An Analysis of Stock Market Efficiency in the Light of Capital Inflows and Exchange Rate Movements: The Indian Context

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Abstract:

This paper investigates the nature of the causal relationship between stock returns, net foreign institutional investment (FII) and exchange rate in India. By applying the techniques of unit–root tests, cointegration and the long–run Granger non–causality test recently proposed by Toda and Yamamoto (1995), we test the causal relationships using monthly data for the period January 1993 to March 2005. The major findings are that (a) a bi-directional causality exists between stock return and the FII, (b) uni-directional causality runs from change in exchange rate to stock returns (at 10% level of significance), not vice versa, and (c) no causal relationship exist between exchange rate and net investment by FIIs.

JEL classification: G1, E4

Keywords: Foreign Institutional Investments, Exchange Rate, Stock Price, Granger Causality, Toda and Yamamoto causality test, and Efficient Market Hypothesis.

I. Introduction:

The ongoing transition in the international financial architecture is exhibiting several features of which capital inflows are perhaps the most important. Emerging economies have experienced massive capital inflows, which in some cases have proved to be traumatic later. Whether such traumatic situations occurred due to incompatible macro economic and exchange rate policies or imprudent banking policy or lack of liquidity in the market is a matter of debate at the theoretical plane and an issue of future policy concern under country specific conditions. Whatever be the reason, the issue boils down to the fact whether such flows are properly paced and properly sequenced such that the inflow of capital is not excessive relative to the maturity of the system in which it must be absorbed; only then the capital flows can be sustained and systemic stability ensured. This may be attained through structural and operational realignment of the domestic and financial sector variables of the economies exposed to global financial network. It is in this context that the interlinkage among the stock market, the most sensitive sector of the economy, exchange rate, the barometer of external interaction and the FII flows, indicator of capital surge needs to be addressed. To what extent the stock market can internalize or in other words, can capture the information on these is a case in point. For otherwise there may arise the possibility of capital flow reversals.

The present study focuses on this issue in the Indian context. In fact, from among the whole gamut of institutional reforms undertaken in India since the 1990’s, gradual abolishment of capital inflow barriers and foreign exchange restrictions, adoption of more flexible exchange rate arrangements deserve a special attention at this juncture to reexamine whether India is approaching towards achieving the twin goals of stability and efficiency of the financial system .

A plethora of researches are being conducted to understand the current working of the economic and the financial system. Interesting results are emerging particularly for the developing countries where the markets are experiencing new relationships which are not perceived earlier. One of the most important changes that Indian capital market witnessed with the reforms is the entry of foreign institutional investors. Since then the country has been receiving increasing amounts of portfolio investment. The analysis of the interrelationship between stock prices, net foreign institutional investment (FII) and exchange rate in the present study runs in terms of efficiency of Indian stock markets.

The Efficient Market Hypothesis (semi-strong form), states that in a semi strong efficient market, everyone has perfect knowledge of all publicly available information in the market. The idea is, whether in a mutually interactive framework, stock market can effectively digest and incorporate all available information about economic variables. This is important because, if it does so, then the rational behavior of market participants ensures that past and current information is fully reflected in stock prices. Otherwise, (a) the market participants are able to develop profitable trading rules and thereby can consistently earn more than average market returns, and (b) the stock market is not likely to play an effective role in channeling financial resources to the most productive sector of the economy.

The use of Granger Causality Test in examining market informational efficiency has been there for quite some time. This is based on the hypothesis that informational efficiency exists if a uni-directional lagged causal relationship from an economic variable to stock prices or bi-directional lagged causal relationship from an economic variable to stock price or from the latter to the former, could not be detected. It implicates that the economic variable neither influences nor is influenced by stock price fluctuations, and the two series are independent of each other and the market is informationally efficient.

However, the traditional Granger causality test is found unable to capture many of the time series properties. This paper makes use of the most recently available econometric technique, as proposed by Toda and Yamamoto (1995), which overcomes the technical problems associated with the traditional Granger Causality test. The study investigates the empirical relationship between stock prices, net FII investment and exchange rate using monthly data from January 1993 to March 2005.

A survey of the existing literature including empirical evidences on the nature of interrelationships between stock prices, net FII investment and exchange rate is conducted in Section II. Section III discuses the methodology employed and presents the variables and data descriptions. Section IV analyses the empirical results followed by concluding observation in Section V.

II. The Present State of Art:

India embarked on a programme of economic reforms in the early 1990s to tie over its balance of payment crisis and also as a step towards globalization. An important milestone in the history of Indian economic reforms happened on September 14, 1992, when the FIIs (Foreign Institutional Investors) were allowed to invest in all the securities traded on the primary and secondary markets, including shares, debentures and warrants issued by companies which were listed or were to be listed on the stock exchanges in India and in the schemes floated by domestic mutual funds. Initially, the holding of a single FII and of all FIIs, NRIs (Non-Resident Indians) and OCBs (Overseas Corporate Bodies) in any company were subject to a limit of 5% and 24% of the company's total issued capital respectively. In order to broad base the FII investment and to ensure that such an investment would not become a camouflage for individual investment in the nature of FDI, a condition was laid down that the funds invested by FIIs had to have at least 50 participants with no one holding more than 5%. Ever since this day, the regulations on FII investment have gone through enormous changes and have become more liberal over time.

There have been attempts to explain FII in India. All the existing studies found that the equity return has a significant and positive impact on the FII (Agarwal, 1997; Chakrabarti, 2001; and Trivedi & Nair, 2003). But given the huge volume of investments, foreign investors could play a role of market makers and book their profits, i.e., they can buy financial assets when the prices are declining thereby jacking-up the asset prices and sell when the asset prices are increasing (Gordon & Gupta, 2003). Hence, there is a possibility of bi-directional relationship between FII and the equity returns. Ahmad et al (2005) make a firm level analysis of FII's role in the Indian equity market. At the aggregate level FII investments and NSE Nifty seem to have a strong bi-directional causality. At the firm level FIIs are influencing equity returns especially in the government owned companies. On the issue of market stability Mazumdar (2004) finds that FII flows have enhanced liquidity in the Indian stock market but not much evidence is there to support the hypothesis that FII flows have generated volatility in the returns. Ahmed et al (2005) also confirms that there has been very little destabilizing effect of FII flows on individual equity returns of the firms during their period of study.

Kumar (2001) inferred that FII flows do not respond to short-term changes or technical position of the market and they are more driven by fundamentals. The study finds that there is causality from FII to Sensex. This is in contradiction to Rai and Bhanumurthy (2003) results using similar data but for a larger period. A study by Panda (2005) also shows FII investments do not affect BSE Sensex. No clear causality is found between FII and NSE Nifty. FIIs are found to follow positive feedback strategy and to have return clustering tendency.

Following the Asian crisis and the bust of info-tech bubble internationally in 1998-99 the net FII has declined by US$ 61 million. But there was not much effect on the equity returns. Chakrabarti (2001) has marked a regime shift in the determinants of FII after Asian crisis. The study found that in the pre-Asian crisis period any change in FII found to have a positive impact on the equity returns. But in the post-Asian crisis period a reverse relation was found, i.e. a change in FII was mainly due to change in equity returns.

There are also a number of studies on exchange rate affecting stock prices directly. Theory explained that a change in the exchange rates would affect a firm's foreign operation and overall profits. This would, in turn, affect its stock prices. The nature of the change in stock prices would depend on the multinational characteristics of the firm. Conversely, a general downward movement of the stock market will motivate investors to seek better returns elsewhere. This decreases the demand for money, pushing interest rates down, causing further outflow of funds and hence depreciating the currency. While the theoretical explanation was clear, empirical evidence was mixed. Aggarwal (1981) found a significant positive correlation between the US dollar and US stock prices while Soenen and Hennigan (1988) reported a significant negative relationship. Soenen and Aggarwal (1989) found mixed results among industrial countries. Ma and Kao (1990) attributed the differences in results to the nature of the countries i.e. whether the countries were export or import dominant. Morley and Pentecost (2000), in their study on G-7 countries, argue that the reason for the lack of strong relationship between exchange rates and stock prices may be due to the exchange controls that were in effect in the 1980s.

Bahmani-Oskooee and Sohrabian (1992) were among the first to use cointegration and Granger causality to explain the direction of movement between exchange rates and stock prices. Since then various other papers analyzing these aspects and using this technique have appeared covering both industrial and developing countries (for example, Granger et.al. 2000; Ajayi et.al. 1998; Ibrahim 2000). Among the more recent studies, Narayan and Smith (2005) in their study on exchange rates and stock prices in South Asia found that exchange rates Granger cause stock prices in India both in the long run and short run. Venkateshwarlu and Tiwari (2005) analyzed bivariate causality between stock prices and exchange rates.

If FIIs use positive feedback trading strategies, causality may run from stock prices to foreign investment. The portfolio balancing efforts of foreign investors would also put pressure on demand for (or supply) of currency, which may affect its exchange rate. On the other hand, the payoff of foreign investors depends on exchange rate movements as well as on stock price movements, and they may rebalance their portfolio in response to an (an anticipated) change in exchange rate. The relationship of FII investment with stock prices on the one hand, and with exchange rate on the other hand may produce indirect relation between exchange rate and stock prices

In the contemporary Indian scenario, study on interlinkage of stock prices, net FII investment and exchange rate is scarce. Using monthly data from April 1993 to March 2004, Badhani (2005) observed (i) bi-directional long-term causality between FII investment Flow and stock prices, but no short-term causality could be traced between the variables, (ii) no long-term relationship between exchange rate and stock prices, but short-term causality runs from change in exchange rate to stock returns, not vice versa, and (iii) exchange rate long term granger causes FII investment flow, not vice versa.

The issue of the above interlinkage among stock price, FII and exchange rate gains importance from its own course of happenings. The current pattern of concomitant advancement of FII flows and the Sensex does pose concern for the market analyst and the researchers. These may have multifaceted ramifications in terms of economic and financial stability of the economy in which exchange rate does have a role to play as discussed above. Apart from exhibiting some concern, the market analysts do not currently observe any destabilizing motion in the current scenario nor do they apprehend it for the future; however, we feel that the time is perhaps ripe for analyzing the interlinkage in the stock price –FII- exchange rate nexus and examine to what extent the stock price can capture the publicly available information on the other two. This is true for the other two variables as well. The concern lies in the fact that if such information is not captured, then there is scope for profitable trading as discussed above which at a faster pace of occurrence may trigger off higher volatility and generate systemic risk. Some studies do reveal volatility clustering at the firm level equity returns but till now these are not transferred to other firms. It may be feared that at a higher pitch such transfer may occur endangering systemic risk in the entire equity market. Attempts are also being currently made by the authorities to check intra-day volatility through 'Block Deals'. Although destabilizing motion is not presently apprehended, some concern are expressed on the sustainability of FII flows since new traders are setting in the market posing edgy character and selling at the slightest concern. There also prevails optimistic outlook which puts forward that FIIs are not 'villains'. In most of the market crashes the FIIs were net buyers (e.g.stock market crash of 2001, market collapse of 1998). Even in the 17 May 2004 Black Monday episode FIIs were not the culprits. Though there was a net outgo there was also a come back in the next month June as a net inflow. Further, improved risk management system was also seen to withstand volatility of '8' sigma against the normal built in capacity of '3-6' sigma variations internationally. It is further argued that FIIs tend to support stock market purely to ensure stability and safety of their own investments. All these reflect much concern on issue of FII, Stock prices and exchange rate interlinkage and this itself justifies our study done in terms of Efficient Market Hypothesis (EMH).

The paper has applied more recently developed techniques in econometrics on the properties of time series that enables to investigate the relationship between integrated economic variables with ease and can provide precise estimates, in the sense that spurious regression problems can be avoided. It has been noted that the traditional Granger (1969) causality test for inferring leads and lags among integrated variables will end up in spurious regression results, and the F – test is not valid unless the variables in levels are cointegrated. Several tests for a unit – root(s) in a single time – series have been proposed (for example, Dickey and Fuller, 1979; Phillips and Perron, 1988). Unfortunately, however, the power of these tests is known to be very low against the alternative hypothesis of (trend) stationarity. Tests for cointegration and cointegrating ranks have also been developed, viz., error correction model due to Engle and Granger (1987) and the vector autoregression error correction model due to Johansen and Jesulius (1990). Unfortunately, these tests are cumbersome and sensitive to the values of the nuisance parameters in finite samples and therefore their results are unreliable, as pointed out by Toda and Yamamoto, (1995) and Zapata and Rambaldi, (1997).

Toda and Yamamoto (1995) proposed a simple procedure requiring the estimation of an "augmented" VAR, even when there is cointegration, which guarantees the asymptotic distribution of the MWALD statistic. This method is applicable "whether the VAR's may be stationary (around a deterministic trend), integrated of an arbitrary order, or cointegrated of an arbitrary order" (Toda and Yamamoto: *Journal of Econometrics 66, 1995*, pp. 227). The methodology that we have applied to examine the nature of the causal relationship between FII, Exchange rates and stock prices in India is discussed in the next section.

III. Methodology and Data Sources:

Traditionally to test for the causal relationship between two variables, the standard Granger (1969) test has been employed in the relevant literature. This test states that, if past values of a variable Y significantly contribute to forecast the value of another variable X_{t+1} then Y is said to Granger cause X and vice versa. The test is based on the following regressions:

$$Y_t = \beta_0 + \sum_{k=1}^{M} \beta_k Y_{t-k} + \sum_{l=1}^{N} \alpha_l X_{t-l} + u_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$X_t = \gamma_0 + \sum_{k=1}^{M} \gamma_k X_{t-k} + \sum_{l=1}^{N} \delta_l Y_{t-l} + v_t \text{ ....} (2)$$

where Y_t and X_t are the variables to be tested, and u_t and v_t are mutually uncorrelated white noise errors, and t denotes the time period and *'k'* and *'l'* are the number of lags. The null hypothesis is $\alpha_\iota = \delta_\iota = 0$ for all *l*'s versus the alternative hypothesis that $\alpha_\iota \neq 0$ and $\delta_\iota \neq 0$ for at least some *l*'s. If the coefficient α_ι's are statistically significant but δ_ι' s are not, then X causes Y. In the reverse case, Y causes X. But if both α_ι and δ_ι are significant, then causality runs both ways.

Recent developments in the time series analysis have suggested some improvements in the standard Granger test. The first step is to check for the stationarity of the original variables and then test cointegration between them. According to Granger (1986), the test is valid if the variables are not cointegrated. Second, the results of Granger causality are very sensitive to the selection of lag length. If the chosen lag length is less than the true lag length, the omission of relevant lags can cause bias. If the chosen lag length is more, the irrelevant lags in the equation cause the estimates to be inefficient. To deal with this problem Hsiao (1981) has developed a systematic autoregressive method for choosing optimal lag length for each variable in an equation. This method combines Granger causality and Akaike's Final Prediction Error (FPE), defined as the (asymptotic) mean square prediction error.

Unit Root Test and Cointegration:

Empirical studies (for example, Engle and Granger, 1987) have shown that many time series variables are non-stationary or not integrated of order zero. The time series variables considered in this paper are the stock prices and seven macroeconomic variables, namely, money supply, index of industrial production, real GDP, rate of inflation, real effective exchange rate, foreign exchange reserves and value of trade balance. In order to avoid a spurious regression situation the variables in a regression model must be stationary or cointegrated. Therefore, in the first step, we perform unit root tests on these eight time series variables to investigate whether they are stationary or not. The Augmented Dickey-Fuller (ADF) unit root test is used for this purpose. The ADF regression equations are:

$$\Delta Y_t = \alpha_1 Y_{t-1} + \sum_{j=1}^{P} \gamma_j \Delta Y_{t-j} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (3)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{P} \gamma_j \Delta Y_{t-j} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (4)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 t + \sum_{j=1}^{P} \gamma_j \Delta Y_{t-j} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots . (5)$$

where ε_τ is white noise. The additional lagged terms are included to ensure that the errors are uncorrelated. The tests are based on the null hypothesis (H_0): Y_t is not I (0). If the calculated DF and ADF statistics are less than their critical values from Fuller's table, then the null hypothesis (H_0) is accepted and the series are non-stationary or not integrated of order zero.

In the second step we estimate cointegration regression using variables having the same order of integration. The cointegration equation estimated by the OLS method is given as:

$$Y_t = a_0 + a_1 X_t + Z_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .. (6)$$

In the third step residuals (Z_t) from the cointegration regression are subject to the stationarity test based on the following equations:

(DF) $\Delta Z_t = \alpha + \beta_0 Z_{t-1} + V_t$ ……………………………. (7)

(ADF) $\Delta Z_t = \alpha + \beta_0 Z_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Z_{t-i} + V_t$ ...…………….(8)

where, Z_t is the residual from equation (6).

Hsiao's Optimum Lag Length:

More recently many studies like Thornton and Batten (1985), Hwang et. al. (1991) and Chang and Lai (1997) have found Hsiao's Granger Causality test provides more robust results over both arbitrary lag length selection and other systematic methods for determining lag length. Hsiao's procedure involves two steps. The first step follows a series of autoregressive regressions on the dependent variable. The independent variable appearing in the first regression is the dependent variable lagged once. In each following regression, one more lag on the dependent variable is added. The m regressions we estimated are of the form:

$Y_t = \alpha + \sum_{i=1}^{m} \beta_i Y_{t-i} + \varepsilon_{1t}$ ……………………………… (9)

where, the choice of lag length is based on the sample size and underlying economic process. It is better to select m as large as possible (for example, we may set m=10). Then we computed the FPE for each regression in the following way:

$$FPE(m) = \frac{T+m+1}{T-m-1} RSS(m) / T$$ ………………………………. (10)

where T is sample size and FPE and RSS are the final prediction error and the residual sum of squares respectively. The optimal lag length, m*, is the lag length which produces the lowest FPE. In the second step, once m* has been determined, regressions are estimated with the lags on the other variables, with lags added sequentially in the same manner used to determine m*. Thus we estimate ten regressions of the form:

$$Y_t = \alpha + \sum_{i=1}^{m*} \beta_i Y_{t-i} + \sum_{j=1}^{n} \gamma_j X_{t-j} + \varepsilon_{2t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

We then compute FPE for each regression as:

$$FPE\ (m^*, n) = \frac{T + m^* + 1}{T - m^* - 1}\ RSS\ (m^*, n)\ /T \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

We choose the optimal lag length for X, n* as the lag length producing the lowest FPE.

Toda and Yamamoto Version of Granger Causality:

Toda and Yamamoto (1995) proposed a simple procedure requiring the estimation of an ‘augmented’ VAR, even when there is cointegration, which guarantees the asymptotic distribution of the MWald statistic. Therefore, the Toda-Yamamoto causality procedure has been labelled as the long-run causality tests. All one needs to do is to determine the maximal order of integration d_{max}, which we expect to occur in the model and construct a VAR in their levels with a total of ($k + d_{max}$) lags. Toda and Yamamoto point out that, for d=1, the lag selection procedure is always valid, at least asymptotically, since $k \geq 1 = d$. If d=2, then the procedure is valid unless k=1. Moreover, according to Toda and Yamamoto, the MWald statistic is valid regardless whether a series is I (0), I (1) or I (2), non-cointegrated or cointegrated of an arbitrary order.

In order to clarify the principle, let us consider the simple example of a bivariate model, with one lag (k=1). That is,

$$x_t = A_0 + A_1 x_{t-1} + e_t \quad \text{--} \quad (13)$$

or more fully,

$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(1)} & \alpha_{12}^{(1)} \\ \alpha_{21}^{(1)} & \alpha_{22}^{(1)} \end{bmatrix} \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \text{------------------ (14)}$$

where $E(e_t) = E\begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} = 0$ and $\mathrm{E}(\mathrm{e}_t e_t^{/}) = \Sigma$

To test that x_2 does not Granger cause x_1, we will test the parameter restriction $\alpha_{12}^{(1)}$ =0. If now we assume that x_{1t} and x_{2t} are I (1), a standard t-test is not valid. Following Dolado and Lutkepohl (1996), we test $\alpha_{12}^{(1)}$ =0 by constructing the usual Wald test based on least squares estimates in the augmented model:

$$\begin{bmatrix} x_{1t} \\ x_{2t} \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(1)} & \alpha_{12}^{(1)} \\ \alpha_{21}^{(1)} & \alpha_{22}^{(1)} \end{bmatrix} \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix} + \begin{bmatrix} \alpha_{11}^{(2)} & \alpha_{12}^{(2)} \\ \alpha_{21}^{(2)} & \alpha_{22}^{(2)} \end{bmatrix} \begin{bmatrix} x_{1,t-2} \\ x_{2,t-2} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \text{------------------ (15)}$$

The Wald statistic will be asymptotically distributed as a Chi Square, with degrees of freedom equal to the number of "zero restrictions", irrespective of whether x_{1t} and x_{2t} are I (0), I (1) or I (2), non-cointegrated or cointegrated of an arbitrary order.

In this study, we used monthly data series for three variables for the period January 1993 to March 2005 forming around 147 observations. The monthly return on stock prices (RBSE) is calculated by taking a percentage change in the BSE Sensitive Index (base: 1978-79=100). The other two variables included in our study are net investments by FIIs (in equities) in the Indian capital market and the indices of Real Effective Exchange Rate (REER) of the Indian Rupee (36-country bilateral weight with base 1985=100). Incidentally, it may be noted that FIIs were allowed to invest in the Indian capital market securities from September 1992. However, investments made by them were first made in January 1993. The data has been compiled from Handbook of

Statistics on Indian Economy published by Reserve Bank of India and various issues of RBI Bulletin.

IV. Empirical Results:

As part of empirical analysis Table 1 displays the summary statistics for the concerned variables over the sample period. The mean is positive for all the variables. The standard deviation (variance) of FII exceeds that of REER, which exceeds that of RBSE. All the variables exhibit positive skewness except RBSE. The significant Jarque Bera statistics shows that the data considered are found to be non-normal except RBSE.

Table1: Summary Statistics of Monthly Series on RBSE, FII and REER

Variables	Mean	Variance	SK	Kurtosis	J-B
Return on Stock Price (RBSE)	0.00664141183	0.004387	-0.05567	-0.24682	0.44599 (0.80011926)
Foreign Institutional Investment (FII)	987.87489796	2995938.088528	2.29901	6.60653	396.82717 (0.00000000)
Real Effective Exchange Rate (REER)	67.1212925170	25.045407	0.55300	-0.49421	8.98835 (0.01117389)

Note: J-B is the Jarque Bera test of normality

In the next step, we determine the order of integration for each of the three variables used in the analysis. Using the standard Augmented Dickey Fuller unit root test analyzed in the earlier section, we have tested on both the levels and the first differences of the series. The results are tabulated in Table 2 and Table3.

Table 2: Results for the Dickey Fuller unit root test for the variables in levels

Variables	Constant, No trend	Constant, With trend
RBSE	-5.16685*	-5.14981*
FII	-1.34643	-2.28135
REER	-0.80803	-1.79255

Note: Asterisk (*) denotes statistically significant at 1% level

Table 3: Results for the Dickey Fuller unit root test in first differences

Variables	Constant, No trend	Constant, With trend
FII	-6.68049*	-6.76017*
REER	-6.05515*	-6.04306*

Note: Asterisk (**) denotes statistically significant at 5% level

Clearly the results suggest that return on BSE sensitive Index is stationary, that is, integrated of order 0. On the other hand, FII and REER are characterized as integrated of order 1, that is, first differencing will render the series stationary.

Having determined that $d_{max}=1$, we then proceed in estimating the lag structure of a system of VAR in levels and our results indicate that the optimal lag length based on Akaike's FPE (using Hsiao's optimal lag technique discussed in the previous section) is 2, that is, k=2. We then estimate a system of VAR in levels with a total of (d_{max}+k) 3 lags.

$$\begin{bmatrix} RBSE_t \\ FII_t \\ REER_t \end{bmatrix} = A_0 + A_1 \begin{bmatrix} RBSE_{t-1} \\ FII_{t-1} \\ REER_{t-1} \end{bmatrix} + A_2 \begin{bmatrix} RBSE_{t-2} \\ FII_{t-2} \\ REER_{t-2} \end{bmatrix} + A_3 \begin{bmatrix} RBSE_{t-3} \\ FII_{t-3} \\ REER_{t-3} \end{bmatrix} + \begin{bmatrix} e_{rbse} \\ e_{fii} \\ e_{reer} \end{bmatrix} \text{-------------}(16)$$

The system of equations is jointly estimated as a "Seemingly Unrelated Regression Equations" (SURE) model by Maximum Likelihood and MWALD test statistic is computed. The results of the MWALD test statistic as well as its *p*-values are presented in Table 4.

Table4: Results of Long Run Causality following Toda-Yamamoto (1995) Procedure

Null Hypothesis	MWALD statistics	*p*-values
Stock price (RBSE) versus foreign investment (FII)		
RBSE does not *Granger cause* FII	5.98856*	0.00323384
FII does not *Granger cause* RBSE	5.53453*	0.00491111
Stock price(RBSE) versus Exchange Rate (REER)		
RBSE does not *Granger cause* REER	0.91525	0.40292515
REER does not *Granger cause* RBSE	2.44487***	0.09062754
Exchange Rate (REER) versus Foreign Investment (FII)		
REER does not *Granger cause* FII	0.06913	0.93324025
FII does not *Granger cause* REER	1.19853	0.30487400

Note: Asterisk (*) denotes statistically significant at 1% level and (***) denotes statistically significant at 10% level

The test results in Table 4 suggest

(i) a bi-directional causality between stock price and the net foreign institutional investment, thus implying that the market informational efficiency hypothesis can be rejected for BSE Sensitive Index with respect to the FII,

(ii) uni-directional causality runs from change in exchange rate to stock returns (at 10% level of significance), not vice versa, implying that the exchange rate movements lead the BSE sensitive index, and

(iii) no causal relationship exist between exchange rate and net investment by FIIs.

V. Summary and Conclusions:

The main objective of the present paper is to determine the lead and lag interrelationships between the Indian stock market, net foreign institutional investment, and exchange rate. To test this, we employ the methodology of *Granger non-causality* recently proposed by Toda and Yamamoto (1995) for the sample period January 1993 to March 2005. In this study, the returns on BSE Sensitive Index is used as a proxy for the Indian stock market and the indices of Real Effective Exchange Rate (REER) of the Indian Rupee (36-country bilateral weight with base 1985=100) for the exchange rate.

The result suggests a bi-directional causality between stock price and the net foreign institutional investment, thus implying that the market informational efficiency hypothesis can be rejected for BSE Sensitive Index with respect to the FII. At the same time it is consistent with the 'base-broadening hypothesis' (Merton, 1987), which postulates a positive and long-term impact of foreign investment on stock prices due to reduction on risk premium from international diversification. The uni-directional causality from change in exchange rate to stock returns (at 10% level of significance), implies that the exchange rate movements lead the BSE sensitive index. At the same time, the absence of any causal relationship between exchange rate and net investment by FIIs imply that the interlinkages between stock price and exchange rate is prominent not due to the presence of foreign institutional investors alone, but attributed to other factors as well. It suggests the policy implication that the authorities can focus on domestic economic policies to stabilize the stock market.

Our results imply that stock prices can capture information on neither the FIIs nor the exchange rate. Investors can therefore apply profitable trading rules to earn supernormal profits. Also FII cannot capture information on exchange rate thus adding to the possibility of application of profitable trading rules. Under the circumstances, the Indian stock market seems to be bearing the underlying strain not currently visible at the surface. The implementation of profitable trading strategy may at any point of time generate over-enthused investment and this, if coupled with market overreaction, may result in a destabilized system. A point also to be noted here is the current concentration of FII funds in the IT and Banking sector, which in any event of flow reversals may worsen the situation.

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