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# Information Stochasticity between Developed and Emerging Markets: Evidence from US-India

**Dr. P. Lakshmi[1], S. Visalakshmi[*2], Dr. Kavitha Shanmugam**

[1,2]Assistant Professor, Department of Management Studies, National Institute of Technology, Trichy 620015, Tamilnadu, India
[3]Professor,Department of Management Studies, JJ College of Engineering & Technology, Trichy – 620 009, Tamilnadu, India

**ABSTRACT**

The globalization of economic systems and the increased pace of information transmission have amplified the contagion effect of risk, especially during financial crises, as a crisis in one region can extend internationally. Rezaei, F., & Moradi, A. (2012), Shah, A., et al (2010). In this context, the present study scrutinizes the relations and distinctiveness of price movements of emerging market (India) with developed market (US) applying open and close values of daily stock market indices from January 2001 to May 2012, using Co-integration tests, Vector error correction Model, Granger causality relationship, Impulse responses function and Variance decomposition method. The results of Co-integration tests and VECM collectively exhibit that both long-run and short-run relationships exist between the stock markets of US-India. In addition, these were magnified in the short-run during the 2007-2009 US financial crisis. From the impulse response results it can be inferred that innovations in NYSE close returns affect both open and close returns of Indian and US markets, with an increased effect on the Indian market. Similar impact is found in the case of NIFTY close returns as well. From the Variance decomposition analysis it is evident that US close and open returns marginally explain the variance of NIFTY close returns. During crisis the impact has almost doubled. In the short run US returns granger cause Indian market returns. The findings implicate that the (US index) developed market acts as a conducing indicator and information stochasticity from the US index swiftly affect the emerging stock market (Indian market).

**KEYWORDS**: Indian stock market; US; VECM; Cointegration; Granger Causality; Impulse Response; Variance decomposition.

## 1. INTRODUCTION

In India the stock market is lingering significant revolution with liberalization measures, and the probe of the nature of integration with other developed and emerging markets would not only give an idea of the prospective gains to be acquired out of portfolio diversification from Indian market, but may also afford some indication of the vulnerability of the country's stock market in case of a regional financial crisis and subsequent setback of capital flows from the region. The globalization of financial systems and the accelerating of entropy transmission have augmented the risk of financial crises, as a crisis in one country can spread to other countries and bring about worldwide crises. However, in recent times, with the intensifying activities of foreign portfolio investors who track international indices and persistently move funds between markets, as well as further linkages with foreign markets through the route of ADR/GDR issues and other channels, correlation between Indian and global stock markets has improved widely necessitating a comprehensive exhaustive study (Rezaei, F., & Moradi, A. (2012), Gholampour, E., Mehrara, M., & Emamverdi, G. (2012), Mehrara, M.,et al. (2012)).

Understanding of the dynamic behavior of stock returns is vital for portfolio managers, policy makers, and researchers. Our study includes the daily index values (both open and close) of the NYSE, and NIFTY, for US, and India respectively. We consider the US time as the ground-zero time, manipulating the lagging times by the trading time in calendar. In order to look into the potentials of arbitrage on a real time basis, a digression on the timing of trading in the two sets of Stock Exchanges, *viz*., domestic and foreign would be in order. Within the same calendar day, the Indian markets close first, and the US market is the last one to close. The trading timings in India commences at IST 9.15 AM and continues till IST 15.30 PM and whereas the trading session in the US starts at IST 19.30 PM on the same day and closes at IST 2:30 A.M on the next day, the Indian trading session is 10 hrs15 min ahead of the US trading session. (See Table 1 for the trading times of markets included in this study). According to Table 1, it is inferred that there is non-overlapping timings between US and India. Therefore, the shock in US market affects the Indian market next day. For the purpose of the study, the US financial crises period

[*]**Corresponding Author:** S. Visalakshmi, Assistant Professor, Department of Management Studies, National Institute of Technology, Trichy 620015, Tamilnadu, India. Email id: visa.sr@gmail.com

is considered from Sep 2007-Feb 2009.The starting and the ending time of the crisis is not precisely the same to other literatures, but it is based on the exploration of the movements of daily returns of the NIFTY index to dissemination of global information. It is during this period that NIFTY exhibited precipitous down trend and high volatility.

TABLE 1: Customary Trading Sessions of NSE and NYSE
(Times in Indian Standard Time)

| DAY T | | DAY T+1 | |
|---|---|---|---|
| **NSE OPEN** | NSE CLOSE | NYSE OPEN | NYSECLOSE |
| ⇩ | ⇩ | ⇩ | ⇩ |
| 09.15HRS | 15.30 HRS | 19.30 HRS | 02.30 HRS |

The main focus of the present study is to compare the speed of transmission of shocks from US to India in the long run, short run deviations and swiftness of recovery during US subprime mortgage crisis. This analysis would enable us to understand whether Indian economy actually remains insulated and could still be considered for portfolio diversification.

The scientific contribution of the paper is listed as follows: i) Dynamic relationship between the stock price movements of developed and emerging markets and ii) To understand whether emerging markets remain insulated and could still be considered for international portfolio diversification.

The paper proceeds as follows: Section 2 comprises Literature review, Section 3 lays out the econometric methodology, Section 4 presents the empirical results and Section 5 offers Conclusion.

## 2. LITERATURE REVIEW

The review is done under two perspectives. viz., studies related to global stock market indices and on research applying econometric analysis.

The short-term and long-term relationships between BSE 500, BSE 200 and BSE 100 Index of Bombay Stock Exchange and crude price by using various econometric techniques was examined (Bhunia,A.,2012).The study was for the period 02.04.2001 and 31.03.2011. The empirical results showed there was a co-integrated long-term relationship between three index and crude price and Granger causality test also revealed that there was one way causality relationship from all index of the stock market to crude price, but crude price was not the causal.

The price discovery using trivariate model for 7 Canadian firms cross-border listed in the Toronto Stock Exchange Market (TSX) and the New York Stock Exchange Market (NYSE) were analyzed and also the information role of each country to the efficient foreign exchange rate shock and to the individual firm's fundamental value change was investigated (Kim, L. C. H. 2010).The results of the study revealed that 5 out of 7 firms found adjustment to the fundamental component of firm's value from home (TSX) market. In the remaining of 2 firms the price discovery takes place equally in both home and foreign (NYSE) markets. To the efficient exchange rate shock, price discovery takes place equally in both markets for 5 out of 7 firms and occurs more in the home market for the rest of 2 firms.

The contribution of cross listings to price discovery for a sample of Canadian stocks listed on both the Toronto Stock Exchange (TSE) and a U.S. exchange was examined (Eun, C. S. and S. Sabherwal 2003). The findings revealed that prices on the TSE and U.S. exchange are co-integrated and mutually adjusting.

Using transactions data of the Kuala Lumpur Stock Exchange and the Stock Exchange of Singapore (SES), the magnitude of their contribution to price discovery was investigated (Ding.,D et al ,1999). The Results indicated that the price series were co integrated and the raw data indicated the presence of arbitrage opportunities, but none exist after taking exchange rate changes into account.

The causal relationship between financial and real sectors in Nigeria by applying Granger causality test and co-integrated vector error correction model for the period 1970 to 2010 was investigated (Akinkugbe, O.,Ekundayo 2013). The results indicated the existence of one co-integrating relation between financial sector variables and real sector variable and also found that there was one way directional causality running from the financial to real sector in the long run.

Intraday price discovery between the Chinese stock index market and the CSI 300 index futures market on one minute high frequency data was, scrutinized from April 16, 2010, to April 15, 2011, the relation between index futures intraday price discovery and exchanges regulations was examined using Granger Causality Method, Johansen co-integration analysis and Vector Error Correction Model (Yu, F., Kou, Y., Tong, W. M., & Ye, Q. 2012).The findings exhibited that the CSI300 index futures was not dominant in the price discovery process in its infancy stage after futures market launched, but the futures market played an important role after an effective control on over-speculation by CFFEX.

A study on some major demand factors that impact on steel industry between 1999 and 2006, based on VECM, Co-integration test revealed that there is long-term equilibrium relationship among real estate industry, relative downstream industries, steel exports and steel industry and the result of variance analysis discovered that real estate will play a major role, and steel exports will play a minimum role on steel output fluctuations (Bin, D. 2007).

A study on the Indian stock market efficiency was conducted by using Ravallion co integration and error correction market integration approaches (Amanulla and Kamaiah, 1995). The data used are the RBI monthly aggregate share indices relating to five regional stock exchanges in India, viz., Bombay, Calcutta, Madras, Delhi, Ahmedabad during 1980-1983. The study revealed a long-run equilibrium relation between the price indices of five stock exchanges and error correction models indicated short run deviation between the five regional stock exchanges. The study found that there is no evidence in favor of market efficiency of Bombay, Madras, and Calcutta stock exchanges while contrary evidence is found in case of Delhi and Ahmedabad.

Our study differs from existing research in the following ways. Firstly, we consider both the opening and closing prices of both the Indian and US index to capture the short run adjustments. Secondly, the current paper attempts to add to the limited volume of literature on the usefulness of co-integration and error correction models in understanding the dynamic relationship.

## 3. METHODOLOGY

### *3.1 Data Selection*

The countries included in this study are U.S and India. The study encompasses daily stock market indices (Open and Close) for the period January 2, 2001 to May 31, 2012 and the data was derived from respective stock exchange websites. Our data series consist of the daily index values of the NYSE, and NIFTY for US and India respectively. Eviews 6.0 package is used for arranging the data and implementation of econometric analyses.

### *3.2 Techniques*

Primarily, natural logarithms of data have been taken before passing to the analysis process. Then, stationarity analysis has been performed for data pertaining to the variables used in the study. The most widely used test among parametric tests is Augmented Dickey-Fuller (ADF-1979) that considers possible structural fracture and trend in the time series. A long term relationship between time series has been searched by applying co-integration test developed by Johansen and Juselius (1990). Both granger causality and vector error correction model are carried out to establish the short run and long-run dynamics. Impulse response analysis inspects and evaluates the impact of shocks cross-section. Variance decomposition tells the proportion of the movements in a sequence to its own shocks versus shocks to the other variable. Impulse response, jointly with variance decomposition, forms innovation accounting for sources of information transmission in a multivariate dynamic system.

#### *3.2.1. Unit root tests*

We first test whether each of the indices, their underlying prices are stationary. The Augmented Dickey Fuller (ADF) tests are used to test for unit roots in the time series. The basic Dickey–Fuller (DF) test (Dickey and Fuller, 1979, 1981) is to examine whether $\rho$<1 in the equation (1),

$$\gamma_t = \mu + \rho\gamma_{t-1} + \varepsilon_{t,}\varepsilon_t \sim N(0,\sigma^2{}_\varepsilon) \quad (1)$$

which, after subtracting $y_{t-1}$ from both sides, can be written as:

$$\Delta\gamma_t = \mu + (\rho - 1)y_{t-1} + \varepsilon_t \quad (2)$$
$$= \mu + \theta\gamma_{t-1} + \varepsilon_t$$

The null hypothesis is that there is a unit root in $y_t$, or $H_0: \theta = 0$, against the alternative $H_1: \theta < 0$, or there is no unit root in $y_t$. The Dickey–Fuller procedure gives a set of critical values developed to deal with the non-standard distribution issue, which are derived through simulation. A sufficient number of lagged differences are included so that the residual series is approximately white noise. If, as expected, each variable is integrated of order one, I (1), then the next step would be to test for Co integration.

#### *3.2.2. Lag length Selection Criteria*

A reasonable strategy to determine the lag length of the VAR model is to fit VAR (p) models with different orders p = 0… $p_{max}$ and choose the value of p which minimizes the model selection criteria. Model selection criteria for VAR (p) could be based on Akaike (AIC), Schwarz-Bayesian (BIC), Final prediction error (FPE) and Hannan-Quinn (HQ) information Criteria.

#### *3.2.3. Co integration test*

Let $Y_t = (Y_{1t},\ldots,Y_{kt})'$ denote an k x1 vector of I(1) time series. $Y_t$ is co integrated if there exists k x1 vector $\beta = (\beta_1 \ldots . \beta_k)'$ such that

$$Z_t = \beta' Y_t = \beta_1 Y_{1t} + \cdots + \beta_k Y_{kt} \sim I(0) \quad (3)$$

The non-stationary time series in $Y_t$ are co integrated if there is a linear combination of them that is stationary. If some elements of $\beta$ are equal to zero then only the subset of the time series in $Y_t$ with non-zero coefficients is co integrated.

There may be different vectors $\beta$ such that $Z_t = \beta' Y_t$ is stationary. In general, there can be 0 r k linearly independent co integrating vectors. All co-integrating vectors form *a co integrating matrix* B. This matrix is again not unique. Some normalization assumption is required to eliminate ambiguity from the definition. A typical normalization is

$$\beta = (1, -\beta_2, \ldots, -\beta_k)' \quad (4)$$

So that the co integration relationship may be expressed as

$$Z_t = \beta' Y_t = Y_{1t} - \beta_2 Y_{2t} - \ldots - \beta_k Y_{kt} \sim I(0). \quad (5)$$

### *3.2.4. Error Correction Model*

A vector error correction (VEC) has co-integration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their co-integrating relationships while allowing for short-run adjustment dynamics. The co-integration term is known as the *error correction* term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

Engle and Granger (1987) state that if a bivariate I(1) vector $Y_t = (Y_{1t}, Y_{2t})'$ is co-integrated with co-integrating vector $\beta = (1, -\beta_2)'$ then there exists an error correction model (ECM) of the form

$$\Delta Y_{1t} = \delta_1 + \phi_1 (Y_{1,t-1} - \beta_1 Y_{2,t-1}) + \sum_{j=1} \alpha^j_{11} \Delta Y_{1,t-j} + \sum_{j=1} \alpha^j_{12} \Delta Y_{2,t-j} + \epsilon_{1t} \quad (6)$$

$$\Delta Y_{2t} = \delta_2 + \phi_2 (Y_{1,t-1} - \beta_2 Y_{2,t-1}) + \sum_{j=1} \alpha^j_{21} \Delta Y_{1,t-j} + \sum_{j=1} \alpha^j_{22} \Delta Y_{2,t-j} + \epsilon_{2t} \quad (7)$$

that describes the long term relations of $Y_{1t}$ and $Y_{2t}$. If both time series are I (1) but are co-integrated (have a long term stationary relationship), there is a force that brings the error term back towards zero. If the co-integrating parameter $\beta_1$, or $\beta_2$ is known, the model can be estimated by the OLS method.

The result is easily generalized to the n-variable model. Formally, the (n x 1) vector $x_t = (x_{1t}, x_{2t}, .., x_{nt})'$ has an error correction representation if it can be expressed in the form:

$$\Delta x_t = \pi_0 + \pi x_{t-1} + \pi_1 \Delta x_{t-1} + \pi_2 \Delta x_{t-2} + \cdots + \pi_p \Delta x_{t-p} + \epsilon_t \quad (8)$$

Where $\pi_0$ =(n x 1) vector of intercept terms with elements $\pi_{i0}$

$\pi$ = is a matrix with elements $\pi_{jk}$ such that one or more of the $\pi_{jk} \neq 0$

$\pi_i$ = (n x n) coefficient matrices with elements $\pi_{jk}(i)$

$\epsilon_t$ = an (nx1) vector with elements $\epsilon_{it}$

The disturbances terms are such that $\epsilon_{it}$ may be correlated with $\epsilon_{jt}$ .

Let all variables in $x_t$ be I (1).Now, if there is an error correction representation of these variables as in (8), there is necessarily a linear combination of the I (1) variables that is stationary. Solving (3.8) for $\pi x_{t-1}$ yields

$$\pi x_{t-1} = \Delta x_t - \pi_0 - \sum \pi_i \Delta x_{t-i} - \epsilon_t \quad (9)$$

Since each expression on the right hand side is stationary, $\pi x_{t-1}$ must also be stationary. Since $\pi$ contains only constants, each row of $\pi$ is a co-integrating vector of $x_t$ . The first row can be written as $(\pi_{11} \Delta x_{1t-1} + \pi_{12} \Delta x_{2t-1} + \cdots + \pi_{1n} \Delta x_{nt-1})$. Since each series $x_{it-1}$ is I (1), $(\pi_{11}, \pi_{12}, \ldots \pi_{1n})$ must be a co-integrating vector for $x_t$.

### *3.2.5. Granger Causality test*

The Granger causality test is employed to determine whether one return series is useful in forecasting another. Based on the definition of Granger causality, a time series X is said to Granger-cause Y if it can be shown that those X values provide statistically significant information about future values of Y (Granger, 1969, 1987).The model is estimated as follows:

$$x_t = \alpha_0 + \alpha_1 y_{t-1} + \beta_1 x_{t-1} + \epsilon_t \quad (10)$$

$$y_t = \gamma_0 + \alpha_2 x_{t-1} + \beta_2 y_{t-1} + \epsilon_t \quad (11)$$

We preceded parameter estimation with the method of least square and Granger causality analysis with F-statistics.

The original hypothesis for F-statistics tests is defined by the following hypothesis:

$H_o: \alpha_1 = \alpha_2 = \ldots = \alpha_n = 0$ against the alternative hypothesis

$H_1: \beta_1 = \beta_2 = \ldots = \beta_n = 0$

If the calculated value of F-statistics is larger than critical value of F-statistics, the original hypothesis of variable *X* can't cause variable *Y* was not proved, that is to say variable *X* is Granger reason of variable *Y.*

### *3.2.6 Impulse response function*

Impulse response analysis is used extensively in econometrics to depict the dynamic relationship among all the variables within VECM. The impulse response function will quantify the shock of new information impulse from stochastic error on the current and future value of each of the endogenous variables. Impulse response function replicates the effects of a shock to one variable in the system on the conditional forecast of another variable, which charts out the dynamic response path and adjustment speed of the variables as a result of the external shocks. We obtained impulse response function by generalized decomposition.

### *3.2.7 Variance decomposition*

Variance decomposition disintegrates unit incremental shock of each variable for certain proportion to its own reason and other variables contribution. Variance decomposition takes the prediction mean square decomposed to function of each variables impulse in VECM, to further evaluate the importance of different structures shock. Comparing the relative significance of information that differs from time to time we can estimate the sluggish and augmented effect of shocks. They give the proportion of the movements in the dependent variables that are due to their 'own' shocks, versus shocks to the other variables. A shock to the *i*th variable will directly affect that variable, but it will also be passed on to all of the other variables in the system.

## 4. EMPIRICAL ANALYSIS

### *4.1 Preliminary Statistics:*

Table 2 reports the descriptive statistics of Stock Market Indices viz., NYSE, and NIFTY. The sample period is from January 2, 2001 to May 31, 2012.

**Table 2: Descriptive Statistics**

| Variables/ Statistics | NYSE Close | NYSE Open | NIFTY Close | NIFTY Open |
|---|---|---|---|---|
| **Mean** | 8.86 | 8.86 | 7.89 | 7.89 |
| **Median** | 8.86 | 8.87 | 8.04 | 8.04 |
| **Maximum** | 9.24 | 9.24 | 8.75 | 8.75 |
| **Minimum** | 8.34 | 8.35 | 6.75 | 6.75 |
| **Std.Dev.** | 0.19 | 0.19 | 0.63 | 0.63 |
| **Skewness** | -0.16 | -0.17 | -0.34 | -0.34 |
| **Kurtosis** | 2.39 | 2.38 | 1.59 | 1.59 |
| **JarqueBera** | 59.29* | 59.52* | 279.25* | 279.00* |
| **Observations** | 2871 | 2871 | 2751 | 2751 |

Note:*Significant @1% level

The descriptive statistics shows that the standard deviation of the Indian index is higher than that of the NYSE. In addition, each index is negatively skewed and non-normally distributed according to the Jarque-Bera normality test.

### *4.2 Unit Root Test:*

Test for VECM requires that the variables of time series data is smooth, therefore we conduct ADF unit root test to examine the stationarity of the variables. Table 3 reports the result of the standard unit root tests on the integration properties of the NYSE and NIFTY- Open & Close Prices. The actual values of these series exhibited trends, so all unit root test regressions include Intercept terms. The choice of lag length was assigned to the Akaike Information Criterion (AIC).

**Table 3: Augmented Dickey Fuller (ADF) Unit Root Test**

| DVariables | Deterministic | NYSE | NIFTY | Inference |
|---|---|---|---|---|
| | | t-statistic | t-statistic | |
| **OPEN** | Intercept | -58.01* | -48.51* | No Unit Root |
| **CLOSE** | Intercept | -57.56* | -49.17* | No Unit Root |

Note: Critical values at 1% level:-3.432455, 5% level:-2.862356, 10% level:-2.567249
*Significant at 1% Level.

Table 3 indicates that the ADF test takes care of possible serial correlation in the error terms by adding the lagged difference terms of the regress and. The ADF test statistic is more negative than the critical value and hence the null hypothesis of unit roots in the first differences ie, the returns of the variables is rejected at 1% level and confirms the stationarity of the returns. In the level form, unit root tests are rejected for all the US-Indian Market. However, the test rejects the null of non-stationarity for all the variables when they are used in their first difference. This shows that all the series are stationary in the first difference, and integrated of order *I* (1) which justifies the need for co-integration test.

### *4.3 Lag Order Selection:*

Table 4 indicates the selected lag from Schwarz information criterion by (*). These are the lags with the smallest value of the criterion.

**Table 4: VAR lag order selection criteria by SC**

| Lag | Log L | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| **0** | 12118.29 | NA | 2.14e-11 | -13.21799 | -13.20596 | -13.21355 |
| **1** | 24550.41 | 24796.42 | 2.79e-17 | -26.76531 | -26.70515* | -26.74312* |
| **2** | 24579.18 | 57.26061 | 2.75e-17 | -26.77925 | -26.67096 | -26.73931 |
| **3** | 24605.03 | 51.33498 | 2.72e-17 | -26.78999 | -26.63358 | -26.73231 |
| **4** | 24638.60 | 66.51035 | 2.67e-17 | -26.80916 | -26.60462 | -26.73372 |
| **5** | 24651.62 | 25.74196 | 2.68e-17 | -26.80591 | -26.55324 | -26.71272 |
| **6** | 24677.30 | 50.65928* | 2.65e-17* | -26.81647* | -26.51567 | -26.70554 |
| **7** | 24687.26 | 19.60754 | 2.67e-17 | -26.80988 | -26.46095 | -26.68120 |
| **8** | 24695.96 | 17.09858 | 2.69e-17 | -26.80192 | -26.40486 | -26.65549 |

Note:* indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.

Table 4 presents the evidence based on the VAR Lag Order Selection Criteria, the LR, FPE, AIC suggests the use of 6 lags, the SC and HQ criteria suggests the use of 1 lag. According to Schwarz (SIC) criterion, subsequent analyses were based on VAR with 1 lag.

### *4.4 Co integration Rank:*

Many time series are non-stationary but move together over time, which implies that the two series are bound by some relationship in the long run. A co-integrating relationship may also be seen as a long-term or equilibrium phenomenon, since it is possible that co-integrating variables may deviate from their relationship in the short run, but their association would return in the long run. Suppose that there are $k$ variables in a system (excluding constant term), denoted as $y_t$ , $x_{2t}$ , . . . $x_{kt}$, there may be up to $r$ linearly independent co-integrating relationships (where $r \leq k-1$) Asgari, M. A. (2013).The Johansen Co integration Rank summary for the US and INDIAN Market is presented in Table 5.

**Table 5: Johansen Co integration Rank Summary**

| **Data Trend** | **None** | **None** | **Linear** | **Linear** | **Quadratic** |
|---|---|---|---|---|---|
| **No. of CEs** | No intercept No Trend | Intercept No Trend | Intercept No Trend | Intercept Trend | Intercept Trend |
| **Trace** | 2 | 2 | 2 | 2 | 2 |
| **Max- Eig** | 2 | 2 | 2 | 2 | 2 |

Note: Selected (0.05 level*) Number of Co-integrating Relations. * MacKinnon-Haug-Michelis(1999)Critical values

The co-integration results (the 'trace' or 'max' statistics) suggest that the series are co-integrated - in other words, all specifications suggest that there are at least two co-integrating vectors for NIFTY. The lag number to be taken into account in application of co-integration test for each comparison was calculated according to Schwarz (SIC) criterion.

### *4.5 Co-integration Results:*

Results of Johansen co-integration test applied for the purpose of finding whether there is a long term relationship between the variables within the scope of the analysis is shown in Table 6.

**Table 6: Johansen Co integration Test Results**

| Countries | Hypo thesized no. of CE(s) | Eigen value | Trace statistic | Critical Value (p<0.05)** | Max-Eigen statistic | Critical Value (p<0.05)** |
|---|---|---|---|---|---|---|
| **US-India** | r = 0* | 0.459713 | 2476.079 | 47.85613 | 1488.039 | 27.58434 |
| | r ≤ 1* | 0.334864 | 988.0403 | 29.79707 | 985.5632 | 21.13162 |

Note: *denotes rejection of the hypothesis at the 0.05 level**MacKinnon-Haug-Michelis (1999) p-values

According to the results of Table 6, the Trace test indicates 2 co-integrating eqn(s) at the 0.05 level and Max-eigen value test also indicates 2 co-integrating eqn(s) at the 0.05 level for NIFTY. Thus it is proven that a long run relationship exists between the US and Indian Markets.

### *4.6 Vector Error Correction Model:*

The parameter estimation of VECM for (2001-2012) is presented in Table 7.1.

**Table 7.1: Vector Error Correction Model Results (Entire Sample)**

| COINTEGRATING EQ: | COINT EQ1 | COINT EQ2 |
|---|---|---|
| LNIFTYCLOSE(-1) | 1.00000 | 0.00000 |
| LNIFTYOPEN(-1) | 0.00000 | 1.00000 |
| LNYSECLOSE(-1) | 1693.71 [45.23] | 1694.32 [ 45.23] |
| LNYSEOPEN(-1) | -1695.04 [-45.29] | -1695.66 [-45.29] |
| C1 | 4.15 | 4.15 |

| Error Correction | NIFTY CLOSE | NIFTY OPEN | NYSE CLOSE | NYSE OPEN |
|---|---|---|---|---|
| ecm$_1$ | -0.83757 | 0.129614 | -0.42107 | -0.00975 |
| | [-8.10365] | [ 1.19450] | [-4.86479] | [-0.24119] |
| ecm$_2$ | 0.837327 | -0.12949 | 0.420814 | 0.010306 |
| | [ 8.10459] | [-1.19386] | [ 4.86375] | [ 0.25515] |
| D(LNIC(-1)) | -0.26976 | -0.25209 | 0.098789 | 0.019538 |
| | [-3.77881] | [-3.36369] | [ 1.65245] | [ 0.70004] |
| D(LNIO(-1)) | 0.253135 | 0.232043 | -0.06968 | -0.01584 |
| | [ 3.41511] | [ 2.98190] | [-1.12255] | [-0.54653] |
| D(LNYC(-1)) | 0.077517 | 0.074142 | 0.046811 | -0.00029 |
| | [ 1.37511] | [ 1.25279] | [ 0.99157] | [-0.01308] |
| D(LNYO(-1)) | 0.070270 | 0.074317 | -0.11339 | -0.00683 |
| | [ 2.59431] | [ 2.61343] | [-4.99881] | [-0.64483] |
| C2 | 0.000288 | 0.000312 | -0.0002 | -0.0003 |
| | [ 0.89297] | [ 0.92244] | [-0.75087] | [-2.40657] |
| R-squared | 0.126780 | 0.028104 | 0.030501 | 0.790016 |
| Adj. R-sq | 0.124606 | 0.025685 | 0.028087 | 0.789493 |
| Sum sq. res | 0.604354 | 0.666106 | 0.423848 | 0.092377 |
| S.E. eqn | 0.015836 | 0.016625 | 0.013262 | 0.006191 |
| F-statistic | 58.31654 | 11.61507 | 12.63650 | 1511.176 |

Note: Figures in [ ] are t-values associated with the respective parameters

The C1 values reflect the log-run price of instancy embedded in the co-integrating vectors. C2 coefficients reflect the long run risk premiums for the various series. The VECM model is based on 1 lag. There are 2 co-integrating vectors. The VECM Results from Table 7.1 indicate that the normalized co integrating coefficients load on two variables - the NYSEOPEN series with negative coefficients & NYSECLOSE series with positive coefficients. This implies that the CLOSE and OPEN returns of the NIFTY Index (INDIA) respond positively to NYSE (US) CLOSE and Negatively to NYSE (US) OPEN returns. Since the value of the Error correction coefficients are very high it can be inferred that the speed of deviation adjustment is also very swift. The coefficients in the VECM give the estimated long-run relationship among the variables, shows how deviations from that long-run relationship affect the changes in the variable in the next period. Assessment of the F-statistics and the adjusted $R^2$, indicate that the variables in the VECM considerably elucidate short-run variation in the NYSEOPEN returns.

The parameter estimation of VECM for the period (2007-2009) is presented in Table 7.2. A sub sample study for the US financial Crisis period is done to identify the behavior of Indian Markets during stress. From Table 7.2 it can be observed that Open and Close returns of Indian Markets exhibit strikingly different levels of responses to US returns during (2007-2009) Financial Crisis. Totally contradicting the long run behavior NIFTY returns respond negatively to US OPEN returns and positively to US CLOSE returns during crisis. The error correction coefficients have significant convergence parameters. The interdependence between the NYSE OPEN returns and the Indian stock markets has become stronger in explaining the short run variations. The Indian Markets deviate much more during crisis.

**Table 7.2: Vector Error Correction Model (Financial Crisis Sub-sample)**

| COINTEGRATING EQ: | COINT EQ1 | COINT EQ2 |
|---|---|---|
| LNIFTYCLOSE(-1) | 1.000000 | 0.000000 |
| LNIFTYOPEN(-1) | 0.000000 | 1.000000 |
| LNYSECLOSE(-1) | -95584.90 [-14.06] | -94910.91 [-14.06] |
| LNYSEOPEN(-1) | 95583.32 [ 14.06] | 94909.34 [ 14.06] |
| C1 | -177.19 | -175.96 |

| Error Correction | NIFTY CLOSE | NIFTY OPEN | NYSE CLOSE | NYSE OPEN |
|---|---|---|---|---|
| ecm$_1$ | -0.64341 | 0.385726 | 0.050303 | -0.00069 |
| | [-2.06596] | [ 1.22498] | [ 0.17106] | [-1.76089] |
| ecm$_2$ | 0.647263 | -0.38921 | -0.05104 | 0.000679 |
| | [ 2.06357] | [-1.22725] | [-0.17234] | [ 1.73351] |
| D(LNIC(-1)) | -0.32208 | -0.34669 | -0.15807 | 0.000874 |

| | | | | |
|---|---|---|---|---|
| | [-1.30884] | [-1.39338] | [-0.65992] | [ 2.74279] |
| **D(LNIO(-1))** | 0.279858 | 0.303929 | 0.221427 | -0.00094 |
| | [ 1.13407] | [ 1.21807] | [ 0.92180] | [-2.94528] |
| **D(LNYC(-1))** | -68.0903 | -70.0636 | -36.2293 | -0.01456 |
| | [-1.21710] | [-1.23861] | [-0.66528] | [-0.20086] |
| **D(LNYO(-1))** | 36.38319 | 34.06823 | 1.124733 | 0.044173 |
| | [ 0.91765] | [ 0.84982] | [ 0.02914] | [ 0.85996] |
| **C2** | -0.13142 | -0.13515 | -0.07149 | -0.00195 |
| | [-1.22515] | [-1.24609] | [-0.68462] | [-13.9982] |
| **R-squared** | 0.162019 | 0.103270 | 0.065650 | 0.999998 |
| **Adj. R-sq** | 0.138806 | 0.078430 | 0.039767 | 0.999998 |
| **Sum sq. res** | 0.214515 | 0.219308 | 0.203256 | 3.60E-07 |
| **S.E. eqn** | 0.024377 | 0.024648 | 0.023728 | 3.16E-05 |
| **F-statistic** | 6.979725 | 4.157376 | 2.536473 | 21811790 |

Note: Figures in [ ] are t-values associated with the respective parameters

### *4.7 Impulse Response Analysis:*

In the Figure 1-2, abscissa axis represents impact function response period (Unit: Daily) upto 10 days, ordinate axis represents the percentage change in each variable.

According to Fig 5 & 6, Impulse response curves show that, as far as the impact of NIFTY open and close to its own lag is concerned, the response goes slightly negative upto 4 lags and remains constant thereafter. However the shocks of NIFTY close have both positive and negative effects on NIFTY open. There seems to be no impact of NIFTY open on NIFTY close. Both NIFTY open and close are impacted by NYSE close in a similar fashion, while NIFTY close shows a marginal increase on the second day and sustains constant after five days, NIFTY open has a positive incremental effect on the third day and decays on the sixth day. Both NIFTY open and close show slight positive impact due to shocks in NYSE open till 4 days. Innovations of NIFTY close create an impact on both NYSE close and open. It lasts upto 4 days in NYSE close and upto 5 days in NYSE open returns. As far as the impact of NYSE open and close to its own lags are concerned, it is positive on the 1st day and remains slightly negative till 4th day and dies out thereafter. There seem to be no impact of NYSE open on NYSE Close. However, the NYSE close has a positive increasing effect on NYSE Open on the 1st and 2nd day, becomes negative on the third day and lasts upto 6 days.

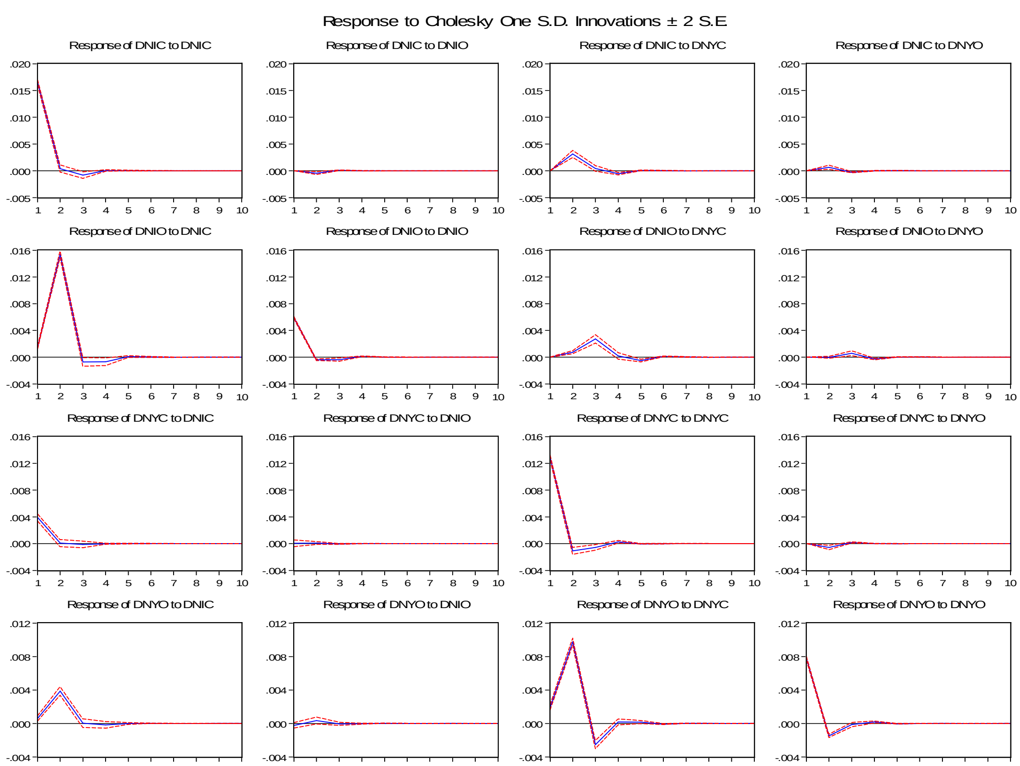


**Fig: 1 Impulse Response Results (Entire Sample)**

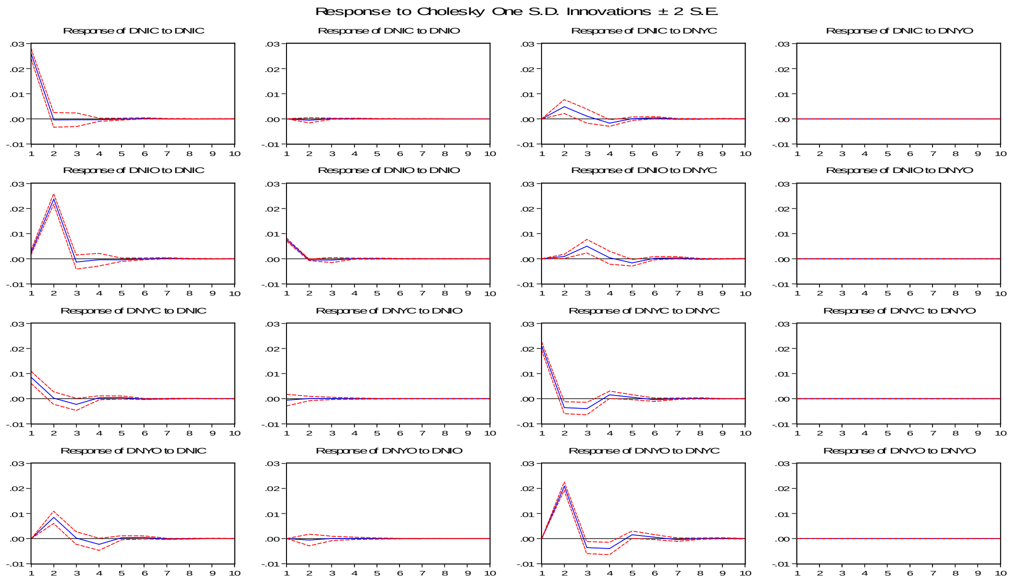


**Fig: 2 Impulse Response Results (Financial Crisis Sub Sample)**

The impact of shocks as per the impulse response results appear to be similar both for the entire sample and during US financial crisis except minor variations in the case of impact of NYSE Open on all the variables in the system including its own lag. From the results it can be inferred that innovations in NYSE close returns affect both open and close returns of Indian and US markets, with an increased effect on the Indian market. Similar impact is found in the case of NIFTY Close returns as well. Meticulously it was observed that one positive SD shock of the open returns of Indian and US markets had a scanty positive effect on its own lag leaving no impact on other variables.

### *4.8. Variance decomposition:*

According to the results of variance decomposition presented in Table (8.1-8.2), US CLOSE returns explain around 5% of the variance of NIFTYOPEN returns forecast error; US OPEN returns explain little on the first day and it increases gradually to 4% of Variations in NIFTYCLOSE returns till 10 days.

**Table: 8.1 Variance Decomposition (2001-2012)**

| Period | NIFTYCLOSE TO NIFTY CLOSE | NIFTYCLOSE TO NYSEOPEN | NIFTYOPEN TO NIFTYCLOSE | NIFTYOPEN TO NIFTYOPEN |
|---|---|---|---|---|
| **1** | 100.0000 | 0.000000 | 11.01089 | 88.98911 |
| **2** | 98.75477 | 1.169068 | 91.48665 | 8.394691 |
| **3** | 98.24821 | 1.039134 | 91.73609 | 7.471837 |
| **4** | 98.56365 | 0.859162 | 92.66225 | 6.583179 |
| **5** | 98.33876 | 1.008881 | 94.15086 | 5.207700 |
| **6** | 98.40158 | 0.970970 | 94.59122 | 4.609155 |
| **7** | 98.49625 | 0.917162 | 95.08886 | 4.129911 |
| **8** | 98.48005 | 0.943125 | 95.56431 | 3.683286 |
| **9** | 98.51155 | 0.924253 | 95.84738 | 3.365922 |
| **10** | 98.54451 | 0.908435 | 96.11939 | 3.099798 |

**Table: 8.2 Variance Decomposition (2007-2009)**

| Period | NIFTYCLOSE TO NIFTYCLOSE | NIFTYCLOSE TO NYSEOPEN | NIFTYOPEN TO NIFTYCLOSE | NIFTYOPEN TO NYSEOPEN |
|---|---|---|---|---|
| **1** | 100.0000 | 0.000000 | 13.30338 | 0.000000 |
| **2** | 98.00488 | 1.201772 | 93.66180 | 0.037124 |
| **3** | 98.04620 | 0.992436 | 93.29871 | 1.272600 |
| **4** | 98.23444 | 0.811953 | 94.38260 | 1.050183 |
| **5** | 98.13838 | 1.042662 | 95.32181 | 0.878874 |
| **6** | 98.32546 | 0.946546 | 95.61608 | 1.114879 |
| **7** | 98.46757 | 0.878255 | 96.11189 | 1.013544 |
| **8** | 98.50362 | 0.902288 | 96.48134 | 0.955080 |
| **9** | 98.59258 | 0.861866 | 96.70558 | 0.984842 |
| **10** | 98.66180 | 0.832737 | 96.94898 | 0.944442 |

During crisis 10% of the variations in NIFTYCLOSE returns are due to US CLOSE; But US OPEN returns explain little on the first day and it increases gradually to 10% of Variations in NIFTYCLOSE returns. In both the cases the impact lasts upto 10 days. On the contrary almost over 95% of the variations in NIFTYCLOSE and NYSECLOSE are explained by their own shocks for entire sample as well as during crisis. For NIFTYOPEN and NYSEOPEN the explanation is slight on the first day (11% for NIFTYOPEN and 17% for NYSEOPEN) and increases tremendously to 91% for NIFTYOPEN and 71% for NYSEOPEN on second day and shows marginal increment upto 10 days.

***4.9 Granger Causality:***

One of the ways to determine short run causality among variables is to employ Granger Causality Test (Engle and Granger, 1987). Table 9 presents the result of pair wise causality. Conferring to Table 9 the pair wise Granger causality test reveals that the null hypothesis of no causality is rejected at 1% level for both NYSECLOSE and NYSEOPEN returns on NIFTYOPEN and CLOSE returns. In other words from the results of granger causality it can be inferred that US (Open and Close) returns influence or precede Indian market (Open and Close) returns. This lends support to the fact that Indian market react to US market in the short run. However NIFTYOPEN and NIFTYCLOSE returns granger cause only NYSEOPEN returns. Further, Bi directional causality exists between NYSEOPEN and NYSECLOSE returns. Similarly Bi directional causality subsists between NIFTYOPEN and NIFTYCLOSE returns.

**Table 9: Granger Causality Test**

| Direction | F-statistic | Probability |
|---|---|---|
| **DNYO does not Granger Cause DNIC** | 8.22732 | 0.00416 |
| **DNYO does not Granger Cause DNIO** | 51.2209 | 1.1E-12 |
| **DNYO does not Granger Cause DNYC** | 10.7748 | 0.00104 |
| **DNYC does not Granger Cause DNIC** | 90.2812 | 4.6E-21 |
| **DNYC does not Granger Cause DNIO** | 247.936 | 2.3E-53 |
| **DNYC does not Granger Cause DNYO** | 5446.52 | 0.00000 |
| **DNIO does not Granger Cause DNIC** | 9.28712 | 0.00233 |
| **DNIO does not Granger Cause DNYO** | 5.62753 | 0.01776 |
| **DNIC does not Granger Cause DNIO** | 16615.8 | 0.00000 |
| **DNIC does not Granger Cause DNYO** | 201.683 | 4.3E-44 |

## 5. CONCLUSION

The study explored the dynamic relationships of the open and close returns of US–Indian stock markets. We employed Co-integration Test, VECM, Impulse responses function, Variance decomposition method and Granger-causality for comparative analysis to investigate the evolving patterns of both long-run and short-run relationship between the developed US and the developing Indian market. The empirical results reveal a long run co-integrating relationship between the two markets. The NYSEOPEN returns coefficient in the VECM shows how deviations from the long-run relationship affect the changes in the NIFTY returns. In the long run the Indian indices' CLOSE and OPEN returns respond positively to US CLOSE and Negatively to US OPEN returns. The short run variation in the Indian Stock Market is highly responsive to NYSE OPEN returns. It is further evident from the error correction results that the coefficient for NIFTYCLOSE is about 0.84(entire sample period) and 0.64(Financial Crises period) with a negative sign and statistically significant. This means that the NIFTY CLOSE deviation in period (t-1) and its long run equilibrium value is corrected by as much as 84 percent for the entire sample and 64 percent during crisis. Since the value of the Error correction coefficients is high, it can be inferred that the speed of deviation adjustment is also very swift. The impulse response results exhibit that innovations in NYSE close returns affect both open and close returns of Indian and US markets, with an increased effect on the Indian market. Similar impact is found in the case of NIFTY Close returns as well. From the Variance decomposition analysis it is evident that US CLOSE and OPEN returns marginally explain the variance of NIFTYCLOSE returns forecast error till 10 days. During crisis the impact of US OPEN and CLOSE returns on the variations in NIFTYCLOSE returns has almost doubled. In the short run US (Open and Close) returns granger cause Indian market (Open and Close) returns. This lends support to the fact that Indian market react to US market in the short run. The findings of the research indicate that Indian Market is integrated to US Market movements implying that developments whether adverse or positive do influence Indian Markets and signals the entropy transmission across the two markets.

## REFERENCES

Amanulla, S., & Kamaiah, B. (1995). Market-integration as an alternative test of market efficiency: A case of Indian stock market. Artha Vignana, Gokhale Institute of Politics and Economics (GIPE) Journal, pp 215 – 230, Vol. XXXVII; Issue 3

Asari, F. F. A. H., Baharuddin, N. S., Jusoh, N., Mohamad, Z., Shamsudin, N., &Jusoff, K. (2011). A Vector Error Correction Model (VECM) Approach in Explaining the Relationship between Interest Rate and Inflation towards Exchange Rate Volatility in Malaysia. *World Applied Sciences Journal,* 12, 49-56.

Asgari, M. A. (2013). The impact of oil price and inflation rate on Iran economic growth (johansen-jusilius co integration) *Journal of Basic and Applied Scientific Research.* 3(1), 634-639

Bai, Y., &Cai, F. (2012). Energy consumption, economic growth and environmental pollution in GansuProvince: Evidence from 1990–2009. In *Robotics and Applications (ISRA), 2012 IEEE Symposium on* (pp. 373-378). IEEE.

Bhunia, A. (2012). Association between Crude Price and Stock Indices: Empirical Evidence from Bombay Stock Exchange. *Journal of Economics and Sustainable Development*, 3(3), 25-34.

Bin, D. (2007, August). Demand Analysis on Engines of Iron and Steel Industry Output Growth. In *Management Science and Engineering, 2007.ICMSE 2007. International Conference on* (pp. 1410-1415). IEEE.

Bonham, C., Gangnes, B., & Zhou, T. (2009).Modeling tourism: A fully identified VECM approach.*International Journal of Forecasting*, 25(3), 531-549

Dağli, H., Sivri, U., & Bank, S. (2012). International portfolio diversification opportunities between Turkey and other emerging markets.*International Journal of Trade and Global Markets*, *5*(1), 4-23.

Darrat, A. F., Zhong, M., Shelor, R. M., & Dickens, R. N. (1998). Forecasting corporate performance: VECM comparison with other time series models. *Studies in Economics and Finance*, *19*(1/2), 49-61.

Darrat, A. F., Zhong, M., Shelor, R. M., & Dickens, R. N. (1998). Forecasting corporate performance: VECM comparison with other time series models. *Studies in Economics and Finance*, 19(1/2), 49-61.

Dickey, D., Fuller, W. (1979). Distribution of the estimators for autoregressive time series with a unit root.*Journal of the American Statistical Association*, 74 (366), pp. 427–431.

Ding, D. K., Lau, S.T., &McInish, T.H. (1999). An investigation of price discovery in informationally-linked markets: equity trading in Malaysia and Singapore. *Journal of Multinational Financial Management*, *9*(3), 317-329.

Eun, C. S. and S. Sabherwal (2003). "Cross-Border Listing and Price Discovery:Evidence from US-Listed Canadian Stocks," *Journal of Finance* 58, 549-575.

Gay Jr, R.D. (2011). Effect of macroeconomic variables on stock market returns for four emerging economies: Brazil, Russia, India, and China. *International Business & Economics Research Journal (IBER)*, 7(3).

Gholampour, E., Mehrara, M., & Emamverdi, G. (2012).The analysis of asymmetric prices of crude oil and prices of imported gasoline to Iran using TAR model. *Journal of Basic and Applied Scientific Research.* 2(11), 10853-10858

Gupta, S. (2011).Study of BRIC countries in the financial turmoil.*International Affairs and Global Strategy*, *1*, 1-15.

Hoxha, A. (2010). Causality between Prices and Wages: VECM Analysis for EU-27. *Romanian Economic Journal*, *13*(37), 3-38.

Jayaraman, T. K., Choong, C. K., & Kumar, R. R. (2012).Role of remittances in India's economic growth. Global Business and Economics Review, 14(3), 159-177.

Jinjin, H., &Guoxing, T. (2008, October).A New Model for Generating Scenarios in ALM. In *Wireless Communications, Networking and Mobile Computing, 2008. WiCOM'08. 4th International Conference on* (pp. 1-4). IEEE.

Kababie, K., &Boehmer, C. R. (2012).*International trade and economic growth in Mexico*. University Library of Munich, Germany

Kim, L. C. H. (2010). Cross-Border Listing and Price Discovery: Canadian Blue Chips Traded in TSX and NYSE. Available at SSRN 1550230

Kularatne, C. (2002). An Examination of the Impact of Financial Deepening on Long-Run Economic Growth: An Application of a VECM Structure to a Middle-Income Country Context. *South African Journal of Economics*, 70(4), 300-319.

Liyan, L. (2011, August). FDI and Economic Development in China: 1978-2008. In*Management and Service Science (MASS), 2011 International Conference on* (pp. 1-4). IEEE.

MacKinnon, J. G., Haug, A. A., &Michelis, L. (1998). Numerical distribution functions of likelihood ratio tests for cointegration.

MacKinnon, J.G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics*, 11 (6), pp. 601–618.

Maysami, R.C., &Koh, T. S. (2000). A vector error correction model of the Singapore stock market.*International Review of Economics & Finance*, 9(1), 79-96.

Mehrara, M., Sargolzaei, M., Ahmadi, R., & Ahmadi, M. (2012). Investigating the relation between financial development and economic growth using ARDL approach case study: Iran. *Journal of Basic and Applied Scientific Research* 2(6), 5932-5936

Onanuga, A. T., &Shittu, A. M. (2010). Determinants of Interest Rate in Nigeria: An Error Correction Model. *Journal of Economics of International Finance*, 2(12), 261-271.

Patnaik, I., &Vasudevan, D. (1999). Interest Rate Determination: An Error Correction Model. National Council of Applied Economic Research

Pavabutr, P., &Chaihetphon, P. (2010).Price discovery in the Indian gold futures market. *Journal of Economics and Finance*, 34(4), 455-467

Pradhan, M. A. H., Afrin, S., & Islam, M.R. (2012). Contribution of Remittance on Current Account of Balance of Payments in Bangladesh: VECM Estimation. *International Journal of Applied Research in Business Administration and Economics, 1*(1).

Rezaei, F., & Moradi, A. (2012). Impact of operating cycles and accruals on the relationship between macroeconomic variables and Firm's stock returns. *Journal of Basic and Applied Scientific Research* 2(12), 12471-12481

Shah, A., Rehman, J. U., Kamal, Y., & Abbas, Z. (2010). The interest rates-stock prices nexus in highly volatile markets: Evidence from Pakistan. *Journal of Basic and Applied Scientific Research* 2(3), 2589-2598

Souhila, C., &Kourbali, B. (2012). Energy Consumption and Economic Growth in Algeria: Cointegration and Causality Analysis. *International Journal of Energy Economics and Policy*, 2(4), 238-249.

Srinivasan, P. (2011). Stock Market Efficiency and Common Stochastic Trends: A Case of NSE and BSE. *The IUP Journal of Financial Risk Management*, 8(2), 25-40.

Weiguo, X., & Yang, Z. (2010, December).Empirical research on the influence of real exchange rate volatility on US FDI in China. In *Information Science and Engineering (ICISE), 2010 2nd International Conference on* (pp. 222-225). IEEE.

Yu, F., Kou, Y., Tong, W. M., & Ye, Q. (2012, September). The relation between index futures intraday price discovery and exchanges regulations. In *Management Science and Engineering (ICMSE), 2012 International Conference on* (pp. 1451-1458). IEEE.