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A Study of the Interrelationship between the Nifty and the Sectoral Indices of the NSE using the Techniques of Unit Root Testing, Cointegration Analysis and Granger Causality Analysis

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Abstract

The National Stock Exchange (NSE) of India is the leading stock exchange in India in terms of the number of transactions per day. The primary index of this exchange is the S&P CNX Nifty, popularly known as the Nifty. In addition the NSE also includes various sectoral indices that track performance of shares across sectors. This paper tries to establish the degree of inter-relationship between the Nifty and the sectoral indices. It attempts to do so using the techniques of unit root, cointegration analysis and Granger causality analysis. It is observed that the Nifty has an influence on the sectoral components and vice versa. This leads to the conclusion that the sectoral performance can be taken as indicator of the overall market performance while the movements of the Nifty can aid in investment decisions relating to particular sectors.

Keywords: ***NSE, Nifty, Sectoral Indices, shares, Unit Root, Cointegration Analysis, Granger Causality Analysis.***

Introduction

The stock market scenario in India is essentially a two-horse race comprising of the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). The former is India's oldest stock exchange while the latter occupies primacy of position in terms of volume of trading, particularly in the derivatives market. Each of these stock exchanges utilises a set of indices as a barometer for different dimensions of the market. Each such basket of indices consists of a primary index and a collection of sectoral indices. This paper focuses on the NSE, thereby limiting itself to the consideration of the S&P CNX Nifty (or simply the Nifty, as per popular use), the primary index of the NSE, and the sectoral indices covering areas like banking, information technology (IT), realty, infrastructure, etc. The attempt here is to examine the degree of inter-relationship among the primary index and its sectoral counterparts. This is sought to be achieved through the application of statistical tools

like unit root testing, cointegration analysis and causality analysis. Unit root testing has been performed using the commonly followed Augmented Dickey Fuller (ADF) test; the cointegration analysis utilises Johansen's Procedure; lastly causality is identified with the help of the Granger Causality Test.

The remaining part of the paper has been arranged as follows:

Section II provides an overview of the literature survey undertaken for the study. Section III outlines the brief objectives for the study. Section IV explains the database and methodology utilised for the study. Section V deals with the results and analysis thereof. Section VI ends the paper with the conclusive observations.

Literature Survey and Justification for the Study

There have been various attempts at using the methodologies that constitute the framework of this paper. A major portion of such research has concentrated on evaluating the relationship between the real economy and the capital markets in various countries. We consider here a brief selection of the relevant literature in this area.

Comincioli and Wesleyan (1996) tried to examine the causal relationship between stock prices and the economy in case of the USA using quarterly data over 24 years. Using Granger Causality Test, they found that stock prices Granger cause economic activity, but not vice versa.

A study by Naka *et al*. (1999) examines the relationship between the BSE Sensex and five macroeconomic variables, viz. – the Index of Industrial Production (IIP), the Consumer Price Index, money supply, interest rate and inflation. The unique feature of this study is that it involved a comparison between the pre and post reform performance employing the techniques of cointegration and vector error correction. It was found that IIP was the largest positive determinant of stock prices, while inflation is the largest negative determinant.

A different perspective is provided by the effort of Pethe and Ajit (2000) where they look into the inter-relationship between stock indices like the Sensex and the Nifty on one hand, and significant macroeconomic variables like the rupee-dollar exchange rate, the prime lending rate, narrow money supply, broad money supply and the IIP. The methodology involved the use of unit root testing, cointegration and error-correction models. The results indicated no cointegration among the variables; further, it was suggested that though the economy is influenced by both the stock indices considered, these indices did not have any impact on the IIP.

Another work by Panda and Kamiah (2001) relates to the causal relations and dynamic interactions among monetary policy, expected inflation, real activity and stock returns in the post-liberalisation period. Here the vector autoregression method was utilised to make conclusions regarding the relationship among variables like monetary policy, expected inflation, real activity and stock returns.

Bhattacharya and Mukherjee (2002) used unit root tests, cointegration and the long-run Granger causality test to the causal relationship between the BSE Sensex and five macroeconomic variables. The conclusion was that there is no linkage between stock prices and money supply, national income and interest rate; the IIP induces increase in stock value; and there is a two-way causality between stock prices and the rate of inflation.

Yet another attempt at establishing the relationship between real economic variables and the stock market in an Indian backdrop was undertaken by Vani et al (2003). Similar efforts were also taken up by Chakravarty (2005).

Islam (2003) has carried out a study for the Malayasian economy where he has dealt with short-term dynamic adjustment and long-run equilibrium relationships among variables like interest rate, inflation rate, exchange rate and IIP. For this purpose he has utilised the error correction modelling technique. The results indicate a variety of short run and long run relationships among these variables.

Osman and Yakup (2003) have undertaken a study devoted to examining the relationship between the Turkish Stock Market and macroeconomic variables like money supply, dollar exchange rate, trade balance and the index for industrial production. Here they used Engel-Granger and Johansen-Juselius cointegration tests and Granger Causality Test for the purpose determining the long-run relationship among the variables.

Sharkasi et al. (2004) have looked into price interdependence between stock markets in Ireland, UK, Portugal, USA, Brazil, Japan and Hong Kong utilising a new testing method,based on the wavelet transform to reconstruct the data series, as suggested by Lee (2002).The authors have found evidence of intra-European (Irish, UK and Portuguese) market co-movements with the US market also weakly influencing the Irish market, apart from co-movement between the US and Brazilian markets and similar intra-Asian co-movements (Japanese and Hong Kong). According to them the European markets affect the markets in the Americas, which in turn influence those in Asia, which again impact the Europen markets, thus completing the circle. Lastly the authors claim evidence for intra-continental relationships and an increase in importance of international spillover effects since the mid 1990's. They suggest that the importance of historical transmissions has decreased since the beginning of the present century.

Dritsaki (2005) has performed some empirical tests in order to examine the long-run relationship between the Stock Market Index of Greece (GEN) and variables like industrial production, inflation and interest rates. The Granger Causality Test was once again applied for identifying the causal relationship among the variables.

The interaction between the real and financial sectors of the Canadian economy formed the focal point of the study by Gauthier and Fuchun (2005). They considered a

long-run relationship for the determination of output, stock market and term structure of interest rates. The study utilised the Vector Correction Model over six variables.

Chandrasekhar and Jayati (2005) undertook a study involving two consecutive years of the BSE Sensex; they concluded that the movements in the manufacturing IIP and the Sensex are independent of one another. Chandrasekhar and Ghosh (2005) also obtained a similar result.

Bhowmik (2008) has attempted an empirical study examining the inter-rela tionship between the BSE Sensex, the sectoral indices of the BSE and some stock indices outside India. Applying the method of cointegrated multiple regression analysis, the study concludes that the movements of the Sensex and some of the sectoral indices in India follow those of the foreign indices, specially those belonging to Asian countries and the United States. The author suggests that the results offer a strong case for integration of stock m arkets across the world.

The paper by Soenen and Johnson (2008) deals with the effects of changes in the consumer price index on industrial production and stock market returns for China. The authors have worked with six different types of Chinese shares covering the period from 1994 to 1998. According to them the results suggest a very significant positive relationship between inflation and real output. Further they have found A positive and significant association between stock returns and real output in current periods. As per their study, inflation does not seem to impact real stock returns in China. While the relationships are applicable to the "B" shares, "H" shares and red chips in China, the returns for the "A" shares do not seem to be affected by the changes in domestic inflation or real industrial production.

Ahmad (2009) has tried to examine the causal relationship between the stock market and the manufacturing sector in India on the basis of data relating to the BSE Sensex and the IIP. In doing so he has resorted to the Engel-Granger cointegration test for measuring the long-term relationship among the the variables and the Granger causality test for evaluating the short-term causal relationship He concludes that there is a long-term relationship between the stock market and the manufacturing sector, while in the short-term, causality runs from the BSE Sensex to the IIP.

The work by Iqbal et al. (2011) examines the dynamic linkages between the equity market of USA and emerging markets of Pakistan and India on the basis of daily data covering the period of January 2003–December 2009. For this purpose it uses the cointegration procedure suggested by Johansen and Johansen and Juselius for discerning the long-term relationship among the markets. It also applies the Granger causality test based on the methodology of Toda and Yamamoto. The authors found no long-term relationship among the markets. There was evidence of unidirectional causality from the New York Stock Exchange to those in Bombay and Karachi.

Chi-man Hui and Ng's paper (2012) relates to examining the relationship between the residential property market and the stock market in Hong Kong. For this purpose they have utilised the Granger causality test, variance decomposition and CUSUM test. A unique feature of this study is that is that it has tried to identify the break points and variation of relation. The results suggest that the correlation between residential property price and stock index had become weaker with time, despite the fact that the residential property price follows the same trend as the stock market during the sample period. The authors suggest that in such a situation there is a greater likelihood for the investors to make more profits by going for portfolio diversification.

Brief Objectives

Following the aforementioned goal of identifying the inter-relationship, if any, among the Nifty and the sectoral indices of the NSE, we formulate the following objectives for the present effort:

1. Examining the data collected for the study in order to evaluate the presence or absence of stationarity
2. Evaluating the possibility of existence of long-term relationship
3. Identifying how the indices influence one another

Data Base and Methodology

The study has been performed for discerning any possible relationship between the Nifty on one hand, and the sectoral components on the other. As some of the constituent scrips of the sectoral indices will obviously feature as components of the Nifty, an alternative approach has been considered where instead of operating with the sectoral indices per se, we consider the constituent scrips corresponding to each sectoral index which do not simultaneously feature as a component of the primary index. It is obvious that the number of such scrips may be substantial. Therefore we have chosen to consider the leading scrips in each case on the basis of market capitalisation. We try to relate the values of the Nifty with those of the non-Nifty scrips from the bank, infrastructure and IT sectors.

The data utilised for the purpose includes values of the Nifty and the selected scrips from 2000 to 2009. Care has been taken to ensure that only those instances are considered where data is concurrently available for all components.

A brief introduction to the major statistical tools that constitute the bedrock of the present effort would be very relevant here.

Whenever a sequence of data is to be used for time series analysis, it is necessary to evaluate whether such data may give rise to spurious phenomena that result in localised short-term effects that die down with time. The property of data that is free from such spurious phenomena is known as stationarity. It has been said that a stochastic process is said to be stationary if its mean and variance are constant over

time and the value of the covariance between the two time periods depends only on the lag between these two periods and not the actual time at which the covariance is computed. The problem with a non-stationary series is that the behaviour of a non-stationary time series can be considered only for the time period under consideration, i.e., it is not possible to generalise for other time periods, thus providing little practical value for forecasting.

For the purpose of testing the existence of stationarity in a data series we use the following equation:

$$Y_t = \rho Y_{t-1} + u_t$$

When $\rho=1$, i.e., when a unit root is present, it indicates a non-stationary process. The above equation can be alternatively written as follows:

$$\Delta Y_t = \delta Y_{t-1} + u_t$$

where $\delta = \rho-1$; obviously the existence of non-stationarity is now denoted by $\delta =0$. While Dickey and Fuller have proposed number of tests for stationarity, in this paper we have utilised the Augmented Dickey-Fuller (ADF) test, which also happens to be the most popular variant of the test. In a few cases, when the ADF test has not proved conclusive, we have opted for the Philips-Perron test.

For the next step, i.e., evaluation of the existence of long-term relationship, we have adopted the cointegration analysis technique proposed by Johansen. The phenomenon of cointegration was introduced by Granger. At a broad level it can be said that cointegration is applicable when several variables are driven by a common stochastic trend; such variables have a particularly strong link that may be of interest. If y_t and x_t are two I(1) variables (i.e., two variables which integrated of the order 1), then they are said to be cointegrated if a linear combination of these variables is I(0) [i.e., stationary], i.e., if there exists a β such that $y_t-\beta x_t$ is I(0).

The third component of the analytic portion of the study is made up of the Granger Causality test. This kind of causality study enters into the picture as cointegration analysis cannot throw complete light on the nature of relationship between specific pairs of variables. However, in the light of the present study, the focus is obviously on the latter as we try to examine the interactions among the Nifty and the diverse sectoral scrips of the NSE.

At first each of the twelve data series is to be tested for stationarity using the ADF test. Once it has been ascertained that each of these series is non-stationary, i.e., all of them are I(1), the Johansen cointegration test is carried out to evaluate the existence of a long-term relationship between the Sensex and each of the sectoral indices. Lastly, we have resorted to the Granger Causality test to identify the contours of the relationship.

Results and Analysis

5.1 Unit Root Test for the Nifty and the Sectoral Indices

The unit root tests for the Nifty and associated scrips of the NSE yielded the following results:

Table 5.1: Results of Unit Root Tests for the NSE Data Series

Sl.No.	NSE Data Series	ADF Test Statistic	p value
1	S&P CNX Nifty	-2.360916	0.4002
2	Bank of India	-3.067000*	0.1145*
3	Bank of Baroda	-3.371831	0.0554
4	GTL	-2.808468*	0.1942*
5	IDBI Bank	-3.024375	0.1256
6	Rolta	-2.429077	0.3642

*Philips-Perron Test Statistic

In this case, two scrips, viz., Bank of India and GTL do not yield convincing results through the ADF test; therefore the Philips-Perron was utilised to arrive at more conclusive results. As all the scrips are ultimately proven to be non-stationary, there is no difficulty in continuing to the cointegration test.

5.2 Cointegration Analysis for Primary and Sectoral Stock Indices.

Applying the cointegration test by the Johansen procedure, the following results are obtained:

Table 5.2: Trace Test for NSE Data Series

Date: 06/24/10 Time: 10:35

Sample (adjusted): 4 2496

Included observations: 2493 after adjustments

Trend assumption: Linear deterministic trend (restricted)

Series: NIFTY BANK_OF_INDIA BOB GTL IDBI_BANK ROLTA

Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.01939	123.1077	117.7082	0.0217
At most 1	0.013307	74.29436	88.8038	0.3477
At most 2	0.00641	40.89729	63.8761	0.8182
At most 3	0.004134	24.86695	42.91525	0.7964
At most 4	0.003533	14.54022	25.87211	0.6128
At most 5	0.002291	5.717226	12.51798	0.497

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 5.3: Max Eigen Value Test for NSE Data Series

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None *	0.01939	48.81334	44.4972	0.016
At most 1	0.013307	33.39707	38.33101	0.1656
At most 2	0.00641	16.03035	32.11832	0.9099
At most 3	0.004134	10.32672	25.82321	0.9528
At most 4	0.003533	8.822997	19.38704	0.7425
At most 5	0.002291	5.717226	12.51798	0.497

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

As the results of the above tests show, there is at least one cointegrating equation at the 5% level of significance. Table 5.4 on the following page demonstrates the cointegrating equation for the NSE data series.

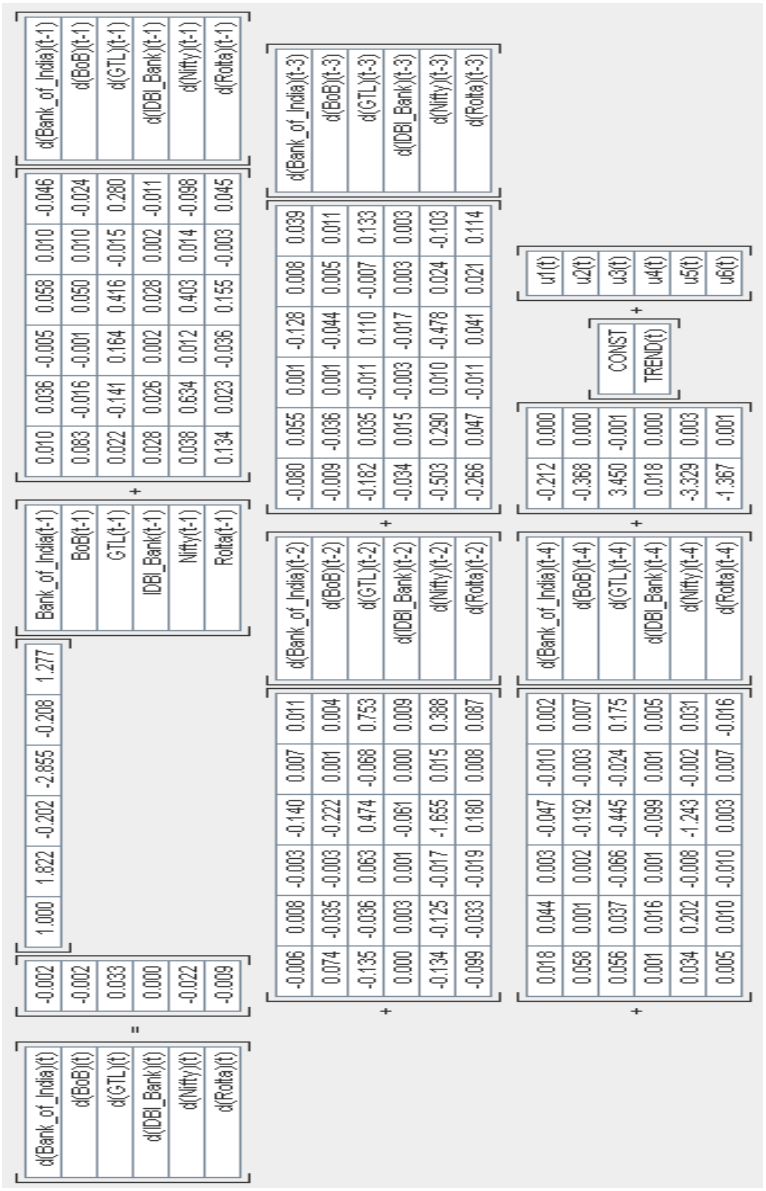
5.3 Granger Causality Test for the Nifty and Sectoral Indices

Now proceeding to the Nifty and the sectoral indices of NSE the results of the Granger Causality test for are as follows:

Table 5.5: Results of Granger Causality Test for the Nifty and Sectoral Indices on the NSE

Sl. No.	H_0	Result	p value
1.	Nifty does not Granger-cause the sectoral scrips of the NSE.	NOT ACCEPTED	0.0000
2.	Bank of India does not Granger-cause the Nifty and the other sectoral scrips of the NSE.	NOT ACCEPTED	0.0010
3.	Bank of Baroda does not Granger-cause the Nifty and the other sectoral scrips of the NSE.	NOT ACCEPTED	0.0189
4.	GTL does not Granger-cause the Nifty and the other sectoral scrips of the NSE.	NOT ACCEPTED	0.0000
5.	IDBI Bank does not Granger-cause the Nifty and the other sectoral scrips of the NSE.	ACCEPTED	0.1941
6.	Rolta does not Granger-cause the Nifty and the other sectoral scrips of the NSE.	NOT ACCEPTED	0.0000
7.	Bank of India, Bank of Baroda and IDBI Bank do not Granger-cause the Nifty and the other sectoral scrips of the NSE.	NOT ACCEPTED	0.0050
8.	GTL and Rolta do not Granger-cause the Nifty and the other sectoral scrips of the NSE.	NOT ACCEPTED	0.0000

Table 5.4: Cointegrating Equation for NSE data series



Since cointegrating by itself cannot suggest the nature of relationship existing among the variables, we take the help of Granger Causality tests to throw more light on this aspect.

Proceeding with the analysis of the results, once gain the primary index influences the behaviour of the sectoral scrips, a fact that is consonance the usual mechanisms of a stock exchange. Similarly, these scrips together exert an impact on the Nifty, thus

showing that on an overall basis, the sectoral representatives can impose themselves on the Nifty to some extent. Considering individual effects of these scrips, Bank of India, Bank of Baroda, GTL and Rolta affect the Nifty IDBI Bank is the only scrip that does have an impact on the Nifty. From the sectoral perspective, both the banking and IT sectors had an influenced the behaviour of the Nifty. The explanation for each of the above may follow from a consideration of the performance of the relevant scrips or sectors.

Conclusion and Policy Prescriptions

The preceding results indicate that there is a possibility that the Nifty may have a long-term relationship with the selected scrips.

It is observed that the Nifty has an influence on the sectoral components and vice versa. This leads to the conclusion that the sectoral performance can be taken as indicator of the overall market performance while the movements of the Nifty can aid in investment decisions relating to particular sectors.

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