stock prices. His study used monthly data from 1974 to 1978 on stock prices and effective exchange rates for the USA. Results show a positive correlation and this relationship is stronger in the short run than in the long run. Giovannini and Jorion (1987) study also arrived with similar results of Aggarwal (1981) in case of the USA. In the same way, the relationship between stock prices and exchange rates were investigated by Bahmani and Sohrabian (1992) in the context of the USA for the period of 1973 to 1988. The Granger causality test results confirmed that there is a short run relationship between the exchange rates and stock prices. While, cointegration test results indicate that there is no evidence of long-run relationship among the same variables. Likewise, Rahman and Uddin (2008) explored the relationship between stock prices and exchange rates in the case of Bangladesh for the period of June 2003 to March 2008. Their study results concluded that there is no long-run relationship between stock prices and exchange rates by employing Johansen cointegration test. The Granger causality test supported short-run relationship between the variables and that runs from stock prices to exchange rates of US dollar and Japanese yen but not the euro and pound sterling.

The long-run and short-run relationship between exchange rates and stock prices were examined by Kumar (2010). This study uses linear and non-linear Granger causality tests for investigating causal relationship and also employed cointegration test for identifying long-run relationship among the studied variables. Results of Granger causality (linear and non-linear) test suggest that there is a bi-directional relationship between stock prices and exchange rates. Similarly, the results of cointegration test evidence no long-run relationship between the variables. Kutty (2010) also examined the relationship between stock prices and exchange rates for the period of January 1989 to December 2006 in the case of Mexico. The empirical results of this study conclude that there is a short run relationship between the studied variables and that runs from stock prices to exchange rates and found no long run relationship between same variables.

Another study by Alagidede et al. (2011) attempted to find out the underlying connection between foreign exchange markets and stock markets in Australia, Canada, Japan, Switzerland and the United Kingdom for the period of January 1992 to December 2005. Results of cointegration tests reveal that there is no long run relationship between the variables. The Granger causality test results indicate that there is unidirectional relationship from exchange rates to stock prices in the case of Canada, Switzerland and United Kingdom. The causal relationship from stock prices to exchange rates was found only in this case of Switzerland. Further, this study employed Hiemstra-Jones test to find
out the non-linear causality. Results show that causality is found from stock prices to exchange rates in the case of Japan and exchange rates to stock prices in Switzerland. Some other studies such as; Ong and Izan (1999) and Nieh and Lee (2001) also examined the relationship between exchange rates and stock prices in case of G-7 countries and results suggest that there is no significant relationship between the observed variables in the long run.

The relationship between stock prices and effective exchange rates for the time span of 1980 to 1986 was examined by Soenen and Hennigar (1988) for the perspective of the USA. Results evidence a significant negative relationship among the variables. Granger et al. (2000); Caporale et al. (2002); Stavarek (2005) and Pan et al. (2007) provided elaborative information on the linkages between stock prices and exchange rates. The changes in stock prices will have influence on the movements of exchange rates. In other way, it is explained that the stock prices can lead the exchange rates with a negative correlation. Precisely, a decrease in stock prices may reduces domestic wealth, which leads to lower the domestic money demand and interest rates and also this further guide to lower the demands of foreign investors for domestic assets and currency. The changes in demand and supply of currencies may lead to depreciation of domestic currency and encourages capital out flow. In other words, when the stock prices move upward, then this will fascinate foreign investors to diversify their investment internationally and gain the profits. Thus, it will lead to appreciate domestic currency and raises capital inflow.

A study of Abdalla and Murinde (1997) explored the relationship between exchange rates and stock prices in the emerging markets of India, Korea, Pakistan and Philippines for the time span of January 1985 to July 1994. This study results provide an evidence of unidirectional relationship and that runs from exchange rates to stock prices in case of India, Korea and Pakistan. However, this study could not find any relationship between exchange rates and stock prices in case of the Philippines. Mishra (2004) analyzed whether foreign exchange markets and stock market are related each other in case of India by using data from April 1992 to March 2002. The Granger causality test results indicate that there is unidirectional relationship and that runs from exchange rates to demand for money and interest rate. Though, this study couldn’t find any causal relationship between exchange rates and stock returns. The results of VAR model indicate that the observed variables are related each other but there is no consistency in this regard. Further, this study employed forecast error variance decomposition method to confirm the relationship among the variables and results reveal that each variable is influenced by other variable (s). In a similar way, Aydemir and Demirhan (2009) investigated the relationship between stock prices and exchange rates for the period of February 23rd, 2001 to January 11th, 2008 by using daily data in case of Turkey. Their study results reveal that there is a bidirectional relationship and also evidenced that there is a positive and negative causal relationship between exchange rates and stock market indices. On the other way, negative causality occurs from exchange rates to all stock market indices.

Economic theory suggests that the changes in foreign exchange can have a significant impact on stock prices by altering cash flow, investment and profitability of the firms. However, there is no empirical harmony in this regard and mostly results are indecisive (Joseph, 2002; and Vygodina, 2006). Similarly, Rahman and Uddin (2009) examined the dynamic relationship between stock prices and exchange rates for the period of January 2003 to June 2008 in three South Asian emerging countries viz. Bangladesh, India and Pakistan. The results of Johansen Co-integration and Granger Causality tests revealed that there are no long run and short run relationship between stock prices and exchange rates, respectively.

### 2.2. The Interest Rates and Stock Prices

The relationship between interest rate and stock prices has been empirically investigated by Zhou (1996). The regression results of his study states that the interest rate has an important implication on stock returns i.e., particularly in the longer horizons. Wong et al. (2005) investigated the long-run relationship between macroeconomic variables and leading stock indices of Singapore and the United States for the period of January 1982 to December 2002. The Granger causality test results indicate
that the performance of stock market may have an impact on the adjustment of central bank’s monetary policy. Results of cointegration test imply that there is a long-run relationship i.e., Singapore stock prices with the interest rate and money supply. However, this study could not find similar results in case of the United States for the same period. Harasty and Roulet (2000) provided evidence of long-term relationship between stock prices, dividends (earnings) and interest rate (long-term) in 16 countries but could not provide the same results for Italian market. Bren et al., (1989) argue that the interest rates are useful in forecasting the sign and the variance of the excess returns of stocks.

Similarly, Arango et al. (2002) attempted to investigate the dynamic relationship between the Bogota stock market returns and short-term interest rate (interbank loan interest rate) by using data from January 1994 to February 2000. Study finds evidence of nonlinear and inverse relationship among the share prices and interest rate. Alam and Uddin (2009) attempted to explore the empirical relationship between interest rate and stock prices of fifteen developed and developing countries and also focused on finding the weak form efficiency of the share markets. This study uses data from January 1988 to March 2003. The evidences of this study reveal that interest rate has negative relationship with the share prices for all the countries. Further, it is identified that the changes of interest rate have a significant negative relationship with the changes of share prices for six countries. Finally, the unit root test results confirm that none of these countries’ stock markets follow random walk (weak form efficiency). Hsing (2004) study found that there is an inverse relationship between interest rate and stock prices. Rigobon and Sack (2004) empirically investigated the impact of monetary policy on asset prices. Their analysis reveals that the increase in short-term interest rates will negatively affect the stock prices.

The linear relationship among interest rate and stock prices was investigated by Uddin and Alam (2007). Their study reveals that interest rate has negative relationship with the share prices and further it evidences that changes of interest rate has substantial negative association with the changes of share prices. Leon (2008) examined the effects of interest rates volatility on stock market returns and volatility for the period of January 31st to October 16th 1998. Results indicate that there is a negative and significant association between conditional market returns and interest rates. Further, it is evidenced that there is a positive connection among conditional variance of returns and interest rates, but however this relationship is not significant. Campbell (1987) and Shanken (1990) studies found that the nominal Treasury bill yield (one-month) is negatively associated with the future stock returns.

Another study by Lee (1997) investigated the connection between interest rate (short-term) and stock prices. His study aim was to predict the excess returns on the stock index with the short-term interest rate, but analysis found the association between these two variables is inconsistent over the time. This indicates that the direction is not the same always and changes gradually from one direction to other such as; negative to positive and even sometimes there is no relationship between them. Farsio and Fazel (2010) empirically investigated the effect of interest rate on stock prices in the UAE by using data from June 2006 to January 2010. This study evidences from Granger causality test that there is a lack of causal association between these two variables and regression model shows that interest rates do not have a robust explanatory power in forecasting the stock prices in the UAE.

Overall, this literature survey indicates that there are numerous studies have been attempted to investigate the link between exchange rates, interest rates and stock prices in both developed and emerging financial markets. The empirical results of these studies are mostly inconclusive in nature. In the light of the above literature survey, the purpose of present study is to contribute to the existing literature on the grounds of connection between call money rates, exchange rates and stock prices. To the best of our knowledge, in Indian context there are some studies have attempted to find out the relationship between macro variables and stock prices in general, and there is no specific study on the relationship between call money rates, exchange rates and stock prices, in particular. Hence, this motivates us to investigate the empirical relationship between call money rates, exchange rates and stock returns in Indian perspective.
3. Empirical Models
3.1. Unit Root Tests

This study uses the conventional unit root tests such as: Augmented Dickey-Fuller (Dickey and Fuller, 1979) test, Phillips-Perron (Phillips and Perron, 1988) test and the KPSS (Kwiatkowski et al. 1992) tests. All of these unit root tests are used to test whether the data contains unit root (non-stationary) or is a stationary process. A series is said to be stationary if the mean and auto co-variances of the series do not depend on the time factor. Any series that is not stationary then it is said to be non-stationary. A series is said to be integrated of order ‘d’ which can be denoted by I (d), means that it has to be differenced ‘d’ times before it becomes stationary. Otherwise, if a series by itself, let say stationary at levels, without having to be differenced, then that is said to be I (0). In the case of both ADF and PP tests, the null hypothesis of non-stationary (unit root) is tested against the alternative hypothesis of stationary.

For the Augmented Dickey-Fuller (ADF) tests; consider a simple AR (1) process:

\[ y_t = \rho y_{t-1} + x_t \delta + \epsilon_t \]  

(3.1)

Where \( y_t \) is the observed variable and \( x_t \) are optional exogenous regressors which may consist of constant or a constant and trend, \( \rho \) and \( \delta \) are parameters to be estimated, and the \( \epsilon_t \) are assumed to be white noise (i.e., zero mean and constant variance). If \( |\rho| \geq 1 \), \( y \) is a non-stationary series and the variance of \( y \) increases with time and approaches infinity, on the other hand if \( |\rho| < 1 \), then \( y \) is a (trend) stationary series. Now, subtracting equation (1) both sides with \( y_{t-1} \), then we get:

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

(3.2)

Where \( \alpha = \rho - 1 \). The null and alternative hypotheses can be written as;

\[ H_0 : \alpha = 0 \ (Y_t \ is \ unit \ root) \]

\[ H_1 : \alpha < 0 \ (Y_t \ is \ stationary) \]

and can be evaluated using the conventional \( t \)-ratio for \( \alpha \):

\[ t_{\alpha} = \frac{\hat{\alpha}}{se(\hat{\alpha})} \]  

(3.3)

Where: \( \hat{\alpha} \) is the estimate of \( \alpha \), and \( se(\hat{\alpha}) \) is the coefficient standard error. The equation (2) is valid only if the series is an AR (1) process, otherwise let say, if the series is correlated at higher order lags, then the assumption of white noise (\( \epsilon_t \)) disturbances and is violated. Thus, the ADF test constructs a parametric correction for higher-order correlation by assuming that the \( y \) series follows an AR (\( p \)) process and adding \( p \) lagged difference terms of the dependent variable \( y \) to the right-hand side of the test regression, such as:

\[ \Delta y_t = \alpha y_{t-1} + x_t \delta + \beta_1 \Delta y_{t-1} + \ldots + \beta_p \Delta y_{t-p} + \nu_t \]  

(3.4)

This augmented specification is then used to test the above null hypothesis by using the \( t \)-ratio (1.3). Therefore, study uses MacKinnon (MacKinnon, 1996) critical values for ADF test and then it has been evidenced that ADF tests are sensitive to the selection of lag lengths. Thus, study determines appropriate lag length by utilizing Schwarz information criteria (SIC).

The Phillips-Perron (1988) test incorporates an alternative (non-parametric) method for controlling serial correlation when testing for a unit root by estimating the non-augmented Dickey-Fuller test equation (3.2) and it is modifying the \( t \)-ratio of the \( \alpha \) coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic. The modified \( t \)-ratio is the same as that of ADF test for the asymptotic distribution of the PP test. Study uses MacKinnon (1996) lower-tail critical and \( p \)-values for this test.
The KPSS (Kwiatkowski et al. 1992) test differs from above unit root tests in that the series $y_t$ is assumed to be (trend) stationary under the null hypothesis. The KPSS test is based on the residuals from the OLS regression of $y_t$ on the exogenous variables $x_t$:  
\[ y_t = x_t' \delta + u_t \]  
(3.5)

The LM statistic can be defined as:  
\[ LM = \sum_t S(t)^2 / (T^2 f_0) \]  
(3.6)

Where $f_0$ is an estimator of the residual spectrum at zero frequency and where $s(t)$ is a cumulative residual function:  
\[ S(t) = \sum_{r=1}^{T} \hat{u}_r \]  
(3.7)

It is based on the residual of $\hat{u}_t = y_t - x_t' \hat{\delta}(0)$. The critical values for the LM test are based on the Kwiatkowski et al. (1992, table-1).

3.2. Granger Causality Test

The Granger (1969) causality procedure is explained as follows; the question of whether $y$ causes $x$ is to see how much of the current $x$ can be explained by past values of $x$ and then to see whether adding lagged values of $y$ can improve the explanation. It is said that $x$ is Granger caused by $y$, if $x$ can predict better from past values of $x$ and $y$ than from past values of $x$ alone. For a simple bivariate model, one can test the following equation:

\[ x_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i y_{t-i} + \sum_{j=1}^{m} \beta_j x_{t-j} + u_t \]  
(3.8)

\[ y_t = \alpha_0 + \sum_{i=1}^{n} \beta_i x_{t-i} + \sum_{j=1}^{m} \alpha_j y_{t-j} + \varepsilon_t \]  
(3.9)

Where; the null hypothesis is that $y$ does not Granger causes $x$ in the first regression equation and $x$ does not Granger causes $y$ in the second regression equation.

3.3. Vector Autoregression (VAR) Models

The Vector Autoregression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR models consists a set of regression equations in which all the variables are assumed to be endogenous. It is believed that each endogenous variable is explained by its own lagged values and also the lagged values of other endogenous variables which are included in the model. It is also assumed that there are no exogenous variables in the model. Hence, only the lagged values of the endogenous variables appear on the right side of the equations. A standard VAR model can be described as follows:

\[ C_t = \alpha_{10} + \alpha_{11} C_{t-1} + \alpha_{12} C_{t-2} + \beta_{11} S_{t-1} + \beta_{12} S_{t-2} + \phi_{11} E_{t-1} + \phi_{12} E_{t-2} + u_{3t} \]  
(3.10)

\[ E_t = \alpha_{20} + \alpha_{21} E_{t-1} + \alpha_{22} E_{t-2} + \beta_{21} S_{t-1} + \beta_{22} S_{t-2} + \phi_{21} C_{t-1} + \phi_{22} C_{t-2} + u_{2t} \]  
(3.11)

\[ S_t = \alpha_{30} + \alpha_{31} S_{t-1} + \alpha_{32} S_{t-2} + \beta_{31} E_{t-1} + \beta_{32} E_{t-2} + \phi_{31} C_{t-1} + \phi_{32} C_{t-2} + u_{3t} \]  
(3.12)

Where, $C_t$ is the call money rate at the time period $t$, $E_t$ is the exchange rate and $S_t$ is the stock price; and $\alpha_{ij}, \beta_{ij}, \phi_{ij}$ are the parameters to be estimated; $u_{3t}$, $u_{2t}$ and $u_{3t}$ are white noise disturbance terms with $E(u_{ii}) = 0, (i = 1,2), E(u_{1t},u_{2t}) = 0$. 
4. Data and Empirical Results

The present study uses monthly data for the time span of April, 1992 to March, 2011. This comprehensive data set enhances the accuracy of the empirical results. The required data on ‘call money rates (monthly weighted average)’ and ‘exchange rates (monthly US Dollar average against Indian rupee)’ are collected from RBI (Reserve Bank of India)’s database on Real-Time Handbook of Statistics on the Indian Economy (HBS). Similarly, the data on monthly closing price indices of BSE-SENSEX and NSE-S&P CNX Nifty are collected from BSE (Bombay Stock Exchange) and NSE (National Stock Exchange) official websites, respectively. As an initiative, the collected data on all the variables are transformed into natural logarithms (ln) before the analysis commence.

Table 1: Summary Statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Median</th>
<th>Max.</th>
<th>Min.</th>
<th>Std. Dev.</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarque-Bera Test</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call M. Rates</td>
<td>1.924</td>
<td>1.901</td>
<td>3.564</td>
<td>-0.315</td>
<td>0.480</td>
<td>0.035</td>
<td>6.122</td>
<td>92.623</td>
<td>0.000</td>
</tr>
<tr>
<td>Exchange Rates</td>
<td>3.711</td>
<td>3.775</td>
<td>3.936</td>
<td>3.403</td>
<td>0.157</td>
<td>-0.738</td>
<td>2.087</td>
<td>28.594</td>
<td>0.000</td>
</tr>
<tr>
<td>Nifty</td>
<td>7.421</td>
<td>7.138</td>
<td>8.715</td>
<td>6.467</td>
<td>0.648</td>
<td>0.691</td>
<td>2.040</td>
<td>26.906</td>
<td>0.000</td>
</tr>
<tr>
<td>Sensex</td>
<td>8.620</td>
<td>8.328</td>
<td>9.916</td>
<td>7.692</td>
<td>0.651</td>
<td>0.728</td>
<td>2.057</td>
<td>28.610</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: The estimation of summary statistics is carried out on the natural logarithm data series of all the observed variables.

The summary statistics of this study are presented in above table 1. This indicates that all the series are having positive mean. The series of call money rates, nifty and sensex are having positive skewness and exchange rates series shows negative skewness. This implies that the positively skewed series are flatter to the right as compared to the normal distribution and while negative skewed series is flatter to the left. The kurtosis values of call money rates are higher than the normal values of it and this suggest that the kurtosis curve is leptokurtic. While the kurtosis values of all other series are less than the normal values of it, and this suggests that the kurtosis curve is platykurtic. In general, value for skewness is ‘zero’ and kurtosis is ‘three’ when the observed series is perfectly normally distributed. Since, the results of this study indicate that none of these series are normally distributed. This view also supported by Jarque-Bera (JB) test, the JB test is used to assess whether the given series is normally distributed or not. Here, the null hypothesis is that the series is normally distributed. Results of JB test find that the null hypothesis is rejected for all the variables and suggest that all the observed series are not normally distributed.

Table 2: Correlation Matrices

<table>
<thead>
<tr>
<th>Variables</th>
<th>Call Money Rates</th>
<th>Exchange Rates</th>
<th>Nifty</th>
<th>Sensex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call M. Rates</td>
<td>1</td>
<td>-0.421</td>
<td>-0.402</td>
<td>-0.383</td>
</tr>
<tr>
<td>Exchange Rates</td>
<td>-0.421</td>
<td>1</td>
<td>0.469</td>
<td>0.436</td>
</tr>
<tr>
<td>Nifty</td>
<td>-0.402</td>
<td>0.469</td>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>Sensex</td>
<td>-0.383</td>
<td>0.436</td>
<td>--</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The analysis of correlation matrices is carried out on the natural logarithm data series of all the observed variables.

The above table provides information on correlation between the observed variables. The call money rates are negatively correlated with exchange rates and stock prices (Nifty and Sensex). This is suggesting that there is an inverse relationship from call money rates to exchange rates and stock prices. In contrary, exchange rates are positively correlated with stock prices. It signifies that both exchange rates and stock prices are moving in the same direction. The results also reveal that there is no high correlation between the identified variables.
Table 3a: ADF and PP Test Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>ADF Level</th>
<th>ADF 1st Difference</th>
<th>PP Level</th>
<th>PP 1st Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Trend</td>
<td>With Trend</td>
<td>Without Trend</td>
<td>With Trend</td>
</tr>
<tr>
<td>Call M. Rates</td>
<td>-4.17*</td>
<td>-6.82*</td>
<td>-5.73*</td>
<td>-6.72*</td>
</tr>
<tr>
<td>Exchange Rates</td>
<td>-1.89</td>
<td>-1.41</td>
<td>-1.69</td>
<td>-1.28</td>
</tr>
<tr>
<td>Nifty</td>
<td>-0.49</td>
<td>-2.32</td>
<td>-0.25</td>
<td>-2.69</td>
</tr>
<tr>
<td>Sensex</td>
<td>-0.42</td>
<td>-2.23</td>
<td>-0.25</td>
<td>-2.54</td>
</tr>
</tbody>
</table>

Note: Where (*) and (**) denote significance level at 1 % and 5 %, respectively. ADF and PP tests examine the null hypothesis of a unit root against the alternative of no unit root. These two tests are performed on the natural logarithm data series.

Table 3b: KPSS Test Results

<table>
<thead>
<tr>
<th>Variables</th>
<th>KPSS Level</th>
<th>KPSS 1st Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without Trend</td>
<td>With Trend</td>
</tr>
<tr>
<td>Call M. Rates</td>
<td>1.005*</td>
<td>0.042</td>
</tr>
<tr>
<td>Exchange Rates</td>
<td>1.420*</td>
<td>0.416*</td>
</tr>
<tr>
<td>Nifty</td>
<td>1.668*</td>
<td>0.347*</td>
</tr>
<tr>
<td>Sensex</td>
<td>1.605*</td>
<td>0.349*</td>
</tr>
</tbody>
</table>

Note: Where (*) and (**) denote significance level at 1 % and 5 % respectively. KPSS test tests the null hypothesis of stationary against the alternative hypothesis of non-stationary. This test is performed on the natural logarithm data series.

The table 3a and 3b display unit root tests results, by encompassing the ADF (Augmented Dickey and Fuller, 1979), PP (Phillips and Perron, 1988) t-statistics and KPSS (Kwiatkowski et al., 1992) LM-statistic. The unit root tests are performed on the natural logarithm data series. The ADF and PP tests are carried out on the assumption that the null hypothesis of a unit root (non-stationary) is tested against the alternative hypothesis of no unit root (stationary). These tests models are estimated at the levels and first-difference for both with and without trend variable in each case. At levels, the ADF and PP tests results of call money rates reject the null hypothesis of unit root at 1 % level of significance for both with and without trend variable. Hence, it suggests that the call money rates are stationary at their level. The ADF and PP tests results on the other variables do not reject the null hypothesis of unit root at the 5 % level of significance for both with and without trend variable. This signifies that these series are non-stationary at their levels. Therefore, we applied ADF and PP tests statistics on the first differenced data of exchange rates, nifty and sensex. The first differenced data results reject the null hypothesis of unit root at 1 % significance level for both with and without trend for all the three variables. Further, we performed KPSS test on all the variables at their levels and first difference. This test presumes that the null hypothesis of no unit root (stationary) is tested against the alternative hypothesis of unit root (non-stationary). The table 3b supplies KPSS test results, at levels the null hypothesis of no unit root is rejected for the model without trend at 1 % level of significance for all the variables, and for the model with trend the null hypothesis is not rejected at 5 % significance level for call money rates and rejected 1 % level of significance for the remaining variables. This test results on first differenced data shows that the null hypothesis is not rejected for all the variables with and without trend at 1 % significance level. Overall, it is understood from the three of unit root tests that the call money rates are stationary (no unit root) at their levels except for the model without trend in the case of KPSS test. Similarly, the results of exchange rates, nifty and sensex reveals that the null hypothesis (non-stationary) has not been rejected at their levels and rejected at their first differenced data for with and without trend variable.
Table 4: Granger Causality Test Results

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>Number of Lags</th>
<th>F- statistics</th>
<th>Causal Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange Rates do not Granger Cause Call Money Rates</td>
<td>2</td>
<td>9.83*</td>
<td>Bidirectional</td>
</tr>
<tr>
<td>Call Money Rates do not Granger Cause Exchange Rates</td>
<td>2</td>
<td>3.55**</td>
<td>Relation</td>
</tr>
<tr>
<td>Nifty does not Granger Cause Call Money Rates</td>
<td>3</td>
<td>0.73</td>
<td>Unidirectional</td>
</tr>
<tr>
<td>Call Money Rates do not Granger Cause Nifty</td>
<td>3</td>
<td>2.79***</td>
<td>Relation</td>
</tr>
<tr>
<td>Sensex does not Granger Cause Call Money Rates</td>
<td>2</td>
<td>0.66</td>
<td>Unidirectional</td>
</tr>
<tr>
<td>Call Money Rates do not Granger Cause Sensex</td>
<td>2</td>
<td>3.12***</td>
<td>Relation</td>
</tr>
<tr>
<td>Nifty does not Granger Cause Exchange Rates</td>
<td>2</td>
<td>1.80</td>
<td>Unidirectional</td>
</tr>
<tr>
<td>Exchange Rates do not Granger Cause Nifty</td>
<td>2</td>
<td>2.88***</td>
<td>Relation</td>
</tr>
<tr>
<td>Sensex does not Granger Cause Exchange Rates</td>
<td>2</td>
<td>1.61</td>
<td>Unidirectional</td>
</tr>
<tr>
<td>Exchange Rates do not Granger Cause Sensex</td>
<td>2</td>
<td>2.99***</td>
<td>Relation</td>
</tr>
</tbody>
</table>

Note: Where ‘*’, ‘**’ and ‘***’ indicate that the null hypothesis is rejected at 1 %, 5 % and 10 % level of significance, respectively. The appropriate lag length is selected based on the Akaike Information Criterion (AIC). The Granger causality test is performed on the stationary data series.

The table 4 exemplifies Granger causality test results. This estimation has been carried out on the stationary variables (first differenced data has been used for all the variables except call money rates) and appropriate lag length is selected based on the Akaike Information Criterion (AIC). The test results demonstrate that the null hypothesis of exchange rates do not Granger cause call money rates is rejected at 1 % level; and the null hypothesis of call money rates do not Granger cause exchange rates is also rejected at 5 % significance level. This implies that there exists a bidirectional relationship between exchange rates and call money rates. Similarly, the null hypothesis of Stock returns (nifty and sensex) do not Granger cause call money rates is not rejected 5 % or lower level but the null hypothesis of call money rates do not Granger cause stock returns is rejected at 10 % significance level. This confirms that there is unidirectional relationship among call money rates and stock returns, which runs from call money rates to stock returns. In the same way, the null hypothesis of stock returns do not Granger cause exchange rates is not rejected at 5 % level, and the null hypothesis of exchange rates do not Granger cause stock returns is rejected at 10 % significance level. This also demonstrates that there is unidirectional relationship between exchange rates and stock returns that runs from exchange rates to stock returns. Largely, the Granger causality test results provide evidence that there is a bidirectional relationship between call money rates and exchange rates. The test results also show that stock returns do not Granger cause neither call money rates nor exchange rates. Despite of this, there is a unidirectional relationship from call money rates and exchange rates to stock returns.

Table 5a: Vector Autoregression (VAR) Models

<table>
<thead>
<tr>
<th>Variables</th>
<th>Call Money Rates</th>
<th>Exchange Rates</th>
<th>Nifty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call Money Rates(_{t-1})</td>
<td>0.560* (0.067)</td>
<td>-0.004 (0.003)</td>
<td>0.006 (0.015)</td>
</tr>
<tr>
<td>Call Money Rates(_{t-2})</td>
<td>0.178* (0.064)</td>
<td>0.008** (0.003)</td>
<td>-0.027*** (0.014)</td>
</tr>
<tr>
<td>Exchange Rates(_{t-1})</td>
<td>4.966* (1.378)</td>
<td>0.224* (0.069)</td>
<td>-0.635** (0.306)</td>
</tr>
<tr>
<td>Exchange Rates(_{t-2})</td>
<td>2.366*** (1.402)</td>
<td>-0.076 (0.070)</td>
<td>-0.290 (0.311)</td>
</tr>
<tr>
<td>Nifty(_{t-1})</td>
<td>0.131 (0.312)</td>
<td>-0.027*** (0.016)</td>
<td>0.213* (0.069)</td>
</tr>
<tr>
<td>Nifty(_{t-2})</td>
<td>-0.036 (0.304)</td>
<td>0.009 (0.015)</td>
<td>-0.094 (0.067)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.481* (0.093)</td>
<td>-0.005 (0.005)</td>
<td>0.049** (0.021)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.599</td>
<td>0.103</td>
<td>0.119</td>
</tr>
<tr>
<td>F-statistic</td>
<td>54.360</td>
<td>4.154</td>
<td>4.903</td>
</tr>
</tbody>
</table>

Note: The VAR models are performed on the stationary data series and standard errors are presented in parentheses.
The Vector Autoregression (VAR) results are presented in the table 5a and 5b. This estimation is carried out on the stationary data series. This study has estimated tri-variate VAR models, with one for each dependent variable in the system. Table 5a reveals that the lagged values of call money rates are significant at 5 % and 10 % level for exchange rates and nifty, respectively. This suggests that there is causation from call money rates to exchange rates and nifty at 5 % and 10 % levels, respectively. There is also causality from exchange rates to call money rate and nifty. No causality is identified from nifty to call money rates and for exchange rates there is causality at 10 % significant level. Similarly, table 5b also presents VAR model results (sensex). The lagged values of call money rates cause exchange rates and sensex at 5 % and 10 % significance level, respectively. The causality is also found from exchange rates to call money rates and sensex. However, there is no reverse causality from sensex to call money rates and exchange rates at both the lags. Largely, the VAR model results indicate that the causality is observed from call money rates to exchange rates and stock returns (nifty and sensex) at 5 % and 10 % significance level, respectively. In the same way, the causality is also observed from exchange rates to call money rates (at 1 % and 10 % levels at both the lags, respectively) and stock returns at 5 % level of significance. On the other hand, there is no reverse causality from stock returns to call money rates and exchange rates at 5 % significance level or lower level. Hence, this suggests that the information is incorporated more quickly into call money rates and exchange rates than in the stock returns.

5. Conclusion
The present study empirically investigated the relationship between call money rates, exchange rates and stock returns in Indian perspective. This study has used monthly data from April 1992 to March 2011 which provides sufficient data set for the empirical analysis. The results of Granger causality test present that there is a bidirectional relationship between call money rates and exchange rates. Further, it evidences that the call money rates and exchange rates Granger cause stock returns at 10 % significance level. This suggests that there is unidirectional relationship and that runs from call money and exchange rates to stock returns. However, this study did not observe reverse causality from stock returns to call money and exchange rates even at 10 % level. The Vector Autoregression (VAR) models are employed for identifying lead-lag interaction among the observed variables. The result of these models reveals that the causality is observed from the lagged values of call money rates to exchange rates and stock returns at 5 % and 10 % level of significance, respectively. Similarly, the causality is also found from the lagged values of exchange rates to call money rates (at 1 % and 10 % level) and stock returns (at 5 % level). In contradiction to this, the reverse causality is not found from
stock returns to call money and exchange rates at 5% significance level. Overall, our study findings are very much important in the perspective of investors and policy makers. In the investors’ point of view, this historical information of call money rates and exchange rates can be utilized for predicting the movements of stock returns. Similarly, this findings also useful for the policy makers in stabilizing the stock market fluctuations by adopting suitable policy measures towards interest rates and exchange rates.

References


