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| **Title** | : | **Analysis of Co Movements of Select US & Indian Stock Price Indexes** |
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## Abstract

The process of financial liberalization in the developing countries has brought about a vast change in their financial environment. Due to the increased flow of funds from the developed countries, as well as, due to the changes in the field of Information Technology, there has been a progressive integration of the emerging markets with the developed markets. The Indian markets are no exception to this phenomenon. The current paper is aimed at studying, whether there exists a long run relationship between the US and Indian stock market indexes. Different econometric tests such as the Engle Granger residual based test of cointegration, Hsiao, Granger and Sims tests of causality are employed in the analysis. The tests reveal that there is a long run relationship between the Nasdaq Composite Index and the NSE Nifty, indicating a direction of causation from Nasdaq Composite Index to NSE Nifty. But, fundamentally these two indexes are vastly different from each other.

# Section I: Introduction

The process of financial liberalization and integration in developing countries has gained much momentum after the works of McKinnon (1973) and Shaw (1973). The authors have been advocating that Financial Liberalisation is essential for both financial development and economic development. According to Das (1993), the process of financial liberalization has brought the capital markets closer by linking them more closely. Further, the developments in field of information technology has played an important role in bringing radical changes in the financial services sector by eliminating the geographical barriers to trading and by increasing the speed of fund transfer. The globalisation of the financial markets around the world has greatly stimulated the demand and supply of cross-border capital flows. Hawawini (1994) points out that there is an increasing flow of funds from developing countries towards emerging markets like the Latin American markets, the Asian markets, the African markets etc. and, therefore, these markets are becoming increasingly important in terms of portfolio management for institutional investors. Because of this, the stock markets worldwide have grown in size, as well depth, over the last one-decade. Total net private capital flows to emerging markets in 1999 were about US $ 71.5 billion, 58 per cent higher than the 1998 figure, and 68 per cent lower than the peak level of 1995 (Mathieson and Schinasi, 2000). But, it has been witnessed that the turnover in developed markets has grown more sharply than in emerging markets. Despite having a large number of companies listed on its stock exchanges, India accounted for a meager 0.4 per cent of the total turnover in 1999. In case of market capitalization, the share of US in worldwide market capitalisation was 46.2 per cent as at end-1999 whereas Indian listed companies accounted for 0.5 per cent of total market capitalization (International Finance Corporation, 2000). As far as the primary market is concerned, the emerging markets witnessed a 15 per cent increase in new issue of capital in the bond and equity markets in 1999. The growth in 1999 was more significant in the equity market; mainly so, because the new issues by Technology, Media and Telecommunication (hereafter referred to as TMT) companies were almost four times as that in 1998. Also, the return on the Standard and Poor/International Finance Corporation Investable (S&P/IFCI) composite; a benchmark dollar based index for emerging market equities has been around 11 per cent in the twelve months of the first quarter of the financial year 2001-2002 (IMF, 2002). In direct contrast, the S&P 500 index earned a negative return of 10 per cent and NASDAQ earned a negative return of 23 per cent for the same period. The recovery in emerging market equity prices reflected an improvement in the prospects for companies in emerging markets. The TMT stocks in emerging markets grew by about 95 per cent, 100 per cent and 170 per cent respectively, compared to overall price growth of about 65 per cent. Therefore it could be said that the pace of the overall growth was mainly due to the growth in the TMT segment. The emerging market equities were however adversely affected by the decline in NASDAQ and other indexes in March-May 2000. This is reflective of the fact that emerging market assets tend to dependent upon developments in advanced countries.

The liberalisation process in Indian economy and the growing importance of TMT stocks in driving the Indian stock markets have contributed to the increased integration of Indian Stock Markets with the Global Markets. The trade liberalisation process in India integrated many Indian and Multinational companies. As a result the financial performance of many Indian Companies became dependant on the performance of their foreign clients especially the TMT companies. As a part of analysing this phenomenon, a number of articles, which appeared in different financial dailies and weeklies, have put forth a viewpoint that there existed a causal

relationship between the NASDAQ Composite index and the Indian stock market indexes (Nifty and Sensex). (To cite a few, Datta, 1999, Joseph and Pinto, 2000) Later, some other analysts put forth a viewpoint that the Dow Jones Industrial Average (DJIA) causes the Indian Stock Market indexes. The aim of the present paper is to study whether there exists a tendency of co movements between the US stock market indexes, (NASDAQ Composite Index and the Dow Jones Industrial Average) and the Indian Stock Market indexes (NSE Nifty and BSE Sensex) and to study the causal relationship between the indexes. To analyse the long run relationship, the cointegration analysis of the indexes considered in the study is conducted so as to analyse whether there exists a long run relationship between them. The residual based approach proposed by Engle and Granger (1987) is used for cointegration analysis. If a pair of time series is cointegrated, there has to be causation in at least one direction (Granger, 1988). To know the direction of causation amongst the cointegrated variables, the causality analysis is conducted using three tests i.e. the Granger Test (1969); Sims Test (1972) and Hsiao Test (1981) are used.

To conduct the analysis, daily data for a period of more than six years spanning from 2nd January 1996 to 2nd Feb 2002 is considered for study. The index values for the common working days for the four indexes studied have been considered. The data is collected from the official websites of the respective Stock Indexes: www.nasdaq.com (NASDAQ-Composite), www.nseindia.com (NSE - NIFTY), www.bseindia.com (BSE-Sensex), www.dj.com (Dow Jones – Industrial Average). From 1996 onwards there has been a conscious effort on the part of SEBI to liberalise the norms for Foreign Institutional Investor (FII) investment in the debt market (in listed or to be listed corporate debt securities or dated government securities, T-bills etc.). The ceiling for FII investment was progressively relaxed. They were permitted to deal in derivative securities. Foreign investments in Indian securities were also made possible through the purchase of GDRs, Foreign currency convertible bonds issued by Indian issuers, which are listed, traded and settled overseas. Also, foreign investors were allowed to invest in Indian securities, outside the FII route, but it needed the approval from RBI and FIPB on a case-to-case basis. The Net FII investment has been in the range of 6,000 to 10,000 crore per annum during the period 1995-96 to 1999-2000. Except for the year 1998-99, in all other years, FIIs have been net purchasers in the Indian market. The reason for the outflow in 1998 can be traced back to the Southeast Asian currency crisis. Also, it was in 1996 that National Securities Clearing Corporation (NSCC) as well as National Securities Depository Limited (NSDL) was established and trading in Dematerialised from commenced in the Indian markets.

Subsequently, the study is covered through the following sections:

**Section two** deals with the changes, in the Indian Capital Market, in the last decade. **Section three** elaborates on the different methods of index calculation and the indexes analysed in the study. **Section four** describes the technique of analysis. **Section five** puts forth the Results of the analysis and discussions thereof. Finally, **Section six** puts forth the concluding remarks.

# Section II: Transition in the Indian Stock Markets

## Capital Market Reforms

Reforms in the capital market consist of: reforms in the primary market and the reforms in the secondary markets.

Primary Market Reforms

One of the first and major reforms that took place in the Capital Markets was the abolition of Capital Issues Controls and introduction of free pricing. Along with this came the regulations regarding disclosures to be made before going for a primary issue, the liberalization of entry norms, stipulation of eligibility norms for primary and secondary market intermediaries, specification of minimum promoter capital requirement and lock in period for the same etc. Besides, the above reforms, the book-building route for issue price discovery has increased the efficiency of the capital raising process. In anticipation of these reforms, the capital market started becoming a major source of finance for the corporate sector. Money raised in Capital Markets accounted for only 1 per cent of gross fixed capital formation in the economy in the 1970s and early 1980s. This figure rose to 6 per cent in 1990 and peaked to 13 per cent in 1993-94, but then fell to 2 per cent by the end of the decade. This phenomenon can be attributed to the series of scams that shook the Indian Securities Markets in the last decade, the regulators were forced to become more conservative and this slowed down the process of liberalization

Secondary market reforms

The reforms in the secondary market have played a very important role in increasing the width and depth of the market. The major reforms that have taken place in the Secondary market are the reforms in the trading system as regards to electronic trading, Dematerialised trading of securities, clearing & settlement mechanism, reforms in the carry forward & margin trading system and the introduction of new investment instruments.

Market oriented economic reforms began in 1991. As a result of financial liberalisation, the administrative controls on bank credit and on the primary market for securities, were relaxed. This made the role of capital markets in the economy all the more important. Almost immediately after the reforms began, there was a prominent scandal of fixed income securities and equity markets. This scam led to the empowerment of Securities and Exchange Board of India (SEBI) and creation of National Stock Exchange (NSE) by the Government of India. NSE was one of the first securities exchanges in the world to pioneer the demutualised structure, where brokerage firms did not own the exchange. Besides this, NSE pioneered many important innovations in the market design in India. The most important innovations being the setting up of nationwide electronic trading in the year 1994, setting up of central counterparty and paperless settlement at the depository in the year 1996 etc.

**Classification of the Reforms**

The reforms brought about a sea change in the Indian bourses. The paper tries to encapsulate these changes into three categories:

1. Institutional Reforms
2. Process and Service Reforms
3. Instrument Reforms

1. Institutional Reforms

As a part of the reform process, four new institutions were created: The Securities and Exchanges Board of India (SEBI), the National Stock Exchange (NSE), the National Securities Clearing Corporation Limited (NSCCL) and the National Securities Depository Ltd. (NSDL).

*SEBI*

The Securities and Exchanges Board of India (SEBI) was formed in 1988. It has gradually adopted many important roles in the area of policy formulation, regulation, enforcement and market development. This is in contrast with conditions prior to SEBI, where exchanges underwent little scrutiny or enforcement. It was after the securities scam of 1992 that SEBI as empowered. SEBI vets every element of market design in India's securities markets; it attempts enforcement against problems such as market manipulation and payments crises and performs oversight of market intermediaries.

*NSE*

In November 1992, leading Financial Institutions at the behest of the Government Of India set up the National Stock Exchange. NSE is owned by IDBI, UTI and other public sector institutions. NSE brought following key innovations in the way the market used to operate:

1. The physical floor was replaced by anonymous, computerised order matching with strict price-time priority.
2. The constraints due to public telecom network were avoided by using satellite communications with the help of very small aperture terminal (VSAT).
3. The form of organization of NSE itself is innovative. NSE is a limited liability company and brokers are franchisees. Hence NSE's staff is free of pressures from brokers and is better able to perform regulatory and enforcement functions.

Hence NSE improved the performance and efficiency of the stock exchange in the following manner:

1. It increased the transparency in the trading mechanism. Users could look at price on a computer screen before placing an order.
2. It brought about complete anonymity regarding identity of the traders. This has reduced greatly the scope for cartel formation and hence market manipulation.
3. It increased the competition in the brokerage industry by setting up a vast network of brokers. This led to a sharp reduction in transaction costs through lower brokerage fees.
4. It increased the operational efficiency of the markets. The automation brought about in the securities market effectively eliminated the vagaries of manual trading.

5. The satellite based trading system gave equal access to the trading floor from all locations in India. This was a major step towards development of the financial sector in cities outside Bombay.

2. Process & Service Reforms

*Nationwide Electronic Trading*

Earlier, an investor willing to transact in a security not traded on the nearest exchange had to route orders through a series of correspondent brokers to the appropriate exchange. This resulted in a great deal of uncertainty and high transaction costs. With the advent of screen based trading system, it has been made possible for an investor to access the same market and order book, irrespective of location, at the same price and at the same cost.

*Central Counterparty*

Unlike the floor trading system, anonymous trading greatly limits the scope for cartel formation and hence limits market manipulation. However, in doing so, it also eliminates the limited control over counterparty risk exercised by the traders. Hence, a central counterparty was established which assumes the counterparty risk of each member. The establishment of the Central counterparty supplemented by the setting up of a settlement guarantee fund which acts as an insurance against possible default have played a major role in increasing the investor confidence in the market mechanism.

*Rolling Settlement*

The Indian equity markets were based on the equity market design followed in England. Hence, the Indian markets followed account period settlement. In July 2001, it was replaced by rolling settlement wherein major stocks in the Indian market were moved to rolling settlement. In case of rolling settlement, trades are netted through the day, and all open positions at the end of the day are settled n days later unlike account period settlement where large leveraged positions can be present which do not normally unwind. The smaller is n, lesser is the delay between the trading date and the settlement date. As a result, the systemic risk associated with investing in the market is reduced. Earlier, the Institutional investors were forbidden from entering into badla and short selling contract, rolling settlement would enable the Institutional investors to buy on one day and sell on the other. Hence, Rolling settlement has a positive impact on the Institutional investors. This would increase the flexibility in transacting of the Institutional Investors. It is widely perceived that rolling settlement would drastically reduce the trading volumes but the reality is that, only the speculative volumes will reduce, which is already very high in India. The trading volume is almost three times the market capitalization. This is thrice the ratio prevailing in US and UK, thus indicating towards the existence of very high speculative volume. Also, it can be noted from the 52 week high and low statistics that in most cases the share price rises to more than double and falls to less than half within a year. This also points towards a very high level of speculative pricing of securities. (Gupta, 2001)

3. Instrument Innovation

The introduction of derivatives trading in India started with the, advent of trading on index futures in June 2000. Within a year trading in index option and trading in options on individual securities commenced in June 2001 and July 2001 respectively. This was followed by

trading in individual stock futures in November 2001. Before the introduction of stock futures, the maximum trading took place in case of stock options. Later, the maximum trading in terms of number of trades as well as in rupee term took place in case of stock futures followed by stock options. The derivatives market turnover has increased from over 26 per cent of the total equity market turnover in May 2002 to over 39 per cent in July 2002. It was noted that by and large, in all the stock derivative instruments, the number of contracts as well as the values of contracts transacted is much more in the NSE than in the BSE. The volumes in futures and options trading in NSE were 10-15 times that of BSE. Hence, NSE has turned out to be the most preferred exchange for investors in the derivative products. (Stock Holding Corporation of India Limited, 2001.)

## Section III: Index Calculation & the Indexes used in the study

An index is a single descriptive statistic that summarizes the relative change in an underlying group of variables. In an equity index the underlying variables are stocks. Equity share price movement is a sensitive element, since it is subject to high risk and return, which arises on account of its size and nature of investment. Indexes of share price serve the purpose of summary measure of behaviour of security prices and stock market. Indexes can be differentiated among themselves by the nature of securities held (Index Grouping) and the weighing scheme (Index Weighing). Indexes are grouped on the basis of: (i) Simple Financial Ratios (ii) Market Capitalisation (iii) Style (Value or Growth). Based on such a grouping one could have two broad types of indexes: (i) Broad based Indexes (Small Cap Index, Mid Cap Index, Large Cap Index, Value based Index, Growth Index, Geographic/Regional Index) (ii) Narrow based Indexes (Specific Economic Sector based Index, Specific Industry based Index)

An Index consists of a number of shares, each of these shares have to be assigned weights so as to calculate the index. There are different methods by which weights can be assigned to the Index constituents. Index constituents can be either equal weighted, price weighted, or cap weighted. Assigning equal weights to the index constituents implies that each stock has equal representation in the index. If the index constituents are weighed on the basis of their price, then the higher the price, the more the weightage of the share in the index. In the case when the index constituents are weighed on the basis of Market Capitalisation of the individual securities, the higher the Market Capitalization (price times the no. of shares) higher is the weightage. The method of assigning weights has an impact on the calculation of index returns, on making adjustments to bonus issues, rights issue etc. (Boss, 2000)

The paper studies the Long run relationship between two of the largest indexes in US (NASDAQ Composite and Dow Jones Industrial Average) and the two largest Indian Stock Market indexes (NSE Nifty and BSE Sensex). The NASDAQ Composite is a broad based index comprising of around 5,000 companies, most of them small companies. On the other hand, DJIA is an average of the stock prices of thirty large US firms covering such diverse industries as financial services, technology, retail, entertainment and consumer goods. Both these indexes are price-weighted indexes. In the Indian Stock Markets, for a long time, there was only one stock exchange and that is the Bombay Stock Exchange. The BSE Sensex was first compiled in 1986. It is a Market Capitalisation Weighted index comprising of thirty stocks of companies, which are leaders in the industries they represent. NSE was set up in Nov. 1992 though its capital market segment was operational only in November 1994. Within a year of commencement of operations, NSE became India's largest exchange. There are very few other parallels to this

episode internationally, where a second exchange displaced the entrenched liquidity on an existing market within under a year (Shah and Thomas, 2000). S&P CNX NIFTY is a well-diversified 50 stock index accounting for 23 sectors of the economy. Both these indexes studied are market capitalization weighted.

## Section IV: Techniques used in the Analysis

**Unit Root Testing**

Time series analysis is about the identification, estimation and diagnostic checking of stationary time series.

**Definition:** The sequence {yt} is said to be covariance stationary if for all t and t-s

1. $E(y_t)= E(y_s)= \mu$
2. $E(y_t-\mu)^2 = E(y_{t-s}-m)^2 = \sigma^2$
3. $E(y_t-\mu)(y_{t-s}-\mu) = E(y_{t-j}-\mu)(y_{t-j-s}-\mu) = \gamma_s$

That is, the mean, variance and covariance are invariant to the time origin.

**Dickey and Fuller (1979, 1981)** devised a procedure to formally test for the presence of a unit root. The proposed test starts with the assumption that a series $X_t$ is following an AR(1) process of this form:

$X_t=\rho X_{t-1}+e_t$ (1)

and then testing for the case of $\rho$ being equal to one (unity and hence 'unit root'). Dickey and Fuller (1979) actually consider three different regression equations that can be used to test for the presence of a unit root:

$X_t=\rho X_{t-1}+e_t$ (2)

$X_t=a_0+\rho X_{t-1}+e_t$ (3)

$X_t=a_0+\rho X_{t-1}+a_{1t}+e_t$ (4)

The difference between the three regressions concerns the presence of the deterministic elements $a_0$ and $a_{1t}$. The first is a pure random walk model, the second ads an intercept or drift term, and the third includes both a drift and linear time trend.

The parameter of interest in all the regression equations is $\rho$; if $\rho = 1$, the series contains a unit root. In this test the null hypothesis is $H_o$:$\rho = 1$, in which case we say X has a unit root. The alternative is $H_1$:$\rho < 1$. If the alternative hypothesis is correct than X is stationary. But if the null is correct, then the variable is nonstationary, so our usual tests do not apply.

*The Augmented Dickey-Fuller Test for Unit Roots*

The Augmented Dickey-Fuller test simply includes AR(p) terms of the $\Delta X_t$ term in the three alternative models. Therefore we have:

$$\Delta X_t=g\ X_{t-1}+\sum_{i=1}^{p}\ \beta_i\Delta X_{t-1}+\ e_t \qquad (5)$$

$$\Delta X_t=\alpha_0+g\ X_{t-1}+\sum_{i=1}^{p}\ \beta_i\Delta X_{t-1}+\ e_t \qquad (6)$$

$$\Delta X_t=a_0+g\ X_{t-1}+a_2t+\sum_{i=1}^{p}\ \beta_i\Delta X_{t-1}+\ e_t \qquad (7)$$

The difference between the three regressions again concerns the presence of the deterministic elements $a_0$ and $a_{2\ t}$. The parameter of interest in all the regression equations is again $\gamma$; if $\gamma = 0$, the series contains a unit root. More recently, Phillips and Perron (1988) have

suggested alternative non-parametric procedure by using the residuals from the DF regression. The advantage of Phillips-Perron test is that it is free from parametric errors.

**Test of Cointegration**

The test of Cointegration identifies the long run structural relationship among the variables under consideration. In other words, it tries to establish whether in the long run the variables under study would move in the same direction or not. The current study envisages to study whether the indexes under consideration move in the same direction in the long run or not.

Consider two time series $x_t$ and $y_t$, these two time series can be said to be cointegrated if: (a) both time series ($x_t$ and $y_t$) are I(1) that is become stationary after first differencing, and (b) there is some linear combination of $x_t$ and $y_t$ that is I(0), that is stationary.

In general for two I(1) variables, any linear combination among them, would be of the form:

$y_t = b_o + b_1 x_t + u_t$

or

$u_t = y_t - (b_o + b_1 x_t)$

for example, with $b_o$ and $b_1$ taking different values, to be I(1) as well. However, if $x_t$ and $y_t$ are linked together in a linear (long-term) relationship then one will find something unusual occurring, namely the second of the two conditions for the existence of cointegration will hold: there will be at least one linear combination of $x_t$ and $y_t$ that will be I(0), that is stationary.

When this is the case, one can be certain that any correlation over time between $x_t$ and $y_t$ is not spurious. When conditions (a) and (b) above hold, it is said that the time series $x_t$ and $y_t$ are cointegrated. Thus, cointegration is the statistical equivalent of the existence of a long-run economic relationship between I(1) variables. The meaning is that of existence of long-run equilibrium relationship.

**Testing for Causal Relationship Amongst the Cointegrated Indexes**

**Granger-Causality Test**

Granger (1988) pointed out that if a pair of time series is cointegrated, then there must be causation in at least one direction. According to the Granger causality (Granger, 1969) approach a variable Y is caused by X, if Y can be predicted better from past values of Y and X, than from past values of Y alone. Four patterns of causality can be distinguished: (a) unidirectional causality from X to Y; (b) unidirectional causality from Y to X; (3) feedback or bi-directional causality; and (d) no causality. For a simple bivariate model, the pattern of causality can be identified by estimating regression of Y and X on all the relevant variables including the current and past values of X and Y respectively and by testing the appropriate hypothesis. By using the following model the causality between two variables can be tested.

$$Y_t = b_0 + \sum_{j=0}^{m} a_j x_{t-j} + \sum_{i=1}^{n} b_i y_{t-i} + u_t \qquad (8)$$

$$X_t = c_0 + \sum_{j=0}^{m} c_j y_{t-j} + \sum_{i=1}^{n} d_i x_{t-i} + v_t \qquad (9)$$

where $u_t$ and $v_t$ are uncorrelated white noise series. Testing the null hypothesis that $a_j = d_j = 0$ for all j (j=0,1…..m) against the alternate hypothesis that $a_j \neq 0$ and $d_j \neq 0$ for at least some js will determine the direction of relationship between X and Y. It is seen that the variables are Integrated of the order one and that two of the variables are co integrated. Hence, Granger causality tests are applied after taking their first difference.

$$DY_t = b_0 + \sum_{j=0}^{m} a_j Dx_{t-j} + \sum_{i=1}^{n} b_i Dy_{t-i} + \delta ECT_{t-1} + u_t$$

$$DX_t = c_0 + \sum_{j=0}^{m} c_j Dy_{t-j} + \sum_{i=1}^{n} d_i Dx_{t-i} + \delta ECT_{t-1} + v_t$$

Where, D denotes the first difference of the variables and $ECT_{t-1}$ denotes the error correction term

**Sims Causality Test**

This test procedure is based on the principle that future does not cause past.

According to Sims (1972), if one regresses Y on past, present and future values of X, the null hypothesis of causal relation from X to Y is equivalent to all the coefficients o the future values of X being equal to zero. For this test, the direction of causation is from the dependent variable to the independent variable.

$$Yt = \alpha + \beta_k X_{t-k} + \beta_{k-1} X_{t-k-1} + \ldots + \beta_1 X_{t-1} + \beta_0 X_t + \lambda_1 X_{t+1} + \lambda_2 X_{t+2} + \ldots + \lambda_m X_{t+m} + u_t \quad (10)$$

**Hsiao Test of Causality**

The procedure of the Hsiao test (Hsiao, 1981) is as follows: In this test, initially the variable, say $Y_t$, is auto regressed up to some lag length say L. The order of lag is to be determined using Akaike Information Criteria, say AIC(m). Keeping the lag order of $Y_t$ fixed, $Y_t$ is regressed on $Y_{t-1}$, ….., $Y_{t-m}$ and current and past values of X (up to a lag of K). Compute the AIC for each of the lag order of $X_t$. Similarly the lag order is selected using Akaike Information Criteria say, AIC (m, n). Now, if AIC(m,n) < AIC(m), then it can be said that X causes Y.

## Section V: Results and Discussion

It can be seen from the OLS results (refer, Table 1(a) through Table 1(c)), that more than half the variation, in both the Indian indexes studied (NSE Nifty and BSE Sensex), is explained by NASDAQ Composite Index; whereas DJIA explains only about 36.5 per cent and 24 per cent variation in the two indexes respectively. Further, it can be seen that the t-statistic and the F-statistic in each of the regression analysis carried out, is significant at 1 per cent level indicating that the variables as well as the overall relationship is significant. In other words, the OLS results indicate that not only are each of the explanatory variables included in the regression analysis important, but also the overall estimated relationship itself is significant. But it has been seen that in each of the OLS regression carried out, the $R^2$ is greater than the DW statistic, which hints at the possibility of spurious regression. (Granger and Newbold, 1974) Hence, the time series have to be tested for stationarity. In the current study, the Augmented Dickey Fuller and Phillips-Perron test of stationarity are used.

Since the absolute value of the ADF as well as the Phillips Perron test statistic is less than the critical statistic at 95 per cent level of significance, the null hypothesis that the time series are non-stationary is not rejected (refer, Table 2). In other words, each of the four times series tested (NASDAQ Composite, Dow Jones Industrial Average, NSE Nifty and BSE Sensex) suffers from the problem of unit root. To make the data stationary, the first difference of each of the time series is tested for stationarity using Augmented Dickey Fuller and Phillips-Perron test. As can be seen, the ADF and PP statistic (absolute value) is greater than the critical statistic at 95

per cent level of significance in each of the four cases. Hence, it could be said that the series is integrated of the order one. Further, the stationarity of the errors generated out of the regression of two non-stationary time series is to be checked. In other words, it is to be tested whether the time series are cointegrated or not. The Engle-Granger residual based test of co integration is conducted for testing the same. The result of the residual based test is represented through table 3(a) to 3 (d). The results indicate that except for the case in which NSE Nifty was regressed on NASDAQ Composite Index, in all other cases, the calculated ADF statistic of the residual term was smaller than the critical statistic. In other words, the error generated out of the regression of two non stationary time series is itself non stationary. Hence it could be said that only NASDAQ Composite Index and NSE Nifty are cointegrated.

Further, the causality test was run for the cointegrated variables so as to determine the direction of causality between the variables. There could be five possibilities: (i) Causality runs from NASDAQ Composite Index to NSE Nifty; (ii) Causality runs from NSE Nifty to NASDAQ Composite Index; (iii) There exists instantaneous causality between the NASDAQ Composite Index and NSE Nifty; (iv) There exists feedback (bi-directional) causality between NASDAQ Composite Index and NSE Nifty; (v) There is no causal relationship between the NASDAQ Composite Index and NSE Nifty. The causal relationship between the two indexes was examined using the (i) Hsiao Causality Test (ii) Granger (GR) Causality test (iii) Sims Test.

The result of the Hsiao Causality Test is depicted through table 4 (a) to 4(c) Table 4(a) contains the results of the univariate regressions for all the variables while tables 4(b) and 4(c) contain the results of the bivariate regressions for NASDAQ Composite Index and the NSE Nifty. From table 4(a) it could be said that both the indexes are to include one lagged value of each of the indexes. Tables 4(b) and 4(c) indicate a bi-directional causality between the two indexes.

Table 5 indicates a unidirectional causality from NASDAQ Composite Index to NSE Nifty as per the Bivariate Granger Causality Test. Finally, Table 6 once again indicates a bi-directional causality between the two indexes according to the Sims Causality Test.

## Section VI: Conclusions

The present study has examined whether a long run relationship exists between two major stock indexes in US namely NASDAQ Composite Index and Dow Jones Industrial Average, on the one hand and two major stock indexes in India namely NSE Nifty and BSE Sensex on the other. The results indicate a cointegrating relationship between NASDAQ Composite Index and NSE Nifty. Further, the causal relationship between the two cointegrated time series is studied using different models. The results indicate varying degree of causal relationships between the two cointegrated time series i.e. NASDAQ Composite Index and the NSE Nifty. But, all of them converge on one point that is, NASDAQ Composite Index causes NSE Nifty.

This may be so because of the liberalisation of Indian economy and the growing importance of TMT stocks in driving the Indian stock markets. As indicated earlier, the trade liberalisation process in India integrated many Indian and Multinational companies. As a result the profit performance of many Indian companies became dependant on the performance of their foreign counterparts especially the TMT companies. The listing of Indian companies in foreign markets also played an important role in the Integration of the Indian Stock Market. However, there remains a lot of dissimilarity between NASDAQ Composite and the NSE Nifty:

a) NASDAQ is an over the counter exchange whose counterpart in India is OTCEI (Over The Counter Exchange of India).
b) NASDAQ Composite Index is calculated by using Market Value Weighted Method, whereas National Stock Exchange is calculated by using Market Capitalisation Weighted Method.
c) The composition of both the indexes are vastly different, whereas NASDAQ Composite comprises of 5,000 scrips with Computer, Biotech and Telecom accounting for 75 per cent of the weightage, NSE Nifty is much more diverse comprising of Fifty scrips representing 25 industries. The Nasdaq Composite index thus is a very broad based index, which consists of a lot of small companies where as while constructing Nifty the most liquid scrips of companies which are leaders in the industries they represent are considered.

The only scrip, which is common in the calculation of Nasdaq Composite and NSE Nifty, is Infosys Technologies Ltd. Therefore it could be said that fundamentally both the indexes are vastly different and any co movements observed may be due to other reasons (behavioural).

Hence, many financial analysts have suggested that Dow Jones Industrial Average may be a better benchmark for the Indian Stock Indexes to follow, but the current study reveals that, in fact, Indian Stock Market indexes do not share a long run relationship with the Dow Jones Industrial Average either. This may be so because DJIA is based on the thirty largest and most liquid stocks traded in the US markets. At the end of 1999, these thirty stocks accounted for 28 per cent of the total market value of US stocks; hence it need not serve as an indicator of the performance of the entire economy. Also, DJIA is a price-weighted index, hence it assigns a higher weightage over time to those stocks that experience higher prices. As a result of this, the index tends to have an upward bias in its estimation of the market's overall performance. Therefore the suggestion that DJIA may be a better benchmark for the Indian stock market indexes is empirically invalidated.

**Table: 1 (a) OLS Regression Results: Independent Variable – NASDAQ Composite**
**Dependant Variable – NSE Nifty**
**(Sample Period: 2/1/1996 to 4/2/2002. (T=1416))**

| Independent Variables | Coefficient | T- Ratio [Probability] |
|---|---|---|
| Intercept | 752.4438* | 95.1963 [.000] |
| NASDAQ Composite | .17506* | 52.4984[.000] |
| R - Squared = .66092 R – bar – Squared = .66068<br>F (1, 1414) = 2756.1 [.000]<br>Residual Sum of Squares 1.94E+07<br>DW = .037411<br>* Significant at 1 per cent | | |

**Table: 1 (b) OLS Regression Results: Independent Variable – NASDAQ Composite**
**Dependant Variable – BSE Sensex**
**(Sample Period: 2/1/1996 to 4/2/2002. (T=1416))**

| Independent Variables | Coefficient | T- Ratio [Probability] |
|---|---|---|
| Intercept | 2667.0* | 91.4879[.000] |
| NASDAQ Composite | .51877* | 42.1822[.000] |
| R - Squared = .55720 R – bar – Squared = .55689<br>F (1, 1414) = 1779.3 [.000]<br>Residual Sum of Squares 2.63E+08<br>DW = .031751<br>* Significant at 1 per cent | | |

**Table:1(c) OLS Regression Results: Independent Variable – Dow Jones Industrial Average**
**Dependant Variable – NSE Nifty**
**(Sample Period: 2/1/1996 to 4/2/2002. (T=1416))**

| Independent Variables | Coefficient | T- Ratio [Probability] |
|---|---|---|
| Intercept | 554.5248 * | 26.7052[.000] |
| NASDAQ Composite | .064877 * | 28.5092[.000] |
| R - Squared = .36500 R – bar – Squared = .36455<br>F (1, 1414) = 812.7756 [.000]<br>Residual Sum of Squares 3.62E+07<br>DW = .018092<br>* Significant at 1 per cent | | |

**Table:1(d) OLS Regression Results: Independent Variable – Dow Jones Industrial Average**
**Dependant Variable – BSE Sensex**
**(Sample Period: 2/1/1996 to 4/2/2002. (T=1416))**

| Independent Variables | Coefficient | T- Ratio [Probability] |
|---|---|---|
| Intercept | 2268.2* | 31.0213[.000] |
| NASDAQ Composite | .17124* | 21.3697[.000] |
| R - Squared = .24412 R – bar – Squared = .24358<br>F (1, 1414) = 456.6639 [.000]<br>Residual Sum of Squares 4.49E+08<br>DW = .017277<br>* Significant at 1 per cent | | |

**Table: 2 Unit Root Test Results**

| Variable | ADF | First Difference ADF Test Statistic | Phillips - Perron | First Difference Phillips Perron Test Statistic | Critical Statistic (95%) | Inference |
|---|---|---|---|---|---|---|
| NASDAQ Composite | -1.4489 | -27.0905 | -.90714 | -33.5401 | -2.8640 | I(1) Stationary at first difference |
| Dow Jones Industrial Average | -1.9567 | -27.6632 | -2.5296 | -36.8205 | -2.8640 | I(1) Stationary at first difference |
| NSE Nifty | -2.2842 | -26.7342 | -1.7362 | -25.3988 | -2.8640 | I(1) Stationary at first difference |
| BSE Sensex | -2.3319 | -25.4862 | -1.7585 | -18.9670 | -2.8640 | I(1) Stationary at first difference |

I(1) = Integrated of order one.

**Table: 3 (a) Unit Root Test Results of Residuals based on OLS Regression of NSE Nifty on Dow Jones Industrial Average**

**Index Independent Variable – Dow Jones Industrial Average**
**Dependant Variable – NSE Nifty**

| Test (Lag) | Test Statistic | AIC | SBC |
|---|---|---|---|
| **DF** | -2.4767 | -6332.4 | -6335.0 |
| **ADF (1)** | -2.5500 | -6332.8 | -6338.0 |
| **ADF (2)** | -2.3872 | -6331.2 | -6339.1 |
| **ADF (3)** | -2.3953 | -6332.2 | -6342.7 |
| **ADF (4)** | -2.4676 | -6332.5 | -6345.6 |
| **95% critical value for the Dickey-Fuller statistic = -3.3419**<br>**AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion** | | | |

**Table: 3 (b) Unit Root Test Results of Residuals based on OLS Regression of BSE Sensex on Dow Jones Industrial Average**

**Index Independent Variable – Dow Jones Industrial Average**
**Dependant Variable – BSE Sensex**

| Test (Lag) | Test Statistic | AIC | SBC |
|---|---|---|---|
| **DF** | -2.3473 | -8076.4 | -8079.0 |
| **ADF (1)** | -2.3912 | -8077.1 | -8082.4 |
| **ADF (2)** | -2.3916 | -8078.1 | -8086.0 |
| **ADF (3)** | -2.3552 | -8079.1 | -8089.6 |
| **ADF (4)** | -2.4284 | -8079.4 | -8092.5 |
| **95% critical value for the Dickey-Fuller statistic = -3.3419**<br>**AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion** | | | |

**Table: 3 (c) Unit Root Test Results of Residuals based on OLS Regression of BSE Sensex on NASDAQ Composite**

**Index Independent Variable – NASDAQ Composite**
**Dependant Variable – BSE Sensex**

| Test (Lag) | Test Statistic | AIC | SBC |
|---|---|---|---|
| **DF** | -3.3358 | -8125.8 | -8128.4 |
| **ADF (1)** | -3.3047 | -8126.7 | -8132.0 |
| **ADF (2)** | -3.3071 | -8127.7 | -8135.6 |
| **ADF (3)** | -3.2289 | -8128.5 | -8139.0 |
| **ADF (4)** | -3.2573 | -8129.4 | -8142.5 |
| **95% critical value for the Dickey-Fuller statistic = -3.3419**<br>**AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion** | | | |

**Table: 3 (d) Unit Root Test Results of Residuals based on OLS Regression of NSE Nifty on NASDAQ Composite**

**Index Independent Variable – NASDAQ Composite**
**Dependant Variable – NSE Nifty**

| Test (Lag) | Test Statistic | AIC | SBC |
|---|---|---|---|
| **DF** | -3.6688 | -6398.8 | -6401.4 |
| **ADF (1)** | -3.6139 | -6399.7 | -6405.0 |
| **ADF (2)** | -3.4592 | -6399.7 | -6407.5 |
| **ADF (3)** | -3.4205 | -6400.6 | -6411.1 |
| **ADF (4)** | -3.4226 | -6401.6 | -6414.7 |
| **95% critical value for the Dickey-Fuller statistic = -3.3419**<br>**AIC = Akaike Information Criterion SBC = Schwarz Bayesian Criterion** | | | |

**Table: 4 (a) Results of Univariate Regressions (Hsiao Test)**

| Lag | NASDAQ (AIC) | Nifty (AIC) |
|---|---|---|
| **1** | **3454.6** | **3601.1** |
| **2** | 3451.0 | 3600.1 |
| **3** | 3448.5 | 3596.2 |
| **4** | 3444.7 | 3592.7 |
| **5** | 3440.8 | 3589.6 |

**Table 4 (b): Results of Bivariate Regression**

| NASDAQ Composite Index Causes NSE Nifty | |
|---|---|
| **Lag** | **NASDAQ** |
| **0** | 3592.2 |
| **1** | 3592.8 |
| **2** | 3604.4 |
| **3** | 3603.5 |
| **4** | 3607.5 |
| **5** | **3607.6** |

**Table 4 (c): Results of Bivariate Regression**

| **NSE Nifty Causes NASDAQ Composite Index** | |
|---|---|
| **Lag** | **Nifty** |
| **0** | 3440.2 |
| **1** | **3447.2** |
| **2** | 3446.5 |
| **3** | 3445.6 |
| **4** | 3444.6 |
| **5** | 3443.8 |

**Table 5: Results of Bivariate Granger Causality Test**

| **Direction of Causation** | **F – stat (Probability)**<br>**(2, 1411)** |
|---|---|
| NASDAQ Composite Index Causes NSE Nifty | 23.6513 (.000) |
| NSE Nifty Causes NASDAQ Composite Index | 0.072303 (.930) |

**Table 6: Results of Sims Causality Test**

| **Direction of Causation** | **F – stat (Probability)**<br>**(3, 1409)** |
|---|---|
| NASDAQ Composite Index Causes NSE Nifty | 19.0458 (.000) |
| NSE Nifty Causes NASDAQ Composite Index | 18.4305 (.000) |

**Table 7: Summary Results of the different Causality Tests**

| **Direction of Causality** | **Hsiao Test** | **Granger Causality Test** | **Sims Causality Test** |
|---|---|---|---|
| **NASDAQ Composite Index Causes NSE Nifty** | ✔ | ✔ | ✔ |
| **NSE Nifty Causes NASDAQ Composite Index** | ✔ | ✘ | ✔ |

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