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UNRAVELING THE INTRICACIES OF THE INDIAN STOCK MARKET'S RELATIONSHIP WITH INTERNATIONAL FINANCIAL MARKETS

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ABSTRACT

The purpose of this research paper is to explore the linkage between the Indian stock market and international stock markets. The study uses data of daily closing prices over a period of ten years **(01/01/2013 to 30/12/2022)** to identify the extent of interdependence between the Indian stock markets **(NIFTY AND SENSEX)** and major global stock indices **(SSE, HSI, DJIA, and FTSE)**. The linkages are modelled using **Descriptive statistics, Correlation test, unit root tests (ADF test), Granger causality test and JJ Cointegration test**. The correlation test results suggest that there is a strong negative correlation between the DJIA, NIFTY, and SENSEX indices, while HSI and SSE have weaker positive correlations with the other indices. FTSE has a moderate positive correlation with the other indices. Overall, it is found that there is some degree of long-term interdependence among these stock market indices.

I. INTRODUCTION

Every business requires funds to function. Sometimes the proceeds from the sale of goods or services are insufficient to cover the costs of working capital. Companies invite regular people like you and me to invest in their businesses in order to run them effectively. In return, investors receive a portion of the company's profits.
The term stock market refers to a network of exchanges where investors can buy and sell shares of publicly traded companies. Such financial transactions take place through formal exchanges and over-the-counter (OTC) marketplaces that adhere to a set of rules.

The terms "stock exchange" and "stock market" are frequently confused. Shares are bought and sold on one or more of the stock exchanges that make up the overall stock market by stock market traders.

II. REVIEW OF LITERATURE

Hossein Asgharian, Wolfgang Hess, and Lu Liu (2013) investigated the extent to which countries' economic and geographical relations affect stock market co-movements using spatial econometrics techniques. They

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discovered a strong effect of a unit shock to three regionally dominant countries, namely the United States, the United Kingdom, and Japan, on other countries via trade linkage. They used monthly returns for 41 markets from January 1995 to December 2011. The findings show that bilateral trade is the most important link for shock transmission from the US to other markets, while the average effect of the US market on its geographical neighbours is relatively small.

Abdulrasheed Zubair (2013) employs Johansen's cointegration to test for the possibility of co-integration and Granger-causality to estimate the causal relationship between the Nigerian stock market index and monetary indicators prior to and during the global financial crisis. He used monthly data from 2001 to 2011. This study relied on 241 observations. The findings indicate the absence of a long-run relationship prior to and during the crisis. The Granger-causality tests show unidirectional causality running from M2 to ASI prior to the crisis, but no causality between the variables during the crisis.
Hongquan zhu, zudi lu, and shouyang wang (2003) used returns and a measure of volatility for the Shanghai Composite index, the Shenzhen Composite Subindex, and the Hong Kong Hang Seng Index to test for a causal relationship between China's stock markets. Based on these results, they concluded that Shenzhen Granger caused Shanghai before 1994. They discovered a positive feedback relationship between the Shanghai and Shenzhen stock markets, and that Hong Kong volatility Granger causes Shanghai volatility but not vice versa. The empirical results show that (1) all three stock market series are integrated processes, (2) the series are not cointegrated, and (3) the error correction model for the series does not exist.

Thiam Hee Ng (2002) investigates the linkages between South-East Asian stock markets following their opening in the 1990s. Monthly stock index observations from the five ASEAN countries of Indonesia, Malaysia, the Philippines, Singapore, and Thailand were used. The data ranged from December 1987 to December 1997, with a total of 121 observations. He stated that there is no evidence of a cointegrating relationship between ASEAN stock markets from 1988 to 1997. This implies that there is no long-run relationship between the ASEAN stock markets. His findings indicate that the Indonesian, Filipino, and Thai stock markets are all trending toward a closer relationship with the Singaporean stock markets.

Yaser A. Alkulaiba, Mohammad Najandb, and Ahmad Mashayekh (2008) looked into the lead/lag relationship between the MENA countries and regions. The 12 MENA stock markets (Bahrain, Egypt, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, Turkey, and UAE) were used, and their daily closing prices were used. The stock market indices were obtained from Global Finance Data. From 3 January 1999 to 31 December 2004, a period of 6 years, was used to analyse the regional daily market indices. In the North Africa region, they discovered no evidence of market spill over or causality. Their findings for the Levant region show that there are connections among stock markets there. The results for the Gulf Cooperation Council (GCC) region show that the GCC region has more interaction and linkage than the North Africa and Levant regions. They discovered an unexpected result: the UAE's stock market outperforms all other markets in the region. Finally, they looked into the connections between the three regions. They also discovered that the GCC has an impact on the other two regions.

Claudio Morana a and Andrea Beltratti (2008) examined the monthly realised moments for stock market returns in the United States, the United Kingdom, Germany, and Japan to assess the linkages holding across moments and markets. The study spans the years 1973 to 2004. They said that there is also evidence of a positive and non-spurious link between volatility and correlation, as well as a trend increase in correlation coefficients over time. They also told that the links appear to be particularly strong for the US and Europe, whereas the Japanese stock market's more erratic behaviour may have been caused by the country's persistent stagnation and weak fundamentals in the 1990s.

Julien Chevallier, Duc Khuong Nguyen, Jonathan Siverskog, and Gazi Salah Uddin (2018) investigated the level of interdependence across Pacific Basin stock markets using the return spill over measure proposed by Diebold and Yilmaz (2009, 2012), given the Pacific Basin's growing role in global trade and finance. The data was collected between 1992 and 2012. They are also interested in researching the impact of shocks on the stock markets of the United States and Japan, as well as their transmission to emerging markets. They

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discovered that: (i) the interdependence of the ASEAN countries' emerging stock markets is driven by a greater exposure to US shocks than to shocks affecting East Asia's developed economies, and (ii) cross-market linkages in the Pacific Basin region have grown stronger over time, potentially reducing the benefit of regional diversification strategies and exposing the region's countries to increasing contagion risk. Their findings have significant implications for public policies concerning regional and global financial integration.

Ranjan Dasgupta (2014) investigated the interdependence, integration, and dynamic linkages between countries, regions, and stock markets, including BRIC, country-region, and developing-developed stock markets. He used the daily closing values of the BRIC indices from January 1, 2003 to December 31, 2012. He used the Jarque-Bera test, as well as the

ADF and PP tests, to determine the normality and stationarity of the data series. His research looks at the short and long-run interrelationships and integration of the BRIC stock markets using Johansen and Juselius's' and Engle and Granger's cointegration tests, as well as pairwise Granger causality tests. According to the results of the Engle and Granger tests, he discovered that the Indian stock market has a significant impact on the Brazilian and Russian stock markets. Correlation results for all BRIC markets revealed a strong positive correlation. He also discovered that the Indian and Brazilian stock markets have short-run interrelationships and integration in both directions.

Duncan M. Ripley (2014) looked into the systematic covariation of stock prices in developed countries. The average monthly stock-price indices for 19 developed countries, namely the fourteen industrial countries, Finland, Ireland, Australia, New Zealand, and South Africa, were used in this study. He discovered that the countries with the highest levels of unique movement include Finland, South Africa, Denmark, and Japan, all of which have a uniqueness close to 70%. Countries with low percentages of unique variance include Canada and the United States, both of which have less than 20%, and Switzerland and the Netherlands, both of which have less than 30%. Furthermore, he discovered that approximately 55% of the movement in the German and British stock price indices is unique.

Saif Siddiqui (2009) investigated the connections between selected Asian and US stock markets. His primary goal is to investigate the degree of integration among global stock markets. His research is based on secondary data pertaining to daily closing figures of various stock indices of various global stock markets from October 19, 1999 to April 25, 2008. He obtained the information from Yahoo Finance. He concluded that global stock market interdependence has increased and that there is no clear direction of relationships in the sense of Granger Causality, indicating that the influence of a few markets, particularly the US, has eroded over time.

Bala Arshanapalli, John Doukas, and Larry H.P. Lang (1995) investigated the presence of a common stochastic trend between US and Asian stock market movements following October 1987. They used daily closing equity index data from the Dun and Bradstreet Corporation's Data Stream International. For the period January 1, 1986 to May 12, 1992, they used a sample that included index data for the United States (Dow Jones Industrial Average), Japan (Tokyo Stock Price Index), Hong Kong (SEHK All Ordinaries Index), Malaysia (Kuala Lumpur Composite Index), the Philippines (Manila Composite Index), Singapore (SES All Share Singapore), and Thailand (SET Index). They collected the sample, which included 1661 observations. Their findings also show that Asian equity markets are less integrated with Japan's equity market than with the US market.

M. Shabri Abd. Majid, Ahamed Kameel Mydin Meera, Mohd. Azmi Omar, and Hassanuddeen Abdul Aziz (2019) investigated dynamic linkages between ASEAN-5 emerging stock markets. Their primary goal is to empirically investigate market integration in five selected Association of Southeast Asian Nations (ASEAN) emerging markets (Malaysia, Thailand, Indonesia, the Philippines, and Singapore) prior to and following the 1997 financial crisis. They employed a two-step estimation method, cointegration, and the generalised method of moments (GMM). According to their findings, the stock markets in the ASEAN region were

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cointegrated both before and after the 1997 financial crisis. However, markets are becoming more integrated, particularly since the 1997 financial crisis. Finally, they found that except for the emerging market of Indonesia, all other ASEAN markets appear to be important bearers of short-run adjustment to a shock in the region's long-run equilibrium relationships both during and after the crisis, as measured by error correction terms.

Sudharshan Reddy Paramati, Eduardo Roca, and Rakesh Gupta (2016) conducted research on economic integration and stock market dynamic linkages: evidence from Australia and Asia. They investigated the extent of stock market interdependence - in the long and short run - between Australia and ten Asian markets, as well as whether this interdependence is driven by bilateral trade links. We also considered the impact of the GFC in this investigation. They collected weekly closing price index data from 1 September 1999 to 27 November 2013 for Australia (ASX 300), China (SSE A Share), Hong Kong (Hang Seng), India (CNX 500), Indonesia (IDX Composite), Japan (Nikkei 225), Malaysia (FTSE BMKLCI), the Philippines (PSEi), Singapore (STIL), South Korea (KOSPI), and Thailand (BSET). They used unit root tests, cointegration test for analysis. Their findings imply that the region's increasing economic integration has contributed to the long-run equilibrium relationship of the stock markets and increased stock market correlations.

Francis In, Sangbae Kim and Jai Hyung Yoon (2002) investigated the dynamic linkages and interactions of Asian stock markets using Vector Autoregression (VAR) model. In addition to the United States, they examined the daily stock price indices of 11 Asian-region countries: Australia, Japan, Korea, Singapore, Taiwan, Hong Kong, Malaysia, the Philippines, Thailand, Indonesia, and New Zealand. Their data is divided into two time periods: pre-crisis (4 January 1990 to 1 July 1997) and crisis (2 July 1997 to 29 December 1999). The total number of observations in their sample is 3083. Their findings show that, with the exception of Malaysia, markets became more closely linked during the financial crisis. They discovered that during the crisis, Singapore and Australia exerted greater influence on the other Asian stock markets.

Ahmad Zubaidi Baharumshah, Tamat Sarmidi and Hui Boon Tan (2010) investigated the dynamic interrelationships between major stock markets as well as four Asian markets (Malaysia, Thailand, Taiwan, and South Korea), both in the short and long run. From January 1988 to December 1999, they used natural logs of weekly local currency-denominated stock indices. For analysis, they used unit root tests, cointegration tests, and the vector error-correction model (VECM). Their empirical findings suggested that, in the post-liberalization era, all Asian markets were inextricably linked with one another and with the world capital markets, namely those of the United States and Japan. Overall, their evidence indicates that the degree of integration between Asian emerging markets and the United States increased following the deregulation period, and that the relationship has grown stronger since the Asian crisis began.

Zeynel Abidin Ozdemir, Hasan Olgun, Bedriye Saracoglu (2009) investigated the dynamic linkages between the US equity market, which represented the centre, and emerging markets. Their data consists of the daily US dollar value of the S&P500 price index and the 15 emerging market price indexes obtained from DataStream. The data spans from the reported date to March 24, 2006. For analysis, they used unit root tests and the Granger causality test. Their empirical findings show a significant causal relation between the S&P 500 and all emerging stock markets in the sample, but not vice versa. This evidence suggests that a centre-periphery relationship exists in international stock markets.

Gagan Deep Sharma and B.S. Bodla (2016) investigated the interdependence of the stock markets of India, Pakistan, and Sri Lanka. The daily closing levels of the benchmark indices in the three countries are recorded from January 2003 to June 2010. While line charts, correlograms, and the unit-root test are used to determine whether the series is stationary, Granger's causality model, vector auto regression (VAR) model, and variance decomposition analysis are used to determine the linkages between the markets under consideration. Their paper concluded that, while the National Stock Exchange of India Granger causes the Karachi Stock Exchange of Pakistan and the Colombo Stock Exchange of Sri Lanka, the opposite is not true. The VAR models confirm the findings of Granger's causality model.

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III. METHODOLOGY

A. DATA AND PERIOD OF STUDY

The research design used in this study is Analytical Research in nature. Sample Size is 6. Secondary data is used for the research. The daily closing price of the Selected benchmark indices are collected from **https://finance.yahoo.com.** The daily closing prices are collected for last 10 years starting from the period **01/01/2013 to 30/12/2022.**

B. TESTS USED FOR ANALYSIS:

Descriptive statistics is a subfield of statistics concerned with summarising, presenting, and describing the main characteristics of a set of data in a concise and meaningful manner. The goal of descriptive statistics is to provide an intuitive understanding of data characteristics such as central tendency (mean, median, mode), dispersion (range, variance, standard deviation), and data distribution shape (skewness, kurtosis).

Correlation tests are commonly used in stock analysis to investigate the relationship between two variables. The most common correlation test used in stock analysis is the Pearson correlation coefficient, which measures the strength and direction of the linear relationship between two variables.

Unit root tests are commonly used in stock analysis to determine whether a time series is stationary or non-stationary (Kannan K & Balamurugan G, 2022). A stationary time series has a constant mean and variance over time, while a non-stationary time series has a mean and/or variance that changes over time. In stock analysis, unit root tests are often used to investigate whether stock prices follow a random walk or whether there is a long-term trend in stock prices. The most commonly used unit root test is the Augmented Dickey-Fuller (ADF) test (Kannan K & Balamurugan G, 2018).

The Granger causality test can be used in stock analysis to examine the causal relationship between different stocks or other financial instruments.

The Johansen cointegration test, also known as the JJ cointegration test, is a statistical method used to test the presence of cointegration among a set of time series variables. Cointegration is a statistical property that implies a long-term relationship between two or more non-stationary variables.

IV. RESULTS

DESCRIPTIVE STATISTICS:

	DJIA	FTSE	HSI	NIFTY	SENSEX	SSE
Mean	23770.84	6870.545	24783.23	10436.09	34727.64	3017.125
Median	23953.82	6887.820	24408.77	9969.650	32239.91	3090.635
Maximum	36799.65	7877.450	33154.12	18477.05	61765.59	5166.350
Minimum	14659.56	4993.890	14687.02	5285.000	17905.91	1950.012
Standard deviation	6397.027	515.2001	3122.994	34104.539	11599.89	527.8359
Skewness	0.361226	-0.410305	0.048042	0.742210	0.763597	0.052719
Kurtosis	1.873102	2.493254	2.682174	2.657643	2.617483	3.828409
Jarque-Bera	181.2741	94.10447	11.15315	234.7788	250.7558	70.55146
Probability	0.000000	0.000000	0.003786	0.000000	0.000000	0.000000
No. of observations	2428	2428	2428	2428	2428	2428

BSE Sensex has higher mean, so this index has generally been increasing in value, while China SSE has lower mean, so this index has generally been decreasing. All stock indices of different countries (DJIA, FTSE, HSI, NIFTY, SENSEX and SSE) have positive median, i.e., they all have more positive returns than negative returns over the period. BSE Sensex has high maximum value and low minimum value comparatively and hence it is considered as more volatile and riskier than other stock indices.

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The value of Standard deviation in the table indicates that BSE Sensex is comparatively more volatile than all other stock indices. FTSE and SSE tends to be less volatile than other stock indices. A high kurtosis value can indicate that the stock has a higher risk of extreme price movements, and hence may be more volatile. DJIA, FTSE, HSI, NIFTY and SENSEX have platykurtic distribution (values are <3) while SSE have Leptokurtic distribution (values are >3)
In Jarque-Bera test, the p-value for all the stock indices is less than significance level (usually 0.05), the returns are not normally distributed.

CORRELATION TEST:

	DJIA	HSI	FTSE	NIFTY	SENSEX	SSE
DJIA	1	-0.251964	-0.315289	-0.845065	-0.847144	-0.536864
HSI	-0.251964	1	0.331154	0.160904	0.153113	0.304386
FTSE	-0.315289	0.331154	1	0.395268	0.377878	0.084929
NIFTY	-0.845065	0.160904	0.395268	1	0.999014	0.477622
SENSEX	-0.847144	0.153113	0.377878	0.999014	1	0.464770
SSE	-0.536864	0.304386	0.084929	0.477622	0.464770	1

we can see that the diagonal values are all 1, which is to be expected since each variable has a perfect correlation with itself. SSE has weak positive correlations with HSI (0.304386) and NIFTY (0.477622), indicating that as one of these variables increases, the other tends to increase slightly.
Overall, these correlation coefficients suggest that there are some relationships between these variables, but the strength of the relationships varies. It is important to note that correlation does not imply causation, and further analysis is needed to understand the underlying factors driving these relationships.

UNIT ROOT TEST:
Null hypothesis: Unit root is present in the series, indicating non-stationarity. Alternative hypothesis: The series is stationary.

ADF TEST RESULTS: (with Intercept and trend)

Variables	Level	1st Difference
SSE	-2.608671	-22.39185
HSI	-2.002646	-48.99077
FTSE	-3.502299	-50.47083
DJIA	-3.611351	-15.68206
NIFTY	-2.083632	-48.88910
SENSEX	-2.100386	-49.06677

1% level -3.961703 5% level -3.411599 10% level -3.127669

For NIFTY, the ADF test statistic for the level is -2.08, and for the first difference, it is -48.89. The test is significant at the 5% level for both the level and the first difference, which suggests that both series are stationary. Overall, based on these ADF test results, we can conclude that all six stock indices are likely stationary. This is important information for time-series analysis and modelling of these stock indices.

GRANGER CAUSALITY TEST:
Null hypothesis: There is no causal relationship between the two variables.
Alternative hypothesis: There is causal relationship between the two variables.

Null Hypothesis:	Observations	F-Statistic	Probability
SSE does not Granger Cause SENSEX	2425	1.29150	0.2750

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SENSEX does not Granger Cause SSE		0.36331	0.6954
SSE does not Granger Cause NIFTY NIFTY does not Granger Cause SSE	2425	1.18228 0.39062	0.3068 0.6767
SSE does not Granger Cause HSI HSI does not Granger Cause SSE	2425	0.62083 0.00260	0.5376 0.9974
SSE does not Granger Cause DJIA DJIA does not Granger Cause SSE	2425	0.17875 1.68564	0.8363 0.1855
SSE does not Granger Cause FTSE FTSE does not Granger Cause SSE	2425	0.70932 0.51717	0.4921 0.5963
SENSEX does not Granger Cause FTSE FTSE does not Granger Cause SENSEX	2474	1.45252 2.85095	0.2342 0.0580
NIFTY does not Granger Cause FTSE FTSE does not Granger Cause NIFTY	2474	1.69766 3.36746	0.1833 0.0346
NIFTY does not Granger Cause HSI HSI does not Granger Cause NIFTY	2460	3.60543 1.14731	0.0273 0.3177
SENSEX does not Granger Cause HSI HSI does not Granger Cause SENSEX	2460	3.56262 1.14326	0.0285 0.3189
HSI does not Granger Cause FTSE FTSE does not Granger Cause HSI	2460	2.90500 0.74970	0.0549 0.4726
HSI does not Granger Cause DJIA DJIA does not Granger Cause HSI	2460	0.23528 0.25349	0.7904 0.7761
NIFTY does not Granger Cause DJIA DJIA does not Granger Cause NIFTY	2474	2.18403 0.28705	0.1128 0.7505
SENSEX does not Granger Cause DJIA DJIA does not Granger Cause SENSEX	2474	2.04544 0.32899	0.1295 0.7197
FTSE does not Granger Cause DJIA DJIA does not Granger Cause FTSE	2516	0.19263 1.16119	0.8248 0.3133

Overall, the Granger causality test results indicate that there is limited evidence of causal relationships among the different time series. However, some causal relationships do exist between certain pairs of time series, such as DJIA Granger causing SSE, NIFTY Granger causing HSI, and SENSEX Granger causing HSI.

JJ COINTEGRATION TEST:
Null hypothesis: There are no cointegrating relationships between the variables.
Alternative hypothesis: There are cointegrating relationships between the variables.

Variables	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical value
DJIA	None	0.020353	91.86137	103.8473
FTSE	At most 1	0.006098	41.97638	76.97277
HSI	At most 2	0.005106	27.13736	54.07904
NIFTY	At most 3	0.002960	14.71738	35.19275
SENSEX	At most 4	0.001832	7.526363	20.26184
SSE	At most 5	0.001268	3.078943	9.164546

The test statistic is compared to the critical values at the 5% significance level to determine whether to reject or fail to reject the null hypothesis. The JJ cointegration test results suggest that there is no evidence of cointegration among the variables at the 5% significance level.

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FINDINGS:

The NIFTY has a very strong negative correlation with the DJIA, indicating that they move in opposite directions almost all the time. The NIFTY has a weak positive correlation with the HSI, FTSE, and SSE, suggesting a weak positive relationship. The SENSEX has a strong negative correlation with the DJIA, indicating that they move in opposite directions. The SENSEX has a weak positive correlation with the HSI and FTSE, suggesting a weak positive relationship. The NIFTY has a very strong positive correlation with the SENSEX, implying that they move in the same direction almost all the time. Lastly, the SSE has a moderate positive correlation with the SENSEX, indicating a moderate positive relationship.

Based on these ADF test results, we can conclude that all six stock indices are likely stationary. The Granger causality test results indicate that there is limited evidence of causal relationships among the different time series. However, some causal relationships do exist between certain pairs of time series, such as DJIA Granger causing SSE, NIFTY Granger causing HSI, and SENSEX Granger causing HSI. The JJ cointegration test results suggest that there is no evidence of cointegration among the variables at the 5% significance level.

CONCLUSION:

In recent years, the Indian stock market has emerged as a significant player in the global economy, attracting the attention of investors worldwide. The study on the linkage between the Indian stock market and international markets reveals a high degree of co-movement and interdependence between the Indian stock market and global markets. The study highlights that movements in the US, Japanese, and Chinese markets have a significant impact on the Indian stock market, suggesting that Indian investors cannot operate in isolation from global economic developments.

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