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MARKET INTEGRATION OF INDIAN STOCK MARKETS: A STUDY OF NSE

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ABSTRACT
The study tries to explore the dynamics of comovement of stock markets of USA, Brazil, Mexico, China and India during the period from January, 1996 to July, 2007 using daily closing price data. The long-term relationships among the markets are analyzed using the Johansen and Juselius multivariate cointegration approach. Short-run dynamics are captured through vector error correction models. The analysis reveals that there is an evidence of cointegration among the markets demonstrating that stock prices in the countries studied here share a common trend. The results reveal that the speed of adjustment of Indian stock market is higher than other stock markets of the world.

KEYWORDS
Unit root test, Johansen's cointegration, Vector Error Correction Model.

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G14, C32

INTRODUCTION
The issue of stock market integration and comovements of stock prices 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 integrated financial market worldwide. Technological innovations have improved market integration. Careful examination of international stock market movements in recent years suggests that there exists a substantial degree of interdependence among national stock markets. It is argued that unexpected development in international stock markets seem to have become important "news" that influences domestic stock markets (Eun & Shim, 1989).

With the automation and liberalization of the Indian stock markets, there has been a perceptible change in the Indian Stock market towards the later part of the 1990s. Trading system in Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) has reached a global standard. It has created a nationwide trading system that provides equal access to all investors irrespective of geographical location. In that sense, technology has brought about equality among the investors across the country. The stock markets introduced the best possible systems; practiced in advanced stock markets like electronic trading system, rolling settlement in place of the account period settlement, increase in trading hour, dematerialization of shares and introduction of derivates etc. The focus on the external sector has prompted many Indian companies, especially those in the area of information technology, to list at the US stock exchanges. With the introduction of advanced practices, transparency has also increased in the stock market. Further, among the significant measures of opening up of capital market, portfolio investment by foreign institutional investors (FIIs) such as pension funds, mutual funds, investment trusts, asset management companies have made the turning point for the Indian stock markets. 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. Thus, given the newfound interest in the Indian stock markets during liberalization period, it is interesting to know integration of Indian stock markets. The financial markets, especially the stock markets, for developing and developed markets have now become increasingly integrated despite the uniqueness of the specific market and country profile. This has happened specifically due to financial liberalization adopted by most of the countries around the world, technological advancement in communications and trading systems, introduction of innovative financial products and creating more opportunities for international portfolio investments. This has intensified the curiosity in exploring international market linkages.

Eun and Shin (1989) detected the presence of substantial amount of interdependence among national stock markets of USA, UK, Canada, Germany, Australia, France, Japan, Switzerland and Hongkong. Using daily closing price data during the period January 1980 through December 1985, the study found a substantial amount of multi-lateral interactions among the national stock markets. The analysis indicated that innovations in the U.S. were rapidly transmitted to other markets in a clearly recognizable fashion, whereas no single foreign market can significantly explain the U.S. market movements.

Over the past 40 years, stock market prices have been analyzed using different methods and data sets by investors and researchers with an objective to determine the forecastability of price changes. Chung and Ng (1991) have shown that developments in the U.S. market have significant influence on return of Tokyo stock market on the next day, but Tokyo stock market of Japan does not influence the returns of U.S. market. Given the U.S.'s dominant economic and political strength in the world market, this finding does not seem surprising. However, the recent leading role of other stock markets of the world and their interactive participation in the U.S. may possibly signal a reversal of the widely-held notion that the spillover stock market effect is solely from the U.S. to other stock markets.

Bhattacharya and Samantha (2001) investigated the extent to which news on NASDAQ helped price formation at the beginning and at the end of a trading day at the Indian bourses using daily data of stock price indices from January 3, 2000 to October 31, 2000. They analyzed the impact of NASDAQ on SENSEX through Ordinary Least Square (OLS) equations under cointegration and error correction framework. The study showed that the news on NASDAQ had played an important role in price formation at the beginning of the new trading day at the Indian bourses. Thus, the study suggested the integration of the Indian capital market with the US market.

Wong, Agrawal and Du (2004) investigated the long-run equilibrium relationship and short-run dynamic linkage between the Indian stock market and the stock markets in major developed countries (United States, United Kingdom and Japan) after 1990 using the Granger causality and cointegration method. Using weekly closing prices data from January 1, 1991 to December 31, 2003, they found that Indian stock market was integrated with mature markets.

Compared to other emerging stock markets in Asia, the Indian stock market has been recognized as relatively less sensitive to changes of Asian and other developed markets of the world. Therefore, in spite of the fact that Indian stock market has largest number of listed companies, it has received little attention while undertaking studies on interconnectedness of world stock markets. Researchers have rarely included the Indian Stock Market while studying the influence of the U.S. markets on Asian markets and interdependence among Asian stock markets (Wong & Ng, 1992, Ng, 2002). These researches are evidences that Indian stock market has not only received relatively less attention of scholars and researchers in the field of international finance but also the market is considered to be somewhat isolated from international markets.

Ahmad, Ashraf and Ahmed (2005) examined the interlinkages and causal relationship between the Nasdaq composite index in the US, the Nikkei in Japan with that of NSE Nifty and BSE Sensex in India using daily closing data from January 1999 to August 2004. The study used Granger Causality and Johansen cointegration methods to examine short run and long term relationship among the stock markets respectively. The results of Co-integration test revealed that there was no long-term relationship of the Indian equity market with that of the US and Japanese equity markets. Granger causality test suggested that there was a unidirectional relationship from Nasdaq and Nikkei to Indian stock markets.

Hoque(2007) explored the dynamics of stock price movements of an emerging market such as Bangladesh with that of USA, Japan and India using daily closing price data starting from January 1, 1990 to December 31, 2000. The indices used for Bangladesh, India, Japan and USA were Dhaka Stock Exchange(DSE) All Share Price Index, BSE30, Nikkei 225 and S&P500 respectively. They analyzed the long term relationships among the markets using the Johansen multivariate cointegration approach and short-term dynamics were captured through vector error correction models. Vector Auto Regression was used to study the impact of shocks of these markets on own markets and other markets. The analysis showed that there was evidence of long term cointegration among the markets suggesting that stock prices in the countries share a common stochastic trend. Impulse response analysis shows that shocks to US market do have an impact on Bangladesh stock market. The response of Bangladesh stock market to shocks Indian stock market is weak. Shocks to Japanese stock market do not generate a response in the Bangladesh stock market.

The integration of Indian stock market with the rest of the world causes the absorption of the news quickly not in the country where the news originates but also in other countries as well. There is an ample literature on financial integration, there are only a few studies related to India. With liberalization in India, changes in the economic environment of the world and growing interdependence of the American and other countries like India, China, Brazil and Maxico, it is interesting to investigate the integration of stock price movements of India with respected to American and other stock markets. China and India are the emerging economics of the world. India has better economic relationship in terms of trade and investment with Maxico and Brazil. The purpose of the paper is to provide analysis with a special emphasis on integrating relationship of the selected stock markets.

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

RESEARCH DESIGN

SAMPLE AND PERIOD OF STUDY

The study uses data on daily closing price of NSE of India, Shanghai Stock exchange of China, IPC of Maxico, Bovespa of Brazil and Standard and Poor (S&P) 500 of United States from 1st January 1996 to 31st December, 2007. We drop the data when any series has a missing value due to no trading. Thus all data are collected on the same dates across the stock exchanges and there are 2951 observations for each series. 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.

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:

$R_t = \log(P_t / P_{t-1})$ or $R_t = \log(P_t) - \log(P_{t-1})$ **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.

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.

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

$$\Gamma_j = -\sum_{i=j+1}^{p} A_j \quad \text{and} \quad \Pi = -\mathrm{I} + \sum_{i=j+1}^{p} A_j$$ **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 ∏ matrix. The ∏ 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 ∏ 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 ∏ is decomposed as ∏=αβ, 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:

$$\lambda_{trace}(r) = -\mathrm{T}\sum_{i=r+1}^{g} \ln(1-\hat{\lambda})$$ **Equation 6**

and

$$\lambda_{\max}(r, r+1) = -\mathrm{T}\ln(1-\hat{\lambda}_{r+1})$$ **Equation 7**

where $\hat{\lambda}$ is the estimated values of the characteristic roots obtained from the estimated ∏ 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.

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.

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.

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 indices, denoted as LNSE, LSSE, LIPC, LBovespa and LSP500, 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
LNSE	0.931 (0.996)	-48.506 (0.000)
LSSE	(-0.454) 0.897	-53.227 (0.000)
LIPC	-0.008 (0.957)	-50.331 (0.000)
LBovespa	-0.779 (0.824)	-52.491 (0.000)
LSP500	-2.293 (0.174)	-56.350 (0.000)

Johansen cointegration test is sensitive to the lag length (Enders, 2004). We employ AIC and SBC criteria to select the lag length to include in the analysis. The results of lag length selection criteria are reported in the Table 2.

TABLE 2: LAG LENGTH SELECTION

Lag	AIC	SBC
0	-0.653423	-0.643105
1	-27.17176	-27.10986*
2	-27.18652*	-27.07302
3	-27.18292	-27.01783
4	-27.18125	-26.96457
5	-27.18097	-26.9127
6	-27.18149	-26.86163
7	-27.1808	-26.80935
8	-27.18448	-26.76144

Here, AIC selects the model with two lags and the SBC selects the model with one lag. We can also determine lag-length using a likelihood ratio test. Under the null hypothesis, we can restrict lag 1 of all coefficients in all five equations to be zero. If this restriction is binding, we reject the null hypothesis. The calculated Chi-square value is 92.97. It rejects the null hypothesis of one lag. Thus, AIC and likelihood ratio test both select the two-lag model.

The second phase involves an assessment on the five market series for cointegration. The cointegration test is to determine whether or not the five nonstationary price indices share a common stochastic trend. Table 3 presents the results of cointegration tests pertaining to the indices. The results reveal the presence of significant cointegrating relationships between the stock market indices under investigation. Both the λ_{trace} and λ_{max} test show two significant cointegrating ranks. This indicates the presence of long-run equilibrium relations between the USA, Chinese, Indian, Brazil and Maxico stock markets. In other words, by and large all the stock indices are moving together.

TABLE 3: JOHANSEN'S COINTEGRATION TEST RESULTS FIVE INDICES

λ_{trace}				
Hypothesized		**Trace**		
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.024322	135.8939	60.06141	0.0000
At most 1	0.017145	64.53726	40.17493	0.0000
At most 2	0.004557	14.41998	24.27596	0.5023
At most 3	3.39E-04	1.183505	12.3209	0.9919
At most 4	6.92E-05	0.200484	4.129906	0.7100
λ_{max}				
Hypothesized		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.024322	71.35667	30.43961	0.0000
At most 1 *	0.017145	50.11728	24.15921	0.0000
At most 2	0.004557	13.23647	17.7973	0.2130
At most 3	0.000339	0.983021	11.2248	0.9929
At most 4	6.92E-05	0.200484	4.129906	0.7100
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				
Johansen Cointegration Equation[1] LNSE-3.42LIPC+2.96LBovespa+0.31LSSE-1.59LSP500=ε_t (8.21) (6.51) (1.42) (3.90)*				

*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 4: PORTMANTEAU TEST FOR AUTOCORRELATION

Lags	Q-test	Prob	Adj. Q test	Prob	Df
5	48.69340	0.3267	48.74364	0.3249	45

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 cointegrating equation normalized on Indian stock price presented in the Table 3 suggests that there is a long-term tendency for NSE to converge with those markets.

The second phase involves estimation of five error correction equations, based on cointegrated model. Table 5 represents the results of VECM. It is used to examine the short run equilibrium dynamics of the stock indices.

TABLE 5: RESULTS OF VECM MODEL

Error Correction:	D(LSP500)	D(LSSE)	D(NSE)	D(LBovespa)	D(LIPC)
ECM(-1)	-0.001823	-0.000898	0.002	-0.000458	-0.007313
	[-2.57889]*	[-0.81774]	[1.93062]	[-0.32163]	[-7.42545]

*Indicates t-statistics

The results suggest that the error correction terms or adjustment coefficients are statistically significant (coefficient of NSE is statistically significant at 90%) except for SSE and Bovespa. The speed of adjustment coefficients is low in magnitude. It can be seen from the Table 5 that the coefficients of error correction terms of all stock markets except NSE are negative. For instance, the positive coefficient of (0.002) of the cointegrating relation in the NSE equation means that the return of the underlying goes up when the cointegrating equation shows positive values (direct relationship). The negative coefficients (-0.001823) of SP 500 of USA and (-0.007313) of IPC of Maxico indicate that the returns of the stock markets go down when the cointegrating equation shows positive values (inverse relationship). The speed of adjustment of Indian stock market is marginally higher than rest of the stock markets. The results in the table 5 suggest that Indian stock market goes back to equilibrium faster.

SUMMARY
The present stud endeavored to explore the dynamics of stock price co-movements of USA, Chinese, Brazil, Indian and Maxican stock markets. Cointegration model is used to examine the long-run equilibrium relationship among the time series. The results demonstrate that stock prices in those countries share a common trend. In general long-term relationship and short-term dynamics have been detected in this study.

The results have several policy implications. If the markets are integrated, arbitrage opportunities would be very low. The absence of arbitrage opportunity may lead to low level of speculation leads to better market efficiency and the return would be proportionate to the risk. The existence of market integration among the stock indices under investigations indicates that diversification among these five markets leads to little benefit to international portfolio investors.

The speed of adjustment of Indian stock market is higher implying it absorbs news faster than other stock markets and therefore, it is considered to be more informationally efficient than other stock markets.

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