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Dependency in Price Discovery Process in Indian Equity Market

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Abstract

On the basis of the inconclusiveness of reports on the efficiency of Indian equity markets, this study made an attempt to examine the linear dependency in the Indian markets, both in BSE and NSE, in three categories of market portfolios, categorized in terms of broad market representation, size and liquidity (constructed based on trade volume) across varying time periods and sub periods. Time domain as well as frequency domain tests such as; Multiple variance ratio test, Joint test of Wright's rank and sign test, and Spectral shape test of random walk were applied in the analysis. Broadly, the period of analysis spanned from 1992 to 2016. The broad market indicators showed evidences of efficiency improvement in the Indian market over the period of time with significant sub-periodic reversal patterns. Furthermore, the study also identified pervasive and significant linear dependency across market segments based on size and liquidity indicating the possibility of beating the market with simple linear trading strategies. Further investigations on periodical changing patterns in the market participation of stake holders and the responsiveness of various policy initiatives on the overall market as well as on the market segments need to be explored to understand the conflicting observations of broad market efficiency improvements and the periodic as well as segments based efficiency divergences observed from this study.

Keywords: Random Walk Hypothesis, Market Size and Liquidity, Parametric and Non-Parametric Tests.

Introduction

The examination of dependency in stock price movement in other words is a verification of whether the stock prices follow random walk process or if the stock returns are profitably predictable. There are numerous studies from various markets that reported dependency in returns such as in; daily returns of several U.K commodity markets (Taylor, 1982), CRSP NYSE and AMEX market indices from 1962 to 1985 (Lo and MacKinlay 1988, 1989), in markets of Korea, Malaysia, Hong Kong, Singapore, Thailand (Huang, 1995), and in Bangladesh, Hong Kong, Malaysia and Taiwan from 1986 to 1995 (Alam et al., 1999) etc. Chang and Ting (2000) reported of dependency in value weighed weekly stock index movements in Taiwan market during the period between 1986 and 1996. They further reported a significant decrease in dependency in the sub period of from 1991 to 1996 compared to that in the sub-period from 1986 to 1990 across different holding periods.

Li and Liu (2012) reported random walk behaviour of stock market returns for 34 Morgan Stanley Capital International (MSCI) country indices and MSCI world index based on the weekly closing price for the period from 1988 to 2010. The analysis based on variance ratio test of Lo and MacKinlay (1988) showed that random walk process in Asia that is for countries such as Hong Kong, South Korea, Taiwan and Singapore and for G7 countries except for Canada and France such as UK, USA, Germany, Italy, and Japan. In case of US market, though not statistically significant, a decline in variance ratio was observed as holding periods increased. In case of other developed countries except for Denmark, Norway, Portugal and New Zealand, the markets in all other countries such as; Australia, Austria, Belgium, Finland, Greece, Ireland, Netherlands, Spain, Sweden and Switzerland evinced random walk process in the price movements. From Emerging and developing markets group, Argentina, Mexico, Philippines and Turkey displayed temporal dependencies in their stock price movements while markets in Thailand, Malaysia, Chile, Indonesia and Jordan found to be weak form efficient. Finally for the MSCI world index, comprising 1643 stocks from various countries also evinced random walk process in its movement.

Rejection of random walk of stock prices both in daily and weekly frequencies based on Chow and Denning test (1993) was reported for seven Gulf Cooperation Council (GCC) markets such as Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE (Abu Dhabi and Dubai markets) by Al-Ajmi and Kim (2012). Patel et al., (2012) reported mixed results of both serial dependence and weak form efficiency across sub-periods in indices of four Asian stock markets such as; BSE Sensex of Bombay Stock Exchange, India; Nikkei 225 of Tokyo Stock Exchange, Japan; Hangseng of Hong Kong; SSE of Shanghai Stock Exchange of China. The study applied runs test, unit root tests, Kolmogorov-Smirnov test, Autocorrelation test and Variance ratio test (Lo and MacKinlay, 1988). The study was carried out in three sub-periods; 2000 to 2003, 2003-2007 and 2007 to 2011. Specifically, overall period analysis and first two sub-period analysis evinced inefficiency in all the markets while BSE Sensex, SSE Composite and Hangseng index evinced weak form efficiency in the third sub-period.

From the African markets for Egypt, Kenya, Mauritius, Morocco, Nigeria, South Africa, Tunisia, Zambia, Smith and Dyakova (2014) using finite sample variance ratio tests on daily data over period from 1998 to 2011 observed periods of dependency and random movements in all these market returns.

In brief, it is learnt that the return formation process across the stock markets are not consistent. Dependency in returns or predictability of returns are found to be varying with respect various to; nature of the economy, level of monitoring in the market, time period of analysis, frequency of the data etc. The returns were found to be following weak form efficiency especially in the developed markets though not in all cases and for emerging markets temporarily dependency was found to be prevailing. Stock Price formation in Asian, Latin American and African countries found to be more inefficient compared to that in European as well as US markets. Most of the studies post 2010 also reported gradual progress towards efficiency across all the markets though not conclusive.

Return Predictability in Indian Equity Market

There are number of studies which have examined the random walk hypothesis in Indian market on the data of various frequencies from BSE and NSE over different time periods and sectors. The evidences reported from these studies are not similar. There are studies that support the random walk hypothesis in Indian market (Gupta 1990; Singh and Kumar, 2009; Mishra and Mishra, 2011, Nalini, 2015). Similarly, there are studies that have reported significant dependence in return series from both the markets (Pant and Bishnoi, 2001; Poshakwale, 2002; Pandey, 2003; Gupta and Basu, 2007; Mehla and Goyal, 2012; Garg and Varshney, 2015). Mobarek and Fiorante (2013) found the rejection of random walk hypothesis in the early sub-periods of 1990s but later periods evinced its slower disappearance indicating an evolution of weak form efficiency in the emerging markets including Indian market. Hiremath and Kumari (2014) in their analysis of both BSE Sensex and CNX Nifty, over the period from 1991 to 2013 and 1994 to 2013 respectively for each indices, observed the following results. Linear dependence in the data found to be evincing cyclical pattern with periods of efficiency and inefficiency in both markets while strong nonlinear dependence was observed in the returns throughout the study period with declining trend in it from 2009. Prosad et al., (2012) also had observed similar trends in six indices from BSE over the period from 2001 to 2010.

Data and Methodology

The periodic changes in the efficiency of Indian market is examined for the bench mark and broad market indices such as; BSE Sensex, BSE 500, NSE Nifty and NSE 500. In the analysis of overall market behaviour, the major market portfolio indices such as; BSE 500 (2nd January 2000- 31st October 2016), NIFTY 500 (7thJune 1999 - 31st October 2016) and bench market indices such as BSE SENSEX (2nd January 1992- 31st October 2016) and NIFTY 50 (2nd January 1995- 31st October 2016) are considered. Apart from the study for the entire data period, broadly two sub-periods were also considered in this analysis; pre 2008 and post 2008 to understand the impact of Global Financial Crisis. But in case of longer period data the analysis considered a sub-period of 1990-1999 which would give picture of the market reaction to initial years of liberalisation reforms and technological up-gradations in the Indian market.

To examine the dependency in portfolio returns across market capitalization, market returns on BSE Large Cap (16th September 2005- 31st October 2016), BSE Mid Cap (3rd April 2003 - 31st October 2016), BSE Small Cap (1stApril 2003 - 31st October 2016), NSE Mid 100 (3rdJanuary 2005 - 31st October 2016), and NSE free float Small Cap 100 (3rd January 1999 - 31st October 2016) were explored both for the entire period as well as for sub-periods.

In case of the analysis of temporal dependency in liquidity based portfolio returns, four portfolios were constructed, two each from both NSE and BSE. In this process we considered the sample frame of constituent companies in NSE 500 and BSE 500 indices as on 31st October 2016. We excluded those companies which were not active in the respective markets in any period from 1st January, 2010 and those with missing data. In this way we chose 433 companies from BSE and 339 companies from NSE for the portfolio construction. The year 2010 was considered as the starting year in order to retain maximum number of companies in the portfolio construction whereby liquidity characteristic across the two extreme portfolios would remain less biased or diluted. From this refined list, portfolios of highest liquidity and lowest liquidity were constructed for each month from January 2010 up to October 2016 based on the monthly average of each company's daily trade volume for each market. Those 20 companies which had highest monthly trade volume constituted the highest liquidity portfolio and those 20 companies with lowest trade volume made up the lowest liquidity portfolio for the respective months. In the next step, daily returns of individual securities in each monthly portfolio were calculated for the respective months from their daily close prices and were averaged daily across the 20 securities to obtain the daily return of the respective portfolio. The daily returns of each of these portfolios; BSE Highest 20, BSE Lowest 20, NSE Highest 20 and NSE Lowest 20 were used to examine the variations in dependency across market liquidity over the period from 5th January 2010 to 31st October 2016.

Methods of Analysis

Though the conditional functional relationship and transformations across the stock return series can take various functional forms, this study considered three types of tests. Time domain linear dependency tests like multiple variance ratio tests (Chow and Denning, 1993) and joint test of Wright's (2000) rank and sign based variance ratio tests (Franch and Contreras, 2004) which are reported to have comparatively better power than the other conventional linear time domain tests (Strandberg and Iglewicz, 2014). Similarly, the third test applied in this analysis is the Spectral shape test proposed by Durlauf (1991). It is a frequency domain test and has power to detect dependency across both linear and nonlinear functional forms of stock returns.

Multiple Variance Ratio Test

The testing procedures applied here is the one proposed by Chow and Denning (1993), an extension of Lo and Mackinlay (1988) variance ratio test which is on the premise that the variance ratio of (1/q)th of the variance of q holding period return to that of one holding period return should be unity for all q where q is any integer greater than one if the return series is generated by random walk and it would hold asymptotically even in the presence of heteroscedasticity and for each q =1,2,3.... (refer Lo and Mackinlay, 1988). Since this methodology face the problem of multiple comparison problem and higher probability of type 1 error Chow and Denning (1993), using the maximum absolute value of the Lo and Mackinaly (1988) statistics for a set of multiple variance ratio estimates, corresponding to a set of predefined q selections, applied the Studentized Maximum Modulus (SMM) critical values to control for test size and to further define the joint confidence interval for these VR (q) estimates (refer Chow and Denning, 1993 for details).

Joint test of Wright's Rank and Sign Tests

Franch and Contreras (2004) proposed an extension of Wright's rank and sign test in multiple variance ratios in line with those of Chow and Denning (1993) and Richardson and Smith (1991) procedures; the Chow and Denning (1993) approach is applied in the present study. In this test, the time series is assigned ranks in case of rank test. Then, the ranks are standardized with either simple linear transformation or an inverse normal transformation. In case of sign test the time series is assigned -1/2 or + ½ depending on the nature of the observation. This transformed data are considered for variance ratio calculations across various intervals and the multiple variance ratio tests are carried out in line with Chow and Denning (1993).

Spectral Shape Test

Durlauf (1991) proposed a general framework for testing martingale difference hypothesis, based on the properties of the shape of the estimated spectral distribution function of the time series. This framework considers all the second moment implications of the hypothesis and the null hypothesis is set as a statement that the shape of the spectral distribution function is a straight line. Anderson-Darling statistic, Cramer von Mises statistic, Kolmogorov-Smirnov statistic and Kuiper statistic, which map random function into a scalar random variable are resorted to examine if the cumulated deviations of the normalised periodogram from this theoretical shape are too large to be attributable to sampling error across the entire spectral distribution function. These cumulated deviations normalised by sample variance are expected to behave like Brownian bridge. It is an appropriate test of martingale difference hypothesis against a broad class of alternatives.

Empirical Results and Discussion:

Table 1 presents the summary of empirical results compiled on the based on the detailed results in tables given in Appendix 1, 2 and 3. As it is learnt from the previous section, both the multiple variance ratio test and Joint test of Wright's rank and sign test results reflect linear dependency in the returns while Spectral shape test results reflect the possible nonlinear dependency as well.

In case of bench mark as well as broad market indices such as BSE Sensex, NSE Nifty, BSE 500 and NSE 500, all test results indicated statistically significant predictability or dependency in their respective return formations in their entire period analysis which covered approximately the time period of 24 years for BSE Sensex, 21 years for NSE Nifty and 16 years for both BSE 500 and NSE 500. These time periods witnessed various structural and regulatory reforms both in stock markets as well as in Indian economy as a whole. It was also a period of various security market scams, Asian financial crisis of 1997, global financial crisis of 2008, entry of various category of investors, technological advancements in stock market transactions, internal as well as external political instabilities etc which could exert the investment decisions making of investors resulting in possible inefficiency or dependency in the price formations in the Indian market.

The sub period 1, Pre 1999, can generally be termed as the first phase of financial market reforms in India. Securities Exchange Board of India Act, 1992 replaced the Capital Issues Control Act of 1947, and National Stock Exchange (NSE), the first demutualised electronic exchange in the country with nation-wide electronic trading was set up in 1992. Reforms in disclosure standards, introduction of code of advertisement for public issues, screen based trading system and various other initiatives were taken up in this period as initial efforts to bring in more transparency in the market. From the empirical analysis we observed that both multiple variance ratio test and Spectral shape test results evinced random walk behaviour in NSE Nifty (1995-1999) though it was rejected by Joint Rank and Sign test. But in case of BSE Sensex, all tests showed possibility of dependency in its returns. With the very entry NSE, became a forerunner in bringing in changes in the stock market functioning in India by providing better quality market compared to BSE, though the latter was the oldest exchange in the country. Therefore, evidences of informational efficiency in the returns of NSE Nifty could be attributed to higher market depth NSE experienced in the initial years compared to BSE.

The Second sub-period spanned from 2000 to 2007 which could be considered as the second phase of structural reforms in the Indian economy. This period covered recovery period of South Asian financial crisis even though the economy as whole was not directly affected, Ketan Parekh Scam, IPO scam and initial years of global financial crisis. The second period results showed higher level of inefficiency or dependency in both the bench market as well as broad market indices in the Indian market. It was also a period large entry of domestic retail investors into the market. All these circumstances can be attributed to the overall inefficiency observed in this period.

The third sub-period of analysis is the post 2007 spanning from 2008 to 2016 covering both the phases of heights of global financial crisis and slower recovery of the economy. From the empirical results we observed that in all the four indices we examined the random walk was accepted by two out three tests in all indices expect in case of BSE 500. One of the differences between BSE and NSE are in terms of percentage share in total turnover. NSE accounted for 85.1 % and BSE accounted for 14.9 in the year 2015-16 while it was 74.98% and 24.98% respectively in the year 2009-10. Similarly, it is also notable that the changes in the nature of trading that have taken place in the market. The share of turnover to total turnover of proprietary trading increased while that of retail investors and institutional investors declined over the period. This indicates the role of possible market making efforts carried out by the proprietary traders during the crisis period. The period also observed initiatives on systematic stability building efforts by market regulators which, together with other developments lead to the gradual improvements in the efficiency of index returns found in the market.

Dependency in the Bench Mark, Broad Market, Size-wise, and Liquidity wise Indices' Returns in India

Table 1. Summary of the Empirical Results

BSESENSEX	**MVR#**	**Spec.Shape##**	**J Rank & Sign****	**Null hypothesis accepted[1]**
Entire sample	X	X	X	**0**
sub period 1	X	X	X	**0**
sub period 2	√	X	X	**1**
sub period 3	√	√	X	**2**
BSE500				
Entire sample	X	X	X	**0**

sub period 2	X	X	X	**0**
sub period 3	X	√	X	**1**
NIFTY				
Entire sample	X	X	X	**0**
sub period 1	√	√	X	**2**
sub period 2	√	X	X	**1**
sub period 3	√	√	X	**2**
NSE500				
Entire sample	X	X	X	**0**
sub period 2	X	X	X	**0**
sub period 3	√	√	X	**2**
BSE L CAP				
Entire sample	√	X	X	**1**
sub period 2	√	√	√	**3**
sub period 3	√	X	X	**1**
BSE M CAP				
Entire sample	X	X	X	**0**
sub period 2	X	√	X	**1**
sub period 3	X	√	X	**1**
BSE S CAP				
Entire sample	X	X	X	**0**
sub period 2	X	X	X	**0**
sub period 3	X	√	X	**1**
NSE M CAP				
Entire sample	X	X	X	**0**
sub period 2	√	X	X	**1**
sub period 3	X	X	X	**0**
NSE S CAP				
Entire sample	X	X	X	**0**
sub period 2	X	X	X	**0**
sub period 3	X	√	X	**1**
BSE T 20				
2010-2016	X	X	X	**0**
BSE L 20				
2010-2016	X	X	X	**0**
NSE T 20				
2010-2016	X	√	X	**1**
NSE L 20				
2010-2016	X	X	X	**0**

N.B. 1 number of tests that accept the null hypothesis that the return formation process follows random walk or martingale difference sequence. √ indicates the acceptance of null hypothesis and **X** indicates the rejection of the null hypothesis at 1% and 5% level of significance . [#]Multiple Variance ratio test, the result are based on the heteroscedastic robust statistics ($z_{2)}$. [##] Spectral Shape t est, results are based on all statistics. [**]Joint test of Wrights rank and sign test, the results based all statistics.

In case of Indices based on market Capitalisation, we observed that all the size based portfolios returns were found to be linearly dependent for the entire sample period and also in sub-periods unlike in the broad market and bench mark indices. The test results indicated relatively better efficiency in BSE Large Cap index returns whereas in both mid cap and small cap portfolios rejection rate of random walk was higher. Literature broadly explains dependency in size based portfolios in various lines such as distress firm effect (Fama, 1991), stock characteristics (Daniel and Titman, 1997) and past and current market performance and psychological biases of investors (Brown and Cliff, 2004, Baker and Wurgler, 2006).

Examination of dependency in liquidity based portfolios returns reveals that irrespective of the nature of liquidity, all the tests reject the null hypothesis of random walk at 1% level of significance, except NSE highest 20 in case of spectral shape test. All the three statistics of spectral shape test showed insignificant variation in the NSE highest 20 portfolio returns the in spectral distribution function. Theoretically, highly liquid portfolios are expected to be more efficient compared to less liquid ones as there will be faster incorporation of information into prices which contradicts to our findings. It can be attributed to the turbulence prevailed both in international as well as domestic financial markets and economies between 2010 and 2016.

Concluding Remarks:

From the analysis, we observed the fluctuations in the efficiency of prices discovered in the market across time periods. Broad market indices evinced gradual improvements in efficiency in the sub-period three while both size and liquidity based indices did not follow the same. Certainly, the size based indices are nothing but the constituents of the broad market indices, therefore, the improvements in efficiency we found in the sub-period three is attributable to the influence of large cap securities traded in the market and not to the market as whole. Similarly, the results also highlight the relatively higher efficiency in price discovery in NSE compared to BSE especially in case of bench mark, broad market and market cap based indices. Apart from this, the inefficiency observed in the indices regardless of the level of liquidity and the trading platform counters the arguments of positive relationship between market liquidity and price efficiency. This evidence takes us to link to Black (1986) and De Long et al., (1990) statements on the presence of noise trading and pricing of noise risk in the market whereby market remain inefficient.

SEBI (Securities and Exchange Board of India) after its inception as market regulator have been taking up various reforms with the objective of investor protection as well as promotion of development of securities market, the Indian market evinced periodical fluctuations in its price efficiency. Therefore, further investigations and monitoring of the periodical changing patterns in the market participation of categories of investors and the responsiveness of various policy initiatives on the overall market as well as on the market segments need to be explored.

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Appendix

Table 2: Dependency in the Broad Market Portfolios in India

Statistic	BSESENSEX	BSE500	NIFTY	NSE500
Multiple Variance Ratio Test#				
For the entire period				
Z1	6.975*	7.574*	5.273*	7.976*
Z2	3.918*	3.991*	3.132*	4.186*
Sub period 1				
Z1	5.032682*		2.155718	
Z2	2.792996**		1.591701	
Sub period 2				
Z1	3.091236*	5.952099*	3.957232*	6.677319*
Z2	1.722562	2.959842**	1.999243	3.26064*
Sub period 3				
Z1	3.135477*	4.642537*	2.643682**	4.371145*
Z2	1.985314	2.663687**	1.651435	2.514352
# Multiple Variance Ratio Test following Chow and Denning (1993) and holding periods considered are; 2, 5, 10, 20, 60). Critical values at 1%, 5% and 10% level of significance are 3.08, 2.56, and 2.31 respectively. *and** indicate Z1and Z2 statistics that are significant and rejected the null hypotheses at 1% and 5% level of significance. Z1statistics assumes homoscedastic disturbances and Z2 statistics are heteroscedastic robust estimates.				
Spectral Shape Test for Random Walk#				
For the entire period				
Anderson-Darling	27.681*	30.323*	15.414*	33.070*
Cramer-von Mises	5.501*	6.129*	3.175*	6.753*
Mellows	2.106*	2.238*	1.539*	2.333*
Sub period 1				
Anderson-Darling	69.70432*		0.3341702	
Cramer-von Mises	10.8581*		0.0407556	
Mellows	3.2342*		0.1698878	

Sub period 2				
Anderson-Darling	764.2656*	908.9598*	813.6218*	872.0693*
Cramer-von Mises	119.7577*	142.4586*	127.5009*	136.6707*
Mellows	10.75777*	11.73345*	11.10022*	11.49256*
Sub period 3				
Anderson-Darling	0.4555209	0.3027117	0.4990922	0.3524206
Cramer-von Mises	0.0577853	0.0374986	0.064132	0.0431888
Mellows	0.1942766	0.1626404	0.204805	0.1741755
[#] Spectral Shape Test for Random Walk based on Durlauf (1991) and Choi (1999).* indicates rejection of null hypotheses at 1% level of significance. (Asymptotic critical values are 3.85 and 2.49 for AD statistic, 0.74 and 0.46 for CVM statistic and 0.75 and 0.58 for Mellows statistic at 1% and 5% level of significance respectively (Choi and Mark, 1997).				
Joint Test of Wrights' Rank and Sign Tests[#]				
For the entire period				
CDR_1	9.24 (3.030**)	8.231(2.934**)	7.439(2.995**)	8.15(3.025**)
CDR_2	8.291(2.993**)	7.638(2.91**)	6.384(3.033**)	7.837(2.969**)
CDS_2	7.565(3.055**)	9.903(2.989**)	6.642(2.973**)	9.925(3.016**)
Sub period 1				
CDR_1	7.562 (2.424)#		5.105363(2.395)#	
CDR_2	6.450(2.425)#		3.908035(2.401)#	
CDS_2	5.899(2.402)#		5.242187(2.401)#	
Sub period 2				
CDR_1	4.103036(2.406)#	5.901533(2.406)#	4.449908(2.406)#	6.104033(2.406)#
CDR_2	3.480572(2.409)#	5.597612(2.409)#	4.09681(2.409)#	6.125134(2.409)#
CDS_2	4.685689(2.433)#	10.05102(2.433)#	5.346112(2.433)#	10.53037(2.433)#
Sub period 3				
CDR_1	3.406296(2.405)#	5.371254(2.405)#	2.968191(2.405)#	5.093472(2.405)#
CDR_2	3.249945(2.376)#	4.863118(2.376)#	2.668511(2.376)#	4.577978(2.376)#
CDS_2	2.742156(2.426)#	5.750218(2.426)#	2.458333(2.426)#	5.487155(2.426)#
[#]Joint test of Wright's Rank and Sign Test in line with Chow and Denning (1993) approach (Franch and Contreras, 2004) for holding periods (2, 5, 10, 20, 60).*Critical values are simulated with 10000 iterations on their respective sample sizes; BSE Sensex, BSE 500, NSE Nifty, NSE 500..** Critical values at 1% level of significance and # indicates critical value at 5% level of significance. Null Hypotheses are rejected in all cases at 1% and 5% level of significance				

Table 3: Dependency Variations in Returns with respect to Market Capitalisation

Statistic	**BSELarge Cap**	**BSE Mid Cap**	**BSE Small Cap**	**NSE Mid 100**	**NSE Small 100**
Multiple Variance Ratio Test[#]					
Period	*2005 to 2016*	*2003 to 2016*	*2003 to 2016*	*2005 to 2016*	*2005 to 2016*
Z1	3.94*	11.24*	15.24*	9.16*	12.05*
Z2	2.430	5.48*	9.03*	4.67*	6.12*
	2005-2007	*2003-2007*	*2003-2007*	*2005 to 2007*	*2005 to 2007*
Z1	1.759	6.767	7.741	4.662	5.653
Z2	1.195	2.723	4.057	2.252	2.657
2008-2016					
Z1	3.440	9.282	13.780	7.755	10.556
Z2	2.066	4.776	7.578	4.038	5.479
[#]Multiple Variance Ratio Test following Chow and Denning (1993) and holding periods considered are; 2, 5, 10, 20, 60. Critical values at 1%, 5% and 10% level of significance are 3.08, 2.56, and 2.31 respectively. *and** indicate Z1and Z2 statistics that are significant and reject the null hypotheses at 1% level of significance respectively. Z1statistics assumes homoscedastic disturbances and Z2 statistics are heteroscedastic robust estimates.					
Spectral Shape Test for Random Walk[#]					
Period	*2005 to 2016*	*2003 to 2016*	*2003 to 2016*	*2005 to 2016*	*2005 to 2016*
Anderson-Darling	188.69*	3938.31*	3940.50*	625.93*	426.50*
Cramer-von Mises	29.49*	617.91*	618.26*	98.05*	66.77*
Mellows	5.33*	24.43*	24.44*	9.73*	8.03*

	2005 to 2007	*2003-2007*	*2003-2007*	*2005 to 2007*	*2005 to 2007*
Anderson-Darling	1537.607	21915.920	24968.080	2689.496	9032.475
Cramer-von Mises	241.104	3440.549	3919.805	421.891	1417.666
Mellows	15.265	57.670	61.556	20.194	37.019
2008-2016					
Anderson-Darling	0.304	0.666	0.719	20.953	1.056
Cramer-von Mises	0.038	0.100	0.109	0.341	0.164
Mellows	0.165	0.257	0.269	0.542	0.350
[#] Spectral Shape Test for Random Walk based on Durlauf (1991) and Choi (1999). * indicates rejection of null hypotheses at 1% level of significance. (Asymptotic critical values are 3.85 and 2.49 for AD statistic, 0.74 and 0.46 for CVM statistic and 0.75 and 0.58 for Mellows statistic at 1% and 5% level of significance respectively (Choi and Mark, 1997).					
Joint Test of Wrights' Rank and Sign Tests[#]					
Period	*2005 to 2016*	*2003 to 2016*	*2003 to 2016*	*2005 to 2016*	*2005 to 2016*
CDR_1	4.27(2.93**)	12.09(3.02**)	16.17(2.97**)	9.86(3.01**)	12.52(3.01**)
CDR_2	3.97(2.94**)	11.65(2.99**)	15.91(2.98**)	9.44(3.00**)	12.33(3.00**)
CDS_2	4.76(2.983**)	16.11(3.018**)	19.06(3.00**)	12.28(3.02**)	11.43(3.02**)
	2005 to 2007	*2003-2007*	*2003-2007*	*2005 to 2007*	*2005 to 2007*
CDR_1	1.653(2.33)	6.623(2.37)	7.141(2.37)	4.656(2.35)	5.808(2.35)
CDR_2	1.531(2.31)	6.454(2.35)	7.184(2.35)	4.583(2.34)	5.734(2.34)
CDS_2	3.071(2.41)	14.614(2.40)	16.216(2.40)	9.236(2.37)	9.985(2.37)
2008-2016					
CDR_1	3.601(2.43)	9.613(2.43)	13.795(2.43)	8.387(2.43)	10.893(2.43)
CDR_2	3.386(2.438	9.440(2.43)	13.883(2.43)	7.971(2.43)	10.85(2.43)
CDS_2	3.988()2.39	9.040(2.39)	12.945(2.39)	8.776(2.39)	8.924(2.39)
[#]Joint test of Wright's Rank and Sign Test in line with Chow and Denning (1993) approach (Franch and Contreras, 2004) for holding periods (2, 5, 10, 20, 60). *Critical values are simulated with 10000 iterations on their respective sample sizes; BSE large cap, BSE Mid cap, BSE Small cap, NSE Mid100, NSE Small100. ** Critical values at 1% level of significance. Null Hypotheses are rejected in all cases at 1% level of significance.					

Table 4: Dependency and Market Liquidity

Variables	BSE Highest 20	BSE Lowest 20	NSE Highest 20	NSE Lowest 20
Multiple Variance Ratio Test#				
Z1	6.2518*	9.9260*	7.2999*	9.7151*
Z2	5.2884*	7.7758*	6.2832*	7.2133*
[#] Multiple Variance Ratio Test following Chow and Denning (1993) and holding periods considered are; 2, 5, 10, 20, 60) Critical values at 1%, 5% and 10% level of significance are 3.08, 2.56, and 2.31 respectively* indicates Z1and Z2 statistics that are significant and reject the null hypotheses at 1% level of significance Z1statistics assumes homoscedastic disturbances and Z2 statistics are heteroscedastic robust estimates				
Spectral Shape Test for Random Walk#				
Anderson-Darling	9.1964*	9314.6670*	0.3123	91.3194*
Cramer-von Mises	1.4059*	1461.9710*	0.0381	14.2413*
Mellows	1.1502*	37.5926*	0.1666	3.7055*
[#] Spectral Shape Test for Random Walk based on Durlauf (1991) and Choi (1999). * indicates rejection of null hypotheses at 1% level of significance. (Asymptotic critical values are 3.85 and 2.49 for AD statistic, 0.74 and 0.46 for CVM statistic and 0.75 and 0.58 for Mellows statistic at 1% and 5% level of significance respectively (Choi and Mark, 1997).				
Joint Test of Wrights' Rank and Sign Tests#				
CDR_1	6.999 (3.007)**	11.297(3.007)**	8.315(3.049)**	14.919(3.049)**
CDR_2	6.553(2.988)**	10.911(2.988)**	7.750(2.984)**	13.722(2.984)**
CDS_2	5.874(3.074)**	8.788(3.074)**	6.564(3.092)**	10.637(3.092)**
[#]Joint test of Wright's Rank and Sign Test in line with Chow and Denning (1993) approach (Franch and Contreras, 2004) for holding periods (2, 5, 10, 20, 60).*Critical values are simulated with 10000 iterations on their respective sample sizes; BSE Highest 20, BSE Lowest 20, NSE Highest 20, NSE Lowest 20.** Critical values at 1% level of significance. Null Hypotheses are rejected in all cases at 1% level of significance				