Co-movement Analysis among different Sectors of Indian Stock Market

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Abstract

The relationship between the stock markets of the developed and emerging countries has been examined extensively in the literature. However, there are very few studies in the literature that attempt to analyse cointegration among different sectors within a single stock market. Hence, this study examines the cointegration among different sectors of Indian Bombay Stock Exchange (BSE) using daily sector indices data from the period January 4, 2010 to May 21, 2013. Stock market sectors include Auto, Bankex, capital-goods, Consumer-durables, FMCG, IT, Metals, Oil & Gas, Power and Realty. The result of Johansen co-integration multiple test reveals one co-integration equation, which shows the integration and an existence of long run equilibrium among the sectors. The bivariate cointegration analysis leads to the conclusion of no cointegration in all the cases of 45 pairs of the sectoral indices except Bankex-IT and Consumer Durables-Realty. This finding implies that there are benefits from portfolio diversification, when domestic investors construct portfolios which include stocks from the sectors which are not cointegrated. The results of the Granger causality tests show that the bidirectional and lead-lag unidirectional short term relationship between different sectors are considerably limited. Moreover, it is found that Auto, Bankex, Capital-goods, Power, Metals and Realty sectors are the leading sectors. However, FMCG, Oil & Gas, IT and Consumer-Durables are the lagging sectors.

Keywords

Diversification; Portfolio; Return; Risk; Volatility

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Introduction

The issue of interdependence between stock markets had been widely studied in the literature. This is because, globalization, financial reforms, advances in computer technology and information processing had reduced the barriers to capital transactions between various countries and increased the linkages between stock market movement in various countries (Darbar and Deb, 1997). In recent years, foreign investors have expressed an increasing amount of interest in the emerging financial markets of ASEAN and Asian NICs due to their potential and favourable experiences. The interest in this region has led to different studies conducted in ASEAN and Asian Newly Industrialised Countries, especially after the 1997 Asian currency crisis [Among others, Granger, Huang and Yang (2000), Moon (2001) and Daly (2003)]. Most of the studies emphasised on the linkages between the developed and Asian markets, the intra-day and week trading activities in emerging Asian markets and the correlation between risk and return as well as their stability. However, as to our knowledge, there are very few attempts to analyse the market interaction among different sectors within a single stock market. Earlier studies by Grubel and Fadner (1971) highlighted that the interdependence of share price movements is much less pronounced among countries than within a country (Karim, 2005).

Hence, the objective of this paper is to examine the integration relationship within the ten major sector price indices of Bombay Stock Exchange of India. Research on the linkages within the stocks market behaviour in India is very pertinent in order to better understand many relevant issues pertaining to the Indian stock market. This is because the Indian stock market operates as an emerging market where its function is different in term of cultural, institutional and regulatory circumstances from those in the developed countries (Karim, 2005).

Literature Review

There are voluminous studies that investigate the level of integration of the world's capital markets over time and across markets. These studies also explore a diversity of issues germane to global market linkages, such as short-run and long-run interdependences of these markets (e.g., Chung and Liu, 1994; Shamsuddin and Kim,2003; Phaylaktis and Ravazzolo, 2005), leaders and followers amongst a set of financial markets (e.g., Arshanapalli and Doukas, 1993; Ghosh et al., 1999; Masih and Masih, 2002), and transmission mechanism of market volatility between countries (e.g., Soydemir, 2000; AuYong et al., 2004; Chung, 2005). A key contribution of this stream of research is the information it uncovers about the diversification potential amongst international capital markets.

However, a handful of studies has been undertaken to address the issue of sectoral index interrelationships concerning a particular economy. This is a persistent question for investors with a preference for domestic equity and reluctance to diversifying internationally because the construction of a well-diversified asset portfolio relies on a sound understanding of how closely different

market sectoral indices are interrelated and how these dynamic interrelationships vary over time.

A well-cited study in this line of research is that of Arbeláez et al. (2001) in which they investigate the short-run and long-run relationships amongst the several stock price indices of the Colombian capital markets. The data include daily price for the six indices of the Medellín Stock Exchange: General, Industrial, Financial, Commercial, Various, and Select, spanning the period between January 2, 1988 and August 9, 1994. In addition to providing substantial evidence of long-run cointegration relationships, the empirical results reveal short-run dynamic linkages amongst the Colombian market sectoral indices in about 50% of the cases. Besides, these short- and long-run linkages have strengthened over time.

Ewing (2003) examined five major Standard & Poor's stock indices (i.e., utilities, transportation, industrials, financials, and capital goods) in order to determine their interrelationships and how shocks to one index are transmitted to the others. By and large, the results of generalized variance decomposition analysis document strong interrelationships among the five Standard & Poor's stock indices.

Karim (2005) examined the integration relationship within the five major sector price indices listed on the main board of the Malaysian stock market. The results of the study show that there exists a short-run causality relationship between the sectors in the Malaysian stock market for the whole period under study. The daily price movement in the construction sector is found to lead the daily price movement from other sectors for the period before and after the financial crisis. However, the trend of causal relationship shifts during the financial crisis in which the financial sector plays a major role in influencing the price movement of other sectors.

Wang et al. (2005) explore the dynamic relationships amongst major sectoral indices of the Chinese stock exchanges in Shanghai and Shenzhen, using daily and monthly returns during the period between 1993 and 2001. Their empirical results reveal a high degree of interdependence, implying that potential diversification benefits from sector - level investments may be relatively limited. They also find that Industry is the most influential sector in both exchanges, while Finance in Shenzhen offers the best diversification tool within the Chinese stock market since this sector is the least integrated with other sectors.

Under a similar spirit, Mohamad et al. (2006) analyze the opportunity for diversification across different economic sectors for long-term investment using sectoral indices of the Malaysian Stock Exchange. The empirical results indicate high, but unstable correlation relationships between different industry sectors in the Bursa Malaysia. This implies that investment managers should account for potential movements in sector-specific and sub-sector-specific risks. The results also imply that investment in one or two sectors of the stock market face higher total risk than in the past due to the increasing sector effects on portfolio investment.

Undertaking the perspective of a Cypriot investor who is interested in domestic portfolio diversification, Constantinou et al. (2008) provide an investigation on the potential gains that may exist on the Cyprus Stock Exchange (CSE). Analyzing daily price indices for twelve sectors of the Cyprus economy, the authors provide evidence of no cointegration in most bivariate cases, concluding that the SCE offers opportunities for making long-run profits from portfolio diversification.

Additionally, the results of no short-run dynamic relationships amongst the sectoral indices lead the authors to the conclusion that traders and investors in the SCE can set up short-run investment strategies.

Al-Fayoumi et al. (2009) investigate the long-run equilibrium relationships and dynamic interactions amongst the daily returns of the Amman Stock Exchange (ASE) indices (i.e., General, Financial, Industrial, and Services) over a sample period extending from September 3, 2000 to August 30, 2007. The multivariate cointegration analysis suggests that the four stock price indices share one long-run equilibrium relationship in the long run. In addition, the results of the Granger's causality analysis provide evidence of bidirectional relationships amongst all sectors, with the Services sector being the exception. Thus, the Services sector may offer appealing diversification opportunities within ASE since this sector turns out to be much less linked to other sectors.

More recently, Ahmed (2012) examined both the long-run and short-run aspects of the inter-sectoral linkages in the Egyptian stock market. The data correspond to daily closing prices for twelve sectoral indices of the Egyptian stock market, covering the period between January 3, 2007 and January 18, 2010. The multivariate cointegration analysis reports evidence in support of the existence of only a single cointegrating vector within the sectoral indices. Moreover, the results of the Granger's causality analysis show that the short-run causal relationships between the sectoral indices are considerably limited and, where they exist, virtually unidirectional. In general, these results lead to the conclusion that there is still room to derive benefits from portfolio diversification in the short run. However, investors with long-term horizon may not benefit from diversifying investments in the different sectors of the Egyptian stock market.

The current study builds upon and extends the literature through the use of Johansen's multivariate cointegration analysis (1988, 1991, and 1995) and Granger's Causality analysis (1969, 1988) with an eye to capturing the short-run and long-run relationships that may exist amongst equity sectoral indices of the Indian Bombay Stock Exchange.

Data Description and Methodology

This empirical study is based on daily closing values of the Bombay Stock Exchange sector indices. Daily closing prices of Auto, Bankex, Capital-goods, Consumer-durables, FMCG, IT, Metals, Oil & Gas, Power and Realty sector for the period from January 4, 2010 to May 21, 2013 has been taken from the website www.bseindia.com. The continuously compounded rate of return is calculated by using the following formula:

Rt = Ln (PT/Pt-1) *100

Where:

Rt = Return on day't';

Pt = Index closing value on week't'

Pt-1 =Index closing value on week't-1'

ln= Natural log.

There are several methods for testing the co-movement of prices in stock markets across the countries. In this study the emphasis is given to test the inter-market relationship among the Indian Bombay Stock Exchange sector indices, via; (i). Descriptive Statistics; (ii) Correlation Matrix, (iii) Co integration Tests, and (iv) Granger Causality Test

Unit Root Test

Cointrgration analysis requires that time series should be integrated of the same order. Stationarity of time series has been examined by using unit root tests. Augmented Dickey-Fuller Test has been employed for said purpose. The Augmented Dickey Fuller test examines the presence of a unit root in an autoregressive model. A simple AR (1) model is

$y_t = \rho y_{t-1} + u_t,$

Where $y_t$is the variable of interest, t is the time index, ρ is a coefficient and u_t is the disturbance term. The regression model can be written as

$\Delta y_t = (\rho - 1)\, y_{t-1} + ut = \delta y_{t-1} + u_t,$

Where, Δ is the first difference operator. This model can be estimated and testing for a unit root is equivalent to testing. δ = 0.

A financial time series is said to be integrated of one order, i.e., I (1), if it becomes stationary after differencing once. If two series are integrated of order one, there may have a linear combination that may be stationary without differencing. If said condition fulfills then these are called cointegrated.

Johansen Cointegration Test

The Johansen (1988) and Johansen and Juselius (1990) procedure test the presence of the long run relationship between the variables. Johansen and Juselius propose two likelihood ratio tests for the determination of the number of cointegrated vectors. One is the maximal eigenvalue tests which evaluate the null hypothesis that there are at most r cointegrating vectors against the alternative of r + 1 cointegrating vectors. The maximum Eigen value statistic is given by,

$\lambda_{max} = - T \ln (1 - \lambda_{r+1})$

Where $\lambda_{r+1}, \ldots, \lambda_n$ are the n-r smallest squared canonical correlations and T = the number of observations.

The second test is based on the trace statistic which tests the null hypothesis of r cointegrating vectors against the alternative of r or more cointegrating vectors. This statistic is given by:

$\lambda_{trace} = -T \Sigma \ln (1 - \lambda_i)$

In order to apply the Johansen procedure, a lag length must be selected for the VAR. A lag length is selected on the basis of the Akaike Information Criterion (AIC).

Granger Causality Test

According to the representation of Granger theorem, if two variables are co-integrated, then there will be at least one direction or unidirectional granger causality must exist which tend to the consequences to find the relationship with error correction model (ECM). Granger causality test is used to determine the causality relation among variables and direction. So by employing pairwise Granger causality test technique is helpful to identify each factor causal relationship. Lag is selected to get appropriate results which are user specified. The time series variables are not stationary at I (0) and no co-integration exist among variables then it would be converted by taking first difference I (1) and applied as follows (Akash et al., 2011):

$$Q_{prob}(W_{t+n} \mid \Theta_t = Q_{prob}(W_{t+n} \mid \omega_t)$$

Q prob is a conditional probability, Θt information set at time t, of past values of **Error! Bookmark not defined.** and ω_t information set containing values for both w_t and U_t for the t period. This is an unrestricted regression equation after while

by running this will help to find out the unrestricted residual sum of square (RSSUR) and also eliminate the lagged values of particular macroeconomic variables (MV) at the first difference to find the restricted regression to obtain the restricted sum of square (RSSR), then I (1) should be the zero for all values of I.F test is considerable to testify the null hypothesis as follows:

$$F = \frac{RSSR - RSSUR / k\text{-}k0}{RSS / N\text{-}k}$$

If the F-Statistic exceeds the critical value at the selected level of significance or the p-value associated to F Statistic is < 0.5 then the null hypothesis is rejected.

Empirical Results

Descriptive statistics for the sector index returns are given in Table 1. These include the distribution of mean, standard deviation, skewness and kurtosis etc. A careful examination reveals that the FMCG sector offers the highest return 0.1% per day at the lowest risk level, while consumer-durables offering second highest return. Auto and Bankex are offering almost the same return i.e. 0.045% per day while Cap-goods, Metals, Oil & Gas, Power and Realty sectors are offering negative returns. All of the markets are negatively skewed except India and France. . The negative values for skewness indicate that the series' distributions are skewed to the left. All sectors exhibit a relatively high kurtosis (>3) except for Oil & Gas and Realty sector. The Jarque-Bera test, an asymptotic test of normality, indicates that none of the price indices is normally distributed at 5% level of significance, as probability is (<0.05) however, Oil & Gas and Realty sector are almost normally distributed.

Table: 1 Descriptive Statistics

	RTN AUTO	RTN BAN	RTN CAP	RTN CONSDU	RTN FMCG	RTN IT	RTN METAL	RTN OILGAS	RTN POWER	RTN REALTY
Mean	0.045	0.046	-0.037	0.077	0.101	0.017	-0.083	-0.019	-0.067	-0.080
Median	0.058	0.080	-0.026	0.127	0.092	0.022	-0.078	-0.099	-0.008	0.033
Std. Dev.	1.285	1.479	1.470	1.442	0.997	1.442	1.647	1.241	1.194	2.066
Skewness	0.008	0.036	-0.058	-0.141	0.031	-0.817	0.079	0.014	-0.200	-0.121
Kurtosis	3.932	3.426	3.776	4.500	4.256	12.753	3.809	3.137	3.940	3.235
Jar-Bera	30.633	6.610	21.723	82.152	55.828	3447.803	23.994	0.691	36.843	4.019
Prob	0	0.036	0.000	0	0	0	0.000	0.707	0	0.133

Correlation Analysis

In Table 2 return matrix shows that almost all the sectors are medium positively correlated with each other while, Bankex sector is strongly positively correlated with Auto, Capital-goods, Meltals, Power and Realty. IT sector is weakly positively correlated with other

sectors. Highest correlation is found between Capital-Goods and Power.

Table 2: Return Correlation Matrix

	RTN AUTO	RTN BAN	RTN CAP	RTN CONSD	RTN FMCG	RTN IT	RTN METAL	RTN OILGAS	RTN POWER	RTN REAL
RTNAUT	1									
RTNBAN	0.729	1								
RTNCAP	0.656	0.749	1							
RTNCON	0.538	0.594	0.525	1						
RTNFMC	0.415	0.438	0.380	0.343	1					
RTNIT	0.392	0.416	0.372	0.298	0.300	1				
RTNMET	0.708	0.744	0.699	0.566	0.435	0.439	1			
RTNOIL	0.586	0.642	0.580	0.466	0.375	0.361	0.656	1		
RTNPOW	0.685	0.769	0.824	0.572	0.431	0.381	0.761	0.650	1	
RTNREAL	0.640	0.734	0.666	0.567	0.382	0.345	0.717	0.587	0.758	1

Unit Root Test

The Augmented Dickey-Fuller (ADF) test results in Table 3 shows that sector indices series are non-stationary in the level form as T-statistic values are greater than critical values at 1% and 5% level of significance also the p-values associated with corresponding T-statistic is greater than 0.5.Hence null hypothesis of a unit root in all the sector series cannot be rejected. In other words, all variables are non-stationary. However, they become stationary series in their first difference as T-statistic values are less than the critical values at 1% and 5% level of significance also the p-values associated with corresponding T-statistic is less than 0.5. This means all of our data is integrated of order one, I (1)

Table: 3 Augmented Dickey-Fuller Unit Root Test

Augmented Dickey-Fuller Test Intercept with Trend				
Variables	**Level**	**Prob**	**First Difference**	**Prob**
	T-Statistic		**T-Statistic**	
Automobiles	-2.63629	0.2641	-26.4285	0
Bankex	-2.16819	0.5063	-25.9523	0
Capital-Goods	-2.13353	0.5257	-25.9994	0
Consumer-Durable	-2.49783	0.3292	-27.4145	0
FMCG	-2.5024	0.3269	-28.533	0
IT	-2.83551	0.1848	-27.6398	0

Metals	-2.56253	0.2979	-27.6927	0
Oil & Gas	-2.37666	0.3916	-28.9914	0
Power	-2.27194	0.4484	-26.9806	0
Realty	-1.7029	0.7495	-25.0764	0

Table: 4 VAR Lag Length Selection Criteria

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	11676.32	NA	3.96E-25	-27.8101	-27.7537	-27.7885
1	26946.51	30139.97	7.80e-41*	-63.97262*	-63.35219*	-63.73481*
2	27036.66	175.7831	7.99E-41	-63.9491	-62.7647	-63.4951
3	27124.27	168.7512*	8.23E-41	-63.9196	-62.1711	-63.2494
4	27188.31	121.8044	8.97E-41	-63.8339	-61.5213	-62.9475
5	27242.45	101.7028	1.00E-40	-63.7246	-60.848	-62.622
6	27307.55	120.7414	1.09E-40	-63.6414	-60.2008	-62.3226
7	27372.57	119.0352	1.19E-40	-63.558	-59.5534	-62.0231
8	27428.4	100.8709	1.32E-40	-63.4527	-58.884	-61.7016
* 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						

Having satisfied with the results of the ADF stationary test, we proceed to conduct the Johansen's cointegration multiple test for that, the order of the Vector Autoregressive Model (VAR) should be determined by either the Akaike Information Criteria (AIC) or the Schwarz Information Criteria (SIC). The AIC is selected in this paper. The result in Table 4 shows that 1 lag length is chosen for the stock market sectors indices in the sample.

Table 5: Multivariate Cointegration Analysis (Trace Statistics)

Hypothesized No. of CE(s)	**Eigen Value**	**Trace Statistic**	**Critical Value 0.05**	**Prob.****
None *	0.090393	254.5505	239.2354	0.0084
At most 1	0.056739	174.4932	197.3709	0.3739

At most 2	0.050001	125.1345	159.5297	0.7442
At most 3	0.033114	81.79103	125.6154	0.9697
At most 4	0.019191	53.33587	95.75366	0.9927
At most 5	0.014893	36.96199	69.81889	0.9804
At most 6	0.012188	24.28258	47.85613	0.9363
At most 7	0.009948	13.92014	29.79707	0.8451
At most 8	0.006145	5.471608	15.49471	0.7569
At most 9	0.000312	0.26337	3.841466	0.6078
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				

The result of Johansen co-integration, multiple test in Table 5 reveals one co-integration equation, which means the integration and an existence of long run equilibrium among the sector indices.

Table 6: Pairwise Bivariate Cointegration Analysis

Sector Indices	**Hypothesis**	**Eigen value**	**Trace Statistic**	**Critical Value 0.05**	**Prob**
Auto-Bankex	$r = 0$	0.0063	5.321155	14.2646	0.7009
	$r \leq 1$	0.004073	3.436498	3.841466	0.0638
Auto-Capital Goods	$r = 0$	0.008103	7.988518	15.49471	0.4666
	$r \leq 1$	0.001339	1.129716	3.841466	0.2878
Auto-Consumer Durables	$r = 0$	0.01203	14.32598	15.49471	0.0744
	$r \leq 1$	0.004879	4.122857	3.841466	0.0423
Auto –FMCG	$r = 0$	0.009671	8.298554	15.49471	0.434
	$r \leq 1$	0.000138	0.116343	3.841466	0.733
Auto-IT	$r = 0$	0.013794	15.19807	15.49471	0.0554
	$r \leq 1$	0.00413	3.489138	3.841466	0.0618
Auto-Metals	$r = 0$	0.010077	8.739776	15.49471	0.39
	$r \leq 1$	0.000252	0.212227	3.841466	0.645

Auto-Oil & Gas	$r = 0$	0.006842	9.034769	15.49471	0.3622
	$r \leq 1$	0.003857	3.253967	3.841466	0.0712
Auto-Power	$r = 0$	0.009857	9.219368	15.49471	0.3455
	$r \leq 1$	0.00103	0.868562	3.841466	0.3514
Auto-Realty	$r = 0$	0.007995	11.14093	15.49471	0.203
	$r \leq 1$	0.005191	4.382299	3.841466	0.0363
Bankex-Capital Good	$r = 0$	0.005513	5.174646	15.49471	0.79
	$r \leq 1$	0.000602	0.508563	3.841466	0.4758
Bankex-Consumer Durables	$r = 0$	0.010153	12.0535	15.49471	0.1544
	$r \leq 1$	0.004085	3.450386	3.841466	0.0632
Bankex-FMCG	$r = 0$	0.00614	5.233929	15.49471	0.7835
	$r \leq 1$	4.93E-05	0.041582	3.841466	0.8384
Bankex-IT	$r = 0$ *	0.01395	15.53373	15.49471	0.0493
	$r \leq 1$	0.004348	3.677313	3.841466	0.0552
Bankex-Metals	$r = 0$	0.006637	5.651109	15.49471	0.7363
	$r \leq 1$	3.68E-05	0.031046	3.841466	0.8601
Bankex-Oil & Gas	$r = 0$	0.006637	5.651109	15.49471	0.7363
	$r \leq 1$	3.68E-05	0.031046	3.841466	0.8601
Bank-Power	$r = 0$	0.005906	5.216122	15.49471	0.7855
	$r \leq 1$	0.000264	0.222674	3.841466	0.637
Bank-Realty	$r = 0$	0.007593	9.888103	15.49471	0.2894
	$r \leq 1$	0.004099	3.462684	3.841466	0.0628
Capital Goods - Consumer Durables	$r = 0$	0.007529	11.13975	15.49471	0.2031
	$r \leq 1$	0.005626	4.761508	3.841466	0.0291
Capital Goods-FMCG	$r = 0$	0.005154	4.413604	15.49471	0.8675
	$r \leq 1$	6.85E-05	0.057774	3.841466	0.81
Capital Goods -IT	$r = 0$	0.009642	10.40865	15.49471	0.2506
	$r \leq 1$	0.00264	2.231096	3.841466	0.1353
Capital Goods-Metals	$r = 0$	0.004793	5.710624	15.49471	0.7294
	$r \leq 1$	0.001959	1.655344	3.841466	0.1982
Capital Goods –Oil & Gas	$r = 0$	0.014065	14.1722	15.49471	0.0783
	$r \leq 1$	0.002624	2.21732	3.841466	0.1365
Capital Goods-Power	$r = 0$	0.014065	14.1722	15.49471	0.0783

		0.002624	2.21732	3.841466	0.1365
Capital Goods-Realty	$r = 0$	0.014065	14.1722	15.49471	0.0783
	$r \leq 1$	0.002624	2.21732	3.841466	0.1365
Consumer Durables-FMCG	$r = 0$	0.009592	8.125295	14.2646	0.3661
	$r \leq 1$	0.000217	0.18302	3.841466	0.6688
Consumer Durables-IT	$r = 0$	0.010377	14.01967	15.49471	0.0824
	$r \leq 1$	0.006161	5.215635	3.841466	0.0224
Consumer Durables - Metals	$r = 0$	0.007656	8.76834	15.49471	0.3873
	$r \leq 1$	0.002712	2.289205	3.841466	0.1303
Consumer Durables – Oil & Gas	$r = 0$	0.008024	12.4232	15.49471	0.1377
	$r \leq 1$	0.006623	5.615354	3.841466	0.0178
Consumer Durables - Power	$r = 0$	0.009788	12.70029	15.49471	0.1263
	$r \leq 1$	0.005216	4.40866	3.841466	0.0357
Consumer Durables - Realty	$r = 0$*	0.012485	15.68817	15.49471	0.0468
	$r \leq 1$*	0.006028	5.096769	3.841466	0.024
FMCG-IT	$r = 0$	0.010695	9.125287	15.49471	0.3539
	$r \leq 1$	4.66E-05	0.039384	3.841466	0.8427
FMCG-Metals	$r = 0$	0.009947	8.559096	15.49471	0.4077
	$r \leq 1$	0.000156	0.131406	3.841466	0.717
FMCG-Oil & Gas	$r = 0$	0.006566	5.567015	15.49471	0.746
	$r \leq 1$	5.17E-07	0.000437	3.841466	0.9851
FMCG-Power	$r = 0$	0.006964	5.991279	15.49471	0.6966
	$r \leq 1$	0.000118	0.09975	3.841466	0.7521
FMCG-Realty	$r = 0$	0.005083	4.412034	15.49471	0.8676
	$r \leq 1$	0.000131	0.110828	3.841466	0.7392
IT-Metal	$r = 0$	0.009607	9.341395	15.49471	0.3347
	$r \leq 1$	0.001414	1.193978	3.841466	0.2745
IT-Oil	$r = 0$	0.011298	14.70362	15.49471	0.0655
	$r \leq 1$	0.00602	5.102257	3.841466	0.0239
IT-Power	$r = 0$	0.009744	9.701702	15.49471	0.3044
	$r \leq 1$	0.001716	1.447571	3.841466	0.2289
IT-Realty	$r = 0$	0.010426	13.57455	15.49471	0.0954
	$r \leq 1$	0.005588	4.729131	3.841466	0.0296

Meta-Oil & Gas	$r = 0$	0.00611	5.898319	15.49471	0.7075
	$r \leq 1$	0.000851	0.719415	3.841466	0.3963
Metal-Power	$r = 0$	0.007832	8.180698	15.49471	0.4463
	$r \leq 1$	0.001839	1.551967	3.841466	0.2128
Metal-Realty	$r = 0$	0.006516	6.031875	15.49471	0.6918
	$r \leq 1$	0.000609	0.513984	3.841466	0.4734
Oil & Gas -Power	$r = 0$	0.007102	6.615483	15.49471	0.6227
	$r \leq 1$	0.000729	0.614152	3.841466	0.4332
Oil & Gas -Realty	$r = 0$	0.010001	12.55379	15.49471	0.1322
	$r \leq 1$	0.004846	4.090231	3.841466	0.0431
Power-Realty	$r = 0$	0.005743	4.969594	15.49471	0.812
	$r \leq 1$	0.000135	0.114145	3.841466	0.7355

In Table 6 the Bivariate Cointegration result indicates that there is no cointegration in all the cases of 45 pairs of sectoral indices except Bankex-IT and Consumer Durables-Realty. This means that mostly these sector indices pairs have no long run relationship.

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Table: 7 Granger Causality Test

Null Hypothesis:	**F-Statistic**	**Prob.**
RTNBANKEX does not Granger Cause RTNAUTO	0.8827	0.414
RTNAUTO does not Granger Cause RTNBANKEX	2.16487	0.1154
RTNCAP_GOODS does not Granger Cause RTNAUTO	1.12377	0.3255
RTNAUTO. does not Granger Cause CAP_GOODS	1.91169	0.1485
RTNCONS_DURB. does not Granger Cause AUTO	4.14134	0.01628*
RTN AUTO. does not Granger Cause CONS_DURB	9.358	0.0001*
RTN FMCG. does not Granger Cause AUTO	0.04845	0.9527
RTN AUTO. does not Granger Cause FMCG	12.5039	4.00E-06*
RTNIT. does not Granger Cause AUTO	1.31337	0.2695
RTN AUTO. does not Granger Cause IT	5.66819	0.0036*

RTN METAL. does not Granger Cause AUTO	0.35583	0.7007
RTN AUTO. does not Granger Cause METAL	2.97656	0.0515
RTNOIL_GAS. does not Granger Cause AUTO	0.20152	0.8175
RTN AUTO. does not Granger Cause OIL_GAS	3.71584	0.0247*
RTNPOWER. does not Granger Cause AUTO	1.54638	0.2136
RTNAUTO. does not Granger Cause POWER	5.87316	0.0029*
RTNREALTY. does not Granger Cause AUTO	2.6707	0.0698
RTNAUTO. does not Granger Cause REALTY	4.18809	0.0155*
RTNCAPGOODS. does not Granger Cause BANKEX	1.05976	0.347
RTNBANKEX. does not Granger Cause CAP_GOODS	5.94879	0.0027*
RTNCONS_DURB. does not Granger Cause BANKEX	5.11705	0.0062*
RTNBANKEX. does not Granger Cause CONS_DURB	11.7571	9.00E-06*
RTNFMCG. does not Granger Cause BANKEX	0.3081	0.7349
RTNBANKEX. does not Granger Cause FMCG	6.82529	0.0011*
RTNIT. does not Granger Cause BANKEX	2.3267	0.0982
RTNBANKEX. does not Granger Cause IT	2.91794	0.0546
RTNMETAL. does not Granger Cause BANKEX	1.8614	0.1561
RTN BANKEX. does not Granger Cause METAL	3.51499	0.0302*
RTN OILGAS. does not Granger Cause BANKEX	2.09253	0.124
RTN BANKEX. does not Granger Cause OIL_GAS	0.69967	0.497
RTNPOWER. does not Granger Cause BANKEX	4.13774	0.0163*
RTN BANKEX. does not Granger Cause POWER	8.62599	0.0002*
RTN REALTY. does not Granger Cause BANKEX	0.06838	0.9339
RTN BANKEX. does not Granger Cause REALTY	3.98033	0.019*
RTN CONSDURB. does not Granger Cause CAP_GOODS	0.0965	0.908
RTN CAP_GOODS. does not Granger Cause CONS_DURB	5.00716	0.0069*
RTN FMCG. does not Granger Cause CAP_GOODS	1.1402	0.3202
RTNCAPGOODS. does not Granger Cause FMCG	14.0714	1.00E-06*
RTN IT. does not Granger Cause CAP_GOODS	2.12665	0.1199
RTN CAPGOODS. does not Granger Cause IT	3.09076	0.046*
RTN METAL. does not Granger Cause CAP_GOODS	0.53466	0.5861
RTN CAPGOODS. does not Granger Cause METAL	0.88102	0.4147
RTN OILGAS. does not Granger Cause CAP_GOODS	0.07347	0.9292

RTN CAPGOODS. does not Granger Cause OIL_GAS	1.95731	0.1419
RTN POWER. does not Granger Cause CAP_GOODS	0.11409	0.8922
RTN CAPGOODS. does not Granger Cause POWER	3.2755	0.0383*
REALTY. does not Granger Cause CAP_GOODS	3.09475	0.0458*
RTN CAPGOODS. does not Granger Cause REALTY	1.19352	0.3037
RTN FMCG. does not Granger Cause CONS_DURB	4.17744	0.0157*
RTN CONSDURB. does not Granger Cause FMCG	0.89388	0.4095
RTN IT. does not Granger Cause CONS_DURB	1.36547	0.2558
RTN CONSDURB. does not Granger Cause IT	2.18948	0.1126
RTN METAL. does not Granger Cause CONS_DURB	3.54915	0.0292*
RTN CONSDURB. does not Granger Cause METAL	3.08148	0.0464*
RTN OILGAS. does not Granger Cause CONS_DURB	0.31428	0.7304
RTN CONSDURB. does not Granger Cause OIL_GAS	1.09138	0.3362
RTNPOWER. does not Granger Cause CONS_DURB	3.48564	0.0311*
RTN CONSDURB. does not Granger Cause POWER	0.37645	0.6864
RTN REALTY. does not Granger Cause CONS_DURB	8.66626	0.0002*
RTN CONSDURB. does not Granger Cause REALTY	0.95287	0.386
RTN IT. does not Granger Cause FMCG	0.3496	0.7051
RTN FMCG. does not Granger Cause IT	1.0829	0.3391
RTN METAL. does not Granger Cause FMCG	5.36927	0.0048*
RTN FMCG. does not Granger Cause METAL	0.0479	0.9532
RTN OILGAS. does not Granger Cause FMCG	2.54821	0.0788
RTN FMCG. does not Granger Cause OIL_GAS	0.03617	0.9645
RTN POWER. does not Granger Cause FMCG	10.4921	3.00E-05*
RTN FMCG. does not Granger Cause POWER	0.54173	0.5819
RTN REALTY. does not Granger Cause FMCG	3.11871	0.0447*
RTN FMCG. does not Granger Cause REALTY	0.39928	0.6709
RTN METAL. does not Granger Cause IT	3.32257	0.0365*
RTN IT. does not Granger Cause METAL	1.36815	0.2551
RTN OILGAS. does not Granger Cause IT	3.0833	0.0463*
RTN IT. does not Granger Cause OIL_GAS	0.15126	0.8597
RTN POWER. does not Granger Cause IT	3.95795	0.0195*
RTN IT. does not Granger Cause POWER	0.84337	0.4306

RTN REALTY. does not Granger Cause IT	3.8215	0.0223*
RTN IT. does not Granger Cause REALTY	0.53332	0.5869
RTN OILGAS. does not Granger Cause METAL	0.15319	0.858
RTN METAL. does not Granger Cause OIL_GAS	0.43349	0.6484
RTN POWER. does not Granger Cause METAL	0.26966	0.7637
RTN METAL. does not Granger Cause POWER	1.43975	0.2376
RTN REALTY. does not Granger Cause METAL	1.89586	0.1508
RTN METAL. does not Granger Cause REALT	1.01314	0.3635
RTN POWER. does not Granger Cause OIL_GAS	0.77784	0.4597
RTN OILGAS. does not Granger Cause POWER	2.00061	0.1359
RTN REALTY. does not Granger Cause OIL_GAS	0.67047	0.5117
RTN OILGAS. does not Granger Cause REALTY	0.50673	0.6026
RTN REALTY. does not Granger Cause POWER	4.83705	0.0082*
RTN POWER. does not Granger Cause REALTY	0.22401	0.7994

The short run interrelationships can be examined by the Granger Causality Analysis. This section concentrates on the return spillover among different stock market sectors. From table 7 we found a bi-directional, short run relationship between Auto & Consumer durables sectors, Bankex & Consumer durable sectors and Metals & Consumer durables sectors. In general unidirectional short run causality is running from Auto, Bankex, Capital-goods, Power, Metals and Realty sectors to the other sectors. In other words, we can say that these are the leading sectors of the Indian stock market. However, FMCG, Oil & Gas, IT and Consumer-durables are the lagging sectors.

Conclusion

This study empirically investigates the cointegration among the different sector indices (i.e. Auto, Bankex, Capital-goods, Consumer-durables, FMCG, IT, Metals, Oil & Gas, Power and Realty) of the Indian Bombay Stock Exchange. Based on the results of Descriptive Statistics it is found that the FMCG sector earned highest average daily return with the lowest standard deviation among all the sectors. The result of Johansen cointegration on multiple test has revealed one co-integration equation, which shows the integration and an existence of long run equilibrium among the sectors. The bivariate cointegration analysis leads to the conclusion that we are unable to reject the null hypothesis of no cointegration in all the cases of 45 pairs of the sectoral indices except Bankex-IT and Consumer Durables-Realty. This finding implies that there are benefits from portfolio diversification, when domestic investors construct portfolios which include stocks from the sectors which are not cointegrated.

The results of the Granger causality tests show that the bidirectional and lead-lag unidirectional short term relationship between different sectors are considerably limited. Moreover, generally unidirectional short run causality is running from Auto,

Bankex, Capital-goods, Power, Metals and Realty sectors to the other sectors. In other words, we can say that these are the leading sectors of the Indian stock market. However, FMCG, Oil & Gas, IT and Consumer-durables are the lagging sectors. Furthermore, based on our causality analysis, we provide evidence that traders and investors in the BSE set up short-run investment strategies.

The results of the present paper are particularly useful to private and institutional investors as well to the financial institutions, for the evaluation and management of their portfolios which include stocks of companies which are listed on the BSE.

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