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Co-integration of Nifty and NASDAQ Composite- An Empirical Investigation

M. Sriram,
Assistant Professor-Finance,
SDM Institute of Management Development,
Mysore, India.
Email: msriram@sdmimd.ac.in

Abstract

The present study has analysed the long term relationship between Nifty and NASDAQ Composite for the period 01/01/2000 to 19/08/2014. The study has employed certain econometric tools to analyse the behaviour of both the series. The study finds that both the series are not normally distributed. Unit Root Test was applied to test for stationarity of data and was found to be stationary at first difference and not at level form. Using Johansen's Co-integration test, it was found that there exists no co-integration/long term association between the Indices. Vector Autoregressive Approach (VAR) indicated that the performance of NASDAQ Composite depended upon the lagged terms of Nifty. To further strengthen the findings, Granger Causality test was employed and the results found unidirectional relationship. Nifty was Granger causing NASDAQ Composite. Short term relationship exists between the indices. The key findings of the study explore the scope of portfolio diversification of Investors and Portfolio managers in the absence of a long term relationship. The Indian market continues to be an attractive destination for Foreign Institutional Investors.

Keywords: *NASDAQ Composite, Nifty, Vector Autoregressive, Granger Causality, Johansen's Co-Integration*
JEL Classification Code: *G15*

1. Introduction

The Indian Capital market stands testimony to developments in the use of technology post liberalisation and globalisation. Trading and settlement, paperless trading and greater transparency in the mechanics of stock trading are the by-products of enhanced application of technology. The developments were on the lines of making the Capital Market developed and on par with the International Markets. The LPG process has vitalised policy makers to liberalise foreign trade policies and hence the improved flow of foreign funds in the form of FDI and Foreign Institutional Investments into the markets. The policy changes have encouraged companies to cross list shares in other overseas exchanges. Indian companies have started to list shares in the U.S (through issue of ADRs) and other bourses and foreign companies are now permitted to raise funds from the Indian Investors through issue of depository receipts in the form of IDR (Indian Depository Receipts). ***Park (1990)*** found that a substantial portion of the variability in ADR returns is accounted for by the variations in the share price of the underlying security in the home market. It is evident that markets are interlinked and the linkages and interdependence between capital markets constitute co-integration. Co-integration refers to the process of identifying the presence of long term dependencies between two stock markets. The study of the existence of inter-linkages among international capital markets has serious implications on determining the extent of portfolio diversification as well as macroeconomic policies of respective countries ***(Nambi et al., 2010)***. It is also a reflection of regional economic linkages between the countries and helps in guiding regional financial policy formulation. If there is no long term relationship, then there is scope for portfolio diversification for the investors and portfolio managers. Investors prefer to hold securities from a variety of firms because diversification reduces portfolio risk. Diversification can be rewarding because stock indices of different countries are affected by different factors and need not necessarily move in the same direction. The presence of short term linkages can be explored as some ASEAN markets have witnessed ***(Roca et al., 1998)***. Also in the recent past there has been flow of foreign investments in the form of Foreign Institutional Investments and through issue of depository receipts; it has become imperative to determine the degree of association between Indian markets and the U.S markets.

1.1 Objectives

The following are the objectives of the study-

1. To study the dynamics of short term linkages between the U.S (NASDAQ Composite) and the Indian Stock market (Nifty).

2. To explore the presence of long term linkages between the markets and interpret the results thereof.
3. To capture the linear interdependencies among the indices selected for the study.

2. Literature Review

Chan et al., (1997) conducted a study on integration of stock markets by including 18 nations covering a 32 year period. These markets were analyzed both separately and collectively in regions to test for the weak form market efficiency. The cross country market efficiency was tested using Johansen's co-integration test. The results showed that only small number of stock markets have shown evidence of co-integration with others. ***Bala et al.,(2001)*** in their study examined the nature and extent of linkage between the US and the Indian stock markets. They used the theory of co-integration to study the interdependence between the Bombay stock exchange (BSE), the NYSE and NASDAQ. The data consisted of daily closing prices for the three indices from January1991 through December 1999. The results supported the notion that the Indian stock market was not affected by the movements in US markets for the entire sample period. ***Wong et al., (2004)*** have empirically investigated the long-run equilibrium relationship and short-run dynamic linkage between the Indian stock market and the stock markets in major developed countries by examining the Granger causality relationship and the pair-wise, multiple and fraction co-integrations between the Indian stock market and the developed stock markets such as US, UK and Japan. The findings of the study reveal that the Indian stock market is statistically, significantly co-integrated with stock markets of United States, United Kingdom and Japan. There is existence of a unidirectional granger causality running from the US, UK and Japanese stock markets to the Indian stock markets. ***Gaural Agarwal et al., (2010)*** in their study on the relationship between Nifty returns and dollar-rupee exchange rate used several statistical tests to study the behavior and dynamics of both the series. It was found that there was unidirectional relationship between Nifty returns and exchange rates using Granger Causality test with the direction running from the former towards the latter. ***Nambi et al., (2010)*** in their study tested whether the Indian stock market is interdependent on the American Stock Markets. The New York Stock Exchange is the largest stock exchange in the world in terms of Market Capitalization. Many Indian companies have listed their shares in America. The extent of co-integration between the major Indian stock exchanges with the leading stock markets of America like NYSE, S&P500 and the NASDAQ was tested using the Engle Grangler test of Co-integration. The data collected was for the time period Jan 1st 2000 to 31st Dec 2008. The authors concluded that there was no co-integration between the markets. ***Sriram et al., (2014)*** in their study on analysing the relationship between Sensex returns and exchange returns from 10-06-

2010 to 11-07-2013 found that both the return series were not normally distributed. Unit Root test was applied to test for the stationarity of data and it was found to be stationary at level form itself. Correlation between Sensex returns and exchange rate was found to be negative and weak. To test the causal relationship between the variables, the authors applied Granger causality test was and it was proved that unidirectional relationship existed between Sensex returns and exchange rate returns. Sensex returns was Granger causing exchange rate returns.

2.1 Research Questions

The following are the research questions pertaining to the study-

*If NASDAQ is replaced with another index, say NASDAQ Composite (A brief write up is given in the Methodology), will the results change?

*Are there short term linkages between the Indices?

* In the absence of a long term relationship, can the study explore the possibility of establishing linear interdependency between the Indices?

3. Methodology

3.1 Data and Period of Study

The study is based on secondary data. The daily data for the Nifty was collected from the website www.nseindia.com and for the NASDAQ Composite, the details were collected from www.finance.yahoo.com . The period of study was from 01.01.2000 to19.08.2014.

NASDAQ Composite is a stock market Index of common stocks similar to the ones listed on NASDAQ stock market. The index is not exclusively an U.S Index as both U.S and non-U.S Companies are listed. It is highly followed in the U.S as an indicator of the performance of high growth stocks.

The following statistical tools were employed to test the hypotheses. The tests namely JB test, Unit root test and Granger Causality test were conducted using E-views software (version 7). Brief explanations about various statistical tools are given below;

3.2 Normality Test

The Jarque-Bera (JB) test (Gujarati, 2003) is used to test whether stock returns and exchange rates individually follow the normal probability distribution. The JB test of normality is an asymptotic, or large-sample, test. This test computes the skewness and kurtosis measures and uses the following test statistic:

$JB = n [S2 /6 + (K-3)2 /24]$

Where n = sample size, S = skewness coefficient, and K = kurtosis coefficient.

For a normally distributed variable, S = 0 and K = 3. Therefore, the JB test of normality is a test of the joint hypothesis that S and K are 0 and 3 respectively. To analyse the pattern of

distribution of data, skewness and kurtosis have been calculated. Zero skewness implies symmetry in the distribution whereas kurtosis indicates the extent to which probability is concentrated in the centre and especially at the tail of the distribution. Kurtosis measures the peakedness of a distribution relative to the normal distribution. A distribution with equal kurtosis as normal distribution is called 'mesokurtic;' a distribution with small tails is called 'platykurtic' and a distribution with a large tail is called 'leptokurtic.'

3.3 Unit Root Test (Stationarity Test)

Empirical work based on time series data assumes that the underlying time series is stationary. Broadly speaking a data series is said to be stationary if its mean and variance are constant (non-changing) over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed (Gujarati, 2003). A unit root test has been applied to check whether a series is stationary or not. Stationarity condition has been tested using Augmented Dickey Fuller (ADF).

3.4 Augmented Dickey Fuller (ADF) Test

Augmented Dickey-Fuller (ADF) test has been carried out which is the modified version of Dickey-Fuller (DF) test. ADF makes a parametric correction in the original DF test for higher-order correlation by assuming that the series follows an AR (p) process. The ADF approach controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression. The Augmented Dickey-Fuller test specification used here is as follows:

$Yt = b0 + \beta\Delta\ Yt\text{-}1 + \mu1\ \Delta Yt\text{-}1 + \mu2\ \Delta Yt\text{-}2 + \ldots.. + \mu p\ \Delta Yt\text{-}p + et$

Yt represents time series to be tested, b0 is the intercept term, β is the coefficient of interest in the unit root test, μ1 is the parameter of the augmented lagged first difference of Yt to represent the pth-order autoregressive process, and et is the white noise error term.

3.5 Granger Causality Test

According to the concept of Granger's causality test (1969, 1988), a time series x_t Granger-causes another time series y_t if series y_t can be predicted with better accuracy by using past values of x_t rather than by not doing so, other information is being identical. If it can be shown, usually through a series of F-tests and considering AIC on lagged values of x_t (and with lagged values of y_t also known), that those x_t values provide statistically significant information about future values of y_t time series then x_t is said to Granger-cause y_t i.e. x_t can be used to forecast y_t. The pre-condition for applying Granger Causality test is to ascertain the stationarity of the variables in the pair. Engle and Granger (1987) show that if two non-stationary variables are co-integrated, a

vector auto-regression in the first differences is unspecified. If the variables are co-integrated, an error-correcting model must be constructed.

The Johansen's Co integration test is used to test the presence of long term equilibrium relationship between the spot and future market of the currencies. The Vector Error Correction Model (VECM) is used to analyse the whether error correction mechanism takes place if some disturbance comes in the equilibrium relationship. If there is no co-integration, the variables have to be differenced d times and a VAR model is constructed where in each variable has an equation has explaining its evolution based on its own lags and lags of other variable model.

3.6 Hypotheses

H_1 – The indices namely Nifty and NASDAQ Composite are not normally distributed.

H_2 - Unit Root exists (i.e. non stationarity) in both the series

H_3- There is a long term relationship between Nifty and NASDAQ Composite Index.

H_4 - There exist no causality between Nifty and NASDAQ Composite Index.

4. Results and Discussion

Table 1

Particulars	Nifty	NASDAQ Composite
Mean	3523.51	2457.016
Median	3593.45	2291.28
Maximum	7897.5	5048.63
Minimum	854.2	1114.11
Standard Deviation	1937.89	758.54
Skewness	0.093	0.912
Kurtosis	1.586	3.43
Jarque Bera	309.62	538.23
Probability	0.00	0.00

Table 1 shows the descriptive statistics of daily closing values of Nifty and NASDAQ Composite for the period selected for the study. It can be seen that the closing price in case of Nifty varies from 854.2 to 7897.5 thereby stating that there is wide fluctuation in the daily closing values of Nifty. Similarly, the closing price of NASDAQ Composite varies from 1114.11 to 5048.62 respectively. The mean value for the entire period is 3523.51 for Nifty and 2457.01 for NASDAQ Composite. Skewness is positive (0.093) for Nifty and NASDAQ Composite (0.912) indicating a relatively long right tail compared to the left one. Kurtosis with 1.586 for Nifty and 3.43 for NASDAQ Composite indicates short tails and the distribution is platykurtic'. The findings are similar to the existing literature and with a high Jarque-Bera statistic, it can be confirmed that the returns series is not normally distributed. Hence, H_1 is accepted

It is a fact that many financial time series data are random walk or non-stationary time series and contain unit root. Test of unit root in the spot and future currency prices of dollar is essential as the presence of unit root may give invalid inferences in the analysis. ADF (Augmented Dickey-Fuller Test) is the popular test for unit root testing of time series.

Table 2 shows the results of ADF test and the result indicates that both (Nifty and NASDAQ Composite) series are non-stationary at level form and hence hypothesis (H_2) is accepted. The data becomes stationary at their first difference and is statistically significant.

Table 2: ADF Unit Root Test for Nifty (Nif) and NASDAQ Composite (Nas)

Particulars	't'Value(Nif)	Probability(Nif)	't' Value (Nas)	Probability(Nas)
At level	0.12491	0.9676	-1.4573	0.5553
At first difference	-56.31564	0.0001	-45.123	0.0001

Table 3: Johansen's Co-Integration Test on Nifty and NASDAQ Composite

Co integration Between	Lag length selected	Co integration test using	No. of Co integrating Equations (CEs)	Eigen Value	Statistic	Critical value at 5%	Probability**
Daily Closing of Nifty and Daily Closing of Nasdaq	1 to 4 (in first difference of 2 series)	Trace test	H_0: r=0 (None) H_1: r ≤ 1 (At most 1)	0.00297 9.43E-06	10.9107 0.0344	15.494 3.841	0.21 0.8528
		Max-Eigen Value test	H_0: r=0 (None) H_1: r ≤ 1 (At most 1)	0.00297 9.43E-06	10.876 0.0344	14.26 3.841	0.165 0.8528

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The co- integration test was introduced by Granger (1981, 1983) and Engle and Granger (1987) to explain stationary equilibrium relationship among the non-stationary variables. The co integration test is useful in analyzing the presence of a stationary linear combination among the non-stationary variables of the same order. If such a combination is found, an equilibrium relationship is said to exist between the variables. The Johansen co integration test is applied in the research study between the closing values of Nifty and NASDAQ Composite .The result of the Johansen's Co-Integration Test are shown in table III. The trace statistics for the calculated Eigen value is less than the table value and hence the null hypothesis of no co integration is accepted. The results are similar for NASDAQ Composite and hence the result indicates the

absence of long term relationship between the Indian and U.S markets. There exists no long term equilibrium relationship between the indices and hence hypothesis ($H_{3)}$ is rejected.

As there is no long term relationship between the markets, a Vector Autoregressive approach is constructed to study the relationship between the variables. The following table (Table IV) presents the result- The VAR results indicate that Nifty's performance depends upon the lagged terms of Nifty. Similarly, the performance of NASDAQ Composite depends upon the lagged term (one) of Nifty. NASDAQ Composite is dependent upon one lagged term of its own. Therefore, it is clearly shown that NASDAQ Composite clearly depends upon the movement in Nifty. To further strengthen the results to identify whether unidirectional or bidirectional relationship exists, Granger Causality test is performed.

Table IV: Vector Autoregressive Results Standard errors in ( ) & t-statistics in [ ]

	NIFTY	**NASDAQ**
NIFTY(-1)	1.068909	0.037914
	(0.01654)	(0.01239)
	[64.6451]*	[3.06045]*
NIFTY(-2)	-0.068925	-0.036615
	(0.01654)	(0.01240)
	[-4.16603]*	[-2.95388]*
NASDAQ(-1)	0.031315	0.984177
	(0.02202)	(0.01650)
	[1.42185]	[59.6444]*
NASDAQ(-2)	-0.031054	0.012922
	(0.02200)	(0.01648)
	[-1.41156]	[0.78394]
C	1.007852	2.625249
	(3.21830)	(2.41122)
	[0.31316]	[1.08876]

*Significant @ 1%

Table 5: Results of Granger Causality Test

Null Hypothesis	Observations	F Statistic	Probability
NASDAQ Composite does not Granger Cause Nifty	3651	1.01667	0.3619
Nifty does not Granger Cause NASDAQ Composite		9.28601	0.0009

Granger Causality test is performed to capture the degree and the direction of relationship between Nifty and NASDAQ Composite. Table V shows pair wise Granger Causality test. It can be seen that the null hypothesis

'NASDAQ Composite does not Granger Cause Nifty' can certainly be accepted as the F statistic 1.01667 is not statistically significant and falls behind the critical value. However, the null hypothesis 'Nifty does not Granger Cause NASDAQ Composite 'certainly can be rejected. Therefore, it can be said that Nifty Granger Causes NASDAQ Composite. This can be confirmed from Table VI. The results show that Nifty Granger Causes NASDAQ Composite as the chi-square value of 18.57203 is statistically significant (probability value 0.0001). NASDAQ Composite does not Granger Cause Nifty as the chi-square value of 2.033336 is not statistically significant (probability value 0.3618) and hence the result is unidirectional causality running from Nifty to NASDAQ Composite. Hence hypothesis (H_4) is rejected.

Table 6: Inference from Granger Causality Test

Dependent variable: NASDAQ Composite			
Excluded	Chi-sq	df	Prob.
NIFTY	18.57203	2	0.0001
All	18.57203	2	0.0001

Dependent variable: NIFTY			
Excluded	Chi-sq	df	Prob.
NASDAQ Composite	2.033336	2	0.3618
All	2.033336	2	0.3618

5. Conclusions and Recommendations

The study finds that the data during the period of study of Nifty and NASDAQ Composite is not normally distributed. The data is non-stationary (Presence of Unit Root) at level form but

became stationary at first difference. Since both the series are stationary at the first difference, the data is eligible for conducting co-integration test. The co-integration results show that both the indices are not integrated in the long run. The findings are similar to the study conducted by ***Nambi et al., (2010)*** but contradict the findings of ***Wong et al., (2004)*** in which the authors claim the presence of a long term relationship between the Indian and developed markets such as U.S, U.K and Japanese markets. The reasons for the absence of co-integration could be the cross listing of shares. Though the issue of ADR by Indian companies was permitted a decade ago, the number of companies as a percentage of total companies listed in the bourses is very low. The same is the case with the issue of IDR by U.S companies to raise equity from the Indian markets. The VAR results also indicate the presence of linear interdependency among the Indices with NASDAQ Composite dependent upon lagged values of Nifty. When analysed the short term relationship between the indices, it is found that Nifty Granger causes NASDAQ Composite inferring that the returns of NASDAQ depends upon the Nifty performance. The results also contradict the findings of ***Wong et al., (2004)*** which revealed a unidirectional Granger causality running from the U.S, U.K and the Japanese market to the Indian market.

The study concludes that by replacing NASDAQ with NASDAQ Composite, the results of the study are similar to the existing literature i.e., there is no long term relationship between the Indices. Short term linkages seem to be present with NASDAQ composite depending on the performance of Nifty. In the absence of a long term relationship, there is a possibility of portfolio diversification either way for Investors and Portfolio Managers. The Indian market continues to be attractive for Foreign Institutional Investors in the short run.

Future studies can focus on the presence of co-integration between India and U.S in terms of foreign trade and Investments, co-integration of Indian Indices with other major Indices across the globe. Such studies may end up with in contrast to the existing literature available. The results may also differ if the frequency of data is changed and sector specific Indices are compared and analysed.

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