COVID -19 and Risk and Return Analysis of Nikkei Stock Exchange

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This paper explores the risk and return analysis between Japan's leading index Nikkei 225 and 20 selected stocks that are listed on the same index. The study considers, the daily returns of the index and stocks for a ten-year period. The selected stocks represent the top eight industries of the economy, calculated based on their index weightage. These industries include automobiles and auto parts, banking, chemicals, electric machinery, foods, machinery, nonferrous metals and services. Results of the study reveals positive low correlation between the index and stocks thus indicating exchange volatility and market sentiment as a driver of the index. The findings further lead to question whether Nikkei 225 as an index is relevant enough to satisfactorily predict the movements of the Tokyo stock exchange. The regression results revealed low R Square value in addition to the significance of F test result indicating that the methodology used is acceptable for the study.

Keywords: Nikkei, Linear Regression, Multivariate and Univariate Distribution, Stock Index, Stock Returns GEL Classification: C6, C2, D53, E4, G3

1. Introduction

Nikkei is leading Japanese stock index comprising 225 companies. Nikkei was established on May 1949 that followed the establishment of the index in September 1950. Tokyo stock exchange was established in 1878 as the second oldest stock exchange in Asia, second to Bombay Stock Exchange that was established three years earlier. The Nikkei got its name from the then existing popular financial daily, Nihon Keizai Shimbun popularly known as 'Nikkei', which also sponsored the calculation of the index. The index value is calculated by considering the average of share prices of the 225 companies listed on it. Nikkei follows price weighted index value, calculated as the simple average of price of all the stock listed on the index divided by total number of stocks. Nikkei represents all major Japanese industries including foods, pharmaceuticals, oil & coal products, rubber products, glass & ceramics, machinery, shipbuilding, automotive, mining and fishery. Electric machinery has more representation in the Nikkei 225. Table 1 details industry wise break up of all 225 companies that make up NIKKEI 225. It reveals that among the 35 industries represented in the index, 8 industries make up for the maximum representation making up for more than fifty percent of all companies. (Table 2).

Table 1 *Industry Wise Break Up of NIKKEI 225*

Industry in Nikkei	Count of Industry in Nikkei	Industry in Nikkei	Count of Industry in Nikkei
Air Transport	1	Nonferrous Metals	11
Automobiles & Auto parts	10	Other Financial Services	2
Banking	11	Other Manufacturing	4
Chemicals	17	Petroleum	2
Communications	6	Pharmaceuticals	9
Construction	9	Precision Instruments	5
Electric Machinery	28	Pulp & Paper	2
Electric Power	3	Railway & Bus	8
Fishery	2	Real Estate	5
Foods	11	Retail	7
Gas	2	Rubber	2
Glass & Ceramics	8	Securities	3
Insurance	5	Services	13
Land Transport	2	Shipbuilding	2
Machinery	15	Steel	4
Marine Transport	3	Textiles & Apparel	4
Mining	1	Trading Companies	7
Warehousing	1		
Grand Total	**225**	Grand Total	**225**

Top 8 Industries of Nikkei

Industry in Nikkei	Count of Industry in Nikkei
Automobiles & Auto parts	10
Banking	11
Chemicals	17
Electric Machinery	28
Foods	11
Machinery	15
Nonferrous Metals	11
Services	13
Grand Total	**116**

2. Literature Review

Empirical Evidences

Since its initial outbreak, the Novel Coronavirus significantly impacted the global economy. Subsequently, this had bidirectional spill over effects on the global stock markets too leading to global financial crisis, Qing (2020). In March 2020, The G7 countries consisting of Canada, France, Germany, Italy, Japan, United Kingdom and the United States of America witnessed their respective stock indices reaching 20-year lows, Japan being the only exception. This clearly indicated the impact that COVID-19 had on increasing market volatility, Yousef (2020). On similar lines, the Chinese industrial sectors, particularly the transportation, mining, electricity & heating, and environment sectors had been adversely impacted by the pandemic. However, manufacturing, information technology, education and health-care industries displayed resilience to the pandemic, Pinglin (2020). In Canada, the stock market responses have been asymmetric displaying an equally idiosyncratic behaviour in COVID cases. Evidences in the United States, revealed an inverse relationship between the stock price movements and workplace mobility of people, Davis (2020). As workplace mobility declined between the period of from February 17th 2020 to March 12th 2020, the VIX index experienced a significant fall in value, Ziemba (2020). Soon after the sharp fall in global stock prices by almost 30 percent followed a dramatic upturn, recovering half of the losses. This recovery lasted between April 9th 2020 till end of May. The US stock market experienced positive returns, predominantly triggered by the Federal Reserve stimulus package, Harjoto (2020). In the US, microeconomic factors negatively impacted the stock prices of industries such as airlines, aerospace, real estate, tourism, oil, brewers, retail apparel, and funerals whereas macroeconomic factors led to losses in industries such as production equipment, machinery, and electronic and electrical equipment, Thorbecke (2020). On the other hand, government restrictions on commercial activities and voluntary social distancing being strictly followed in a service oriented economy like that of the US led to the U.S. stock market crash, Baker (2020). In summary, it was observed that the US stock market reacted negatively towards news of more confirmed COVID cases as well as the reported death cases with a significant impact on stock market volatility, Abedin (2020). Studies conducted by Gormsen, (2020) concluded that European stock markets faced extremely low bounds on the expected growth rates and returns based on the dividend futures. Further research based on the multifractal detrended fluctuation analysis (MFDFA) suggested the existence of multifractality in European stock markets that suffered the most, Chaudhary (2020). The COVID-19 outbreak demonstrated maximum efficiency of the Spanish Stock Market while Austria having the least, Aslam (2020). Another study by Goh (2021) on the European Stock Markets pointed towards abnormal stock market return. These returns seemed to be relatively more sensitive to COVID cases as compared to confirmed deaths cases. The sample data were drawn from Coronavirus cumulative indicators like the Relative Cumulative Coronavirus Deaths (RCCD). On comparing the BSE SENSEX with the S&P 500 and Nikkei 225 and the FTSE 100, it was found that the Indian stock markets had the same standard deviation as the global markets but had higher negative skewness and higher positive kurtosis of returns, making the Indian market comparatively more volatile, Chaudhary (2020). During their period of study, the BSE SENSEX and NSE NIFTY fell approximately by 38% indicating abnormal returns wiping off a whopping 27.31% of the total market capitalization of the Indian stock market. Observations from the Jakarta Stock Exchange and the Indonesian Stock Exchange suggested that interest rate in Indonesia had positive impact on the stock market index, whereas the foreign exchange rate (forex) negatively impacted the stock market index, Goh (2020). Even though the major global economies experienced immense hardships during the pandemic, there were some countries that had been successful to insulate themselves from adversities to a great extent. One such exception was the Vietnamese Stock Market which was successful in managing the pandemic. Although before lockdown, COVID-19 had a significant negative impact on Vietnam's stock returns, the lockdown period had a contrasting positive influence on the stock market. Similar studies conducted by Anh, (2020) also provided similar results. Countries like Malaysia and Singapore had quite minimal effects of their stock market movements and associated market volatility, Yong (2020). Studies conducted by Camba, (2020) through robust least squares regression using MM-estimation method on the Philippines Stock Exchange concluded that COVID-19 daily infection had a negative and statistically significant effect on the Philippines Stock Exchange. In the Balkans, the Macedonian Stock Exchange represented by the MBI 10 fell by 22.34% in the month of March in 2020, thus severely impacting the stock market capitalization of oil companies, travels agencies and the manufacturing sectors that were exposed to the corona outbreak, thus sinking their market value by an approximate 10%, Tatjana (2020). The Gulf Cooperation Council which includes the United Arab Emirates, Saudi Arabia, Qatar, Oman, Kuwait and Bahrain suffered immensely during the coronavirus outbreak with

evidence suggesting an inverse relationship between the daily returns of major stock market indices and COVID-19 confirmed deaths, Bahrini (2020) while countries like Egypt, Jordan, Morocco and Tunisia displayed similar results to the outbreak, Amr (2020). As a result of the pandemic outbreak, the trading behaviour of individual and institutional investors of both Arabs and foreign investors residing in the gulf countries significantly changed and appeared to be more sensitive to the spread of the Coronavirus, Mertzanis (2020).

Quantitative models

Risk and return analysis are a tool that helps investors to cherry pick a right stock Ramasamy, (2021). In a study conducted for a limited period of time Marzia, (2021) the effect of COVID in UAE Bank Stocks has been studied using the regression analysis. The study considered the Abu Dhabi Securities Exchange and Dubai Financial Market and studied twelve banks over three years' time frame. The study concluded that the Covid cases resulted in volatility in prices, however, the Covid fatalities did not seem to have an impact in stock price. In a macro study conducted over three Asian stock exchanges, Korean SE Kospi Index, the Japanese Nikkei 225, and the Chinese Shanghai Shenzhen CSI 300 Index, on the COVID 19 cases and volatility in stock price, Gil-Alana, (2020) conclude that Nikkei 225 was volatile due to the pandemic, however Korean and Chinese exchanges volatility was long term and were not induced due to Covid. Their research applied fractional integration as a methodology to analyze the variables over a time series.

According to Morck, (1990), investors can take cues from stock market. In his seminal paper, Keyes, (1972) attempted to predict future market value of a stock by analyzing the statistical data regarding company's past and present performance applying correlation and regression analysis. During that time, using statistical analysis for investment analysis was relatively made the research a path breaking episode for future researchers to follow. In the study, year on year stock market returns for a stock was used as dependent variable and almost sixteen variables were used as independent variables including return of equity, annual sales growth, price gain, dividend yield. The objective of the study aligned with the objectives of this paper as well, to determine if one could use data of past and present to predict future. In an attaempt to develop a stock market prediction model Khan, (2018) analyzed multiple stock exchanges. The study evaluated the NYSE, London Stock Exchange, NASDAQ and Karachi Stock Exchange along with three giant global conglomerates Apple, Microsoft, and Google. The paper discussed various work done in investment analysis field using machine learning, artificial intelligence and neural network to predict stock markets along with Artificially intelligent enabled trading system and artificial intelligent system with support vector machines. The linear regression model was being used for its robustness and simplicity. This paper gave insights about how regression is part of a model and machine learning algorithm.

3. Methods

A quick summary on the tools employed in this risk analysis of the Nikkei 225. Statistical analysis involves making educated guesses through hypotheses. We use 'descriptive statistics' which provides summary of the available data and 'inferential statistics' that helps in drawing conclusions.

Descriptive statistics is primarily used for two important quantitative measures, one is the central tendency measure and the other one being the measure of dispersion which explains how the data is spread out or scattered. Central tendency is revealed by mean – the average, median – middle number of the ordered list and mode – the most repeating number. Dispersion is explained by Variance and Standard deviations. Variance is the sum of the squared deviations from the Mean, divided by the degree of freedom (number of data points minus one). Variance is the measure of risk, whereas standard deviation indicates the consistency. The presence of outliers in the data will affect these values. Results based on samples are referred as statistics whereas outcomes based on population data are referred as parameters.

Kurtosis and Skewness are key indicator of the shape of the histogram plotted on each variable and thus indicates the behavior patter of the stock and index. Kurtosis say how much of the data is densely populated around a specific range and skewness indicate to which side of the graph the data is leaning towards.

The Excel's descriptive options were used to generate data. It is interesting to note that the Index shows very high kurtosis (126) and high negative skewness (-11). There are 1730 data points out of 2466 that are lying in the range of -1.0% to 1.02% returns. There are stocks where the kurtosis is high - Trend micro (8.94), Olympus (18.57) and Nintendo (32). Two stocks that are very close to symmetric with the skewness near zero are, Fujitsu Limited (-0.02) and Kao Corporation (0.06).

Inferential statistical analysis helps in predicting the behavior of the population in future by studying a sample or the population. Through hypothesis testing we prove or disprove the predictions. Here, for our analysis we use multiple regression testing, as there is more than one independent variable. Microsoft Excel supports maximum of 16 independent variables at a time. In the regression analysis, we need to determine whether the independent variables (individual 20 stocks part of the Nikkei 225) have any effect on the dependent variable (the index of Nikkei 225).

The regression provides a test score and the p-value. The test score is important, and P-value is key as it represents the probability of the impact was by chance. P-value needs to be interpreted along with the threshold set by significance level, which is generally set upfront to 0.05 or 5% value at the beginning of the analysis. When the P-value is less than the significance level, then we can say that the impact of the independent variable on the dependent variable is significant, strong, and meaningful.

We use ANOVA (Analysis of Variance) is employed when there more than two variables to be tested for relationship. This is also referred as F-test. The 'Significance F' is essentially P-Value for the F-Test, which help in deciding whether the hypothesis is accepted or rejected. One-way ANOVA in used when we are studying the impact on one independent variable.

For the statistical analysis of the data, we are using MS excel regression-analysis option available under 'Data Analysis'. The result is a three tabular output viz., Summary Output regression table, ANOVA table and the final table listing Coefficients, t Stat, P-value etc. This R^2 indicate how much of the variance in the underlying data is captured by the regression model and expressed as number between 0 and 1 or as percentage. R^2 = explained variance / total variance. Goal of the regression model is the get a lowest sum square of R, so that the dispersion is less and most of the data points are closest the regression line. The regression model is good if its value is above .80. Closer to 1, the regression is best fit. Linear regression model, this is represented by a straight-line equation y= mx+c. where c is the y-intercept and m is the slope of the line. The slope indicates the magnitude of the influence on the dependent variable y by the independent variable x. Multiple R is co-relation coefficient, which measure the liner relationship strength between the variables. This can be a value between -1 and +1, indicate who the variables involved are related in linear manner. A value of zero means no relationship at all exist between the variables.

R^2 is coefficient of determination, which indicates the fitness of the model. It shows as to how many data points fall on the regression line. Higher this value is better. Adjusted R^2 is a value that consider the number data points on the independent variables. Standard error shows how much the data is far away from the regression line, so smaller value is better fit. ANOVA provides df (degree of freedom), SS is sum of squares, MS is mean square, and F is F test and Significance F is the P-Value of F test. 'Significance F' it has to be less than .05 to be considered. If more than 0.05, this regress is not useful. Then come the co-efficient for individual independent variables**.** The stocks that are highly correlated are from these industries Rubber, Electric Machinery, Automobiles, Shipbuilding, Banking, Steel, Services

Results

\	Industry	N225 Close	Aeon	Ajinomoto	Bridge stone Corp.	Canon	Central Japan Railway	Daiichi Sankyo	Fujitsu Ltd.	Hitachi	Honda	Inp Corp.	Kao Corp.	Kawasaki Heavy Industries	Mizuho Financial Group	Nintendo	Nippon Steel	Obayashi Corp.	Olympus	Osaka Gas	Toyota	Trend Micro
N225 Close	Index	1.00																				
Aeon	Retail	0.09	1.00																			
Ajinomoto	Foods	0.08	0.42	1.00																		
Bridgestone Corporation	Rubber	0.11	0.42	0.36	1.00																	
Canon	Electric Machinery	0.09	0.37	0.28	0.52	1.00																
Central Japan Railway	Railway & Bus	0.09	0.49	0.44	0.51	0.44	1.00															
Daiichi Sankyo	Pharma.	0.09	0.42	0.37	0.39	0.32	0.42	1.00														
Fujitsu Limited	Technology Services	0.09	0.31	0.28	0.41	0.37	0.30	0.32	1.00													
Hitachi	Electric Machinery	0.11	0.37	0.30	0.57	0.53	0.42	0.35	0.47	1.00												
Honda	Automobile	0.11	0.43	0.33	0.66	0.58	0.48	0.38	0.44	0.63	1.00											
Inpex Corporation	Mining	0.08	0.33	0.20	0.43	0.43	0.35	0.27	0.34	0.49	0.50	1.00										
Kao Corporation	Chemicals	0.09	0.45	0.45	0.41	0.37	0.48	0.39	0.29	0.34	0.38	0.23	1.00									
Kawasaki Heavy Industries	Shipbuilding	0.10	0.37	0.26	0.57	0.52	0.44	0.32	0.41	0.64	0.66	0.52	0.30	1.00								
Mizuho Financial Group	Banking	0.11	0.41	0.31	0.58	0.52	0.50	0.39	0.44	0.60	0.65	0.50	0.35	0.62	1.00							
Nintendo	Services	0.07	0.24	0.24	0.30	0.28	0.26	0.26	0.32	0.32	0.31	0.22	0.25	0.28	0.35	1.00						
Nippon Steel	Steel	0.10	0.38	0.26	0.53	0.52	0.44	0.31	0.42	0.60	0.65	0.54	0.28	0.65	0.62	0.29	1.00					
Obayashi Corporation	Construction	0.09	0.40	0.34	0.45	0.40	0.48	0.35	0.32	0.42	0.45	0.36	0.38	0.43	0.46	0.23	0.42	1.00				
Olympus	Precision Instruments	0.08	0.27	0.22	0.34	0.28	0.25	0.28	0.30	0.38	0.39	0.27	0.28	0.32	0.34	0.22	0.31	0.32	1.00			
Osaka Gas	Gas	0.08	0.43	0.46	0.41	0.36	0.52	0.41	0.31	0.38	0.40	0.32	0.42	0.34	0.41	0.26	0.37	0.41	0.24	1.00		
Toyota	Automobile	0.12	0.47	0.39	0.68	0.56	0.53	0.43	0.48	0.66	0.76	0.47	0.42	0.65	0.69	0.35	0.63	0.46	0.38	0.46	1.00	
Trend Micro	Services	0.10	0.33	0.34	0.43	0.37	0.35	0.38	0.38	0.43	0.43	0.31	0.37	0.39	0.40	0.28	0.36	0.39	0.34	0.34	0.45	1.00

Reporting Research Results

Analysis is done under three categories. Stocks that are highly correlated with index, stocks that are moderately correlated and stocks that are completely un correlated. Highly correlated stocks are considered those whose correlation value is greater than 0.60. From the results, it is evident that several Automobiles and Electric Machinery stocks are highly correlated with the index, indicating a strong relationship between the overall index and these specific industries. additionally, on further analysis, it is observed that Food and Retail industry are not correlated with any other industry or the index. This is evidenced from the correlation of Aeon with index and other stocks. At the same time, the Rubber industry is highly correlated with Automobiles industry. This is evident from the high correlation of Bridgestone Corporation with Honda (66%) and Toyota (68%). Electric Machinery is highly correlated with Automobiles and Ship Building. Hitachi supports Toyota and Honda by providing necessary electrical equipment required by them in their manufacturing process. Hitachi, is also highly correlated with Kawasaki, a massive shipbuilding company that specializes in manufacturing of aerospace systems, hydraulic equipment, and industrial robots. The correlation between Honda and Toyota is very high indicating cohesiveness in their

price change. Honda and Kawasaki shows same correlation with Bridgestone, Hitachi, Mizuho, Nippon, Toyota, and each other. Mizuho Bank is displays strong correlation with Nippon, Toyota, Honda, and Kawasaki. Nippon steel is highly correlated with automobiles Toyota and Honda, shipbuilding Kawasaki and Mizuho bank. For analysis, moderately correlated stocks are considered those whose correlation value is greater than 0.40 and less than and equal to 0.59. It is observed that Aeon is moderately correlated with Foods, Rubber, Railway, Pharmaceuticals, Automobiles, Chemicals, Banking, Osaka. Bridgestone corporation, rubber industry moderately correlated with all the stocks. For analysis, uncorrelated stocks are considered those whose correlation value is less than 0.20. it is observed that there are no uncorrelated stocks. All stocks within themselves show moderate to high levels of correlation.

4. Discussion

R-Square is 2% indicates that the regression on index with the stock is not predictable.

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	14%
R Square	2%
Adjusted R Square	1%
Standard Error	9%
Observations	2466

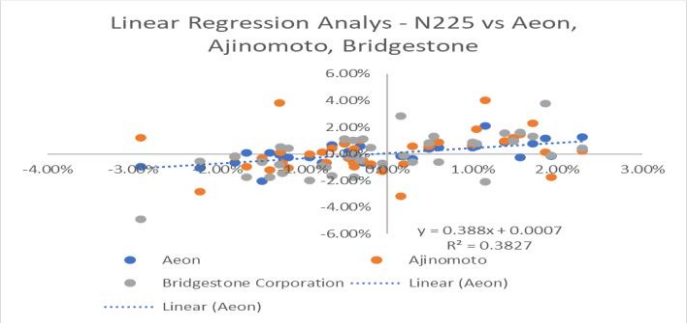
ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	16	0.36	0.02	3.10	0.00
Residual	2449	17.94	0.01		
Total	2465	18.30			

	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	-0.01	0.00	-4.20	0.00	-0.01	0.00	-0.01	0.00
Aeon	0.06	0.14	0.43	0.67	-0.22	0.34	-0.22	0.34
Ajinomoto	0.08	0.13	0.62	0.54	-0.17	0.33	-0.17	0.33
Bridgestone Corporation	0.09	0.15	0.59	0.55	-0.21	0.39	-0.21	0.39
Canon	0.03	0.15	0.22	0.82	-0.26	0.32	-0.26	0.32
Central Japan Railway	0.01	0.14	0.10	0.92	-0.26	0.29	-0.26	0.29
Daiichi Sankyo	0.09	0.11	0.84	0.40	-0.12	0.31	-0.12	0.31
Fujitsu Limited	0.07	0.10	0.66	0.51	-0.13	0.26	-0.13	0.26
Hitachi	0.10	0.13	0.77	0.44	-0.16	0.36	-0.16	0.36
Honda	0.11	0.16	0.71	0.48	-0.20	0.42	-0.20	0.42
Inpex Corporation	0.02	0.10	0.21	0.83	-0.18	0.22	-0.18	0.22
Kao Corporation	0.09	0.14	0.65	0.52	-0.19	0.37	-0.19	0.37
Kawasaki Heavy Industries	0.04	0.12	0.37	0.71	-0.19	0.27	-0.19	0.27
Mizuho Financial Group	0.05	0.17	0.29	0.77	-0.28	0.38	-0.28	0.38
Nintendo	0.03	0.08	0.42	0.68	-0.12	0.18	-0.12	0.18
Nippon Steel	0.02	0.12	0.16	0.87	-0.21	0.25	-0.21	0.25
Obayashi Corporation	0.08	0.12	0.65	0.51	-0.16	0.31	-0.16	0.31

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	13%
R Square	2%
Adjusted R Square	2%
Standard Error	9%
Observations	2466

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	0.32	0.08	11.10	0.00
Residual	2461	17.98	0.01		
Total	2465	18.30			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.01	0.00	-4.21	0.00	-0.01	0.00	-0.01	0.00
Olympus	0.09	0.07	1.23	0.22	-0.05	0.23	-0.05	0.23
Osaka Gas	0.14	0.14	1.00	0.32	-0.13	0.41	-0.13	0.41
Toyota	0.43	0.14	3.16	0.00	0.16	0.69	0.16	0.69
Trend Micro	0.20	0.10	1.97	0.05	0.00	0.41	0.00	0.41



These are highly volatile stocks. Significance F is 0.00 proving that the regression is acceptable for further study. As a next step, checking the individual P-value again proves the high volatile nature of the member stocks. Toyota standout with P-Value 0, indicating it predictability though only R Square is 2%.

5. Conclusions

This paper aimed to a statistical analysis between an index and its components. It was interesting to note that the correlation of the index and its components. Though positive, they strength of relationship was extremely low, mildly suggesting that the index may not be an accurate representation to extrapolate the entire stock exchange characteristics. Nikkei as stated in this paper is a volatile stock index. It is one of the most volatile stock indices in a developed country. This volatility is evident from the outcome of the statistical analysis between the index and the stocks. The analysis threw light on the correlation among the stocks in the index. The automobile stocks movements are tightly coupled besides of the stock correlation are in the less correlated range. This analysis also indicated the industries that are tightly coupled with respect to stock price movements, how automobile and shipping reacts with banking and other industries.

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