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# Sectoral Correlations and Interlinkages: NSE



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## A b s t r a c t

An efficient portfolio is a well-diversified portfolio that gives the investor opportunities to earn money and provide cover against risks. Understanding the intersectoral linkages and correlations among various sectors in a stock market will help an investor to diversify the portfolio and reduce risk efficiently. This study aims at examining the underlying linkages and correlations among eight sectors in the Indian National Stock Exchange (NSE) using a Granger causality test under VAR environment. The results of the study based on nine years' data from 2009 to 2018 show that an effective portfolio can have two classifications –stocks from Pharma and Media as group one (defensive stocks) and picks from IT, Bank, Financial Services, Realty, Auto and FMCG sector as group two (somewhat Cyclical). The study further proves that the usual definition for cyclical and defensive sectors have undergone some profound changes.

*Keywords: Portfolio Diversification, intersectoral linkages, ADF Test, Granger causality.*

The investment pattern is changing from one generation to another as a result of an increase in risk-taking appetite of different generations. It was plots and land for our forefathers who were risk-averse investors, it became bank FD's, postal deposits and chit funds etc. for baby boomers who were born after the 1950's, and it is stock markets for the Millennials, born after 1980. The fundamentals of wealth creation have made the stock market investments and portfolio diversification attractive for the stock market players. The famous example of Wipro Ltd, wherein a meagre Rs. 10000 worth of investments made in the stock in the early 1980's grew to a whopping 741 crores in 2019 (Rangarajan, 2019). This example showcases another gem of investment called value-based investing. The golden principle of wealth creation- "the value-based investing" framed by ace investor Benjamin Graham coupled with appropriate portfolio diversification strategies will make the investments grow by leaps and bounds in the long run.

Stock Market plays a pivotal role in the growth of the industry and commerce in a country. As stock markets also signal the growth of an economy, government and central banks keep a close watch on the ups and downs in the stock market. The stock market is important for the industry as well as for investors. As far as investors are concerned, their investment preference always relates to stocks of those sectors with maximum returns and minimum levels of risks. Construction of a portfolio of multiple assets helps investors get maximum returns at a given level of risk (Abreu & Mendes, 2009). However, the large input data requirement and enormous time make the risk-return analysis cumbersome. In this context, index models for portfolio selection is a reliable method as the overall performance of the stock markets is usually tracked and reflected in the performance of various stock market indices.

Information about stock market helps the investor to invest in the markets with potential diversification benefits. Here an investor can increase return or reduce risk by diversifying his investment portfolio in segmented stock markets. Instead of orienting equity investment to one company or sector, the best option is investing in large mid and small-cap stocks across high growth stable sectors (Vlastakis & Markellos, 2012). Other studies related to the amalgamation of the stock markets and the financial markets also helps investors figure out the benefits and limitations of portfolio diversification (Ahmed, 2011). Another important aspect of

being considered is the international transmission of shock among national stock markets which widens the scope of stock market integration or segmentation. The policymakers who are well informed of stock market integration or segmentation could clearly understand the sectoral connections which help them take precautionary measures to prevent the systemic shocks to ensure the stability of the economy (Sharma & Dhiman, 2016). With the liberalisation of economies, easement of legal barriers, increase in the number of transnational companies in the countries etc, portfolio diversification seems to be a challenge even to the most expert investors. Along with this, the high uncertainty in the financial and economic environment across the world makes it look like an almost impossible task.

Allocation of capital to stocks from different sectors is subject to the performance and anticipated growth of the concerned sector. Thus, the investors could create a portfolio by this sectoral allocation and keep on revising this portfolio by favourable new information from the concerned sector. The investors can observe the performance of various sectors from the respective sectoral indices. The success of investors, fund managers and other market players depending on their knowledge on market integration. Studies on stock market integration at the sectoral level highlight the importance of sectoral analysis as it determines whether the impact of the crisis on the main indices is consistent at the sectoral level as well (Arvind, 2017).

The investor selection of specific stocks depends on their risk-return perspectives. Measured risk brings prospects of higher returns. While operating riskier investments, risk management strategies should evolve to mitigate losses. Instead of orienting equity investment to one company or sector investing in large and small-cap stocks across high growth and the stable sector is apt action. While evaluating a stock for investment, study about its price movement and financial health of the company is of utmost importance (Jorion, 2000). Based on these cautions, the performance of stock markets can quickly identify and judged by an investor by looking at its market index. The market index provides a yardstick to measure the performance of a particular stock and also provide investors for forecasting future trends in market movements. Thus, choice of individual stocks within each of the selected area could be made by the individuals or portfolio managers based on analysis which generally aims at accrual of higher returns, given a risk level (Cowles, 1944).

Sectoral linkage has become one of the most discussed topics in the portfolio creation process (Yilmaz et al., 2015; Siczka & Hołyst, 2009; Garas & Argyrakis, 2007) The linkage among various sectors in Indian stock market should be analysed on the basis of sectoral interlinkages. The studies of sectoral inter-linkages are all the more important for a developing country like India so that positive growth stimuli among sectors could be identified and fostered to sustain the economic growth momentum. Identifying sectoral linkages and correlations in the stock market would also help the investors diversify their investment portfolio, thereby reducing the risk of making a huge loss by 'putting all eggs in a single basket'. This study has used a multivariate Granger causality test by fitting a Vector Auto Regressive (VAR) model to assess the mutual causal effect among eight sectoral indices in National Stock Exchange (NSE) namely, IT, PHARMA, REALTY, MEDIA, AUTO, BANK, FINANCIAL SERVICES and FMCG for a period spanning 10 years starting from January 2009. The results of the Granger causality test would help descry the unobserved interlinkages among these eight sectors and would provide useful insights to the investors to diversify their existing investment portfolios.

### Review of literature

There are a number of studies examining the inter-sectoral correlation among different sectors in the stock markets around the world. The relevant literature pertaining to this study are discussed here.

The interrelationship among sectoral indices in Athens stock market was examined by Patra & Poshakwale (2008). They used cointegration to find evidence for long-run relationship and variance decomposition to test the short-run relationship. Their results show that the banking sector was strongly correlated with other sectors in the short run, and it accounted for the major share of volatility and returns from the other sectors.

The long-run and short-run sectoral correlation in the Bombay Stock Exchange (BSE) was investigated by Noor et al. (2014), and the findings portray that except Bankex-IT and Consumer durables-Realty, no other long-run relationship was observed. The evidence for the short-run relationship was also limited. The stock market of Cyprus also showed similar trends where there was little evidence for bivariate cointegration in the long run and no active sectoral correlation in the short-run (Constantinou et al., 2008). Another study conducted in China to check the inter-

sectoral correlation in Chinese stock exchanges gives evidence for strong interdependency among sectors (Wang et al., 2005).

Many studies showed that the increasing interdependency among countries might significantly reduce the benefits of portfolio diversification, especially during bearish market (Olienyk et al., 2002 and Glezakos et al., 2007). A study conducted by Ahmed et al. (2018) analysed the correlation in the sectoral indices in Colombo stock exchange using a multivariate cointegration and granger causality test. The study aimed at creating a diversified portfolio to reduce risks. The results show that the sectors were not integrated with each other, and the Colombo stock exchange offers good diversification opportunity to the investors.

Siddique (2009) asserted that the understanding of the global stock market composition is significant for both investors and portfolio managers in India. The study also pointed out that the individual and institutional investors should grasp a healthy diversified portfolio to decrease risk.

Sarkar et al., (2009) studied the interrelation between Indian stock market with other markets around the world and identified a strong correlation between the global stock market and the Indian stock market with the impact of US stock market on India being the most prominent.

The study of Bhalla (2011) shows that the extent of stock price volatility is influenced by the extent of integration between the domestic and international capital market as well as regulating framework governing the stock market. The behaviour of stock prices in India during the nineties was influenced by the net investment by FII and trend in the international stock exchange.

Raj & Dhal (2008) analysed the integration of India's stock market with the global and major regional market and found that there is a lack of evidence of integration of stock market in terms of local currency. This situation gives rise to concerns that the Indian stock market integration to be a success only if there is an adequate role of domestic investors.

The study conducted by Kaur et al. (2009) identified a bivariate relationship between manufacturing and agriculture sector in India. Further assessing the interlinkages between sectors, the study shows long-run association among banking, manufacturing, trade hotels, transport and communication sectors.

Harvey (1995) suggests that the improvement in market efficiency is consistent with increasing integration with world markets. But, Kim & Singal (2000) viewed that the national stock markets are different since they operate in the economic and social environments of different countries. Accordingly, a country's financial market functions when prices reflect the fundamentals and risks of other countries. Linkages among fundamentals across nations result in financial integration.

Chebby (2010) examined the link between agriculture growth and other sector growth of the economy such as manufacturing transportation, tourism, telecommunication, commerce and service sector using the Johansen Co-integration and Granger Causality in the case of Tunisia and concluded the existence of a long-run relationship between agricultural growth and other sectors of the economy.

Ahmed (2008) in his study, explored how stock prices in India led economic activity and movement in the interest rate, which significantly influences the stock prices. The study confirmed that the Indian stock market seemed to be driven not only by actual performance but also by expected potential performances.

The general lack of interest of the stock market in India in the important basic capital and intermediate good in the aftermath of the excessive attention paid to computer, software, telecommunications, electronic media, pharmaceuticals and consumer non-durables. This happens so due to investors preference for quick returns. If the stock market does not support the basic capital industries, it will undermine the efforts of the state in the form of development financial institutions. (Rao, Murthy & Ranganathan, 1999). In the case of crisis-hit ASEAN countries, the efficient capital market is more important as these are struggling to reduce the dependency on bank loans (Click & Plummer 2005).

Barari et al. (2008) showed the macroeconomic implication of stock market integration and more specific aspects of integration, such as understanding the time-varying nature of market integration among developing countries. The relationship between macro-economic variables and the stock market is dynamic and requires extensive and frequent studies to interpret the interlinkages.

The increased globalisation of financial markets resulted in a situation of smaller markets following larger markets. Aggarwal & Rivoli (1989), in their study, examined the

relationship by concluding that the Asian market followed the US market movements on a day-to-day basis. This was confirmed by another study which showed that the greater the international integration of equity markets, the higher the degree of correlation among national equity prices (Cashin et al., 1995).

Most of the studies exploring the short run sectoral interdependency in stock markets used a Granger Causality test. This study also follows suit to investigate the short-run interrelationship among sectors in the National Stock Exchange (NSE) of India.

### Materials and Methods

The data used for the study comprised the daily returns of the eight sectoral indices of NSE from 1st April 2009 to 28th March 2018. The sectors included in the study are IT, PHARMA, REALTY, MEDIA, AUTO, BANK, FINANCIAL SERVICES and FMCGs. The log difference of the data was taken using the following equation prior to the analysis.

$$R = \ln(P_1/P_0) \dots \dots \dots (1)$$

Where, R is the returns, P1 denotes the current day's price, P0 shows the price for the previous day and Ln denotes the log transformation of the data.

A prerequisite for testing the cause and effect relationship using the Granger Causality test among various sectoral indices is to ensure that all the variables are stationary. The ADF test (Dickey & Fuller 1981) was conducted to check whether the variables contained unit root or not. The optimal lag structure was determined by AIC (Akaike information criteria). This empirical analysis is conducted based on the assumption that the time series data used for mathematical modelling are not stationary. Stationary time series are those in which the statistical properties will remain constant over a period of time.

Kayral & Karacaer (2017) had used the Granger Causality Wald test to find the cause and effect relationship of US stock market returns and Exchange rate changes on the stock market volatilities in emerging economies.

This study also uses a granger causality wald test to assess the short-run causal effect among the variables. For testing the relationship, first, a vector autoregressive model (VAR) was fitted, and then the Granger causality test was conducted for each equation in the VAR model. VARs are a system of

equations that depend on the outcome of other variables. The following equations show how  $y_t$  and  $x_t$  attain value from the lags of the  $x$  and  $y$ s.

$$y_t = \beta_{10} - \beta_{12}x_t + \gamma_{11}y_{t-1} + \gamma_{12}x_{t-1} + u_{yt} \dots\dots\dots(2)$$

$$x_t = \beta_{20} - \beta_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}x_{t-1} + u_{xt} \dots\dots\dots(3)$$

Granger causality can be conducted by following a three-step procedure.

At first we regress  $y$  on  $y$  lags without considering the lags of  $x$ .

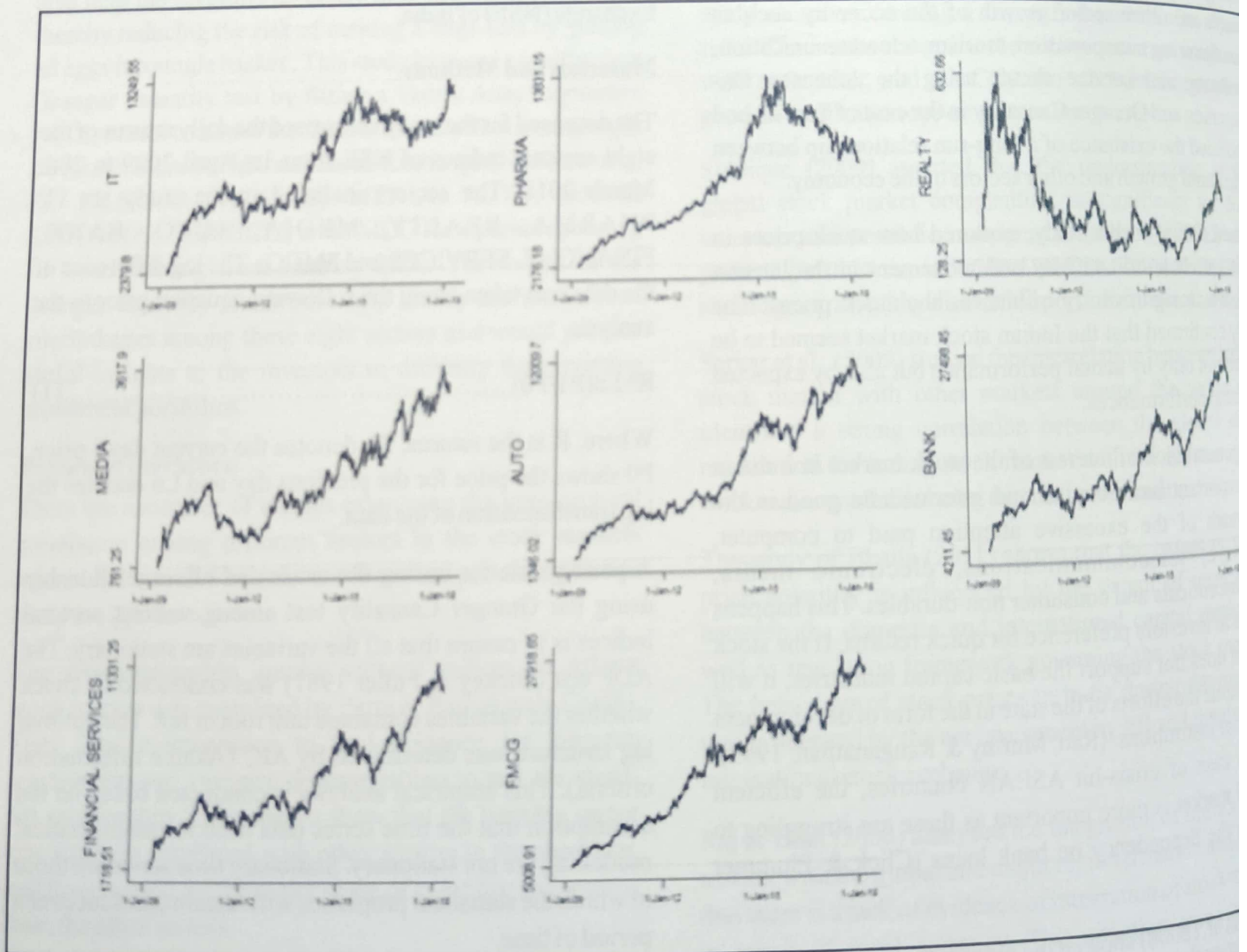
$$y_t = a_1 + \sum_{j=1}^m \gamma_j y_{t-j} + e_t \dots\dots\dots(4)$$

Secondly, we add the lags in  $x$  and regress again

$$y_t = a_1 + \sum_{i=1}^n \beta_i x_{t-i} + \sum_{j=1}^m \gamma_j y_{t-j} + e_t \dots\dots\dots(5)$$

Finally, we test the null hypothesis that  $\beta_i = 0 \forall i$ , using an F-test.

Figure 1 shows the time-series line graphs for each sector with the range of variation prior to the log difference transformation.



**Figure 1. Sectoral Indices Line Graphs**

The descriptive statistics for the variables along with the Shapiro Wilk normality tests are given in Table 1.

Table 1. Descriptive Statistics

Variable	IT	PHARMA	REALTY	MEDIA	AUTO	BANK	FIN SERVICES	FMCG
Mean	0.00077	0.00063	0.00015	0.00068	0.00097	0.00082	0.00083	0.00076
Std. Dev.	0.01387	0.01135	0.02412	0.01457	0.01317	0.01574	0.01498	0.01127
Skewness	-0.1246	0.01601	0.03867	0.30629	0.47054	0.73399	0.87895	-0.0143
Kurtosis	13.2668	10.3373	7.8991	7.2243	10.002	11.0619	13.66	6.9356
Shapiro-Wilk (W)	0.91685	0.95365	0.95993	0.97133	0.96325	0.95338	0.94525	0.96479
P Value	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>

Table 1 shows the results of the descriptive statistics along with the normality test results. From the results it could be seen that the mean returns of AUTO, BANK and FINANCIAL SERVICES were above 80% and outperformed the returns from other sectors. Except for the IT sector, all other sectors showed positive skewness. The

values of kurtosis for all the variables under study are positive. The Shapiro Wilk normality test result shows that the p value for all the variables are 0.00. Hence, we reject the null hypothesis that the data under study follows normal distribution.

Table 2. Augmented dickey Fuller Test (ADF Test)

Variable	Test Statistic	P Value	Critical Values		
			1%	5%	10%
IT	-35.27	<b>0.000</b>			
PHARMA	-34.59	<b>0.000</b>			
REALTY	-33.06	<b>0.000</b>			
MEDIA	-33.26	<b>0.000</b>	-3.43	-2.86	-2.57
AUTO	-30.66	<b>0.000</b>			
BANK	-31.93	<b>0.000</b>			
FINANCIAL SERVICES	-31.916	<b>0.000</b>			
FMCG	-34.947	<b>0.000</b>			

Table 2 shows the result of ADF test. From the result it could be seen that all the variables are having lesser Test statistic than the critical values which denotes the stationarity of data

sets. Data was made stationary as a prelude for doing the causality test.



**Table 3. Granger Causality Wald Tests**

Dependent Variables Independent Variables	IT	PHARMA	REALTY	MEDIA	AUTO	BANK	FIN SERVICES	FMCG
IT		1.06	<b>8.33*</b>	1.23	<b>11.9**</b>	2.28	<b>7.71*</b>	2.24
PHARMA	1.97		3.58	3.131	0.846	0.876	1.91	0.1351
REALTY	3.13	2.13		0.292	0.194	0.768	0.259	0.052
MEDIA	0.86	3.55	1.235		5.81	1.57	2.72	1.6
AUTO	3.29	3.35	2.614	1.25		0.664	0.476	4.572
BANK	<b>5.75*</b>	1.63	<b>6.34*</b>	1.13	4.84		1.334	1.6
FIN SERVICES	<b>8.23*</b>	1.67	<b>8.26*</b>	1.63	4.81	<b>6.14*</b>		0.748
FMCG	2.26	2.08	2.56	0.393	<b>13.9**</b>	3.14	<b>5.92*</b>	

\*p < 0.05, \*\*p < 0.001.

Usually, the market treats IT and Pharma stocks as paired stocks and expects them to move together. But, contrary to the researchers' expectation, Pharma index for the given period was not moving along with IT. From our analysis, it is clear that Pharma sector still remains a defensive bet for the investors as it doesn't have any correlation with other sectors and hence could be made a part of investors' portfolio to balance the volatility.

Study further points out that IT sector stocks have lost the tag of a defensive investment as it has become cyclical in nature and is seen moving along with Realty, Automobile and Financial Services sector. This might be due to the following factors:

- The share of IT companies from the domestic market is increasing, and there is a shift in the trend wherein the domestic economy has started contributing more towards their bottom line. (Singh, 2019)
- Overseas business exposures of IT firms have started showing a bearish trend.

It is interesting to note that the performance of Financial sectoral index could be used for predicting the performance of the banking index. It may be due to the contagion effect. For instance, the issues in the companies like IL&FS, DHFL etc. did trigger a mass correction in the market values of banking stocks as most of the banks are having exposure in Financial service industry (either in the form of loans or investments). In financial terms, The IL&FS group had a systemic borrowing of nearly Rs 91,000 crore. Out of which, it has raised Rs 57,000 crore through bank loans. (Mudgil, 2018)

FMCG and Automobile stocks are showing the strong connection and hence cannot be used together (in larger proportions) for portfolio creation. From the study, it is understood that to be on a safer side, the portfolio should include stocks showing no connection with other sectors (Pharma, Media and FMCG) on one side and stocks showing dependence on other sectoral indices on another side. (realty, financial services etc.)

An ideal portfolio as per this study should constitute stocks from

1. Pharma and Media (as defensive stocks) and
2. all other sectors (as cyclical stocks)

The ideal proportion of the defensive and cyclical stocks can change from investor to investor.

**Conclusion and future research directions**

Our study has given an approximate solution for portfolio diversification to be made in NIFTY 50 based markets using VAR Granger causality test. The term "approximate solution" requires special emphasis because no models or trend forecasts will be able to predict the market with cent per cent accuracy. The present study was successful in explaining the changing dynamics of various sectors and suggesting the appropriate changes to be made in the portfolio based on the NIFTY 50 momentum changes. The major findings of the study imply that an efficient portfolio would consist of 50% stocks from pharma and media as defensive stocks and 50% from the rest of the six sectors as cyclical stocks.

One of the limitations of the study is that the analysis was primarily done for a period of 10 years. The study can be expanded by including data from the latest financial year. Interlinkage of various sectors of NIFTY 50 have been analyzed in the current study without considering the dynamics of various macro-economic variables. This limitation provides further scope for the study. The long term relationship among various sectors and the spillover effects among various sectors also provide scope for further research.

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