THE COMBINATION OF RELATED FIRMS' SHARE PRICES AND SHARE PRICE
PREDICTION TECHNIQUES IN THE INDIAN STOCK MARKET, WITH SPECIAL
REFERENCE TO THE IT INDUSTRY.

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Abstract

This research focuses on the correlation among the different stock prices in the Indian stock market. Technical analysis was used to predict stock price movements. India is the third largest country in the world based on GDP, but less than 6 percent of the total population is investing money in the stock market. Out of this, only a few percent of the people made money in the market. The majority of them are losing money because they lack awareness and do not know when to enter or exit the market. This research paper clearly addresses how investors can better understand the different stock prices and predictions. In this research, regression, partial simple correlation, post hoc testing, and different technical (suttee indicator) indicators were used for stock prediction. The primary focus area of the research was to determine if the share prices of the companies in the same industry exhibit synchronicity, when the behaviour of comovement was tested by considering ten companies as one group and Nifty IT index as another group, the results indicated that there exists a comovement between the share prices the companies and also between the individual companies and Nifty IT index. Secondly, the study was conducted to determine if Sutte Indicator and Linear regression models predict the share prices accurately. This would assist investors in making better decisions.
Keywords: Stock Price, Index Return, SUTTE Indicator and Stock Price Prediction.

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1.1 INTRODUCTION

The securities markets act as a conduit for money to move from those with excess capital to others in need of capital. It enhances the country's economic progress by facilitating capital mobilization. Unused resources are effectively used. The securities market promotes the meeting of capital seekers and investors. This boosts the country's savings and investments. The securities market is divided into the following categories: The main market is the market where securities are originally offered for sale. A new or existing corporation can issue it. Issuing firms, underwriters, and investment brokers all play important roles in the primary market. Stock exchanges are secondary marketplaces where existing securities are purchased and sold. It improves liquidity by allowing investors to buy and sell assets anytime they wish. Stock exchanges facilitate, regulate, and control securities trading. Investors trade on stock exchanges through brokers and agents who are licensed to do so. The stock exchange can only trade listed stocks. The goal of listing securities on the stock market is to safeguard investors' interests. The stock exchange follows a set of rules and regulations. Commission brokers and dealers are the two types of stock exchange participants. The stock exchange floor is only accessible to members of the stock exchange. Stock exchanges serve several purposes. It improves liquidity by allowing investors to buy and sell assets anytime they wish. Stock exchanges facilitate, regulate, and control securities trading. Investors trade on stock exchanges through brokers and agents who are authorized to do so. The stock exchange can only trade listed stocks. The goal of listing securities on the stock market is to safeguard investors' interests. The stock markets adhere to a set of rules and regulations. The stock exchange's members are categorized as commission brokers and dealers. This research paper will help the investors to know about active trading systems to make more return for their investment in the stock market.

1.2 STATEMENT OF THE PROBLEM

The main concern of the research is to analyses the behavior of share prices of the companies belonging to the same industry and analyzing to see whether any company influences the movement of the index significantly. Most of the researcher used different model for prediction but the investors keep on losing their money in the market. This second area of research is finding if there are any share price prediction models, which will work in real time based on the historical share prices

1.3 RESEARCH GAP IDENTIFICATION

Earlier researches were conducted to establish the existence of comovement in share prices because of their growth, earnings volatility, information uncertainty and leverage. However, there was scope for further research in the areas of studying the price movements of the companies belonging to the same industry. A new indicator called suttee indicator, which is not widely used to predict the share prices, was empirically tested to have lower Mean Absolute Deviation, Mean Squared Error and Mean Absolute Percentage Error. This gave a scope for conducting further research to apply the technique on the historical share prices and measure if there are significant deviations between the actual and predicted prices. In order to conduct a comparative study between suttee indicator and any other stock prediction method, linear regression method waschosen.

1.4 OBJECTIVES

The study has the following major objectives, which are as follows:

- To determine the degree of similarity in the share price movements of the companies in the IT industry
- To compare the share price movements of the IT companies as one group and the index (Nifty IT) as another group.
- To determine whether the methods of prediction, which uses only the past share, pricesas the input to forecast is accurate.

1.5 THEORETICAL FRAMEWORK

Stock price comovement

Stock market predictions have always been a vague area of study with some theories and indicators working in real time while some might not. Some metrics might work during specified conditions but might not hold true in the other markets. Thus the paper aims to study the comovement of stock prices of the companies falling under the same industry. Chu et al., 2015 proposed that there is a relationship between stock returns and investor sentiments. Based on a linear Granger causality test and the original time series, they find one-directional causality from stock returns to investor sentiment. This paper studies the comovement based on the behaviour and attitude of the investors. The study by Brady & Premti, 2018 indicates that the investors rely on reference points and private information signals while making decisions under uncertainty.Another study by Sobolev et al., 2017 shows that whilemaking their decisions, they were influenced by properties of both news items and price series but they relied more on the former. In the work of Alhomaidi et al., 2018 the study indicates that theclassification of stock

into the same group has an effect on its price comovement with other stocks in the same group. The study by Ahmad et al., 2016 shows that there is high correlation among the stock markets in the selected period of time. Thus these studies conclude the existence of comovement based on classification, investor sentiments and during a specific period of time. McDonald IV, 2017 has presented his views on positive and negative price shocks in individual securities and the degree to which they affect related firms in the same industry. His study reveals that when industry returns and stock returns both respond to a positive (negative) price shock, future revenues and earnings per share are higher (lower) for both the firm experiencing the shock and for the industry as a whole. A paper by Ferreira & Orbe, 2017 analyzes the dynamics of pair comovements between different domestic European stock market returns (Spain, France, Germany, Switzerland and the United Kingdom) seeking to check whether there is a unique source of risk driving those dynamics. The study by Mishra & Dhole, 2015 shows that the extent of comovement is lower for firms affiliated with business groups and firms with high debt and that the comovement is higher for growth firms and firms belonging to industries with high earnings volatility. Another study by Greenwood & Sosner, 2007 analyses the comovement between the stocks included in the Nikkei 225. It shows that the stocks that were added to the index began to move with other index securities much more than previously and the stocks that were deleted from the index began to move with other index securities much less. Another paper by Luoa & Xie, 2012 suggests that stock comovement in industries with high information uncertainty is more likely driven by correlated bias (illusionary correlation) in trading activities and is not related to common fundamental shocks.

Degree of accuracy of stock price predictions

Another objective of the research was to study the degree of relationship between the expected and the actual share prices. There are numerous factors which affects the share prices to a great extent. It can be economic, industry-specific or company-specific factors. The study by Vychytilová et al., 2019 studies the effect of macroeconomic variables on the automaker industry. The findings show that there are positive linkages between automaker's stock return volatility and explanatory variables such as stock market development, GDP and unemployment. A similar study by Mohammed & Rumman, 2019 examined the impact of five macroeconomic indicators (oil price, gas price, money supply, interest rate, and producer price index) on the performance of Qatar Stock Exchange. Another research on macroeconomic variables by Banda et al., 2019 show that inflation has a significant positive relationship with stock prices. However, a negative relationship was found between interest rates and stock prices. Thus, the macro economic factors also play a vital role in stock price volatility. A study by Pham et al., 2018 tried to identify the factors that can explain the stock returns. The results displayed that Return on equity and changes in it were informative to determine the expected stock returns. In addition, the level of capital turnover and the financial cost ratio, together with changes in capital and the financial cost ratio was proved to have incremental explanatory powers for explaining expected returns. Another study by Chowdhury et al., 2019 tried to study the effects of corporate disclosures on the share price movements. For the companies it was found that corporate disclosure had no significant impact but across the industry, this study has found statistically significant difference of price change between before and after corporate disclosure A paper by Sutkatti & Torse, 2019 studied various traditional as well as recent techniques used for stock market prediction. The results show that various machine learning models as well as hybrid and ensemble model give higher rate of accuracy. Another study suggests that trading network predicts stock prices better. Research paper by Sun et al., 2014 proves that accuracy of stock price prediction is significantly improved by the inclusion of trading relationship indices. The paper by Mäkinen et al., 2019 proves that a new CNN-LSTM-Attention model (developed) was able to predict jumps one minute ahead from limit order book data. A paper by Dang & Duong, 2016 proposed an approach of using time series analysis and improved text mining techniques to predict daily stock market directions. A research by Nelson et al., 2017 employed LSTM networks to

predict future trends of stock prices based on the price history, alongside with technical analysis indicators. It attempted to determine if the price of a particular stock will be higher or not than the current price in 15 minutes in the future. The results turned out to be 55% accurate. It was found that there was correlation between the financial news and the stock prices with a high accuracy of 73%. A paper by Jiang et al., 2019 says that the information content of the time series of price impact is able to significantly improve volatility prediction accuracy for individual stocks and offer economic gains to a mean-variance utility investor. The paper by Khuwaja et al., 2019 says that by employing phase space reconstruction and extreme machine learning, improves the predictive performance by 4.5%. This paper proposed a framework to predict the stock price movement by transforming the features using (phase space reconstruction) PSR and extracting the phase space correlations amongst them to model the price movement There are various other studies which makes prediction using the support vector machines, Bayesian regularised radial basis function network, and the extent to which the prediction is affected by global and local information. On the other hand the stock prices can also be predicted by using the company's financial information. There are several valuation techniques and using a combination of techniques gives a higher degree of accuracy. The findings of the study showed that the valuations which were done by averaging the results of various valuation methods obtained a higher degree of accuracy. These findings were reported in the work of Prusak, 2017. Another paper by Adebiyi et al., 2014 used ARIMA model to build stock price prediction model. Results obtained revealed that the ARIMA model has a strong potential for short-term prediction and can compete favourably with existing techniques for stock price prediction. The study by Chu & Qiu, 2018 says that the Price Limit Hits (PLH) displays significant forecasting power for future volatilities. The work by Emekter et al., 2018 performed studies to check if the stocks are overpriced in the market using duration dependence test. There has been interesting study by Karathanasopoulos et al., 2015 which uses novel hybrid method for the prediction of the directional movement of financial assets. The results revealed that the proposed methodology produces a higher trading performance. The study by Almujamed, 2018 shows that the past returns (using moving averages) help in predicting current share prices. An advanced study by Sheelapriya & Murugesan, 2016 tried Bayesian regularised radial basis function network (BR-RBFN) as a novel approach to capture the 1-day daily future stock price movement. The results revealed that this proposed model performs well with prediction accuracy approximately 99.5%, compare to other advanced non-linear models chosen for this experiment. Comparison was made with the ARIMA, GARCH models, EMA, SMA, Relativestrength index, and Average Directional Index, independence test, network performance evaluation to test its accuracy. Month is least correlated with the trend of another month. However 70% accuracy wasobserved in the daily prediction models. The work by Ahmar et al., 2017 propose an indicator called ‒Sutte Indicatorǁ (Calculated using moving averages as base) has a better level of reliability compared to two other indicators method Simple Moving Average (SMA) and Moving Average Convergence/ Divergence (MACD) based on the Mean Squared Error (MSE), Median Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE). However the study by Quiros et al., 2018 shows the importance of using moving averages as the basis for developing the best trading rules. It says that the buy and sell strategies formulated by using moving averages as the base outperforms any other strategies. Thus it can be concluded that using technical strategies using moving average as the base gives reliable results.

Comparison with other markets
The paper by McMillan, 2016 examines stock market predictability across a range of international markets and seeks to consider the role of global and local informationin terms of any predictive power using dividend growth predictability regression. The results revealed that with respect to the home market dividend-price ratio model, there is very little evidence of predictive power. But by adding US-based variables the predictive power of the model was enhanced. The results also stressed the need to separate different components in the dividend-

price ratio to reveal the full predictive power of the ratio. In a further study by McMillan, 2016 an analysis was done to determine whether the stock return predictability varies over regimes of behaviour that depend on the level of inflation. The results showed that the evidence in the favour of predictability was mixed and thus not very reliable. The study by Menon, 2018 reveals that there is a significant relationship between the index values of the BSE and NYSE and TSE. Thus by understanding the various prediction techniques and by finding the inter-relationships between the actual and expected share movements and by analysing if the share prices of the companies in the same industry comove, this research aims to give an insight about the fundamental understanding required for investors.

1.6 HYPOTHESIS DEVELOPMENT

The study about stock movements is an effort to achieve two objectives by conducting research. The first objective is to test whether a significant relationship exists between the stock prices of different companies belonging to the same industry and their industry's index. The general assumption in the technical analysis is that the stock prices of the companies move in synchronization with its industry's movement. This study aims to check the assumption and conduct statistical tests to check whether the stock prices of different companies in the same industry exhibit co-movement with regard to the industry's performance. The hypotheses for this test are as follows:

- H_0: The mean stock prices of the companies and the industry index are equal.

- H_1: The mean stock prices of the companies and the industry index are not equal.

The second objective of the study aims to test the statistical relationship between the actual and predicted stock prices. Stock price prediction has always been an area of ambiguity. Thus, a study to check the degree of relationship between the actual stock prices and the expected stock prices is conducted to check the accuracy of the stock prediction method. The hypotheses for this test are as follows:

- H_0: There is no significant difference between the actual and predicted stock prices.

- H_1: There is significant difference between the actual and predicted stock prices.

1.7 RESEARCH METHODOLOGY

Exploratory Research is the chosen approach as there is a lot of ambiguity in the area of study. Quota sampling is the sampling design used in the study. From the list of listed companies, subgroups were created based on the industries to which each company belonged. The predefined quota to be satisfied in this study was that the companies, in order to be selected should belong to Computers – software sector.

Statistical tools used

Multiple factor ANOVA test using planned contrasts and a post hoc test named Tukey HSD is used to compare the share prices with that of the index. Paired sample t-test is used to determine the statistical significance between the actual and the predicted share prices. Sutte indicator and linear regression is used to predict the share prices to compare which prediction method displays better accuracy.

The Share prices of all the above mentioned companies are to be compared with that of the industry index – Nifty IT using **'Multiple factor ANOVA test using planned contrasts'**. The test of homogeneity of variances will either reject or accept the null hypothesis. And the ANOVA output will help in determining if there are differences between the groups. By employing contrast test it can determined if there is relationship between the company's stock prices and the market index. Post Hoc test – Tukey HSD will help in comparing each and every company's returns with the Nifty IT index returns. The results of this test will list out the companies which follow the market index and the companies which do not, thereby enabling us to identify the number of companies included in the index which influences the industry index as a whole.

For testing the statistical relationship between the actual and predicted stock prices **'Paired sample t-test'** is employed. Stock prices are predicted using technical method called as Sutte Indicator. This method is proved to have a higher accuracy in prediction in comparison with the moving averages and its accuracy is tested using Mean of Square Error (MSE), Mean Absolute Percentage Error (MAPE) and Mean Absolute Deviation (MAD) measures. The correlation between the actual and the predicted prices is calculated. The general fact is - higher the correlation lesser the standard error. After all these steps, paired sample t-test results are analysed. If the results are not statistically significant, it implies that there is very little or no difference between the actual and the predicted stock prices and thus the stock prediction method is accurate enough to be employed in actual practice.

1.8 ANALYSIS AND INTERPRETATION

Stock price movement

The study conducted aims to see the behaviour of share prices of the companies in the same industry. To study this, the daily increase or decrease of share prices of 10 companies namely, HCL Technologies Ltd., Hexaware Technologies Ltd., Infosys Ltd., JustDial Ltd., MindTree Ltd., NIIT Technologies Ltd., Tata Consultancy Services Ltd., Tata Elxsi Ltd., Tech Mahindra Ltd., Wipro Ltd., which belong to the same industry (Computers – Software) were computed. The results indicated that the increase or decrease in the daily share prices were not uniform (i.e.) while some company's share prices rose, the other company's share prices fell, irrespective of the companies belonging to the same industry. However, to empirically test the existence or non-existence of the comovement among the share prices, ―Multiple factor ANOVA test using planned contrasts‖ was employed. Since the daily increase or decrease in share prices did not indicate any pattern, the study was extended to see the comovement between the 10 companies listed above with that of the Nifty IT index. To apply the Multiple factor ANOVA test, the essential condition is that the data is to be tested for homogeneity of variances. The test can be carried on further only if the variances are equal (i.e.) the results should not be statistically significant. Table – 1 shows the results for homogeneity of variances.

Table 1- Test of Homogeneity of variances

Oneway

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
IncreaseAndDecrease	Based on Mean	225.949	10	2682	.000
	Based on Median	224.488	10	2682	.000
	Based on Median and with adjusted df	224.488	10	309.792	.000
	Based on trimmed mean	225.965	10	2682	.000

For the test of homogeneity of variances, the significance value is 0.000 which is lesser than 0.05. Hence the variances are not equal. Since the assumption of homogeneity of variances is violated, Welch's ANOVA is employed. It compares two means to see if they are equal. It is an alternative to the Classic ANOVA and can be used even if your data violates the assumption of homogeneity of variances. Table – 2 below shows the results of Welch test. The results of Welch test indicate that the significance value is 0.916 which is greater than 0.05. This reveals that the means are almost equal, indicating that there are no significant differences between the means of different groups.

Table 2 - Welch test

Robust Tests of Equality of Means

IncreaseAndDecrease

	Statistic[a]	df1	df2	Sig.
Welch	.459	10	1029.030	.916

a. Asymptotically F distributed.

Contrast Coefficients

Contrast	HCLTechn	Hexaware	Infosys	Justdial	Mindtree	NIITTech	TataElxs	TCS	TechMahi	Wipro	ZNiftyIT
1	1	1	1	1	1	1	1	1	1	1	-10

Company

Contrast Tests

		Contrast	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
IncreaseAndDecrease	Assume equal variances	1	-110.9365	37.17514	-2.984	2682	.003
	Does not assume equal variances	1	-110.9365	111.54890	-.995	242.577	.321

ANOVA test is further conducted to see if there are significant differences between the groups. Table – 3 below shows the results of ANOVA test. ANOVA test is 0.497 which is greater than 0.05. So we accept the null hypothesis. Hence we can conclude that there are no significant differences between the groups.

Table 3 - ANOVA

ANOVA

IncreaseAndDecrease

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28656.658	10	2865.666	.938	.497
Within Groups	8194075.964	2682	3055.211		
Total	8222732.623	2692			

To make a comparison between the companies as pairs we conduct the contrast test. Table – 3 shows the results of contrast test. The sun of coefficients of a contrast test should always be equal to one. Here the price movements of individual companies are compared with that of Nifty IT index. Therefore, the coefficients for individual companies is consideredas 1 and that of the Nifty IT index is considered to be negative 10 (Negative of sum of the coefficients of individual companies). Since the results of homogeneity of variances test indicates that the variances are not equal, we need to consider the significance value of 0.321 in the contrast test. Since the value is greater than 0.05 we can conclude that there is no significant difference between the increase and decrease of 10 companies as one group and Nifty IT index as another group.

To display a better picture and also to view pairwise comparisons of the price movements, a post hoc test called Tukey HSD (Honestly Significant Difference) was conducted. Table - 4 shows the results of the post hoc test conducted.

Table 4 – Post Hoc test - Tukey HSD (Among companies)

Post Hoc Tests

Multiple Comparisons

Dependent Variable: IncreaseAndDecrease
Tukey HSD

(I) Company	(J) Company	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
HCLTechn	Hexaware	.73184	4.99405	1.000	-15.3563	16.8199
	Infosys	-.26867	4.99405	1.000	-16.3568	15.8194
	Justdial	-.10796	4.99405	1.000	-16.1961	15.9801
	Mindtree	-.11286	4.99405	1.000	-16.2010	15.9752
	NIITTech	-1.42510	4.99405	1.000	-17.5132	14.6630
	TataElxs	.60265	4.99405	1.000	-15.4854	16.6908
	TCS	-1.81878	4.99405	1.000	-17.9069	14.2693
	TechMahi	-.11429	4.99405	1.000	-16.2024	15.9738
	Wipro	.26893	4.99405	1.000	-15.8192	16.3570
	ZNiftyIT	-11.31807	5.00431	.461	-27.4392	4.8031
Hexaware	HCLTechn	-.73184	4.99405	1.000	-16.8199	15.3563
	Infosys	-1.00051	4.99405	1.000	-17.0886	15.0876
	Justdial	-.83980	4.99405	1.000	-16.9279	15.2483
	Mindtree	-.84469	4.99405	1.000	-16.9328	15.2434
	NIITTech	-2.15694	4.99405	1.000	-18.2450	13.9312
	TataElxs	-.12918	4.99405	1.000	-16.2173	15.9589
	TCS	-2.55061	4.99405	1.000	-18.6387	13.5375
	TechMahi	-.84612	4.99405	1.000	-16.9342	15.2420
	Wipro	-.46291	4.99405	1.000	-16.5510	15.6252
	ZNiftyIT	-12.04991	5.00431	.362	-28.1711	4.0713

Infosys	HCLTechn	.26867	4.99405	1.000	-15.8194	16.3568
	Hexaware	1.00051	4.99405	1.000	-15.0876	17.0886
	Justdial	.16071	4.99405	1.000	-15.9274	16.2488
	Mindtree	.15582	4.99405	1.000	-15.9323	16.2439
	NIITTech	-1.15643	4.99405	1.000	-17.2445	14.9317
	TataElxs	.87133	4.99405	1.000	-15.2168	16.9594
	TCS	-1.55010	4.99405	1.000	-17.6382	14.5380
	TechMahi	.15439	4.99405	1.000	-15.9337	16.2425
	Wipro	.53760	4.99405	1.000	-15.5505	16.6257
	ZNiftyIT	-11.04940	5.00431	.499	-27.1706	5.0718
Justdial	HCLTechn	.10796	4.99405	1.000	-15.9801	16.1961
	Hexaware	.83980	4.99405	1.000	-15.2483	16.9279
	Infosys	-.16071	4.99405	1.000	-16.2488	15.9274
	Mindtree	-.00490	4.99405	1.000	-16.0930	16.0832
	NIITTech	-1.31714	4.99405	1.000	-17.4052	14.7710
	TataElxs	.71061	4.99405	1.000	-15.3775	16.7987
	TCS	-1.71082	4.99405	1.000	-17.7989	14.3773
	TechMahi	-.00633	4.99405	1.000	-16.0944	16.0818
	Wipro	.37689	4.99405	1.000	-15.7112	16.4650
	ZNiftyIT	-11.21011	5.00431	.476	-27.3313	4.9111

Mindtree	HCLTechn	.11286	4.99405	1.000	-15.9752	16.2010
	Hexaware	.84469	4.99405	1.000	-15.2434	16.9328
	Infosys	-.15582	4.99405	1.000	-16.2439	15.9323
	Justdial	.00490	4.99405	1.000	-16.0832	16.0930
	NIITTech	-1.31224	4.99405	1.000	-17.4003	14.7759
	TataElxs	.71551	4.99405	1.000	-15.3726	16.8036
	TCS	-1.70592	4.99405	1.000	-17.7940	14.3822
	TechMahi	-.00143	4.99405	1.000	-16.0895	16.0867
	Wipro	.38179	4.99405	1.000	-15.7063	16.4699
	ZNiftyIT	-11.20521	5.00431	.477	-27.3264	4.9160
NIITTech	HCLTechn	1.42510	4.99405	1.000	-14.6630	17.5132
	Hexaware	2.15694	4.99405	1.000	-13.9312	18.2450
	Infosys	1.15643	4.99405	1.000	-14.9317	17.2445
	Justdial	1.31714	4.99405	1.000	-14.7710	17.4052
	Mindtree	1.31224	4.99405	1.000	-14.7759	17.4003
	TataElxs	2.02776	4.99405	1.000	-14.0603	18.1159
	TCS	-.39367	4.99405	1.000	-16.4818	15.6944
	TechMahi	1.31082	4.99405	1.000	-14.7773	17.3989
	Wipro	1.69403	4.99405	1.000	-14.3941	17.7821
	ZNiftyIT	-9.89297	5.00431	.665	-26.0141	6.2282

TataElxs	HCLTechn	-.60265	4.99405	1.000	-16.6908	15.4854
	Hexaware	.12918	4.99405	1.000	-15.9589	16.2173
	Infosys	-.87133	4.99405	1.000	-16.9594	15.2168
	Justdial	-.71061	4.99405	1.000	-16.7987	15.3775
	Mindtree	-.71551	4.99405	1.000	-16.8036	15.3726
	NIITTech	-2.02776	4.99405	1.000	-18.1159	14.0603
	TCS	-2.42143	4.99405	1.000	-18.5095	13.6667
	TechMahi	-.71694	4.99405	1.000	-16.8050	15.3712
	Wipro	-.33372	4.99405	1.000	-16.4218	15.7544
	ZNiftyIT	-11.92072	5.00431	.379	-28.0419	4.2004
TCS	HCLTechn	1.81878	4.99405	1.000	-14.2693	17.9069
	Hexaware	2.55061	4.99405	1.000	-13.5375	18.6387
	Infosys	1.55010	4.99405	1.000	-14.5380	17.6382
	Justdial	1.71082	4.99405	1.000	-14.3773	17.7989
	Mindtree	1.70592	4.99405	1.000	-14.3822	17.7940
	NIITTech	.39367	4.99405	1.000	-15.6944	16.4818
	TataElxs	2.42143	4.99405	1.000	-13.6667	18.5095
	TechMahi	1.70449	4.99405	1.000	-14.3836	17.7926
	Wipro	2.08771	4.99405	1.000	-14.0004	18.1758
	ZNiftyIT	-9.49929	5.00431	.719	-25.6205	6.6219

TechMahi	HCLTechn	.11429	4.99405	1.000	-15.9738	16.2024
	Hexaware	.84612	4.99405	1.000	-15.2420	16.9342
	Infosys	-.15439	4.99405	1.000	-16.2425	15.9337
	Justdial	.00633	4.99405	1.000	-16.0818	16.0944
	Mindtree	.00143	4.99405	1.000	-16.0867	16.0895
	NIITTech	-1.31082	4.99405	1.000	-17.3989	14.7773
	TataElxs	.71694	4.99405	1.000	-15.3712	16.8050
	TCS	-1.70449	4.99405	1.000	-17.7926	14.3836
	Wipro	.38322	4.99405	1.000	-15.7049	16.4713
	ZNiftyIT	-11.20378	5.00431	.477	-27.3250	4.9174
Wipro	HCLTechn	-.26893	4.99405	1.000	-16.3570	15.8192
	Hexaware	.46291	4.99405	1.000	-15.6252	16.5510
	Infosys	-.53760	4.99405	1.000	-16.6257	15.5505
	Justdial	-.37689	4.99405	1.000	-16.4650	15.7112
	Mindtree	-.38179	4.99405	1.000	-16.4699	15.7063
	NIITTech	-1.69403	4.99405	1.000	-17.7821	14.3941
	TataElxs	.33372	4.99405	1.000	-15.7544	16.4218
	TCS	-2.08771	4.99405	1.000	-18.1758	14.0004
	TechMahi	-.38322	4.99405	1.000	-16.4713	15.7049
	ZNiftyIT	-11.58700	5.00431	.423	-27.7082	4.5342

The results of Tukey HSD show that the directions of price movements among the companies are similar. The significance value is greater than 0.05 for all the pairwise comparisons which leads to acceptance of null hypothesis which states that there are no significant differences between the means of the share price movements of the companies. The significance value of 1 for the pairwise comparisons among the company indicates that the means are identical. This might be because the increase and decreases in the share prices might be very little and hence implies that the share prices of the companies in the same industry show comovement. To prove the existence of comovement between each of the individual companies and that of the industry index – Nifty IT, the Post hoc test, Tukey HSD was extended to generate pairwise comparisons between each company and Nifty IT index. Table - 5 shows the results of Tukey HSD test.

Table – 5 - Post Hoc test - Tukey HSD (Between companies and Nifty IT index)

ZNiftyIT	HCLTechn	11.31807	5.00431	.461	-4.8031	27.4392
	Hexaware	12.04991	5.00431	.362	-4.0713	28.1711
	Infosys	11.04940	5.00431	.499	-5.0718	27.1706
	Justdial	11.21011	5.00431	.476	-4.9111	27.3313
	Mindtree	11.20521	5.00431	.477	-4.9160	27.3264
	NIITTech	9.89297	5.00431	.665	-6.2282	26.0141
	TataElxs	11.92072	5.00431	.379	-4.2004	28.0419
	TCS	9.49929	5.00431	.719	-6.6219	25.6205
	TechMahi	11.20378	5.00431	.477	-4.9174	27.3250
	Wipro	11.58700	5.00431	.423	-4.5342	27.7082

The results of the post hoc test indicate that the p- values are greater than 0.05 for all the comparisons. This indicates that there is positive comovement between the price movements of individual company and that of the Nifty IT index. It can also be concluded that since there is a positive correlation between the share price movements of the sample companies, the correlation between the individual company and Nifty IT is also positive.

Accuracy of the stock price prediction methods
The stock prices are predicted using two different methods in the study undertaken, namely; Sutte Indicator and Linear Regression.

Sutte Indicator

Sutte Indicator is a technical indicator which assists in making investment decisions regarding buy and sell decisions. This indicator is not widely used and is a comparatively a new technique to forecast the share prices. The indicator is tested to be more reliable when compared to the moving averages method or the Moving Average Convergence Divergence method (MACD) in terms of Mean Average Deviation, Mean Squared Error and Mean Absolute Percentage Error (Ahmar, 2017). The formula to calculate the Price predictions using Sutte indicator is as follows:

$$SUTTE - PRED = \frac{SUTTE\%L + SUTTE\%H}{2}$$

$$SUTTE\%L = Ck+Ck\text{-}1 + Ck\text{-} LK/2$$
$$SUTTE\%H = Ck+CK\text{-}1 + Hk\text{-}Ck$$

Where,

C_k = Closing stock price for the day of k.
C_{k-1} = Closing stock price for the day of k−1.
L_k = The lowest stock price for the day of k.
H_k = The highest stock price for the day of k.
SUTTE%L = The lowest limit price of Sutte indicator.
SUTTE%H = The highest limit price indicator of Sutte indicator.
SUTTE-PRED = Stock prediction price using Sutte indicator.

After the share, prices are predicted using the Sutte indicator, t-test is conducted to check the accuracy of the prediction model. Table – 6 indicates the results of paired samples statistics. It can be noticed that the means of the actual and the predicted values are close enough. The highest difference between the means is 20, which is for the company, NIIT Technologies Ltd., and the lowest difference in means is 3 which is for the company, Wipro Ltd. The next step is to check if these differences in mean are statistically significantly different.

Table 6 – Paired sample statistics (Sutte Indicator)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	HCLClose	496.4262	245	28.08942	1.79457
	HCLPredicted	502.6163	245	28.50496	1.82111
Pair 2	HexawareClose	394.0531	245	59.98300	3.83217
	HexawarePredicted	401.5061	245	61.59403	3.93510
Pair 3	InfosysClose	672.3276	245	53.65035	3.42759
	InfosysPredicted	679.4286	245	53.96455	3.44767
Pair 4	JustdialClose	511.6816	245	51.77438	3.30774
	JustdialPredicted	523.3673	245	51.96172	3.31971
Pair 5	MindtreeClose	946.4367	245	92.20465	5.89074
	MindtreePredicted	962.3224	245	94.01189	6.00620
Pair 6	NIITClose	1176.1469	245	119.13814	7.61146
	NIITPredicted	1196.5714	245	119.07375	7.60734
Pair 7	TCSClose	1909.4041	245	145.06119	9.26762
	TCSPredicted	1927.8000	245	147.49142	9.42288
Pair 8	TataElxsiClose	1132.6000	245	182.41520	11.65408
	TataElxsiPredicted	1150.4041	245	184.88300	11.81174
Pair 9	TechMahiClose	709.6367	245	50.69891	3.23903
	TechMahiPredicted	719.6898	245	50.63193	3.23476
Pair 10	WiproClose	232.6490	245	26.21442	1.67478
	WiproPredicted	235.4286	245	26.69070	1.70521

In order to calculate the level of correlation between the pairs, paired samples correlation test is conducted. Table - 7 indicates the correlation between the 10 pairs of actualand predicted share prices of the following companies - HCL Technologies Ltd., Hexaware Technologies Ltd., Infosys Ltd., JustDial Ltd., MindTree Ltd., NIIT Technologies Ltd., Tata Consultancy Services Ltd., Tata Elxsi Ltd., Tech Mahindra Ltd., Wipro Ltd.

Table 7 - Paired samples correlations (Sutte Indicator)

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	HCLClose & HCLPredicted	245	.978	.000
Pair 2	HexawareClose & HexawarePredicted	245	.993	.000
Pair 3	InfosysClose & InfosysPredicted	245	.994	.000

Table 7 - Paired samples correlations (Sutte Indicator) (Cont.)

		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
Pair 1	HCLClose - HCLPredicted	-6.19010	5.88572	.37602	-6.93077	-5.44943	-16.462	244	.000
Pair 2	HexawareClose - HexawarePredicted	-7.45306	7.53590	.48145	-8.40139	-6.50473	-15.480	244	.000
Pair 3	InfosysClose - InfosysPredicted	-7.10102	6.00282	.38351	-7.85643	-6.34561	-18.516	244	.000
Pair 4	JustdialClose - JustdialPredicted	-11.68571	9.38494	.59958	-12.86673	-10.50470	-19.490	244	.000
Pair 5	MindtreeClose - MindtreePredicted	-15.88571	14.82394	.94707	-17.75118	-14.02024	-16.774	244	.000
Pair 6	NIITClose - NIITPredicted	-20.42449	17.72188	1.13221	-22.65464	-18.19434	-18.040	244	.000
Pair 7	TCSClose - TCSPredicted	-18.39592	17.52780	1.11981	-20.60165	-16.19019	-16.428	244	.000
Pair 8	TataElxsiClose - TataElxsiPredicted	-17.80408	17.20115	1.09894	-19.96870	-15.63946	-16.201	244	.000
Pair 9	TechMahiClose - TechMahiPredicted	-10.08306	8.35785	.53396	-11.10483	-9.00129	-18.827	244	.000
Pair 10	WiproClose - WiproPredicted	-2.77959	2.28869	.14622	-3.06760	-2.49158	-19.010	244	.000

The correlation between all the pairs of actual and predicted price is greater than 0.90. This indicates a very strong positive correlation between the actual and the predicted price. The high correlation reveals two important aspects. First, a high correlation indicates that the standard error in testing the hypothesis is considerable low. Second, a high correlationindicates that the actual and the predicted prices tend to be similar in terms of ranking. Although the correlation is high, it cannot be concluded that the predicted price is accurate enough. To prove that the predicted prices are accurate, paired sample t-test is conducted. Table - 11 displays the results of t-test. The significance value is 0.000 for all the companies, which is lesser than 0.05. This indicates that the difference between the actual and the predicted prices are significant and thus Sutte Indicator does not predict the share prices accurately. However, the prices predicted are closer to the actual prices.

Linear Regression

Linear regression helps in forecasting the values of dependent variable (y), given the values of independent variable (x). The dependent variable in the study is the stock prices, while the independent variable used is the date.

The formula to calculate the regression is as follows:

$$y = ax + b$$

y = the predicted value or dependent variable

b = the slope of the line

x = the coefficient or independent variable

a = the y-intercept

The share prices are predicted using the regression model. For the purpose of regression past prices of one year is considered. Initially, the share price prediction were doneusing three years past prices, two years past prices and one year past prices. The time frame of one year was finalised based on the Mean Absolute Percentage Error (MAPE) metric. Table – 8 shows the MAPE values for the ten companies for the three sets of inputs considered for regression.

Table 8 – Mean Absolute Percentage Error

Companies/Years	3 years past prices (Apr 2018 – Mar 2022)	2 years past prices (Apr 2020 – Mar 2022)	1 year past prices (Apr 2021 – Mar 2022)
HCL Technologies Ltd	13.66%	4.26%	4.54%
Hexaware Technologies ltd	24.93%	19.07%	27.63%
Infosys Ltd	26.58%	29.18%	9.56%
JustDial Ltd	71.88%	30.64%	8.62%
MindTree Ltd	48.33%	39.03%	15.31%
NIIT Technologies Ltd	42.36%	33.28%	12.21%
Tata Consultancy Services Ltd	30.65%	26.39%	14.03%
Tata Elxsi Ltd	18.68%	16.41%	21.76%
Tech Mahindra Ltd	36.49%	27.55%	6.02%
Wipro Ltd	11.68%	8.11%	11.07%

From the table, it can be interpreted that in most of the cases, MAPE is the least when the stock price are predicted using one year past share prices. Lower MAPE values indicatesa better prediction accuracy and thus stock prices predicted using recent one year data is considered. Once the share prices are predicted using linear regression, t-test is conducted to check the accuracy of the prediction method. Table – 8 indicates the results of paired samples statistics. It can be noticed that the means of the actual and the predicted values are fairly close enough. The highest difference between the means is 20, which is for the company, NIIT Technologies Ltd., and the lowest difference in means is 3 which is for the company, for Wipro Ltd. The next step is to check if these differences in mean are statistically significantly different.

Table 9 - Paired sample statistics (Regression)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	HclActual	496.3902	246	28.03296	1.78732
	HclPredicted	502.6423	246	17.38079	1.10816
Pair 2	HexaActual	394.1341	246	59.87397	3.81742
	HexaPredicted	458.3902	246	48.94756	3.12078
Pair 3	InfyActual	671.9268	246	53.93877	3.43901
	InfyPredicted	605.7439	246	31.71344	2.02198
Pair 4	JustDialActual	511.5650	246	51.70096	3.29633
	JustdialPredicted	503.3089	246	14.72282	.93869
Pair 5	MindTreeActual	945.8821	246	92.42655	5.89290
	MindTreePredicted	858.0732	246	87.17949	5.55836
Pair 6	NIITActual	1174.9472	246	120.37473	7.67481
	NIITPredicted	1031.7967	246	121.69946	7.75927
Pair 7	TcsActal	1907.5407	246	147.68570	9.41610
	TcsPredicted	1635.3618	246	95.62048	6.09654
Pair 8	TataElxsiActual	1132.0772	246	182.22710	11.61838
	TataElxsiPredicted	1194.2398	246	91.40319	5.82765
Pair 9	TechMActual	709.3537	246	50.78977	3.23824
	TechMPredicted	713.3577	246	68.84453	4.38937
Pair 10	WiproActual	232.5854	246	26.17989	1.66917
	WiproPredicted	254.6870	246	11.50384	.73346

From the results, it is noticed that the means of the actual and the predicted prices are closer. However, when compared with the mean differences obtained using the Sutte indicator, the mean differences between actual and predicted share prices under the linear regression tend to be higher. In order to check the level of correlation between the actual and the predicted prices, paired correlation test is used. Table 10 indicates the results of the correlation test.

Table 10 – Paired samples correlation (Regression)

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	HclActual & HclPredicted	246	.385	.000
Pair 2	HexaActual & HexaPredicted	246	-.730	.000
Pair 3	InfyActual & InfyPredicted	246	.777	.000
Pair 4	JustDialActual & JustdialPredicted	246	.090	.159
Pair 5	MindTreeActual & MindTreePredicted	246	-.403	.000
Pair 6	NIITActual & NIITPredicted	246	.622	.000
Pair 7	TcsActal & TcsPredicted	246	.606	.000
Pair 8	TataElxsiActual & TataElxsiPredicted	246	-.649	.000
Pair 9	TechMActual & TechMPredicted	246	.706	.000
Pair 10	WiproActual & WiproPredicted	246	.888	.000

The correlation test reveals negative correlation between the actual and the predicted share prices for three companies. For the rest of the companies, the correlation is positive. However strong correlation can be notices only for the predicted prices of Infosys Ltd, NIIT Technologies Ltd, TCS Ltd, Tech Mahindra Ltd. and Wipro Ltd. However, on a comparative basis (between the Sutte Indicator and Linear Regression), the correlation values are significantly lower under the linear regression model. This jeopardises the level of accuracy of the prediction method. To test further as to whether the differences in the mean are significant, paired samplet-test is employed. Table 11 displays the results of paired sample t-test. The significance value is 0.000 for most of the companies and 0.014 for one company. These values are lesserthan 0.05, which indicates that the differences between the actual and the predicted prices are significant. However the significance value for Tech Mahindra is 0.199 which is greater than 0.05 and indicates that there is no significant difference between the actual and the predicted price. This indicates that the linear regression method is not accurate enough to be relied upon because in most of the cases, there are significant differences between actual and predicted share price.

Table 11 – Paired sample t-test (Regression)

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	HclActual - HclPredicted	-6.25203	26.69529	1.70203	-9.60451	-2.89956	-3.673	245	.000
Pair 2	HexaActual - HexaPredicted	-64.25610	101.28007	6.45738	-76.97516	-51.53703	-9.951	245	.000
Pair 3	InfyActual - InfyPredicted	66.18293	35.43196	2.25806	61.73327	70.63258	29.297	245	.000
Pair 4	JustDialActual - JustdialPredicted	8.25610	52.46499	3.34505	1.66738	14.84481	2.468	245	.014
Pair 5	MindTreeActual - MindTreePredicted	87.80894	150.46478	9.59328	68.91311	106.70478	9.153	245	.000
Pair 6	NIITActual - NIITPredicted	143.15041	105.18620	6.70643	129.94080	156.36002	21.345	245	.000
Pair 7	TcsActual - TcsPredicted	272.17886	117.69199	7.50377	257.39874	286.95899	36.272	245	.000
Pair 8	TataElxsiActual - TataElxsiPredicted	-62.16260	251.36187	16.02625	-93.72940	-30.59580	-3.879	245	.000
Pair 9	TechMActual - TechMPredicted	-4.00407	48.81615	3.11240	-10.13455	2.12642	-1.286	245	.199
Pair 10	WiproActual - WiproPredicted	-22.10163	16.82496	1.07272	-24.21456	-19.98869	-20.603	245	.000

1.9 FINDINGS AND DISCUSSIONS

The existence of comovement between the different companies was established in the study. However the factors inducing such comovement is not analysed in depth. Such a comovement might not hold true in all the cases. In fact, the pairwise comparisons amongst the companies also revealed that the means of price movements were identical rather than being similar. This arises mainly because the price movements are very little in terms of rupee value. In most of the cases, the share prices do not fluctuate very widely in a single day, thus not revealing significant differences in price movements among various companies. The prediction method employed is purely based on historical prices. In reality, the share prices reflect a lot of other factors like the company performance, competitor's performance, changes in the trends of the industry, systematic and unsystematic risk factors, political changes, climatic factors and so on. These are some of the common factors which affect the share prices. In reality, it is impossible to list out all the factors that can significantly affect the share prices. These factors are not just limited to a particular country. Even international policy implementations or political changes affect the stock prices worldwide. Therefore it is impossible to create an exhaustive list of all the factors which has an influence over the share prices. The findings of the study might not be applicable and relevant to all the companies belonging to different industries. Further, as the methods are tested only for a particular timeframe, there are chances that the share prices of that particularyear were influenced by particular factor which might not have occurred in the other years. Another limitation of the study is that, the suttee indicator used the previous day's data while the linear regression used previous one year's data. It is possible that this difference in time frame has caused the significant difference in the correlation and the significance values (p-values) of suttee indicator and linear regression. The share prices are also affected by behavioural factors like investor sentiments and their psychological mood which cannot be quantified and determined in advance. These factors adversely affect the scientifically tested prediction methods. The usual assumptions of the most of the models are that the investors behave in a rational way. But in practical scenarios, investors tend to behave emotionally rather than rationally. Behavioural tendencies are an important element because these factors drive demand and supply in the share market which in turn determines the price of the shares being traded. The study is purely conducted on the basis of past prices. But there are conflicting viewpoints with regard to future share prices. Some authors are of the view that the share prices are a reflection of the past while others believe that the share prices are efficient and are a function of publicly available as well as private insider information. These conflicting viewpoints make the study debatable.

1.10 IMPLICATIONS OF THE RESEARCH

More academic research in the following areas could be useful. The first area is to refine the measure of stock return comovement (Synchronicity) by identifying and measuring the extent to which the firm's fundamental value drivers are correlated. This step or approach would greatly minimize the measurement error inherent in the methodology and would also help in drawing cleaner inferences. Another area of concern is to conduct further analysis to examine the stock price comovement in the context of specific types of market segmentation. For example, separate analyses for industries with more support from government, more predictable earnings, market leaders, and so on, will provide valuable insight into the efficacy of the research undertaken. Further research work can also be done on the relationship between the index and the effects of demand shocks on particular securities of the same industry. In India, the index is computed using the free float market capitalisation method. This method employs the current market price and the total outstanding shares available for trading in the market. A further work

to study if the demand shocks for a few company's shares has any impact or affects the index on the whole. Irrespective of the various ways to predict share prices, there is no conclusive evidence of a particular prediction model working under all scenarios. Thus an attempt can be made in the further studies to establish a hierarchy of various prediction models in terms of the level of accuracy. Research can be undertaken in the following area to check if the price comovement is a result of the all the companies being included in the index. The behaviour of synchronicity could be tested to see if the price still showed comovement if any of the company is removed from the index or by performing the same study for a company which is not a part of the index.

1.11 CONCLUSION

In this research the first area of study was to determine if the share prices of the companies in the same industry exhibit synchronicity. The behaviour of comovement was also tested by considering the ten companies (HCL Technologies Ltd., Hexaware Technologies Ltd., Infosys Ltd., JustDial Ltd., MindTree Ltd., NIIT Technologies Ltd., Tata Consultancy Services Ltd., Tata Elxsi Ltd., Tech Mahindra Ltd., Wipro Ltd.,) as one group and Nifty IT index as another group. Results indicate that there exists a comovement betweenthe share prices the companies and also between the individual companies and Nifty IT index. The second area of study was to determine if Sutte Indicator and Linear regression models predict the share prices accurately. The results show that both the methods do not succeed in predicting the share prices accurately. However, prices predicted by linear regression method were not significantly different from that of the actual prices for Tech Mahinda. But a comparison between the Sutte indicator and linear regression method reveals that the MAPE values are significantly lower in the Sutte indicator methods than that of the linear regression method. Lower MAPE defines better accuracy of the prediction method employed. Table – 12 shows the MAPE values for both the methods.

Table 12 – MAPE values for Sutte Indicator and Regression

Name of the company	MAPE % for Sutte Indicator	MAPE % for linear regression
HCL Technologies Ltd	0.85%	4.54%
Hexaware TechnologiesLtd	1.91%	27.63%
Infosys Ltd	1.08%	9.56%
JustDial Ltd	2.34%	8.62%
MindTree Ltd	1.7%	15.31%
NIIT Technologies Ltd	1.77%	12.21%
Tata ConsultancyServices Ltd	0.98%	14.03%
Tata Elxsi Ltd	1.59%	21.76%

Tech Mahindra Ltd	1.44%	6.02%
Wipro Ltd	1.2%	11.07%

The values reveal that Sutte indicator is better measure in terms of standard error as the MAPE values are comparatively lesser. Further the correlation between the actual and predicted price is also high. Even though there are significant price differences between actual and predicted, the Sutte indicator seems to provide better buy and sell signals as compared to the moving averages method. Although the prices predicted by the Sutte indicator are not accurate, the direction of price movements seem to follow the direction as predicted by the indicator (i.e.) if the Sutte indicator predicts the prices to move up, the actualprices tend to move up in most of the cases and vice versa.

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