A Comparatative Study On The Co-Movement Of Nifty And Global Indices (DAX, DJI, Hang Seng) During Pre And Post Covid Period

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1. Abstract

Nowadays, thanks to the advancement of modern technology, pertinent information may travel easily throughout the globe. If the information is affecting the economy of that nation, the stock markets are also responding to it. Many academics have recently expressed interest in researching the long-term correlation between national stock market indices and other international indices. We have made an effort to research the potential co-movement and co-integration of indexes with comparable market caps, such as the NIFTY, DAX, DJI, and HANG SENG. The study examines the indices' weekly close prices during the ten-year period between April 2011 and March 2021. We also talk about the issues that affected the key indices during the Covid period, which was extremely stressful. The "Granger and Causality Correlation" test was used to study the measurement of co-integration and attempt to analyse collinearity among the chosen indices in order to determine whether there is a long-term and short-term link between them. The outcome reveals a long-term, significant positive correlation between the chosen indices. In contrast to the Asian Market, the correlation has diminished with the American and European markets. Therefore, the study is useful for the investors who trade based on the interdependencies of the indices and understand their co-movement.

Keywords: Co-integration among the indices, Co-relation, Regression, Collinear in long term, Jarque Bera, Multivariate analysis, Descriptive analysis.

2. Introduction

The introduction of new financial products has revolutionized the global financial sector. Over the years, the stock market has also witnessed a lot of innovative items. Any nation's stock market index's performance reflects the state and future outlook of that nation's economy. On arrival of any news that affects the world economy broadly, a country's index may likewise respond similarly to other global indexes. Therefore, an investors should accept the risk of systemic hazards that are related to their investment when they invest in any global index. The liberalization and internationalization of the "Foreign Exchange" created an open capital flow that leads to cross-border correlation. To increase capital mobility, one needs a varied portfolio that enhances earnings and combines the stock markets. This has prompted several experts to explore the connections between stock markets. Academic research on the benefits of global diversification is substantial. The international equity markets could have provided American investors with better risk and return opportunities between 1959 and 1966, according to Grubel (1968). Levy and Sarnat (1970) explore international correlations between 1951 and 1967 and show the benefits of investing in both developed and emerging equity markets for diversification.

Given the widespread belief in the benefits of international diversification over the past 20 to 25 years and the current significance of diversification for research and practise in

international finance, we believe it is important to examine how international diversification has actually performed, not just over the last 20 years since the beginnings of academic research but over much longer periods of world market history. Here, using long-term historical data, we assess whether the global diversification strategies have helped investors over the last ten years. We also evaluate the potential for future global diversification while keeping in mind the long-term lessons from the history of the capital markets.

The majority of financial indicators, particularly stock index series, are non-stationary. When we attempt to construct a linear relationship between these variables using the Ordinary Least Squares (OLS) method, we obtain false regression and erroneous results. We wish to check for any potential co-integration between the Nifty and other global indexes in this study.

We took into account the NIFTY, DAX, DJI, and HANG SENG indices in this study. The outcomes of the stock index represent the relevant economic reality, and all four indexes have comparable market capitalizations, a diversified investor base, are interrelated, and share similar difficulties and problems. Further, the long-term correlation between these foreign indices with Nifty also has been tested through various models during Covid pandemic period. It is observed that the global stock indices have gone through a tremendous stress during the Covid 19 period i.e. from

April 2020 till March 2022. Therefore, a study on the long-term relationship as well as Covid pandemic period among the indices is also very interesting to understand whether there is any change in pattern in correlation among the indices.

3. Literature review

The interdependencies of various markets and financial indicators were only studied on the basis of short-run correlation research prior to Granger's theory of long-term linkages, known as co-integration. Since then, several initiatives to advance and develop the co-integration theory have been done in this domain. Johansen came out with fresh methods for computing and deciphering multivariate co-integrations.

In order to understand how the indices are interdependent and to determine the stochastic movement of the indices, analysis was conducted, according to Dadhich M.et al. (2019). To continue the inquiry, econometric models like Dickey-Fuller, Johansen Co-integration, and Granger Causality were applied. Investors can predict movement and understand interdependencies thanks to the result, which supports both uni- and bi-directional causality between the indexes.

Kasa used Johansen's cointegration test to analyse the connections across stock markets and found strong support for a single common trend in the US, Japan, Germany, British, and Canadian markets from 1974 to 1990. Many established equity markets move their stocks in synchrony over the long term, according to numerous research.

The Granger causality, which states that "return explains the actual action" and that "differences in country's inflation are also explained by the "interest rate," is applied, in accordance with Lee, 1992, to demonstrate the causal relationship between ROA, relative activity, and "post-war inflation".

First, daily frequency, total mutual fund flow is also related to market returns, according to Wrner and Edlen 2001, who used high frequency day-to-day stock data for the years 1998 to 1999 to investigate the relationship

between the outcomes of the markers and total flows into United States equity "mutual funds". The link between institutional trends and money flow also affects the results. The second "finds scant empirical" evidence that the price changes of securities have an impact on mutual funds. 3rd, identify the important connections between returns and cash flow. The relationship implies that there is a one-day lag in the flow of money and a previous day's return. Stakeholders, however, require a "overnight period to react".

According to Korea and Parwada's investigation on the relationship between market stock results and "mutual funds" conducted in 2007, the results show that while there is a strong correlation between returns and both purchases and sales and the "internet flows," it is only marginally significant.

The established markets and economies, such those in the United States and Europe, have been the subject of the majority of stock market correlation studies. Several studies have been done to examine the outstanding Asian stock markets. The researchers found that just a small number of the publications examined the co-integration of the Asian, European, and US stock markets. As a result, it is strongly encouraged to investigate the co-integration among the chosen indexes with comparable market capitalization.

4. Research Methodology and Materials:
4.1 Data and Period of Study:

Weekly close prices of Nifty, DAX, DJI and Hang Seng for the period of April 2011 to March 2020 with 470 observations have been downloaded from the website yahoo finance. The data period constituted as long-term period. Further, weekly close prices of Nifty, DAX, DJI and Hang Seng for the period of April 2020 to March 2022 with 105 observations have been downloaded from the website yahoo finance. The data period constituted as Covid-19 period. However, we have plotted Sensex also in the graph to understand whether the movement of Indian indices (Nifty and Sensex) are in same line or not. Since every index exhibits a monotonous nonlinear pattern, all cointegration analysis

computations have been performed on the index series' natural logarithm.
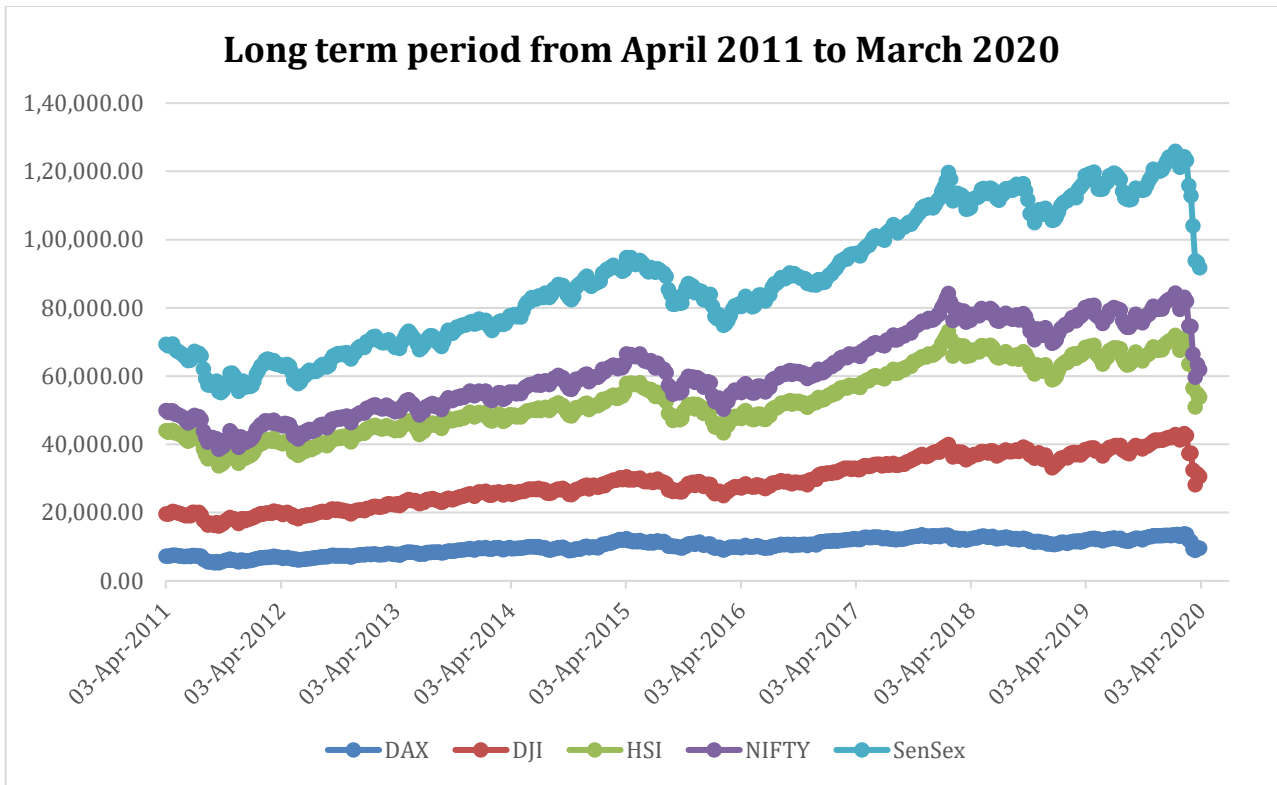

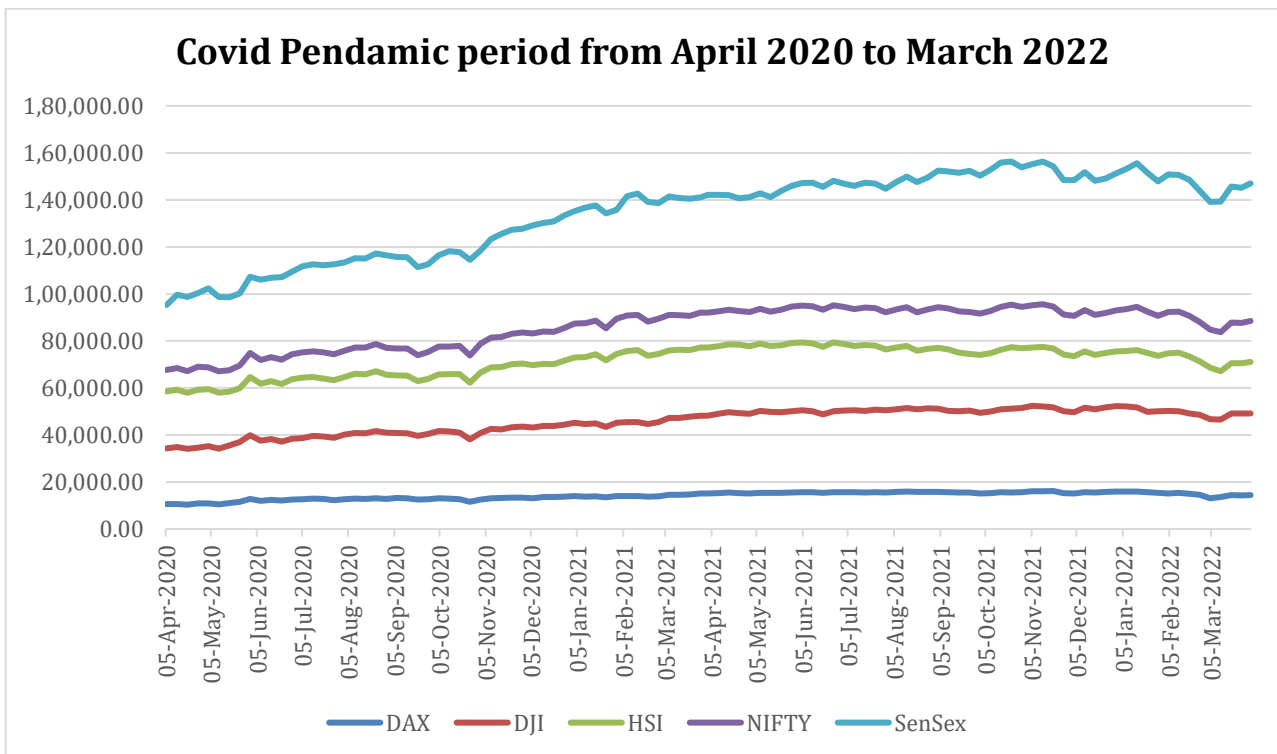*Figure 1: Movement of indices (source of data: yahoo finance and self-created)*

Figure 2: Movement of indices (source of data: yahoo finance and self-created)

Y-O-Y return generation by Indices					
Date	**DAX**	**DJI**	**HSI**	**NIFTY**	**SENSEX**
Mar-2012	-3.74%	6.72%	-15.74%	-9.35%	-10.60%

Mar-2013	10.25%	10.24%	5.70%	4.87%	8.49%
Mar-2014	26.60%	12.68%	3.60%	20.55%	18.60%
Mar-2015	23.43%	8.23%	12.29%	28.26%	22.91%
Mar-2016	-18.16%	0.17%	-18.90%	-10.17%	-7.72%
Mar-2017	25.71%	16.13%	17.62%	18.94%	16.12%
Mar-2018	-1.76%	16.65%	24.81%	10.25%	10.79%
Mar-2019	-0.72%	9.63%	-0.52%	15.35%	18.64%
Mar-2020	-20.68%	-20.33%	-22.38%	-30.71%	-22.90%
Mar-2021	58.59%	57.48%	24.54%	83.92%	64.37%
Mar-2022	-4.58%	4.60%	-23.99%	17.47%	19.51%

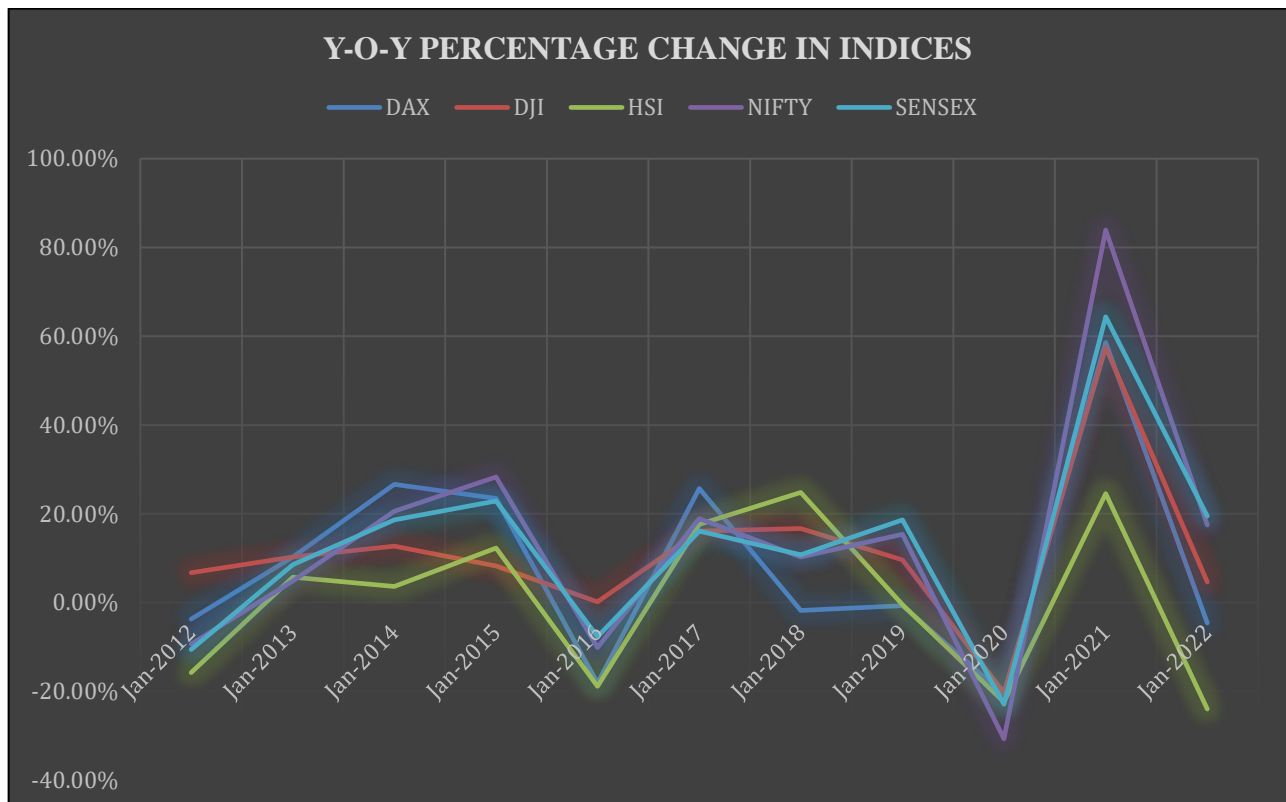*Figure 3: Return generated by different Global and Indian indices*

Figure 4: Graphical representation of the return generated by the Global and Indian indices.

From the above tables it is apparent that most of the global indices as well as Indian indices have been moved almost in the same direction. Even on the onset of Covid 19 pandemic i.e. 2020-21 the global indices have generated similar negative return like Indian indices. However, in the year 2021-22, it is observed that the Indian indices have relatively performed better than global indices. Therefore, it is more interesting to find out whether the long-term correlation between global indices and Indian indices still holds true.

INDICES	CAGR (%) Comparison
DAX	6.49%
DJI	9.82%
HSI	-0.94%
NIFTY	10.47%

SENSEX	10.56%

Figure 5: CAGR for the period April 2011 to March 2022

From the above table it is observed that except HIS, all other global and Indian indices have generated more or less a compounding annual growth rate (CAGR) in the range of 6.5% to 10.5% for the period of April 2011 March 2022.

5. Study tools:

The analysis is "data interpreted" from the outcome of Granger Causality and correlation. Further, regression model helps to measure relationship between more independent variable. In this research study, regression models help to measure the relationship of

Nifty and other global indices. 'ANOVA' is used to compare groups at the same time. 'T' teat refers to a 'statistical teat' that is used to compare the means of 2 samples. In this study we have also used the statistical analysis such as 'Coefficient' which measures the statistical relationship between 2 variables. Multivariate analysis is also being conducted to find the relationship between 'independent variable and dependent variable'. In this research study multivariate analysis is conducted to measure the impact of global indices on the movement of Nifty.

6. Interpretation and analysis
6.1 Pre-Covid Period Analysis:
By using different statistical measurement and tolls let us find out the relationship and co-movement of Global indices and Indian indices. We are considering long term relationship for the period April 2011 to March 2020 for DAX, DJI, Hang Seng with Nifty.

6.2 Correlation & Coefficients:

Correlations

		Price Nifty 50	Price DJI	Price DAX	Price HANG-SENG
Price Nifty 50	Pearson Correlation	1	.975**	.924**	.807**
	Sig. (2-tailed)		.000	.000	.000
	N	522	522	522	522
Price DJI	Pearson Correlation	.975**	1	.910**	.796**
	Sig. (2-tailed)	.000		.000	.000
	N	522	522	522	522
Price DAX	Pearson Correlation	.924**	.910**	1	.815**
	Sig. (2-tailed)	.000	.000		.000
	N	522	522	522	522
Price HANG-SENG	Pearson Correlation	.807**	.796**	.815**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	522	522	522	522

**. Correlation is significant at the 0.01 level (2-tailed).

Table 1: Correlation matrix among the indices.

The above table shows the correlation between Nifty and other Global indices. The analysis helps to understand the relationship between Nifty and other Global indices. The correlation value between Nifty and DJI is .975 which is below 1 but positive. The value defines the positive relationship (Kulal et al. 2020). The correlation value between Nifty and DAX is .924 which is below 1 but in positive. This value also defines the positive relationship between Nifty and DAX. The correlation value between Nifty and HANG-SENG is .807 which is also below 1 but is positive therefore it also defines the positive relationship between Nifty and HANG-SENG (Singh et al. 2018). According to the correlation analyses above table, Nifty and international indices have a good association. The analysis's "2-tailed significance value" for all correlation is 000. The variables utilized for the correlation study are said to be insignificant.

6.3 Descriptive Statistics:

Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Price DJI	522	22381.7300	10771.4800	33153.2100	19740.12080	242.6987646	5545.016172	30747204.35	.350	.107	-1.024	.213
Price Nifty 50	522	10539.0000	4624.3000	15163.3000	8566.024904	108.6379424	2482.085760	6160749.720	.292	.107	-.707	.213
Price DAX	522	9917.2400	5189.9300	15107.1700	10341.27485	99.9415906	2283.397433	5213903.835	-.390	.107	-.890	.213
Price HANG-SENG	522	15561.7100	17592.4100	33154.1200	24284.99935	141.3891211	3230.362399	10435241.23	.282	.107	-.614	.213
Valid N (listwise)	522											

*Table 2: Descriptive statistics for Global and Indian indices.*

The above table shows the descriptive statistics of Nifty and other Global indices. This table shows mean, median and variance value of nifty and other global indices. Fore descriptive statistical historical data from April 2011 to March 2020 of Nifty and other global data is used. Mean value shows the verge value of the data (Lau, 2018). The above table shows that the mean value of DJI is 19740.12 which indicates that the average price of DJI index in the last ten years is 19740.12. The mean value of the other index shows that the average price in the last ten years, which is for Nifty 50, is 8566.024, for DAX the average price is 10341.27 and for HANG SENG it is 24284.99.

Maximum and minimum value shows in the above table indicate the highest price and lowest price of index in the last 10 years. In this above table it shows that in the last 10 years the highest price of DJI went to 33153, Nifty went to 15163, DAX went to 15107 and HANG SENG went to 33154 (Wang et al. 2021). Minimum value indicates the minimum price of the index after it went down in the last ten years. The minimum price of DJI index 10771, for Nifty is 4624, for Dax is 5189 and minimum price of HANG SENG is 17592. The variance shown in the above table indicates the difference in minimum and maximum price of the stock index.

In this above table. Skewness and Kurtosis of stock data is also measured through descriptive statistics. The table shows the skewness of DJI is 0.350, Nifty is 0.292, for DAX -0.390 and for HANG-SENG it is 0.282 (Ji et al. 2021). The value of kurtosis for DJI is -1.024, Nifty -0.707, for DAX -0.890 and for HANG-SENG is -0.614.

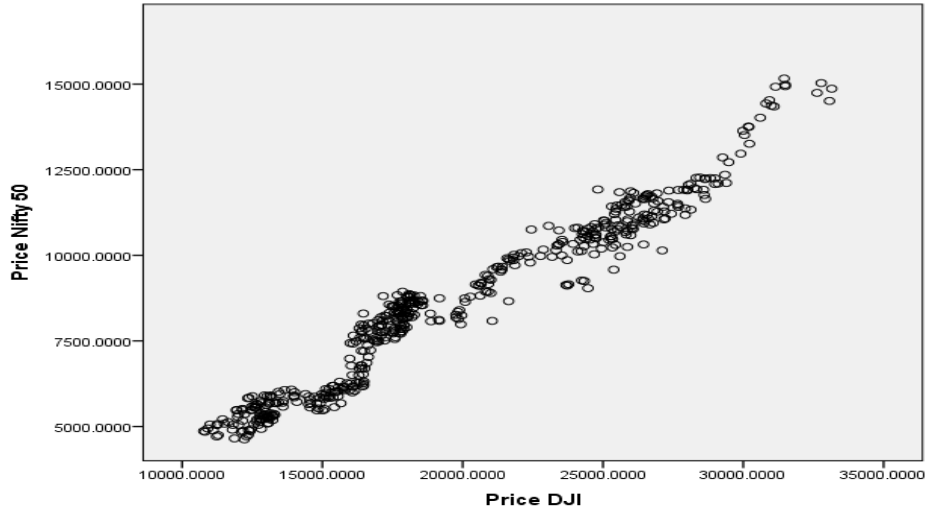## 6.4 Scatter plot of representation between Nifty and HANG-SENG
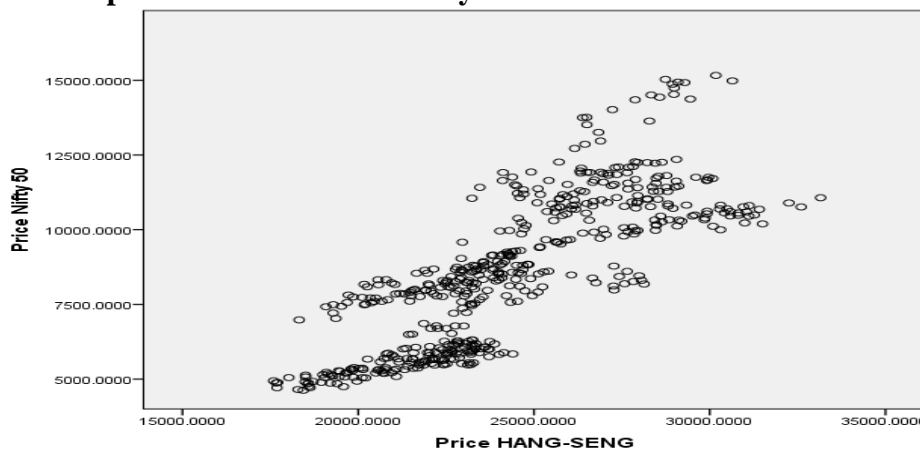
Figure 6: Scatter plot of Nifty and HANG-SENG (source: SPSS)

The above figure shows the scatter plot of Nifty and HANG SENG index. In this plot the price of Nifty is treated as a dependent variable and HANG-SENG is treated as an independent variable. The scatter plot used to measure the relationship between Nifty index and HANG-SENG index (Sarkar et al. 2020). The above plot shows not a very strong relationship between the Nifty index and HANG-SENG index. Each dot represented in minimum distance shows the relationship between two variables.

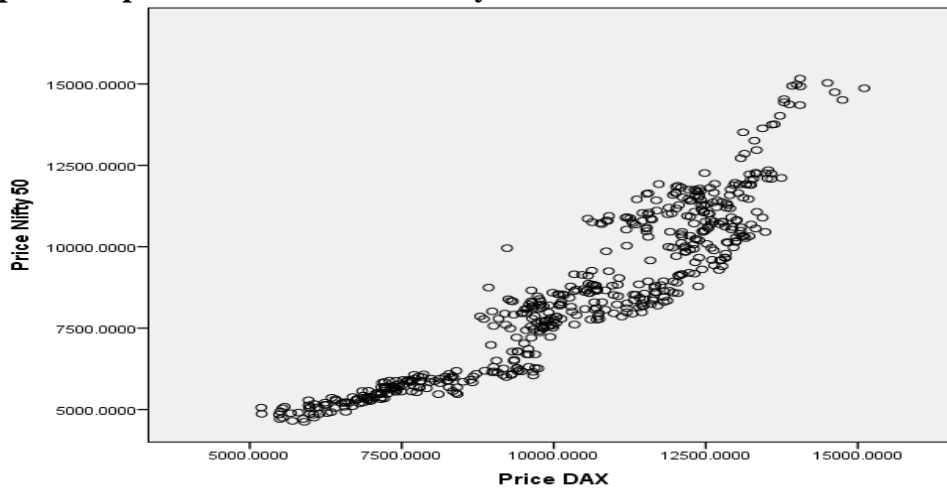## 6.5 Scatter plot of representation between Nifty and DJI

Figure 7: Scatter plot of Nifty and DJI (source: SPSS)

The above figure shows the scatter plot of Nifty and DJI index. In this plot the price of Nifty is treated as a dependent variable and DJI index is treated as an independent variable. The scatter plot used to measure the relationship between Nifty index and DJI index (Bi, 2021). It helps the readers to visually understand the relationship between two variables. The above plot shows a positive relationship between the Nifty index and DJI. Each dot represented in minimum distance shows the relationship between two variables (Jang et al. 2021). In the above graphical plot it shows that most dots are at minimum distance and it also helps to find that all dots go in the same direction. This indicates that the historical price of the Nifty and DJI index has a positive relationship.

6.6 Scatter plot of representation between Nifty and DAX

Figure 8: Scatter plot of Nifty and DJI (source: SPSS)

The above figure shows the scatter plot of Nifty and DAX index. In this plot the price of Nifty is treated as a dependent variable and Price of DAX index is treated as an independent variable. The scatter plot used to measure the relationship between Nifty index and DAX index (Roni et al. 2021). It helps the readers to visually understand the relationship between dependent and independent variables. The above plot shows a positive relationship between the Nifty index and DAX index. Each dot represented in minimum distance shows the relationship between two variables. In the above graphical plot it shows that most dots are at minimum distance and it also helps to find that all dots go in the same direction (Jančoková, 2021). This indicates that the historical price of the nifty and DAX index has a positive relationship.

6.7 Regression Statistics:
The regression model helps to measure the relationship between more independent variables with one dependent variable. In this research study, regression models help to measure the relationship of nifty with global indices such as DAX, DJI, HANG-SENG (Kai et al. 2018). In the regression model nifty will

be selected as a dependent variable and DAX, DJI, HANG-SENG will be independent variables. Model summary of Regression models help to measure the value of R, "R square", "Adjusted R square" and "std error" of the estimate.

Regression Statistics	
Multiple R	0.658851831
R Square	0.434085735
Adjusted R Square	0.430434675
Standard Error	0.016669691
Observations	522

6.8 ANOVA and t test:
The ANOVA test is used to compare groups at same time. It helps to determine the relationship between more than two groups. T test refers to a "statistical test" that is used to compare the means of 2 samples. It also helps to measure the hypothesis test to find the null value presented in the group of measures (Akoglu, 2018). In this research study the ANOVA test and t test is used to measure the relationship of mutual funds with the Indian stock market. ANOVA and t test models help to measure the value of df, mean square, F and Significance.

	df	SS	MS	F	Significance F
Regression	3	0.09911353	0.033037843	118.8930783	3.72293E-57
Residual	465	0.129213554	0.000277879		
Total	468	0.228327084			

Table 3: statistical values of Anova and t test

6.9 Multivariate Analysis:

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Corrected Model	Price DJI	1.602E+10[a]	521	30747204.35	.	.	1.000	.	.
	Price DAX	2716443898[a]	521	5213903.835	.	.	1.000	.	.
	Price HANG-SENG	5436760679[a]	521	10435241.23	.	.	1.000	.	.
Intercept	Price DJI	2.034E+11	1	2.034E+11	.	.	1.000	.	.
	Price DAX	55823705968	1	55823705968	.	.	1.000	.	.
	Price HANG-SENG	3.079E+11	1	3.079E+11	.	.	1.000	.	.
PriceNifty50	Price DJI	16019293465	521	30747204.35	.	.	1.000	.	.
	Price DAX	2716443898	521	5213903.835	.	.	1.000	.	.
	Price HANG-SENG	5436760679	521	10435241.23	.	.	1.000	.	.
Error	Price DJI	.000	0	.					
	Price DAX	.000	0	.					
	Price HANG-SENG	.000	0	.					
Total	Price DJI	2.194E+11	522						
	Price DAX	58540149866	522						
	Price HANG-SENG	3.133E+11	522						
Corrected Total	Price DJI	16019293465	521						
	Price DAX	2716443898	521						
	Price HANG-SENG	5436760679	521						

a. R Squared = 1.000 (Adjusted R Squared = .)
b. Computed using alpha = .05

Table 4: Test between Nifty and global indices

The above table shows Multivariate analysis between dependent variable and fixed variable. In this test DAX, DJI and HANG SENG are treated as dependent variables where Nifty is treated as fixed variable. The above table shows that the error for all three dependent variables is 0 which indicates that the data of the dependent variable does not find error (Lamba et al. 2021). The test measure means square value for all three dependent variables. Mean square value of index DAX is 5213903, for index DJI mean square value is 30747204 and mean square of index HANG SENG is 10435241.

Case Processing Summary

		N	%
Cases	Valid	522	85.9
	Excluded[a]	86	14.1
	Total	608	100.0

a. Listwise deletion based on all variables in the procedure.

Table 5: Case processing summary for Nifty and global indices (Source: SPSS)

This table shows the case processing summary for Nifty and other global indices. The above table shows that the total number of cases is 608 where 522 is the valid number and 86 is the excluded number (Maity et al. 2021). In percentage 85.9% cases are valid and 14.1% cases are excluded.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.912	.964	4

Table 6: Reliability statistic of Nifty and global indices (Source: SPSS)

This is the table of reliability statistics between Nifty and other global indices such as DAX, DJI and HANG SENG. Reliability statistics measure the consistency of a test or experiment. It is a measure of how well the results of a test or experiment can be reproduced or replicated (Mary et al. 2021). Reliability statistics provide an indication of how reliable or consistent an experiment or test is. In the above table N value shows the total number of items used for in statistics. In this statistic cronbach's alpha value is .912 and "cronbach alpha based on standardized items" is .964

Inter-Item Covariance Matrix

	Price DAX	Price Nifty 50	Price DJI	Price HANG-SENG
Price DAX	5213903.835	5236198.610	11524487.17	6011324.038
Price Nifty 50	5236198.610	6160749.720	13424733.44	6468416.222
Price DJI	11524487.17	13424733.44	30747204.35	14267001.61
Price HANG-SENG	6011324.038	6468416.222	14267001.61	10435241.23

Table 7: Covariance matrix between Nifty and global indices

Covariance is a measure of how two or more than two variables change with respect to each other. Specifically, it measures the degree to which two variables are linearly associated. The covariance matrix is a square matrix that contains the variances and covariances for all pairs of variables in a given dataset (Mishra et al. 2020). It can be used to identify correlations between variables, inform principal component analysis, and aid in other types of data analysis. The above table shows the covariance matrix of indian stock index nifty and other global indices which include DAX, DJI and HANG SENG (Misra, 2018). The covariance matrix helps to understand the dependence of variables on each other. As per the table it shows that the covariance value between Nifty and DAX is 5236198.610. The covariance value between Nifty and DJI is 13424733.44 and value of covariance between nifty and HANG SENG is 6468416.222. The result of the covariance matrix indicates that

the price of Nifty is most correlated with price of DJI.

6.10 Jarque Bera Statistics:

The test of Jarque Bera is a suitable test for this study as it defines whether the sample data have the kurtosis and skewness balancing a general distribution in this text here consider three-term small, mid- and long-term index data of Nifty and others global indices such as DAX, DJI and HSI. On the stock markets of India, Germany, the United States, and Hong Kong, a test of normality is conducted. The data series is anticipated to be non-normal at the 5% level. The information will be examined using Jarque-Bera.

$$JB = \frac{n}{6}\left(S^2 + \frac{1}{4}(K-3)^2\right)$$

(Source: Researchgate.net)

	DAX	DJI	HIS	NIFTY
Mean	10341.27	19740.12	24285	8566.02
Median	10657.07	18007.22	23721.33	8392.68
Minimum	5189.93	10771.48	17592.41	4624.3
Standard Division	2283.4	5545.02	3230.36	2482.09
Skewness	-0.389575	0.350049895	0.281611787	0.29234794
Excess Kurtosis	-0.889726	-1.024351288	-0.614469761	-0.7066611
Observations	522	522	522	522
Jarque Bera	-87.13764	38.62904128	35.63573363	35.498664
Pvalue	#NUM!	0	0	0

Table 8: Long term period considering period from 1st April 2011 to 31st March 2021.
(Source: self-created in excel)

6.11 Covid Period Analysis

It is observed from the above analysis that the selected global indices display a positive relationship on their movement with Nifty. However, it is important to note whether the same relationship exists during covid pandemic period i.e. from April 2020 to March 2022.

6.12 Correlation:

	Dax	*DJ*	*Hang Seng*	*Nifty*
DAX	1			
DJI	0.79315929	1		
Hang Seng	0.492207789	0.446839368	1	
Nifty	0.672868865	0.604715606	0.5970509	1

6.13 Regression Statistics:

Multiple R	0.743765624
R Square	0.553187303
Adjusted R Square	0.539782922
Standard Error	0.018696362
Observations	104

6.14 Anova and 't' test:

	df	SS	MS	F	Significance F
Regression	3	0.043277376	0.014425792	41.26914227	1.93324E-17
Residual	100	0.034955396	0.000349554		
Total	103	0.078232772			

6.15 Multivariate Analysis:

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.005453696	0.001879829	2.901165421	0.004572477	0.001724168	0.009183224	0.001724168	0.009183224

DAX	0.348891846	0.100329782	3.477450443	0.000750761	0.149840416	0.547943277	0.149840416	0.547943277
DJI	0.154328902	0.121959856	1.265407384	0.208665854	-0.087635979	0.396293783	-0.08763598	0.396293783
Hang Seng	0.335998808	0.076217435	4.40842448	0.0000262	0.184785587	0.487212029	0.184785587	0.487212029

7. Conclusion

The paper made an effort to evaluate the relationship between the "chosen" global indices and Nifty. It has been found that there is a stronger correlation between the Nifty and the DAX, DJI, and Hang-Seng indices. Yet, since the pandemic might not have hit every economy equally, it is intriguing to look at the influence of COVID 19 on the indices. The study is also highly helpful for investors who build a portfolio spanning various stock markets. This finding encourages us to understand the direction of correlation between future stock market indices since the maximum degree of correlation between two stock market indices will explain the other stock market. By clarifying the direction of the relationship between the two stock markets, this research will support the prognosis of another stock market. Additionally, Granger Causality analysis of the co-movement shows that the Nifty 50 futures are able to describe the future stock markets of the DAX (Germany) and DJI (NASDAQ, USA), and that they even display a bidirectional movement with the future of the Hang Seng. However, the movement of DAX index is the most identical with the movement of Nifty. The study also demonstrates that during Covid period the same trend continues.

8. Future Scope of Study:

We have worked on three international indices that share traits with Nifty. It would be intriguing to see whether other worldwide indices for the same time period show the same strong correlation.

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