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Exchange rate and Indian capital market*

Indrajit Roy and Dipankar Biswas
Department of Statistics and Information Management, Reserve Bank of India, Mumbai

Abstract

The paper attempts to investigate whether or not a causal relationship exists between exchange rates and stock market returns in India based on daily data covering January 1, 2006 to April 30, 2009. For analysis purpose, two stock indices (*viz.*, Sensex of Bombay Stock Exchange (BSE), S&P CNX Nifty of National Stock Exchange of India Limited (NSE)), and three exchange rates (*viz.*, Indian Rs./US dollar, Indian Rs./Euro, and Indian Rs./Yen rates) was considered. To examine the issue of causation between stock prices and exchange rates, the standard Granger causality test was performed for the reference period as well as for the calendar years 2006, 2007, 2008 and January – April of 2009. The results suggest that during the reference period as well as in all the calendar years under consideration, the NSE Nifty Granger causes to INR-USD exchange rate, INR-Yen exchange rate and BSE-SENSEX return. However, in the case of NSE Nifty and Euro exchange rate, a stable causal relationship was absent during the reference period as well as during each of the selected calendar year. In the case of EURO exchange rate and BSE Sensex, the analysis reveals significant existence of causal relation from Sensex to EURO with 4 and 5-days lag, during the full reference period, but the relation is absent for the individual calendar years 2006, 2007, and 2008.

Key words: Granger causality; Cointegration; Exchange rate; Stock prices

* The views expressed in the paper are those of the authors and not necessarily of the institution to which they belong.

1 Introduction

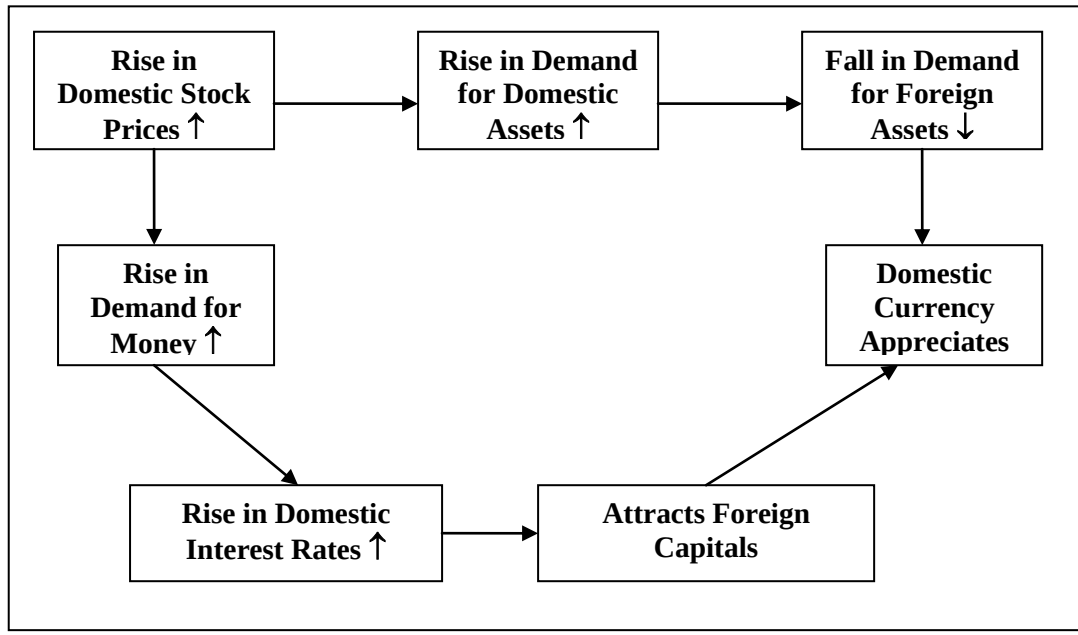
Stock market is one of the most sensitive segments of the economy and is treated as forward looking or leading indicator for the economy. The common belief is that the information on major stock market across the globe, change in the domestic benchmark interest rate as well as fluctuation in foreign exchange rate of the domestic currency has considerable influences on the domestic stock market. In this context one pertinent question is: What exactly is the relationship between stock market and exchange rate? In other words, which one influences the other? There are many empirical analysis on this particular issue and the findings of the researchers are divergent and there is no consensus on the firm relationship between stock market and exchange rate across the country and time point. This paper tries to find out the causal relationship between stock markets in India and domestic exchange rate of major world currencies using the data from January 1, 2006 to April 30, 2009. The paper is organized into five sections. Section 2 gives the literature review describing the relationship between the stock market performance and the exchange rate behaviour. It also discusses on the empirical research works and results related to this field of economic and financial studies. Section 3 gives a brief description to the methodology applied for investing the causal relationship. Data coverage and empirical analyses are provided in Section 4. Section 5 concludes.

2 Literature review

Classical economic theory suggests a relationship between the stock market performance and the exchange rate behaviour. Dornbusch and Fisher (1980) focused on the association between the current account and the exchange rate. They affirmed that currency movements affect international competitiveness and the balance of trade position, and consequently the real output of the country, which in turn affects current and future cash flows of companies and their stock prices. Movements in the stock market may also affect exchange rates. Equities, being part of wealth, may affect the behaviour of exchange rates through the demand for money according to the monetarist models of exchange rate determination (Gavin, (1989)).

There is no theoretical consensus on the relationship between stock prices and exchange rates either. The portfolio balance models of exchange rate determination postulate a negative relationship between stock prices and exchange rates and that the causation runs from stock prices to exchange rates (Diagram 1).

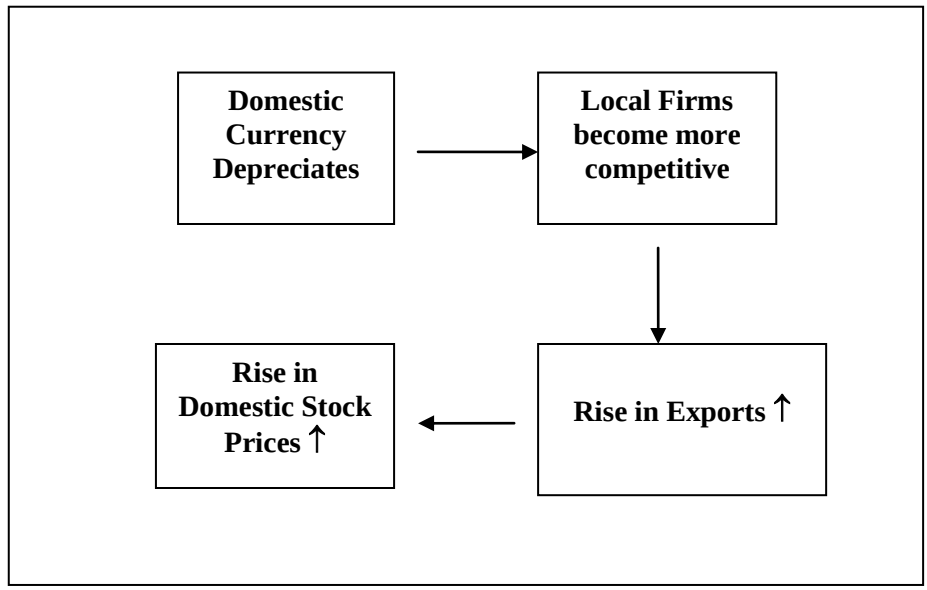
Diagram 1



In these models individuals hold domestic and foreign assets, including currencies, in their portfolio. Exchange rates play the role of balancing the demand for and supply of assets. An increase in domestic stock prices lead individuals to demand more domestic assets. To buy more domestic assets local investors would sell foreign assets (they are relatively less attractive now), causing local currency appreciation. An increase in wealth due to a rise in domestic asset prices will also lead investors to increase their demand for money, which in turn raises domestic interest rates. This again leads to appreciation of domestic currency by attracting foreign capital. Another channel for the same negative relationship is increase in foreign demand for domestic assets due to stock price increase. This would also cause a domestic currency appreciation.

In contrast, a positive relationship between stock prices and exchange rates with direction of causation running from exchange rates to stock prices can be explained (Diagram 2). Domestic currency depreciation makes local firms more competitive, leading to an increase in their exports. This in turn raises their stock prices.

Diagram 2



A weak or no association between stock prices and exchange rates can also be postulated. The asset market approach to exchange rate determination treats exchange rate to be the price of an asset. The exchange rates are determined by expected future exchange rates. Any factor that affects future values of exchange rate will affect today's exchange rate. The factor that causes changes in exchange rates may be different from the factor that causes changes in stock prices. Under such scenario, there should be no link between stock prices and exchange rates.

Most of the empirical literature that had examined the stock prices-exchange rate relationship focused on examining this relationship for the developed countries, as well as for developing countries. Some studies had found a significant positive relationship between stock prices and exchange rates (e.g., Aggarwal (1981), Solnik (1987), and Smith (1992)) while others had reported a significant negative relationship between the two (e.g., Soenen and Hennigar (1998)). There were some studies that had found very weak or no association between stock prices and exchange rates (e.g., Franck and Young (1972), Eli Bartov and Gordon M.Bodnor (1994)).

Franck and Young (1972) examined the relationship between stock prices and exchange rates by using six different exchange rates and found no relationship between these two financial variables.

Solnik (1987) examined the impact of several variables (exchange rates, interest rates and changes in inflationary expectation) on stock prices by using monthly data from nine western markets, *viz.*, U.S., Japan, Germany, U.K., France, Canada, Netherlands, Switzerland, and Belgium. He found exchange rate depreciation to have a positive but

insignificant influence on the U.S. stock market compared to change in inflationary expectation and interest rates.

Yu Qiao (1997) examined the possible interaction between daily stock price indices and spot exchange rates obtained from the financial markets of Hong Kong, Tokyo, and Singapore over the period from January 3, 1983 to June 15, 1994. His results, based on the Granger causality test, showed that the changes in stock prices were caused by changes in exchange rates in Tokyo and Hong-Kong markets. However, no such causation was found for the Singapore market. The reverse causality from stock prices to exchange rates was observed for only Tokyo market. Therefore, for Tokyo market, the existence of feedback problem was evident.

Clive W.J Granger, Bwo-Nung Huang and Chin Wei Yang (1998) examined the causality issue using Granger causality tests and impulse response function for nine Asian countries, *viz.*, Hong Kong, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore, Thailand and Taiwan. They used daily data for the period January 3, 1986 to November 14, 1997. For Japan and Thailand they found that exchange rates led stock prices with positive correlation. The data from Taiwan suggested that stock prices led exchange rates with negative correlation. Data from Indonesia, Korea, Malaysia, and the Philippines indicated strong feedback relations while that of Singapore failed to reveal any recognizable pattern.

Nath and Samanta (2003) examined the causal relationship between returns in stock market and forign exchange market in India. They used daily data from March 1993 to December 2002. They found absence of causal link during this period.

3 Methodology

3.1 Unit root test

A series is said to be (weakly or covariance) *stationary* if the mean and autocovariances of the series do not depend on time. A difference stationary series is said to be *integrated* and is denoted as I(d) where 'd' is the order of integration. The order of integration is the number of uni-t roots contained in the series, or the number of differencing operations it takes to make the series stationary. For a random walk series, there is one unit root, and hence, it is an I(1) series. Similarly, a stationary series is I(0). Standard inference procedures do not apply to regressions which contain an integrated dependent variable or integrated regressors. Therefore, it is important to check whether a series is stationary or not before using it in a regression. The formal method to test the stationarity of a series is the unit root test. A unit-root test is often necessary before empirical studies. Based on the result by Dickey and Fuller (1979), the Augmented Dickey and Fuller (ADF) test was generally employed as shown below:

$$\Delta y_t = \alpha + \beta t + (\rho - 1) y_{t-1} + \sum_{i=1}^{k-1} \theta_i \Delta y_{t-i} + a_t$$

where, $\Delta = 1 - L$, y_t is a macroeconomic variable such as exchange rate or stock price; t is a trend variable; a_t is a white noise term. The null hypothesis is H_0: $\rho = 1$, and y_t *is* said to possess the unit root property if one fails to reject H_0.

3.2 Granger causality

In order to analyze the relationship between exchange rates and stock indices, this paper focuses on causality among these variables using the method developed by Granger (1969). Granger causality test is a technique for determining whether one time series is useful in forecasting another. Ordinarily, regressions reflect "mere" correlations, but Clive Granger argued that, there is an interpretation of a set of tests as revealing something about causality. Since this method is used in a number of economic studies, only brief explanations of this method is explained below.

Let X_t and Y_t be two stationary time series with zero means. The simple causal model is

$$X_t = \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t ,$$

$$Y_t = \sum_{j=1}^{m} c_j X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-j} + \eta_t ,$$

where, ε_t, η_t are taken to be two uncorrelated white-noise series, i.e., $E[\varepsilon_t \varepsilon_s] = 0, E[\eta_t \eta_s] = 0, s \neq t$, and $E[\varepsilon_t \varepsilon_s] = 0, \forall t, s$. Here, *'m'* can equal infinity but in practice, of course, due to the finite length of the available data, *'m'* will be assumed finite and shorter than the given time series. Y_t is causing X_t provided some b_j is not zero. Similarly X_t is causing Y_t if some c_i is not zero. If both of these events occur, there is said to be a feedback relationship between X_t and Y_t.

The more general model with instantaneous causality is

$$X_t + b_0 Y_t = \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t ,$$

$$Y_t + c_0 X_t = \sum_{j=1}^{m} c_j X_{t-j} + \sum_{j=1}^{m} d_j Y_{t-j} + \eta_t .$$

If the variables are such that this kind of representation is needed, then instantaneous causality is occurring and knowledge of Y_t will improve the "prediction" or goodness of fit of the first equation for X_t.

4 Empirical analysis

To examine whether stock prices and exchange rates are related, using data from India, we consider two stock indices (*viz.*, Sensex of Bombay Stock Exchange (BSE), S&P CNX Nifty of National Stock Exchange of India Limited (NSE)), and three exchange rates (*viz.*, Indian Rs./US dollar, Indian Rs./Euro, and Indian Rs./Yen rates). The study uses daily data for the period (henceforth, termed as 'reference period') from January 1, 2006 to April 30, 2009. Chart 1 presents the movements of Stock prices *vis-à-vis* selected exchange rates, during the reference period.

During the reference period, both stock prices (BSE and NSE) and US Dollar exchange rate had exhibit opposite movement (with correlation coefficient -0.87). From January 2006 to January 2008, BSE Sensex increased from the level of 9,500 to almost 21,000, before falling down to nearly 8,300 during mid-march 2009. On the other hand, the Rs./USD exchange rate declined from Rs. 44.8 in January 2006 to below Rs. 40.0 in mid-January 2008, and thereafter, it started increasing and reached at the level of Rs. 51.0 during March 2009 (Chart 1). However, it should be mentioned that, BSE Sensex and NSE Nifty exhibit the same movement with correlation coefficient 0.99 (Table 1).

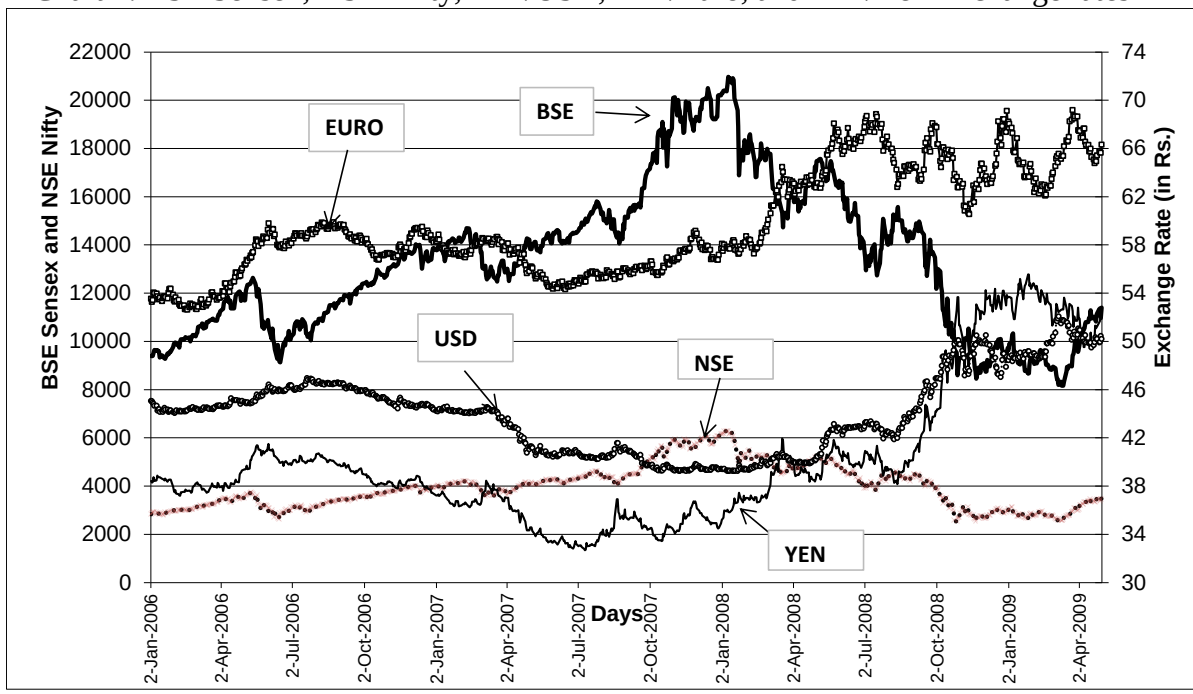
It is also observed that, during the reference period, the movement of Euro exchange rate was not similar to that of US Dollar, having values within the band of Rs. 49.9 and Rs. 69.2 with considerable volatility for at least two months.

Table 1: Stock Indices and Exchange Rates – Correlation Coefficients and Standard deviations

Stock Index / Exchange Rate	Correlation Coefficient					Standard Deviation
	NSE S&P Nifty	BSE SENSEX	EURO	YEN	US DOLLAR	
NSE S&P Nifty	---	0.99	-0.12	-0.61	-0.86	901.8
BSE SENSEX		---	-0.15	-0.65	-0.87	3090.2
EURO			---	0.70	0.44	4.3
YEN				---	0.84	5.9
US DOLLAR					---	3.3

In the case of Yen, the movement, almost similar to that of US Dollar, was observed during the reference period. However, after a sharp decline from Rs. 41.0 in June 2006 to Rs. 33.0 in mid-July 2007, the Yen exchange rate started rising, and reached at the level of Rs. 55.0 during January 2009.

Chart 1: BSE Sensex, NSE Nifty, INR/USD, INR/Euro, and INR/Yen Exchange rates



4.1 Unit Root Test

Prior to testing for cointegration, the Augmented Dickey-Fuller (ADF) test with Schwartz Information criterion is performed on the BSE Sensex, NSE Nifty and the exchange rate series to determine the order of integration of these series. In this case, the logarithmic transformation of all the series is considered. The performance of the test was based on with and without a deterministic trend. It is observed that, the deterministic trend has no significant impact for generating a stationary series. Table 2 reveals that the null hypothesis of a unit root in the level series cannot be rejected in the stock prices as well as in the exchange rates. The presence of unit root in the first difference of stock price indices (NSE and BSE) and exchange rates series (US Dollar, Euro and Yen) is rejected, implying that, these series are integrated to order 1, i.e., I(1). Charts A1 to A5 in Annex presents the stationary movements of log-difference values of BSE Sensex, NSE Nifty, Rs./US dollar, Rs./Euro, and Rs./Yen exchange rates.

Table 2: Unit root test results

Series Name	Lag	ADF Test Statistic	p-value
Log(BSE)	1	0.30	0.77
Log(NSE)	0	0.29	0.77
Log(USD)	0	0.76	0.88
Log(EURO)	0	1.07	0.93
Log(YEN)	0	1.06	0.92
ΔLog(BSE)	0	-32.33**	0.00
ΔLog(NSE)	0	-28.43**	0.00
ΔLog(USD)	0	-29.42**	0.00
ΔLog(EURO)	0	-30.40**	0.00
ΔLog(YEN)	0	-30.20**	0.00

** implies significance at 1 per cent level.

4.2 Cointegration test – results

On the basis of unit root tests, reported in Section 4.1, the Johansen's maximum likelihood approach is applied to examine the long-run relationship between stock prices and exchange rates. This approach uses a maximum likelihood procedure that tests for the number of cointegration relationships and estimates the parameters of those cointegrating relationships.

Table 3: Unrestricted cointegration rank test (trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value (at 5% level)	Prob.**
Log(BSE) ~ Log(USD)				
None	0.00182	2.54	12.32	0.90
At most 1	0.00111	0.96	4.13	0.38
Log(BSE) ~ Log(EURO)				
None	0.00365	3.38	12.32	0.80
At most 1	0.00024	0.21	4.13	0.70
Log(BSE) ~ Log(YEN)				
None	0.00302	2.78	12.32	0.87
At most 1	0.00017	0.15	4.13	0.75
Log(NSE) ~ Log(USD)				
None	0.00176	2.64	12.32	0.89
At most 1	0.00128	1.11	4.13	0.34
Log(NSE) ~ Log(EURO)				
None	0.00361	3.37	12.32	0.80
At most 1	0.00026	0.23	4.13	0.69
Log(NSE) ~ Log(YEN)				
None	0.00315	3.09	12.32	0.84
At most 1	0.00040	0.35	4.13	0.62

Trace test indicates no cointegration at the 0.05 level

**MacKinnon-Haug-Michelis (1999) *p*-values

Table 3 reveals that there is no cointegrating vector between stock prices and exchange rates, and hence, no long-run equilibrium relationship exists between these two series. It also affirms that, no error correction term will be included in the Granger causality test equation.

4.3 Causality test

To examine the issue of causation between stock prices and exchange rates, the standard Granger causality test is performed for up to 5-days lag (Table 4). Nath and Samanta (2003) experimented with a maximum lag of 5- days from the consideration that there are 5 trading days in a week and they hoped that 5 days period would be adequate to get effects of one market to another under the assumption of substantial informational efficiency. This paper also considers the same assumption and perform causality test with a maximum lag of 5- days.

4.3.1 Granger causality test (NSE Nifty vs. Exchange rates) – results

In order to find the causal relationship between NSE Nifty and selected exchange rates, the Granger causality test was performed for the reference period as well as for the calendar year. During the reference period as well as in all the calendar years under consideration, the NSE Nifty Granger causes to USD exchange rate with up to 5-days lag. Moreover, the rejection of hypothesis of non-causality from USD to NSE Nifty at 5 per cent level, with up to 3-days lag, during the reference period, may give perception to the existence of feedback system. However, this may not true if we look at the results of the causality test performed in each selected calendar year (Table 4).

In the case of NSE Nifty and Euro exchange rate, a stable causal relationship was absent during the reference period as well as during each of the selected calendar year. Moreover, over the reference period, the feedback problem was noticed, but we ignore this case due to the absence of strong bi-directional causality in each of the calendar years.

During the whole reference period as well as in calendar year 2007, 2008 and 2009 the strong causal relation was observed from NSE Nifty to Yen exchange rate (with 1 per cent level of significant and up to 5 days lag). However, the same relation was not noticed in 2006. It may also be noted from the result that, in 2006, the null hypothesis of non-causality from Yen exchange rate to NSE Nifty was rejected at 1 per cent level of significance and with 5-days lag. In the other calendar years as well as during the reference period, no such causal relation was noticed.

Table 4: Granger Causality Test (NSE Nifty vs. Exchange Rates)

Period	Null Hypothesis (H_0)	Significant level of F-statistic				
		Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
January 1, 2006 to April 30, 2009	ΔLog(USD) ≠> ΔLog(NSE)	*	*	*		
	ΔLog(NSE) ≠> ΔLog(USD)	**	**	**	**	**
	ΔLog(EURO) ≠> ΔLog(NSE)		*	*		
	ΔLog(NSE) ≠> ΔLog(EURO)		*			*
	ΔLog(YEN) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(YEN)	**	**	**	**	**
January 1, 2006 to December 31, 2006	ΔLog(USD) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(USD)	**	**	**	**	**
	ΔLog(EURO) ≠> ΔLog(NSE)					**
	ΔLog(NSE) ≠> ΔLog(EURO)					
	ΔLog(YEN) ≠> ΔLog(NSE)					**
	ΔLog(NSE) ≠> ΔLog(YEN)					
January 1, 2007 to December 31, 2007	ΔLog(USD) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(USD)	**	**	**	**	**
	ΔLog(EURO) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(EURO)		*			
	ΔLog(YEN) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(YEN)	**	**	**	**	**
January 1, 2008 to December 31, 2008	ΔLog(USD) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(USD)	**	**	**	**	**
	ΔLog(EURO) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(EURO)	*	*			
	ΔLog(YEN) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(YEN)	**	**	**	**	**
January 1, 2009 to April 30, 2009	ΔLog(USD) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(USD)	**	**	*	**	*
	ΔLog(EURO) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(EURO)	*		**	*	**
	ΔLog(YEN) ≠> ΔLog(NSE)					
	ΔLog(NSE) ≠> ΔLog(YEN)	**	**	**	*	*

* Significance at 5 per cent level. ** Significance at 1 per cent level.

Note: The symbol ≠> means 'does not Granger cause'

4.3.2 Granger causality test (BSE Sensex vs. Exchange rates) – results

The similar causality test was also performed between BSE Sensex and exchange rates for the reference period as well as for the calendar years. The causal relation of BSE Sensex with exchange rates was different from the relation, which was observed in the case of NSE Nifty and exchange rates. During the reference period, the USD exchange rate granger causes significantly (i.e., at 1 per cent level) to the BSE Sensex. The rejection of null hypothesis (H_0) that, BSE Sensex does not cause USD exchange rate, at 5 per cent level, implies the existence of feedback problem with 1-day lag period. Further, the analysis for causal relation within a year produces mixed results. During the calendar year 2006, the significant causal relation from USD to BSE was observed up to 5-days lag period. Similar case was also noticed during 2008. In contrast, no significant causal relation was observed in 2007 and 2009 (January – April period). Therefore, the result is inconclusive (Table 5).

In the case of EURO exchange rate and BSE Sensex, the analysis reveals significant existence of causal relation from Sensex to EURO with 4 and 5-days lag, during the full reference period. However, the above causal relation is absent for the individual calendar years 2006, 2007, and 2008.

The similar causal relationship was observed in the case of BSE Sensex and Yen exchange rate. During the reference period, the Granger causality test rejected the null hypothesis (H_0): "Yen exchange rate does not cause BSE Sensex", at 1 per cent level of significance with up to 5-days lag and at 5 per cent level with 4 and 5 days lag. However, the causal relationship was unstable as the same relationship was not evident in 2006, 2007 and 2009.

Table 5: Granger Causality Test (BSE Sensex vs. Exchange Rates)

Period	Null Hypothesis (H_0)	Significant level of F-statistic				
		Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
January 1, 2006 to April 30, 2009	ΔLog(USD) ≠> ΔLog(BSE)	**	**	**	**	**
	ΔLog(BSE) ≠> ΔLog(USD)	*				
	ΔLog(EURO) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(EURO)				**	**
	ΔLog(YEN) ≠> ΔLog(BSE)	**	**	**	*	*
	ΔLog(BSE) ≠> ΔLog(YEN)					
January 1, 2006 to December 31, 2006	ΔLog(USD) ≠> ΔLog(BSE)	**	**	*	*	*
	ΔLog(BSE) ≠> ΔLog(USD)					
	ΔLog(EURO) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(EURO)					
	ΔLog(YEN) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(YEN)					*
January 1, 2007 to December 31, 2007	ΔLog(USD) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(USD)					
	ΔLog(EURO) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(EURO)					
	ΔLog(YEN) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(YEN)		*			
January 1, 2008 to December 31, 2008	ΔLog(USD) ≠> ΔLog(BSE)	**	**	**	**	*
	ΔLog(BSE) ≠> ΔLog(USD)					
	ΔLog(EURO) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(EURO)					
	ΔLog(YEN) ≠> ΔLog(BSE)	**	**	**	**	*
	ΔLog(BSE) ≠> ΔLog(YEN)					
January 1, 2009 to April 30, 2009	ΔLog(USD) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(USD)					
	ΔLog(EURO) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(EURO)		*	*		**
	ΔLog(YEN) ≠> ΔLog(BSE)					
	ΔLog(BSE) ≠> ΔLog(YEN)					

* Significance at 5 per cent level. ** Significance at 1 per cent level.

Note: The symbol ≠> means 'does not Granger cause'

4.3.3 Granger causality test (BSE Sensex vs. NSE Nifty) – results

Besides the investigation of causal relationship between stock prices and exchange rates, we also tried to find out some dynamic relation between BSE Sensex and NSE Nifty. During the reference period as well as in each of the selected years, a strong causal relation from NSE Nifty to BSE Sensex was observed. In each of the cases, the null hypothesis of non-causality was rejected at 1 per cent level for up to 5-days lag. Although the result shows existence of feedback problem, during the reference period, with 3 to 5-days lag, the same was not observed in 2006, 2008 and January 1, 2009 to April 30, 2009 period (Table 6).

Table 6: Granger causality test (BSE Sensex vs. NSE Nifty)

Period	Null Hypothesis	Significant level of F-statistic				
		Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
January 1, 2006 to April 30, 2009	ΔLog(NSE) ≠> ΔLog(BSE)	**	**	**	**	**
	ΔLog(BSE) ≠> ΔLog(NSE)			*	*	*
January 1, 2006 to December 31, 2006	ΔLog(NSE) ≠> ΔLog(BSE)		**	**	**	**
	ΔLog(BSE) ≠> ΔLog(NSE)					
January 1, 2007 to December 31, 2007	ΔLog(NSE) ≠> ΔLog(BSE)	**	**	**	**	**
	ΔLog(BSE) ≠> ΔLog(NSE)				**	**
January 1, 2008 to December 31, 2008	ΔLog(NSE) ≠> ΔLog(BSE)	**	**	**	**	**
	ΔLog(BSE) ≠> ΔLog(NSE)					
January 1, 2009 to April 30, 2009	ΔLog(NSE) ≠> ΔLog(BSE)	**	**	**	**	**
	ΔLog(BSE) ≠> ΔLog(NSE)					

* Significance at 5 per cent level. ** Significance at 1 per cent level.

Note: The symbol ≠> means 'does not Granger cause'

5 Conclusion

The objective of this paper is to investigate empirical relationship between stock markets in India and domestic exchange rate of major world currencies using the data from January 1, 2006 to April 30, 2009. For analysis purpose, two stock indices (*viz.*, Sensex of Bombay Stock Exchange (BSE), S&P CNX Nifty of National Stock Exchange of India Limited (NSE)), and three exchange rates (*viz.*, Indian Rs./US dollar, Indian Rs./Euro, and Indian Rs./Yen rates) was considered. ADF test results identified all these series as I(1) series and Johansen's cointegration technique revealed non-existence of long-run stable relationship between stock indices and exchange rates.

To examine the issue of causation between stock prices and exchange rates, the standard Granger causality test was performed for up to 5-days lag, based on the

assumption that, due to the existence of substantial informational efficiency in the market, 5 days period would be adequate to get effects of one market to another. The Granger causality test was performed for the reference period as well as for the calendar years 2006, 2007, 2008 and January – April of 2009. The results are summarized as under:

a. Stock Market indices and USD Exchange rate:
During the reference period as well as in all the calendar years under consideration, the NSE Nifty Granger causes to USD exchange rate with up to 5-days lag. However, no stable causal relationship was observed between BSE Sensex and USD exchange rate.

b. Stock Market indices and EURO Exchange rate:
In the case of NSE Nifty and Euro exchange rate, a stable causal relationship was absent during the reference period as well as during each of the selected calendar year. In the case of EURO exchange rate and BSE Sensex, the analysis reveals significant existence of causal relation from Sensex to EURO with 4 and 5-days lag, during the full reference period, but the relation is absent for the individual calendar years 2006, 2007, and 2008.

c. Stock Market indices and YEN Exchange rate:
During the reference period as well as in all the calendar years under consideration, the NSE Nifty Granger causes to YEN exchange rate (except in 2006). However, except in 2008, no stable causal relationship was observed from YEN exchange rate to BSE Sensex.

d. NSE Nifty and BSE Sensex:
During the reference period as well as in each of the selected years, a strong causal relation from NSE Nifty to BSE Sensex was observed.

However, further exploration is needed to identify the existence of a generic causal relationship between stock prices and exchange rate.

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Indrajit Roy
Department of Statistics and Information Management,
Reserve Bank of India,
C-8, Bandra-Kurla Complex,
Bandra(E), Mumbai – 400051.
Email*: iroy@rbi.org.in*

Dipankar Biswas
Department of Statistics and Information Management,
Reserve Bank of India,
C-8, Bandra-Kurla Complex,
Bandra(E), Mumbai – 400051.
E-mail: *dbiswas@rbi.org.in*

ANNEXURE

Chart A1: Movement of Δ(Log(BSE))

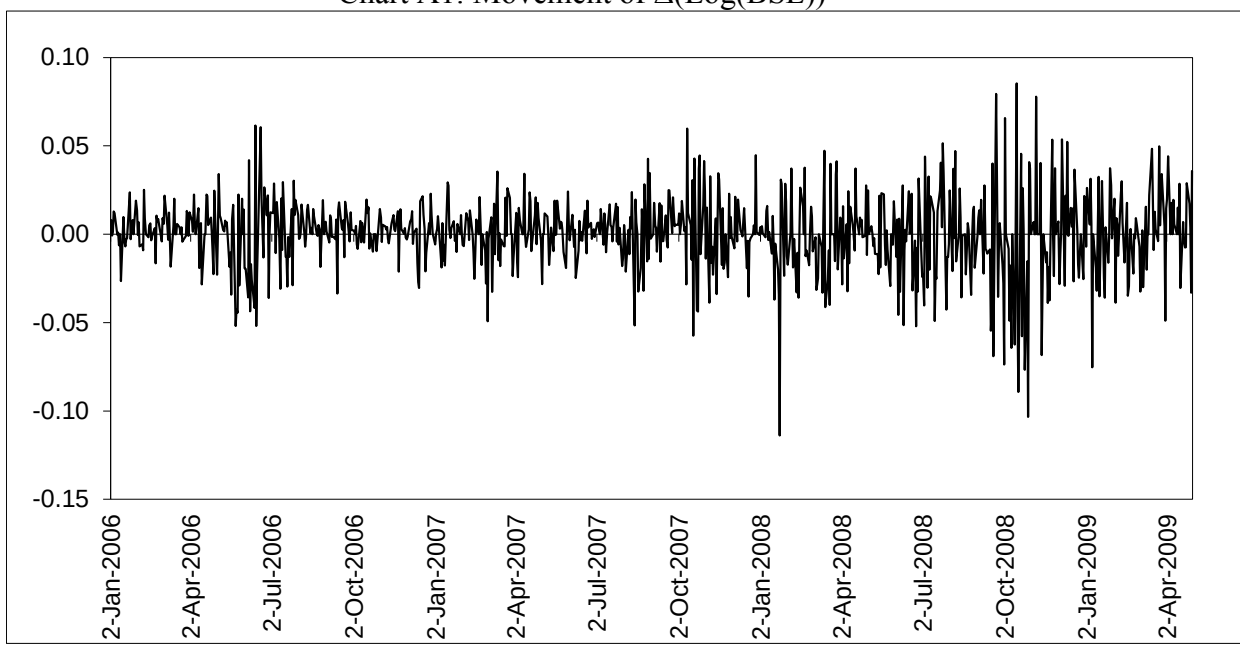

Chart A2: Movement of Δ(Log(NSE))

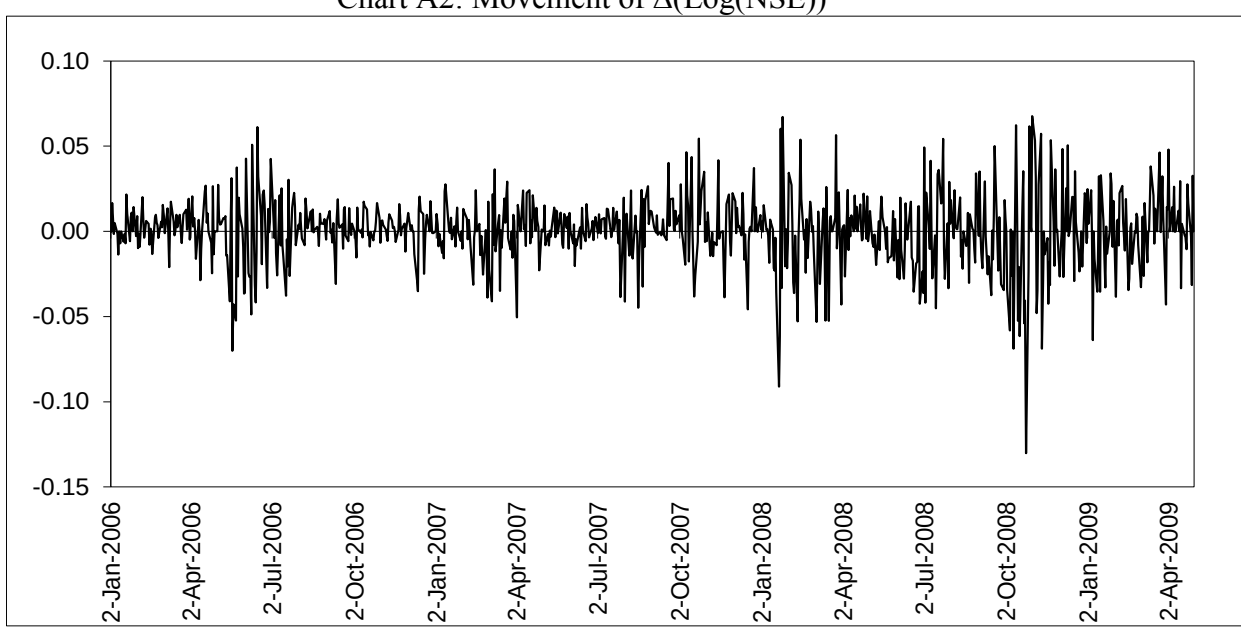

Chart A3: Movement of Δ(Log(EURO))

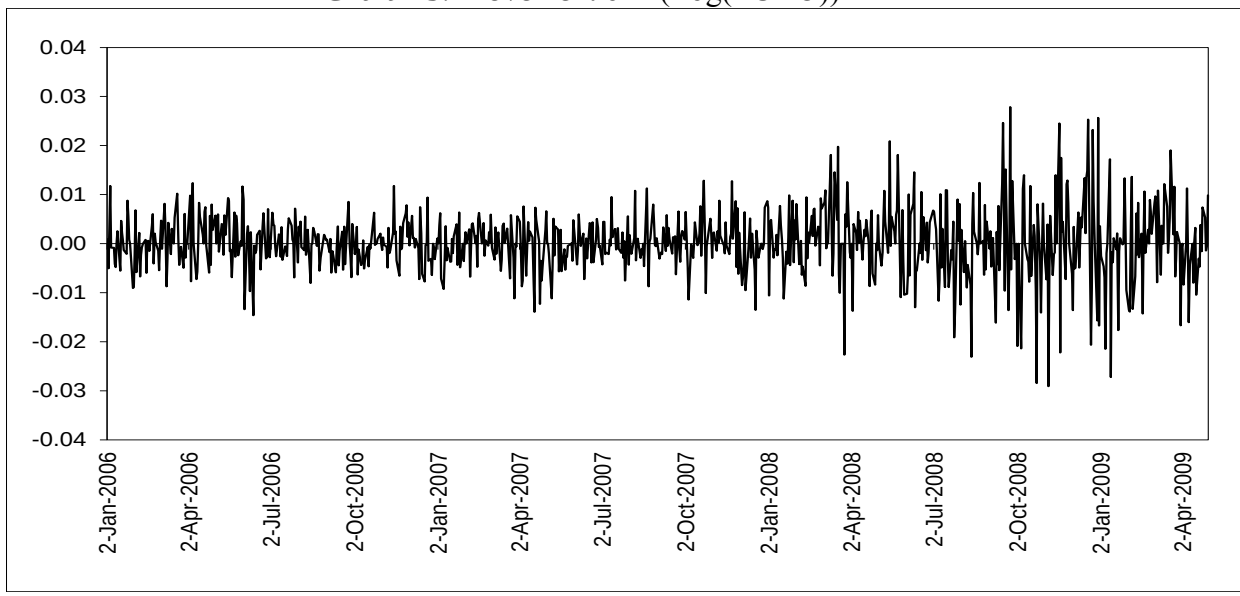

Chart A4: Movement of Δ(Log(YEN))

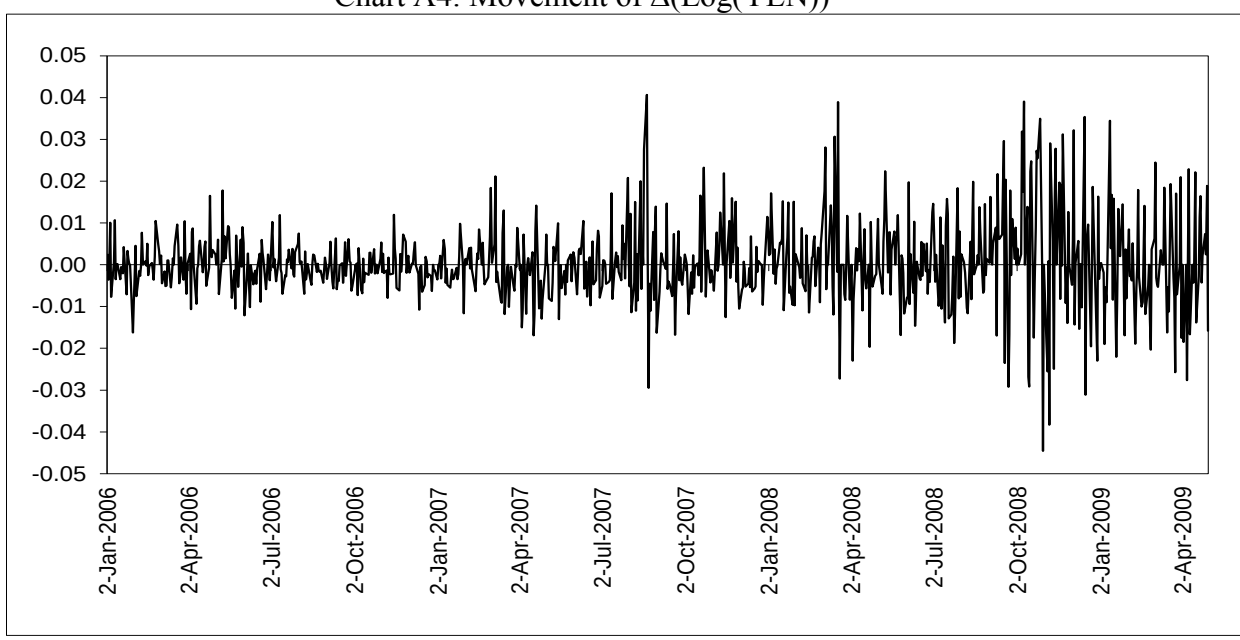

Chart A5: Movement of Δ(Log(USD))