EMPIRICAL INVESTIGATION OF RELATIONSHIP BETWEEN STOCK MARKET AND FOREIGN EXCHANGE RATE: A STUDY OF INDIA

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ABSTRACT

*The paper attempts to analyze long-term relationships among Indian stock market and foreign exchange rate (INR/USD) using the Johansen and Juselius multivariate cointegration approach. We use daily data of Sensex of BSE and foreign exchange rate during Jan 2010 to June 2014. Short-run dynamics are captured through vector error correction models. The analysis reveals that the markets here do not share a long term common trend.*VECM model indicates the presence of short term relationship between the series. *The results reveal that the speed of adjustment of Sensex of BSE is higher.*

1. Introduction

The issue of stock market integration and comovements of stock prices and exchange rate across economies has received considerable attention in economic literature. Integration is the process by which markets become open and unified so that participants in one market have an unimpeded access to other markets. The financial market's integration in general implies that in absence of administrative and informational barriers, risk adjusted returns on assets of the same tenor in each segment of the market should be comparable to one another.

Recent globalization and free movements of capital across boundaries of nation have ushered in a sea change in the financial architecture of the economy. Since the inception of the financial sector reforms in the beginning of 1990's, the implementation of various reform measures including a number of structural and institutional changes in the different segments of the financial markets, particularly since 1997, have brought in a dramatic change in the functioning of the financial sector of the economy (Bhattacharya and Mukharajee, 2005).

With the financial sector reforms initiated in 1991, not only FIIs and NRIs are allowed to invest in Indian stock markets, Indian corporate have been allowed to tap the global market with global depository receipts (GDR), American depository receipts (ADR) and foreign currency convertible bonds (FCCB) since 1993. All these changes have led to substantial improvement in market capitalization, liquidity and efficiency of the Indian capital market.

The deregulation and market liberalization measures and the increasing activities of multinational companies have accelerated the growth of Indian stock market. The analysis on stock markets has come to the fore since this is the most sensitive segment of the economy and it is through this segment that he country's exposure to the outer world is most readily felt. The present study is an endeavour in this direction. It analyses the relationship between stock prices and foreign exchange rate of India. The study uses Johansen cointegration and vector error correction model to examine the relationship.

Aggarwal (1981) detected a significant positive correlation between the US dollar and US stock prices.whileSoenen and Hennigan (1988) found a statistically significant negative relationship. Soenen and Aggarwal (1989) found mixed results among industrial countries. 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.

Bhattachrya and Mukharajee(2008) examined the nature of the causal relationship between stock prices and macroeconomic aggregates like exchange rate, foreign exchange reserve and value of trade trade balances. They tested the causal relationship using unit root tests, cointegration and long run granger causality tests using monthly data for the period 1990-91 to 2000-01. The results indicated that there was linkages between stock markets and the three variables.

Bahmani-Oskooee and Sohrabian (1992) point out that there is a two-way relationship between the U.S. stock market and the exchange rates.AbhayPethe and AjitKarnik (2000) has investigated the inter relationships between stock prices and important macroeconomic variables, viz., exchange rate of rupee vis - a - vis the dollar, prime lending rate, narrow money supply, and index of industrial production. The study found some relationship between them.Nath and Samanha (2003) examined the relationship between exchange rate and stock prices for india using daily closing price data of S&P CNX Nifty and exchange rate (expressed Indian Rupee per U S Dollar) from March 1993 to December 2002. The study found that the two markets are not interrelated.

The purpose of the paper is to investigate the nature of relationship between stock market and foreign exchange rate(INR/USD) of India.

The organization of the paper is as follows. Section 2 discusses research design.Results are presented in section 3. Section 4 summarizes.

2. Research Design

2.1 Sample and Period of study

The study uses data on daily closing price of Sensex of India, Shanghai Stock exchange of China, Henseng of Hongkong and Nikkei of Japan starting from 1st January 2010 to 1stJune, 2014. Many changes took place during the period like introduction of rolling settlement, transactions in futures and options, the bull run and the highs in the indices, increased FII inflows across the world stock markets, gradual lifting of restrictions on capital flows and relaxation of exchange controls in many countries etc. These changes might have influenced the degree of comovement among the stock markets. It will be instructive to examine the cointegration of the stock markets.

2.2 Methodology

Daily returns are identified as the difference in the natural logarithm of the closing index value for the two consecutive trading days. It can be presented as:

$$R_t = \log(P_t / P_{t-1}) \text{ or } R_t = \log(P_t) - \log(P_{t-1}) \qquad \textbf{Equation 1}$$

Where R_t is logarithmic daily return at time t. P_{t-1} and P_t are daily prices of an asset at two successive days, t-1 and t respectively.

2.2.1 Unit root test

Augmented Dickey-Fuller (ADF) test is employed to test the validity of market integration hypothesis. A unit root test is a statistical test for the proposition that in an autoregressive statistical model of a time series, the autoregressive parameter is one. It is a test for detecting the presence of stationarity in the series. The early and pioneering work on testing for a unit root in time series was done by Dickey and Fuller (Dickey and Fuller 1979 and 1981). If the variables in the regression model are not stationary, then it can be shown that the standard assumptions for asymptotic analysis will not be valid. In other words, the usual "t-ratios" will not follow a t-distribution; hence they are inappropriate to undertake hypothesis tests about the regression parameters.

Stationarity time series is one whose mean, variance and covariance are unchanged by time shift. Nonstationary time series have time varying mean or variance or both. If a time series is nonstationary, we can study its behaviour only for a time period under consideration. It is not possible to generalize it to other time periods. It is, therefore, not useful for forecasting purpose.

The presence of unit root in a time series is tested with the help of Augmented Dickey-Fuller Test. It tests for a unit root in the univariate representation of time series. For a return series R_t, the ADF test consists of a regression of the first difference of the series against the series lagged k times as follows:

$$\Delta r_t = \alpha + \delta r_{t-1} + \sum_{i=1}^{p} \beta_i \Delta r_{t-i} + \varepsilon_t$$

Equation 2

$$\Delta r_t = r_t - r_{t-1}; r_t = \ln(R_t)$$

The null hypothesis is H0: $\delta = 0$ and H1: $\delta < 1$. The acceptance of null hypothesis implies nonstationarity.

We can transform the nonstationary time series to stationary time series either by differencing or by detrending. The transformation depends upon whether the series are difference stationary or trend stationary.

2.2.2 Co-integration Test

The purpose of the co-integration test is to determine whether a group of nonstationary series is co-integrated or not. The presence of cointegrating relation forms the basis of the Vector Error Correction (VEC) model specification. The test for the presence of cointegration is performed when all the variables are non-stationary and integrated of the same order. Cointegration exists for variables means despite variables are individually nonstationary, a linear combination of two or more time series can be stationary and there is a long-run equilibrium relationship between these variables. In the present study, we use method proposed by Johansen (1991). This method can be explained by considering the following general autoregressive representation for the vector Y.

$$Y_t = A_0 + \sum_{j=1}^{p} A_j Y_{t-j} + \varepsilon_t$$

Equation 3

where Y_t is a nx1 vector of nonstationary variables, A is a nx1 vector of constants, p is the number of lags, A_j is nxn matrix of coefficients and ε is assumed to be a nx1 vector of Gaussian error terms.

In order to use Johansen's test, the above vector autoregressive process can be reparametrized and turned into a vector error correction model of the form:

$$\Delta Y_t = A_0 + \sum_{j=1}^{p=1} \Gamma_j \Delta Y_{t-j} + \Pi Y_{t-p} + \varepsilon_t$$

Equation 4

where

$$\Gamma_j = -\sum_{i=j+1}^{p} A_j \quad \text{and} \quad \Pi = -I + \sum_{i=j+1}^{p} A_j$$

Equation 5

Δ is the difference operator and I is nxn identity matrix.

The issue of potential cointegration is investigated when we compare the both sides of equation 4. As Y_t is integrated of order 1 i.e. I(1), ΔY_t is I(0), so are ΔY_{t-j}. This implies that left-hand side of equation 4 is stationary since ΔY_{t-j} is stationary; the right hand side of equation 4 will also stationary ΠY_{t-p} is stationary. The Johansen test centres on an examination of the $\prod$ matrix. The $\prod$ can be interpreted as a long run coefficient matrix. The test for cointegration between the Y's is calculated by looking at the rank of the $\prod$ matrix via eigenvalues. The rank of the matrix is equal to the number of its characteristic roots (eigenvalues) that are different from zero. The information on coefficient matrix between the levels of the $\prod$ is decomposed as $\prod = \alpha\beta$, where the relevant elements, the α matrix are adjustment coefficients and β matrix contains the cointegrating vectors.

There are two test statistics for cointegration under the Johansen method to test for number of characteristic roots. There are trace and the maximum eigenvalues test:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} \ln(1-\hat{\lambda})$$

Equation 6

and

$$\lambda_{\max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1})$$

Equation 7

where $\hat{\lambda}$ is the estimated values of the characteristic roots obtained from the estimated $\prod$ matrix, T is the number of usable observations and r is the number of cointegrating vectors.

The trace test statistics, test the null hypothesis that the number of distinct cointegration vectors is less than or equal to r against the alternative hypothesis of more than r cointegrating relationships. From the above, it is clear that λ_{trace} equals zero when all $\hat{\lambda}$ =0.

The maximum eigenvalue statistics test the null hypothesis that the number of cointegrating vectors is less than or equal to r against the alternative of r+1 cointegrating vectors.

Johansen and Juselius (1990) provided critical values for the two statistics. If the test statistics is greater than the critical value from Johansen's table, reject the null hypothesis in favour of the alternative hypothesis discussed above. It may be possible that though series do not share long term common trend but there may be short term relationship which can be examined through VECM.

2.2.3 Short-run dynamics of the system

Short run dynamics of the system is examined through error correction model. The discussion on the model is given in the following section.

2.2.3.1 Error Correction Model

If variables are nonstationary and are cointegrated, the adequate method to capture short run dynamics is Vector Error Correction Models (VECMs). It examines the responses of a variable to changes and innovations in other variables and the adjustments that it takes to correct for any deviations from the long-run equilibrium relationship. Under cointegration, the VECM can be written as:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + A_t + \varepsilon_t$$

Equation 8

where α is the matrix of adjustment or feedback coefficients, which measures how strongly deviations from equilibrium, the r stationary variables $\beta' Y_{t-1}$, feedback into the system. If there are $0<r<p$ cointegrating vectors, then some of the elements must be non zero.

3. Results and Discussion

A prerequisite for testing cointegration between the stock indices is the all variables are non-stationary. The first phase in the estimation process is deciding the order of integration of the individual price index series in natural log levels. The log of the time series denoted as LSensexand Ler are tested for unit roots using the Augmented Dickey-Fuller (ADF) test using lag structure indicated by Schwarz Bayesian Information Criterion (SBIC). The results of the Augmented Dickey Fuller test for unit root test are given in Table 1. It shows that all the variables are non-stationary at their log level. However, they are stationary at their first difference and are integrated of order one as the actual values reported in the Table 1 exceed MacKinnon 's critical values of -3.43, -2.86 and -2.56 at 1%, 5% and 10% levels respectively. Thus, all the series under investigation are I(1). This means that all the series are individually integrated.

Table 1 Unit root test

Stock markets	Log Level	First Difference of Logarithmic series
LSensex	-2.309 (0.169)	-34.598 (0.000)
Ler	-0.558 (0.877)	-29.147 (0.000)

Johansen cointegration test is sensitive to the lag length(Enders, 2004). We employ SBC criteria to select the lag length to include in the analysis. Here, it selects the model with 12 lag.

The second phase involves an assessment on the two series for cointegration. The cointegration test is to determine whether or not the nonstationary series share a common stochastic trend. Table 2 presents the results of cointegration tests pertaining to the indices. The results reveal the presence of insignificant cointegrating relationships between the stock market indices under investigation. Both the λ_{trace} and λ_{max} test show no significant cointegrating ranks. This indicates the absence of long-run equilibrium relations between the Sensex and foreign exchange rate. In other words, by and large the series are not moving together.

Table 2 Johansen's Cointegration Test Results Five Indices

λ_{trace}				
Hypothesized		**Trace**		
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.013211	18.05609	15.49471	0.0201
At most 1	0.000020	0.023002	3.841466	0.8794
λ_{max}				
Hypothesized		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.023211	18.03309	14.26460	0.0121

At most 1 *	0.00003	0.023002	3.841466	0.8794
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

***Figure in the parenthesis are t-statistics.[1]The cointegrating vector is normalized on the NSE stock index.**

The model adequacy test of Johansen cointegration is tested using Portmanteau test for autocorrelations. The result of the test at lag length is tabulated as below:

Table 3 Portmanteau test for Autocorrelation

Lags	Q-test	Prob	Adj. Q test	Prob
15	10.17	0.75	10.26	0.74

The result suggests no residual autocorrelation after the model is fit. It implies that the model is adequate to capture the cointegration among the stock markets.

The second phase involves estimation of the error correction equations, based on cointegrated model. Table 4 represents the results of VECM. It is used to examine the short run equilibrium dynamics of the stock indices.

Table 4 Results of VECM model

Error Correction:	**D(LSensex)**	**D(LSSE)**
ECM(-1)	-0.0083	-0.00076
	[-4.100]*	[-0.8200]

***Indicates t-statistics**

The results suggest that the error correction terms or adjustment coefficients are statistically significant for Sensex.The speed of adjustment coefficients is low in magnitude. It can be seen from the Table 4 that the coefficients of error correction terms of Sensex is negative. The negative coefficients indicate that the returns of the stock markets go down when the cointegrating equation shows positive values (inverse relationship).

4. Summary

The present stud endeavored to examine the long-run equilibrium relationship among Indian Stock Market and Exchange Rate. The results demonstrate that the series do not share long term relationship. VECM model indicates the presence of short term relationship between the series. The speed of adjustment of Sensex is statistically significant suggesting that it absorbs news faster. It is, therefore, considered to be more informationally efficient.

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