

Analysing Stock Market Returns and Twitter Sentiments of Investors

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Abstract

It has been found that investors are extensively using social media platforms like microblogging site Twitter to share their thoughts and opinion about stocks of different companies. The objective of the study is to analyze the relationship between investor sentiments and stock prices. Previous researches have shown that there is relationship between Twitter feeds related to companies and their respective stock prices during the day. In this study we are analyzing whether tweet feed affects Nifty prices or Nifty prices have an impact on tweets by investors.

The research is based on Twitter and financial data collected during the period February 22, 2018 to March 8, 2018. We have used R programming for collection and filtering of data. Personal Twitter account was linked with R and tweets are extracted with the help of the twitter Application Programming Interface (API). Financial data comprises of daily closing prices of Nifty Index stocks was collected from February 22, 2018 to March 8, 2018 from NSE website. To analyse the data Automated Dicky Fuller Test, Cointegration Test, Correlation analysis, Granger Causality Test has been conducted.

Out of fifty sample companies nineteen companies have shown high degree of significant correlations between stock returns and investor sentiments. The relationship is positive between stock returns and total tweets and positive sentiments and negative between stock returns and negative twitter sentiments. Nifty being benchmark index has negative relationship with total tweets score and positive sentiment score which implies that there are other factors which affect Nifty twitter sentiments. The results of trace test show that there are two cointegrating equations for relationship between closing price of Nifty and total tweets score and negative tweets score. The companies including Bajaj Finance Ltd., Cipla Ltd., IndusInd Bank Ltd., Reliance Industries Ltd., Tata Consultancy Services Ltd. and Tech Mahindra Ltd. shows that tweet sentiments lead stock returns. The study also shows that there is significant relationship between investor twitter sentiments and stock returns in Indian stock market. The implications of this study are relevant for investors, analysts and companies.

Key Words: Stock Return, Twitter Sentiment, Investor

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INTRODUCTION

Researchers around the globe are using social media data to judge the mood of people in the society. Corporates are using the data to market their products, while governments use data to gauge impact of public sentiments on elections. The social media data are helping government as well as private organizations in designing policies and strategies. Social media sites such as twitter have attracted a lot of attention in analyzing the moods and beliefs of people. Moreover, various tools and software are available to assess twitter data and predict through the sentiments of people.

The trend of analyzing twitter data has attracted many academicians as well as practitioners in financial markets. A major segment of financial markets i.e. stock markets seems to move with the market sentiments on twitter. Twitter has become a platform to judge the mood of society. The mood of investors has a great impact on the stock markets. The sentiment analysis of twitter data has revealed that mood of the people sync with the stock market movements. It is now understood that the stock market movements can be predicted (almost) accurately by conducting sentiment analysis on twitter data. Moreover, studies have also found that festive times in which the moods of the investors are happy have a positive impact on the stock prices. Happy mood leads to the positivity in the market and markets boost, as the investors are willing to take risk. On the other hand, when investors are sad and angry, say due to hike in taxes by government, the anger is reflected in stock prices as the markets become bearish. Stock prices fall and people start losing their faith in the market. There comes in the negativity which further leads to negative returns on the stocks and investors become risk-averse. Thus, it should not be ignored that investment decisions are highly dependent on the mood of investors. And an easy way to judge the mood of investors is through the analysis of their data available on twitter.

Financial market data analysis is done by investors, asset management companies, portfolio managers, investment and financial advisors, and many other market participants. Investors and traders in the stock markets perform various

analysis such as fundamental analysis and technical analysis while investing in the stocks. Both fundamental and technical analysis have a limitation that behavioural aspects of the investors and market participants are not considered and thus they prove to be weak instruments in predicting stock's price. With the emergence of behavioural finance and its importance known in the current scenario, behavioural aspect associated with the stock markets cannot be ignored. By applying a behavioural analysis with the fundamental and technical analysis, stock prices can be predicted more accurately and thus investors can earn huge returns by taking advantage of the sentiments in the market. With a prior knowledge of market sentiments investors can frame their investment strategies which can help them earn abnormal profits from the markets, especially in a market like India. In India, the sentiment analysis can be a very useful tool in predicting stock market movements as the markets in India have huge population of retail investors. As the major proportion of investors includes retail investors and only a few are professional investors, Indian stock market suffers from noise trading and professional investors earn more at the cost of retail investors. This is due to inappropriate stock market news dissemination. In such a scenario, twitter comes as a cheap and easy source of stock market news and information to the retail investors and they take their decision based on such sources of news. Thus, a major population of investors in India is dependent on the news and information available to them from the sources such as twitter. Thus, strategizing on the twitter data can help the investors earn exceptional returns.

Stock prices are almost accurately predictable by carrying out sentiment analysis on the twitter data. But relying wholly on sentiment analysis is not the correct approach for predicting stock market movements. While predicting stock market movements it should be kept in mind that there are chances that twitter can flash false news and thus mislead the investors. Thus, interrupting stock markets for small durations.

The objective of this paper is to understand role of twitter in analyzing stock market. It has been done through analyzing twitter feeds related to Nifty 50

companies and studying its relationship with stock price movements. The rest of the paper is organized as follows. Section two discusses review of literature, section three explains methodology of the study, section four analyses the results and section five concludes the research.

REVIEW OF LITERATURE

One of the early researches which were conducted to predict the stock market trends through tweets. It was based on randomised sub sampling of millions of tweets based on selective emotional keywords out of which 4 were optimistic and 4 were pessimistic. Results were that optimistic tweets are much higher than pessimistic ones and tweet data is negatively correlated with NASDAQ, S&P50 and Dow Jones however has a positive correlation with VIX (Zhang et. al, 2010).

Elfayoumy & Schnusenberg (2017) investigated the bidirectional relationship between the return on stock volatility and tweets that existed. The methodology adopted was analysing minute to minute stock price of 150 stocks, 180 mins each day for 13 days i.e June 2, 2014 to June 18, 2014 of 30 stocks in Dow Jones Industrial Average and their tweet data using BEKK-MVGARCH. Results showed that more than 80% of stock returns are affected by lagged innovation of tweet data however the effect on tweets from change in returns was only 7%. 73% of tweets affected the volatility of returns on stocks and 33% tweets are affected by volatility. The implications were that social media strategy plays a crucial role to gain advantage.

Fischer & Freidman (1984), Fisher & Statman (2003), and Bremmer (2008) also examine the influence of consumer sentiment on the stock market, measured from conference board data. This study is based on the confidence that consumer has on an economy well as personal financial position. Study shows unilateral relationship between sentiments of investor and social networks and tries to figure out the effect of such sentiments on stock price. The study gathered tweets on daily basis from people from diverse backgrounds using twitter in south-east University and applied lexicographic analysis over the period of three months and analysed that daily stock

prices gets affected by economic movement in the country.

Park et al. (2016) analysed the perception of diner in 4 Asian restaurant serving different cuisines. They analysed 86015 tweets which were referring Asian restaurants using data mining and sentimental analysis to understand meaningful pattern and emotional state of tweets. The techniques used were sentimental analysis and ANOVA and average sentimental scores were calculated which was lower for Chinese restaurants as compared to other three. The researchers also stated that there were positive tweets about the food quality and most of the negative tweets were about service quality.

Olivia & Sheng (2011) analysed the effect on process of micro blogs on stocks and analysing and evaluating their predictive power through data mining and sentimental analysis algorithms. Researchers 72,221 micro blogs from stocktwits.com over the period of 3 months and list of top 10 stock tickers were considered along with intraday data collected from yahoo finance. They found that these micro blogs have strong power of predicting future directions of market.

Liew et al. (2016) studied impact on IPOs over stock price of tweets. They tried to identify the relationship of IPOs raw return from opening price to closing price and sentimental analysis of related tweets, these include tweets on prior days for such as last 3 days and tweets on same day and quantum of return on opening day. Data related to tweet sentiments were collected from iSENTIUM LLC. IPO data is collected for 2 years whereas tweets were collected irrespective of actual trading hours. The author concluded that the sentiments related to IPOs can predict first day returns from opening prices to closing. Methodology adopted was cross section- regression analysis. In India, a study by Rao & Srivastava (2012) investigated the complex relationship between the literature related to investing like bullishness, volume, agreement etc through tweets with volatility, volume and prices of stock. They analysed 13 techie stocks and 4 million tweets of these stocks along with tweets related to NASDAQ-100 and DJIA. They used correlation, Granger's causality analysis expert model mining system(EMMS) and MaxAPE. The

results show high correlation, high value of R-square and low MaxAPE.

Pagolu et al. (2016) analysed the degree of correlation between rise and fall of stock prices and tweets expressing opinions. Tweets were extracted using twitter4J on Microsoft and correlated with stock price of Microsoft. The study concluded that any positive news about the company encourage the investors to invest in the company leading to increase in the stock price and hence correlation do exist.

Caliño et al. (2016) focused on the fact that the opinion of a single person can be influenced by public sentiments and moods. It was country oriented research which focused on movement of closing index of Philippines stock exchange due to tweets by Filipino public. Tweets were collected using python and granger causality testing method was applied. The result provided prediction model based on regression algorithm and p values and suggested that tweets collected can help in predicting future values of Philippines exchange.

Nguyena et al. (2015) aimed to construct a model to predict stock price movement with the help of the sentiment from social media. In contrast to previous approaches wherever the general moods or sentiments were considered, the sentiments of the particular topics of the corporate are incorporated into the stock prediction model. Topics and connected sentiments were extracted from the texts in a message board with the help of our planned technique and existing topic models. Comparing the accuracy average over 18 stocks in one year of transaction, their technique achieved a 2.07% higher performance than the model using solely historical costs.

Ranco et al. (2015) studied 30 stocks from Dow Jones Industrial Average (DJIA) index for 15 months data. They analysed the data using Karl Pearson correlation and Grangers causality index and it was observed that there was low level of correlation and Grangers causality between the time series. However it was observed that there is a significant positive relationship between abnormal returns and twitter sentiments for this event study was conducted.

METHODOLOGY: WEB MINING, DATA PROCESSING AND SENTIMENTAL CLASSIFICATION

The objective of the study is to analyse the relationship between investor sentiments and stock prices. Now a days investor express their sentiments using social media like twitter and many other. Previous researches have shown that there is a relationship between twitter feeds related to companies and their respective stock prices during the day. In this study we are analyzing on Nifty data that whether tweets affects Nifty prices or Nifty prices have an impact on tweets by investors.

The research is based on twitter and financial data collected during the period February 22, 2018 to March 8, 2018. We have used R programming for collection and filtering of data. Personal twitter account was linked with R and tweets are extracted with the help of the API.

R is a programming language which is an open source software used for statistical computing and graphics. This free source software is supported by foundation of statistical computing and is very widely used by statisticians, programmers and data miners. The popularity of R has been growing widely in recent years. It was created by John Chambers in 1976 at Bell Labs. It has variety of statistical and graphical techniques such as linear and nonlinear modeling, classical statistical tests, time-series analysis, classification, clustering, etc. The capacities of R are reached out through client made bundles, which permit particular factual systems, graphical gadgets, import/send out abilities, revealing apparatuses and so on. These bundles are produced fundamentally in R, and some of the time in Java, C, C++, and Fortran. The R packaging framework is additionally utilized by analysts to make compendia to arrange to explore information, code and report records efficiently to share and open chronicling.

twitter, *devtools*, *jsonlite*, *httr*, *stringr*, *ggplot2* are certain packages which were required to be installed in R-studio before starting collection of data.

The focus of this research is on 50 companies listed under NIFTY50. The reason for choosing these

companies is that the stocks of these companies are very popular and are highly traded in the market. Popularity has also helped in collection of considerable amount of tweets relating to such stocks.

Step 1: After installing above packages in R we signed up in twitter and developed API using twitter developers which require certain steps.

Step 2: After signing up and registration we used certain codes to extract tweets using certain keywords with respect to dates, language and other required filters.

Step 3: The tweets data so obtained is in a list format which is required to be converted into data frames for further analysis.

Step 4: Next step involved is removal of duplicate tweets, although retweets means a tweet is more popular and large number of population has shared their opinion but it does not depict true sentiments, it might be due to some influential person who has large number of followers who has retweeted.

Step 5: This step involve fine-tuning of data, this means in order to get more relevant data for easy analysis we removed unnecessary elements like numbers, symbols and http links. We used gsub command to remove the same.

Step 6: After cleaning of data we break the phrases

into individual terms and unlisted it.

Step 7: Opinion lexicons are downloaded which consist of positive and negative terms from the given links and are stored in work directories of R (sample R code given in appendix).

Step 8: Wordbag so obtained is matched with positive and negative words and per day negative and positive score was calculated accordingly. The total tweets score, positive tweets score and negative tweets score was collected for analysis purpose.

Financial data comprises of closing price and returns of NIFTY50 stocks were collected from February 22, 2018 to March 8, 2018 from NSE website.

To analyse the data Automated Dicky Fuller Test, ARCH test, Cointegration Test, Correlation analysis, Granger Causality Test has been conducted.

ANALYSIS AND INTERPRETATION

In this section analysis has been carried out to understand investor sentiments and its relationship with stock prices of Nifty 50 companies. Table 1 shows mean scores of all fifty companies listed in Nifty. The score shows average daily tweets for that company, positive tweets and negative tweets about the company.

Table 1: Mean Scores of NIFTY Fifty Companies

	Closing_price	Total_tweets	Positive_tweets	Negative_tweets	Returns
NIFTY Index	10396.7	2530	997	605	-0.11
Aurobindo pharma	604.58	25	4	2	0.44
Adani Ports and Special Economic Zone Ltd.	402.51	8	1	1	-0.14
Ambuja Cements Ltd.	249.515	3	1	1	-0.87
Axis Bank Ltd.	528.72	231	60	80	-0.22
Asian Paints Ltd.	1111.41	6	2	1	0.05
Bajaj Auto Ltd.	2973.13	16	5	2	-0.28
Bajaj Finance Ltd.	1638.62	11	4	2	0.26
Bharat Petroleum Corporation Ltd.	435.385	110	21	6	0.26
Bharti Airtel Ltd.	419.145	4	1	1	-0.42
Bharti Infratel Ltd.	338.715	23	4	5	-0.11

Bosch Ltd.	18579.3	2	1	1	-0.50
Cipla Ltd.	585.48	86	28	14	-0.29
Coal India Ltd.	309.285	10	2	1	-0.03
Dr. Reddy's Laboratories Ltd.	2183.93	10	2	1	-0.10
Eicher Motors Ltd.	27339	3	1	1	0.14
GAIL (India) Ltd.	451.73	21	3	1	-0.64
HCL Technologies Ltd.	944.075	126	59	12	0.09
HDFC Bank Ltd.	1870.81	1089	318	221	0.02
Hero MotoCorp Ltd.	3553.23	3	1	1	0.29
Hindalco Industries Ltd.	236.575	40	6	6	-0.67
Hindustan Petroleum Corporation Ltd.	376.105	207	35	21	-0.64
Hindustan Unilever Ltd.	1315.12	5	2	1	-0.28
Housing Development Finance Corporation Ltd.	1807.11	1609	300	167	-0.11
I T C Ltd.	263.365	909	208	97	-0.31
ICICI Bank Ltd.	309.055	611	145	183	0.62
Indiabulls Housing Finance Ltd.	1251.52	13	2	2	-0.29
Indian Oil Corporation Ltd.	376.95	45	8	8	0.40
IndusInd Bank Ltd.	1682.25	5	1	1	0.62
Infosys Ltd.	1154.66	88	22	9	0.10
Kotak Mahindra Bank Ltd.	1088.77	4	2	1	0.29
Larsen & Toubro Ltd.	1304.06	18	4	1	0.06
Lupin Ltd.	797.545	5	2	2	-0.52
Mahindra & Mahindra Ltd.	727.065	1172	307	82	0.36
Maruti Suzuki India Ltd.	8777.39	398	108	56	-0.03
NTPC Ltd.	163.45	73	8	7	0.21
Oil & Natural Gas Corporation Ltd.	186.535	264	37	35	-0.39
Power Grid Corporation of India Ltd.	195.135	54	10	11	0.11
Reliance Industries Ltd.	928.69	385	68	44	-0.10
State Bank of India	264.435	398	52	56	-0.49
Sun Pharmaceutical Industries Ltd.	540.235	39	9	6	-0.21
Tata Consultancy Services Ltd.	3045.29	1956	384	79	-0.15
Tata Motors Ltd.	359.545	411	113	37	-0.48
Tata Steel Ltd.	661.315	69	16	9	-0.04
Tech Mahindra Ltd.	613.595	73	40	7	0.27
UPL Ltd.	709.675	256	54	23	0.39
UltraTech Cement Ltd.	4132.12	2	0	1	-0.02
Vedanta Ltd.	325.04	37	9	3	-0.49
Wipro Ltd.	290.475	477	163	20	-0.34
Yes Bank Ltd.	318.18	345	66	46	-0.10
Zee Entertainment Enterprises Ltd.	565.965	2	1	1	-0.10

The further tables establish relationship between investor sentiments captured through tweets and its relationship with stock prices. For this Augmented Dickey Fuller test has been applied and all series were found to be stationary at level 1.

Correlation analysis has been carried out to know the relationship between variables. Then cointegration test has been applied on price data, and later on lead lag relationship has been established based on Granger causality test.

Table 2 : Correlation Analysis of Stock Returns and Investor Twitter Sentiments

Company Name	Total Tweets	Positive Sentiment	Negative Sentiment
Adani Ports and Special Economic Zone Ltd.	-0.187146366	0.114922406	-0.969549225
Aurobindo Pharma Ltd.	0.567348561	0.242302811	-0.324632167
Bajaj Auto Ltd.	0.199515501	0.061235222	0.613123185
Bharti Airtel Ltd.	0.77919366	0.433362068	0.126369911
Bosch Ltd.	0.564548234	0.685487177	-0.425946422
Dr. Reddy's Laboratories Ltd.	0.530572228	-0.152356789	-0.504574392
Eicher Motors Ltd.	0.788208551	0.535254531	-0.03474556
HCL Technologies Ltd.	0.245723368	-0.273759129	-0.508568496
Hero MotoCorp Ltd.	0.642439548	0.517284781	0.319786421
Hindalco Industries Ltd.	-0.344949508	-0.543860892	-0.808366668
Hindustan Unilever Ltd.	0.039014712	0.472827799	-0.504390765
Indian Oil Corporation Ltd.	0.666698059	0.086397899	0.199168179
IndusInd Bank Ltd.	0.530346022	0.55326856	0.086210329
NTPC Ltd.	0.692552744	0.459139133	0.06276052
Tata Steel Ltd.	0.526274449	0.516713478	-0.048123696
Tech Mahindra Ltd.	-0.59129888	-0.470638039	-0.379266105
Vedanta Ltd.	0.602695782	0.623620411	0.676974959
Zee Entertainment Enterprises Ltd.	0.304687447	0.616387371	-0.416774845
NIFTY Index	-0.58064537	-0.678808409	-0.335705448

Table 2 shows correlation analysis of stock returns with investor tweets of those stocks which have reported significant correlations. H₁ hypothesis was that there exist significant correlations between Twitter sentiment and stock market indicators. Nifty has high degree of negative relationship with total tweets score and positive

sentiment score. High degree of positive relationship was seen in returns of Aurobindo Pharma Ltd., Bharti Airtel Ltd., Dr.Reddy's Laboratories Ltd, Eicher Motors Ltd., Hero MotoCorp Ltd., Indian Oil Corporation Ltd., IndusInd Bank Ltd. and Vedanta Ltd with respect to total tweets score. High degree of positive

correlation is also seen in returns and positive sentiment score in Bosch Ltd, Eicher Motors Ltd., IndusInd Bank Ltd., Tata Steel Ltd., Vedanta Ltd. and Zee Entertainment Enterprises Ltd. Negative sentiment score have inverse relationship with total returns of Adani Ports and Special Economic Zone Ltd., Dr. Reddy's Laboratories Ltd., HCL Technologies Ltd., Hindalco Industries Ltd. and

Hindustan Unilever Ltd. There are significant correlations which exist between stock returns of companies and their positive, negative or total twitter sentiments for almost 19 companies out of 51. So, H_1 is partially accepted, that there exist significant correlations between stock returns and investor sentiments.

Table 3: Cointegration Test between Closing Price of Nifty and Twitter scores

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
Series: CLOSING_PRICE TOTAL_TWEETS				
None *	0.985541	39.81883	15.49471	0
At most 1 *	0.523316	5.92722	3.841466	0.0149
Series: CLOSING_PRICE POSITIVE_TWEETS				
None	0.639198	12.60354	15.49471	0.1302
At most 1 *	0.426512	4.448144	3.841466	0.0349
Series: CLOSING_PRICE NEGATIVE_TWEETS				
None *	0.9681	32.56946	15.49471	0.0001
At most 1 *	0.465285	5.008166	3.841466	0.0252
Trace test indicates 2 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 3 depicts cointegration test results for Nifty prices and twitter sentiment scores. The results of trace test show that there are two cointegrating equations for relationship between closing price of Nifty and total tweets score and negative tweets score. But only one cointegrating equation exists

for relationship between Nifty prices and positive tweets score. To know the direction of their relationship we have applied granger causality test. The further tables of Granger causality test only shows data of those companies which have got significant results.

Table 4: Granger Causality Results of Returns of Nifty Companies and Positive Twitter Sentiments

COMPANIES		F-Statistic	Prob.
NIFTY 50	positive_tweets to returns	0.2346755	0.804099
	return to positive_tweets	11.486378	0.0392559
Asian Paints Ltd.	positive_tweets to returns	9.4029496	0.0510294
	return to positive_tweets	0.7525057	0.543423
Bajaj Finance Ltd.	positive_tweets to returns	19.103409	0.0196439
	return to positive_tweets	1.5441462	0.3458905
Cipla Ltd.	positive_tweets to returns	37.417803	0.0075668
	return to positive_tweets	1.7159297	0.3185496
Coal India Ltd.	positive_tweets to returns	6.123414	0.0872796
	return to positive_tweets	1.0843487	0.4421913
Dr. Reddy's Laboratories Ltd.	positive_tweets to returns	0.0889899	0.9171813
	return to positive_tweets	13.303139	0.0322557
Hindustan Unilever Ltd.	positive_tweets to returns	1.5997757	0.3366212
	return to positive_tweets	10.072981	0.0466626
I T C Ltd.	positive_tweets to returns	0.0645898	0.9387201
	return to positive_tweets	47.974457	0.0052792
NTPC Ltd.	positive_tweets to returns	11.747138	0.0381025
	return to positive_tweets	0.7224358	0.5544892
Tata Consultancy Services Ltd.	positive_tweets to returns	8.9573682	0.0543254
	return to positive_tweets	0.2340335	0.8045456
Tech Mahindra Ltd.	positive_tweets to returns	28.901336	0.0109597
	return to positive_tweets	1.7066433	0.3199344
UltraTech Cement Ltd.	positive_tweets to returns	7.3977577	0.0692175
	return to positive_tweets	1.6730347	0.3250309
Wipro Ltd.	positive_tweets to returns	9.2392013	0.052201
	return to positive_tweets	0.521636	0.63912
Zee Entertainment Enterprises Ltd.	positive_tweets to returns	1.4180938	0.3685429
	return to positive_tweets	7.8494337	0.0642627

Table 4 explains Granger causality results between returns and positive sentiment score and it can be found that Nifty returns Granger causes positive tweets (F-value- 11.486378). In case of many other companies including Asian paints, Bajaj Finance Ltd., Cipla, Ltd., Coal India Ltd., NTPC Ltd., Tech. Mahindra

Ltd., TCS Ltd., UltraTech Cements Ltd. and Wipro Ltd. positive tweets Granger cause returns as the results are significant at 5 percent level. But for rest of the companies including Dr. Reddy's Laboratories Ltd., Hindustan Uniliver Ltd., ITC Ltd. and Zee Entertainment Enterprises Ltd. returns granger causes positive tweets score

Table 5 : Granger Causality Results of Returns of Nifty Companies and Negative Twitter Sentiments

COMPANIES		F-Statistic	Prob.
NIFTY Index	negative_tweets to returns	0.0962404	0.910939
	return to negative_tweets	0.1915813	0.835021
Bosch Ltd.	negative_tweets to returns	1.4081141	0.370442
	return to negative_tweets	9.3634989	0.051308
GAIL (India) Ltd.	negative_tweets to returns	4.5588458	0.123183
	return to negative_tweets	5.7123485	0.094847
HCL Technologies Ltd.	negative_tweets to returns	7.8784998	0.063964
	return to negative_tweets	3.2576071	0.177033
Indiabulls Housing Finance Ltd.	negative_tweets to returns	1.6581337	0.327334
	return to negative_tweets	10.38462	0.044839
IndusInd Bank Ltd.	negative_tweets to returns	0.0284106	0.972247
	return to negative_tweets	8.4707745	0.05835
Lupin Ltd.	negative_tweets to returns	7.260933	0.070845
	return to negative_tweets	0.9463483	0.480131
Tata Steel Ltd.	negative_tweets to returns	1.4849757	0.356226
	return to negative_tweets	6.5593187	0.080295
Vedanta Ltd.	negative_tweets to returns	9.7827966	0.048474
	return to negative_tweets	2.2668296	0.251289

Table 5 shows relationship between returns and negative sentiment score. The results show that there is no significant relationship between negative sentiment score of Nifty Index and its returns. Returns Granger causes negative tweets

score is significant for Bosch Ltd. (F value- 9.3634989), GAIL Ltd., Indiabulls Housing Finance Ltd., IndusInd Bank Ltd. and Tata Steel Ltd (F value- 6.5593187). Negative sentiment Granger cause returns is significant for HCL technologies Ltd., Lupin Ltd. and Vedanta Ltd.

Table 6: Granger Causality Results of Returns of Nifty Companies and Total Twitter Sentiments

COMPANIES		F-Statistic	Prob.
NIFTY Index	total_tweets to returns	0.0401431	0.961159
	return to total_tweets	5.3322565	0.010287
Asian Paints Ltd.	total_tweets to returns	0.5121197	0.643659
	return to total_tweets	7.1524246	0.072182
Bajaj Finance Ltd.	total_tweets to returns	15.723026	0.025702
	return to total_tweets	0.4723508	0.663225
Cipla Ltd.	total_tweets to returns	8.9155164	0.054653
	return to total_tweets	7.6341771	0.066548
Dr. Reddy's Laboratories Ltd.	total_tweets to returns	0.3327051	0.740454
	return to total_tweets	5.9028179	0.09121

IndusInd Bank Ltd.	total_tweets to returns	6.3024724	0.084292
	return to total_tweets	1.7661468	0.311231
Reliance Industries Ltd.	total_tweets to returns	5.8645526	0.091922
	return to total_tweets	0.2415701	0.799329
Tata Consultancy Services Ltd.	total_tweets to returns	8.2104999	0.060712
	return to total_tweets	0.0212084	0.97916
Tata Motors Ltd.	total_tweets to returns	0.062132	0.940936
	return to total_tweets	6.3499587	0.083529
Tech Mahindra Ltd.	total_tweets to returns	8.664076	0.056694
	return to total_tweets	3.9460414	0.144549

Table 6 depicts relationship between total Twitter sentiments and stock returns. Nifty Index returns Granger causes total Twitter sentiments and the results are highly significant. Returns causes total tweets score for Asian Paints Ltd., Cipla Ltd., Dr. Reddy's Laboratories Ltd. and Tata Motors Ltd.

The companies including Bajaj Finance Ltd., Cipla Ltd., IndusInd Bank Ltd., Reliance Industries Ltd., Tata Consultancy Services Ltd. and Tech Mahindra Ltd. shows that total tweets score Granger causes returns.

Table 7 : Summary of Significant Relationship of Stock Returns and Investor Twitter Sentiments

Company Name	Correlation Sign			Granger Causality Directions		
	Positive sentiment	Negative Sentiment	Total tweets	Returns to Positive Sentiments	Returns to Negative Sentiments	Returns to Total Tweets
Bosch Ltd.	+		+		↘	
Dr. Reddy's Lab. Ltd.		-	+	↘		↘
HCL Technologies Ltd.		-			↙	
Hindustan Unilever Ltd.		-		↘		
IndusInd Bank Ltd.	+		+		↘	↙
NTPC Ltd.			+	↙		
Tata Steel Ltd.	+		+		↘	
Tech Mahindra Ltd.			-	↙		↙
Vedanta Ltd.	+	+	+		↙	
Zee Entertainment Ent. Ltd.	+			↘		
NIFTY Index	-		-	↘		↘

Table 7 shows summary of companies which have shown significant relationship as per correlation and Granger causality test. There are 11 stocks which have significant correlation between stock returns and investor sentiments with significant

Granger causality results. For Nifty index we see that there is inverse relationship between index returns and its total tweets and positive sentiments of investors which implies that there are other factors that affect investor sentiments rather than

only returns and Granger causality shows that Nifty returns causes investor sentiments. This implies that index changes first and then investor discuss about it on Twitter and there may be other factors that affect the kind of discussion whether positive or negative that take place on Twitter about Nifty. Since Nifty is a benchmark index so its movement is affected by macro-economic factors, global factors, news about constituent companies, bearish and bullish trends of the market which can be studied to judge the clear impact of investor sentiment about Nifty.

The correlation analysis of the sample companies reveal that returns has positive relationship with total twitter score and positive sentiment score, which implies that returns and twitter discussion move in similar direction. Stock returns and negative sentiment score has inverse relationship which implies that when stock returns for companies is improving negative twitter sentiment decreases. The results are similar to Mao et al. (2012). This shows that Twitter sentiments affect stock returns.

The second research question was to understand the direction of relationship between stock returns and investor sentiments on Twitter. The Granger causality test has shown mixed results. Positive sentiments *Granger cause* stock returns for most of the companies. For half of the companies total tweets score *Granger cause* stock returns. But in case of negative sentiment score majority of companies show that stock returns *Granger cause* negative sentiments. This implies that for many companies Twitter sentiments leads the stock market returns, so we cannot ignore investor sentiments on Twitter. But for other half of the sample companies it is that stock returns leads and Twitter sentiment follows. These results are similar to Rao and Srivastava (2012). With respect to Nifty we found that index return leads and Twitter sentiment follows. To establish this we need to dig deeper in future by taking some high frequency data.

CONCLUSION

The results of the analysis shows that Indian investors have posted various positive and negative sentiments about companies listed in Nifty Index. Out of fifty sample companies

nineteen companies have shown high degree of significant correlations between stock returns and investor sentiments. The relationship is positive between stock returns and total tweets and positive sentiments and negative between stock returns and negative twitter sentiments. Nifty being benchmark index has negative relationship with total tweets score and positive sentiment score which implies that there are other factors which affect Nifty twitter sentiments. High degree of positive relationship was seen in Aurbindo Pharma Ltd., Bharti Airtel Ltd., Dr.Reddy's Laboratories Ltd, Eicher Motors Ltd., Hero MotoCorp Ltd., Indian Oil Corporation Ltd., IndusInd Bank Ltd. and Vedanta Ltd with respect to total tweets score.

Stock returns of sample companies and overall Nifty Index are correlated with investor twitter sentiments. This implies that twitter sentiments must be carefully analysed with respect to the positive or negative opinion of public as it can help predict the behavioural inclination of public about the stocks. There are other macro-economic and company specific factors that can influence stock prices but, mood of public can also give some insights to investors and analysts about the market.

Two cointegrating equations were found between closing price of Nifty and total tweets score and Nifty and negative tweets score. Nifty returns leads twitter sentiments. Asian Paints Ltd., Cipla Ltd., Dr. Reddy's Laboratories Ltd. and Tata Motors Ltd returns affect tweets. The companies including Bajaj Finance Ltd., Cipla Ltd., IndusInd Bank Ltd., Reliance Industries Ltd., Tata Consultancy Services Ltd. and Tech Mahindra Ltd. shows that tweet sentiments lead stock returns. The results of Granger causality test are also mixed as for half of the sample companies twitter sentiments lead and stock returns follows, and for remaining other companies stock returns leads and twitter sentiment follows. This implies that we cannot ignore the role of investor sentiments whether positive or negative, as they can affect investment decision of buy or sell of stocks and overall affect the stock price. The herding behaviour, bull and bear phase, market overreactions can be very easily predicted from twitter sentiments as it provide quick review of investor sentiments on stocks and markets overall.

The study also shows that there is significant

relationship between investor twitter sentiments and stock returns in Indian stock market. The implications of this study are relevant for investors, analysts and companies. The investors and investment managers should carefully analyse investor sentiments discussed through twitter about companies and overall stock market, so they can see the mood of the market and make their investment strategies in the light of behavioural trends about the market. Even companies can gauge their share price direction from the twitter sentiments of the investors. Asset and mutual fund managers can design their social media marketing strategy around this theme. The future studies can focus on studying investor twitter sentiments by taking more variables like happy, sad, calm, relax, anxious and see their separate impacts on stock market prices. Analysis can be carried out for Nifty and other stocks in future studies by taking high frequency stock data and minute to minute or hourly twitter updates so that some depth analysis can be carried out on cause and effect analysis. The similar study can be carried out by taking data for longer time duration for establishing more strong relationships which was the limitation of this study that sample duration was short. Overall, it can be corroborated that investor sentiments do have an important role to play in influencing market behaviour and affects stock returns.

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