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A Study of the Impact of Crude Oil Volatility on the Indian Economy and Global Indices

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ABSTRACT

Crude Oil has a major influence on the world economy. The price volatility of crude oil affects economies- and stock indices as an extension of that. This study aims to establish the impact of the price volatility of crude oil on the Indices of some Worlds major economies like India, China, Japan, South Korea, and the USA. These are the countries that depend on the most on imports of oil. This paper also explores the consequence of crude oil volatility on all the sectors of the Indian Economy like Realty, Metal, services, IT, etc. For this procedure, the GARCH (1, 1) model was used, coupled with an OLS regression model. The GARCH (1, 1) model is used to predict the conditional volatility of returns in financial markets, and the OLS Regression model is used to test and the impact of said volatility on the indices. The findings show that almost all the sectors in India be it banking, IT, media, etc. all faced a certain impact when the crude oil prices were volatile. This paper aims to determine and justify the extent of the said impact of crude oil on all the economies.

INTRODUCTION

Crude oil is the base for many products including fuel for transportation and electricity generation. Crude oil's by-products are used for essential products such as asphalt, fertilizer, and paraffin wax. Hence, crude oil is an essential part of every economy. Every economy is affected by the constant changes in the price of crude oil.

Many papers have studied the effects of crude oil on the economic situation. Many Indian companies rely on the price of crude oil being healthy. This includes tires, lubricants, shoes, refineries, and airlines. The profits of these companies are negatively affected by the high investment costs. This could affect stock prices. On the other hand, oil companies in the country may benefit from higher oil prices. One of the papers on how crude oil affected the inflation of an economy. Oil is a very important commodity, and it is needed to meet the needs of domestic fuel. And it is a necessary raw material used in several industries. Rising crude oil prices mean that this will increase production costs. This price hike will eventually be passed on to consumers which has led to inflation. The finding of a paper indicates that an increase of $ 10 / barrel on the price of crude oil could increase inflation by 10 points (0.1%). Oil prices affect transportation by 95%. That creates high food prices. It also contributes to 45% of industrial products and about 20% of residential use. As a result, higher oil prices increase the cost of everything you buy, resulting in lower inflation.

Oil prices have an impact on the U.S. economy but are moving in two directions due to industrial diversity. High oil prices can drive job creation and investment as it becomes economically viable for oil companies to use expensive shale deposits. However, high oil prices also hit businesses and consumers with high travel and production costs. Low oil prices are detrimental to the oil industry, but it also benefits production in other sectors where fuel costs are a major concern. (Ross, 2020)

This paper has a similar objective with the base in mind of how crude oil's price volatility affects the stock indices and sectors of the Indian economy. Indices taken for the analysis includes China's Shanghai Composite Index, the USA's S&P 500, Japan's NIKKEI 225, and South Korea's Korea Composite Stock Price Index. Apart from Nifty 50, 10 sectoral indices are included for analysis including Bank Nifty and Nifty Auto.

The secondary data collected is used for GARCH (Generalized Autoregressive Conditional Heteroskedasticity) and OLS Regression (Ordinary Least Squares Regression) for analysis.

It is important to understand the effects of the volatility of crude oil prices on the economy as it is one of the most traded international commodities and is used by every economy for various purposes.

LITERATURE REVIEW

Stock market volatility results from the change in stock market prices, which move as new information arrives, causing changes in the overall market settings. Researchers have developed techniques to measure and forecast volatility as it can help in predicting stock market returns and take directional views on the market. One of the developments in this regard is the construction of the volatility index, i.e., VIX. Volatility Index (VIX) measures stock market expectations of short-term volatility as conveyed by stock options prices. The objective of this paper is to determine how efficiently VIX measures volatility when compared to other models like EWMA, GARCH, EGARCH, etc. The study found GARCH to be an improvement over other models as it considers current volatility to be dependent on past volatility as well as reversion of this volatility to a mean value over time. He found that out of all the volatility models, GARCH (1, 1) was found to provide the best forecast. (Chopra)

Research on the interdependencies on financial and commodities markets has led to analyzing not only returns and volatility, but also their spillovers. Volatility spillovers are closely associated with market co-movements and this phenomenon becomes quite pronounced during crisis events when, usually, financial market volatility sharply increases and spills across markets. (Jozef Barunı´k, 2015)

The volatility spillover effect exists widely in different types of financial markets. It instigates the volatility conduction process from one financial market to another. The volatility spillover effect reflects the variable's second-moment relationship, in which market volatility is influenced not only by its early stage but also by volatility coming from other markets. (Han, 2015)

Rising crude oil price volatility in recent years has been a source of concern because of its possible negative impact on the general price levels and real output for large oil-consuming countries including the United States, Japan, and China. High crude oil prices, price volatility, and expected energy costs contribute at least in part to higher world food prices and may potentially curb economic growth in the fastest growing economies of the world. We find evidence that the behavior of crude oil prices and equity indexes while showing nonlinearities, is not consistent with chaotic structure. We identify variations of GARCH processes as the models that best explain the nonlinearities in these series. Therefore, we propose bivariate GARCH (1, 1) models to ascertain the flow of information and volatility spillovers between crude oil prices and equity indexes. (Bahram Adrangi, 2014)

This study was conducted by Tadahiro Nakajima. (Nakajima, 2019) To investigate the volatility spillover effects of prices of crude oil and its products on Japan's oil future market. First, this paper examines the transfer of risk between crude oil prices and the future oil market in Japan oil market. Second, it compares the performance of the two Granger causality tests using visual variability (RV) and the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model. The author estimates the daily RV of crude oil, paraffin, and gasoline listed on the Tokyo Commodity Exchange and assesses Granger's risk by differentiating between these variables using a vector autoregression

model. Also, the author estimates the EGARCH model based on daily data and Granger causality tests on differences between future assets of assets using Hong's method (2001). The results of the RV approach reveal that the perception that there is a mutual volatility spillover between crude oil and the petroleum products markets.

The study was conducted by Harnesh Makhija, P.S. Raghukumari (Raghukumari, 2016) and looks at the impact of crude oil prices on stock market indices, with data from June 2005 to July 2015 of Sensex (India) and SSE (China). A Variance Decomposition analysis was conducted on the output from Granger Causality Test to check for the aftermath. The outcome shows that in the short run, 0.97% fluctuation can be accounted for on Sensex by the change in oil prices and the same in long run was noted at 1.09%. Whereas in China, short-run shock on oil prices can cause a 3.21% fluctuation on SSE and 3.86% in long run. In conclusion, both countries witness a change in their respective indices from a shift in oil prices, but at a marginal rate. When the market is bullish for goods and services leading to an increase in production, transportation, and shipping activities, leading to an increase in oil consumption.

(Gargesha, 2018) Dr. S. Sathyanarayana and Prof. Sudhindra Gargesha conducted a study to find the effect of crude oil prices and other commodities on the Indian Stock Market. They studied the cause-and-effect relationship of the same with benchmark indices as Nifty 50 and BSE Sensex. The data in use was secondary taken over 17 years from January 1st, 2000 to March 31st, 2017. The initial phase tested the existence of stationarity by running the ADF test. In the second phase, they run descriptive statistics to look at the behavior of both the variables, followed by conducting a regression model to check the significance level. As crude oil is a basic commodity that every nation uses, it has a direct as well as an indirect effect on the economy. A rise in the price of crude oil impacts the energy prices causing a ripple down effect on virtually every aspect of the business. The tests showed that crude oil had a positive coefficient with the dependent variable (Sensex). This shows that they share a direct relationship with the index. Crude is also statistically significant at 0.01. Regression, when performed with Nifty as the dependent variable, shows similar results. Crude showed a positive direct relationship. The outcome of performing GARCH depicted crude as significant in the volatility of the dependent variables (indices).

(Jo, September 2014) The purpose of this paper was to investigate how oil price uncertainty affects global real economic activity between 1958 and 2008. This paper suggests that the oil price volatility has a significant negative impact on global real economic activity. High oil price volatility alone can significantly reduce global industrial production. The research found out that when doubling of oil price volatility is directly related to a significant decline in world industrial production of 0.4% annually.

(C.O. Mgbame, September 2015) This paper is in line with the works of various scholars who review that there is a significant relationship between oil price volatility and the economic growth of Nigeria. The research suggests that the oil price volatility helps in determining the government expenditure level, rate of inflation, level of unemployment which leads to determining Nigeria's economic growth. The paper also suggests that countries like Nigeria who depend heavily on imports for energy resources such as oil, etc. should look for alternative and more manageable sources of foreign exchange and government revenue to boost their country's economic growth.

(Amir Mansour Tehranchian, 2017) This paper investigates the impact of oil price volatility on the economic growth of Iran. The study used the time series data of the GDP of Iran and oil prices in Iran during 1980-2014 from the Central Bank of Iran. The oil price volatility data was generated using the GARCH method. The research found out the threshold value for oil price volatility using the TR method is 1147.77, and that the coefficient of oil price volatility reduces in the later part of the data as compared to the first. Thus, the coefficient of oil price volatility was reducing as the period increased. This indicated that the effectiveness of oil price volatility has decreased on economic growth over time.

The paper aims to determine the changes in stock prices due to changes in prices of crude oil. With the help of a different perspective, the paper considers linear and non-linear long-term relationships between oil prices and stock prices at the disaggregated sector level. The primary question is whether oil price changes affect sector stock prices equally. Sector sensitivity to oil prices will be different as some sectors are highly affected by oil prices than others. The industrial composition also takes place as large markets have diversified industries whereas small markets have concentrated industries. The paper also investigates the relationship between oil prices and stock markets post the Asian Financial Crisis to the Global economic crisis till 2008. The second half of the paper looks at how the oil price shock may affect the macroeconomic variables and stock prices. (Philippe Foulquier, 2011)

This paper studies crude oil price variations on the French and American stock market returns using daily observations of Brent crude oil prices, the CAC40, and the Dow Jones Industrial Average indexes from 1999 to 2012. There is strong evidence of fractional integration between oil and stock market indices suggesting that there is a presence of a relationship that governs their long-term price movements. The oil prices are determined by simple forces of supply and demand. The low price of oil in the year 2014 was due to the slower growth of the Chinese economy and the world trying to reduce carbon emissions reduced the oil demand and hence reduced the price. The policymakers make appropriate policies to reduce the impact of adverse oil price effects on production and economic activities, while investors can optimally design their diversification and hedging strategies, considering the oil price persistence patterns. (Heni Boubaker, 2016)

This paper determines the strength and extent of a causal relationship between BRICS (Brazil, Russia, India, China, and South Africa) stock returns and real oil price using the frequency domain approach of Breitung and Candelon. The quarterly data from the year 1998 to 2015 shows that the impact of oil price on the stock market is not uniform across all the nations of BRICS. Despite the slowly fluctuating components of oil price exert a significant influence on real stock returns in Brazil and Russia, medium and long-term hidden factors were found as potential contributors to the Chinese share market. The oil dependence profile, the distribution of market share between companies, the financial system efficiency, and the effectiveness of regulation in securities markets have been offered to explain the heterogeneous responses of the BRICS stock market. (Jamal Bouoiyour, 2016)

(Basel, 2020)'s research work showcases the volatility spillover among stock indices, international crude oil prices, and major stock returns of oil-importing countries. This is done by using the DCC-MGARCH model. The research paper shows that the interrelationship between all three components is different. The stock indices and the oil-importing countries have a higher correlation while the oil-exporting

countries have a higher correlation with the oil markets. Similarly, the correlation between the oil prices and the stock returns is also high.

(Manoj, 2019)'s work includes using the ARCH and GARCH models to study the comparative performance of Indian exchange rate fluctuations during volatility spillover from crude oil prices. They conducted the study for two periods, namely, UPA-2 (pre-Modi government) from 2009 to 2014 and the Modi government period from 2014 to 2019 to evaluate the performance of exchange rates during those periods. The study's conclusion states that the UPA-2 period was exposed to the GARCH effect due to volatility from crude oil price fluctuations, while the Modi government period was exposed to volatility from Indian terms of trade only.

(Anand, 2014)'s study in this research paper shows the international crude oil markets witnessing significant fluctuations and the fluctuations having ramifications on the economy. This paper attempts to model the volatility spillover from oil price returns to the returns of the Indian stock market. The research paper suggests that the fluctuations in the crude oil price returns exert a significant impact on the volatility of the stock market returns. They made use of the BEKK parameterization of the bivariate GARCH model and various tools of continuous wavelet analysis to understand the dynamics of volatility spillover between the two components, concluding that high-frequency components will be dominant in the oil price-stock market relationship.

OBJECTIVES

- To study the extent of the relationship, and the existing dynamic between crude oil price volatility and equity price indices.
- To explore the extent to which returns of market indices can be affected by oil prices.
- To predict future volatility in the equity indices and analyze the spillover effect from crude oil prices.
- To analyze the impact of crude oil price volatility on the various sectors of the Indian economy, and foreign economies, and the possible reasons for the same.

RESEARCH METHODOLOGY

DATA COLLECTION DETAILS

The data employed for this study is secondary and quantitative in nature and has been procured from online databases. For our analysis, we have taken historic 10- year daily closing values, from 1st March 2011 to 1st March 2021, for the following:

1. Crude Oil Prices
2. Country Wise Indices:

a) India-
- Nifty 50 Index
- Nifty Auto Index
- Nifty Bank Index
- Nifty Services Index
- Nifty FMCG Index
- Nifty IT Index
- Nifty Media Index
- Nifty Energy Index
- Nifty Pharma Index
- Nifty PSE Index
- Nifty Realty Index

b) China- Shanghai Composite Index or Shanghai Stock Exchange
c) USA- Standard & Poor's 500 Index or S&P 500 Index
d) Japan- Nikkei 225 Index
e) South Korea- Korea Composite Stock Price Index or KOSPI

The countries chosen are the 5 economies that import the most crude oil. All sectoral indices of the Indian economy were considered to gauge the impact of crude oil volatility on the different sectors of the economy- assuming the indices are accurate representations of the industry. For the remaining 4 countries, the major indices that are representative of the entire economy are considered for this study.

METHODS USED FOR ANALYSIS

GARCH (Generalized Autoregressive Conditional Heteroskedasticity):

GARCH is a statistical modeling technique used to help predict the volatility of returns on financial assets. It is appropriate for time series data where the variance of the error term is serially autocorrelated following an autoregressive moving average process. GARCH is useful to assess risk and expected returns for assets that exhibit clustered periods of volatility in returns. GARCH models can be used in the analysis of several different types of financial data, such as macroeconomic data, financial institutions typically use them to estimate the volatility of returns for stocks, bonds, and market indices. (Rasure, 2021)
In this paper, we have used the GARCH (1, 1) model i.e., the most widely used form of GARCH to predict our future volatility of the returns of both crude oil and our selected indices. This model states that current volatility is influenced by the value of our time series in the previous period, as well as the volatility of the previous period. The formula for GARCH (1, 1) is given below-

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad (1)$$

Where σ_t^2 is the conditional volatility, and ε_{t-1}^2 are squared unexpected returns for the previous period. ω would be positive always; and α and β would be non-negative (>=0). ε_{t-1}^2 are derived from a conditional mean equation that could be simple random walk model ($r_t = c + \varepsilon_t$), or AR (1) model ($r_t = c + \gamma * r_{t-1} + \varepsilon_t$), or any other ARMA model. But generally conditional mean equations are kept simple as it can cause convergence problems in GARCH estimation (Alexander, 2001). Where r_t is the returns from a financial series.

(Inani, 2016)

OLS Regression (Ordinary Least Squares Regression):
Ordinary least squares (OLS) regression is a statistical method of analysis that estimates the relationship between one or more independent variables and a dependent variable; the method estimates the relationship by minimizing the sum of the squares in the difference between the observed and predicted values of the dependent variable configured as a straight line. (Jr, 2019)

Regression is used in finance, investing, and other disciplines and attempts to determine the strength and character of the relationship between one dependent variable and a series of other variables (known as independent variables). The two basic types of regression are simple linear regression and multiple linear regression. There are non-linear regression methods for more complicated data and analysis. Simple linear regression uses one independent variable to explain or predict the outcome of the dependent variable Y, while multiple linear regression uses two or more independent variables to predict the outcome of the dependent variable Y. The general equation for simple linear regression (which is the form of regression employed in this study) is as follows:
Simple linear regression**:** Y = a + bX + u
Where:

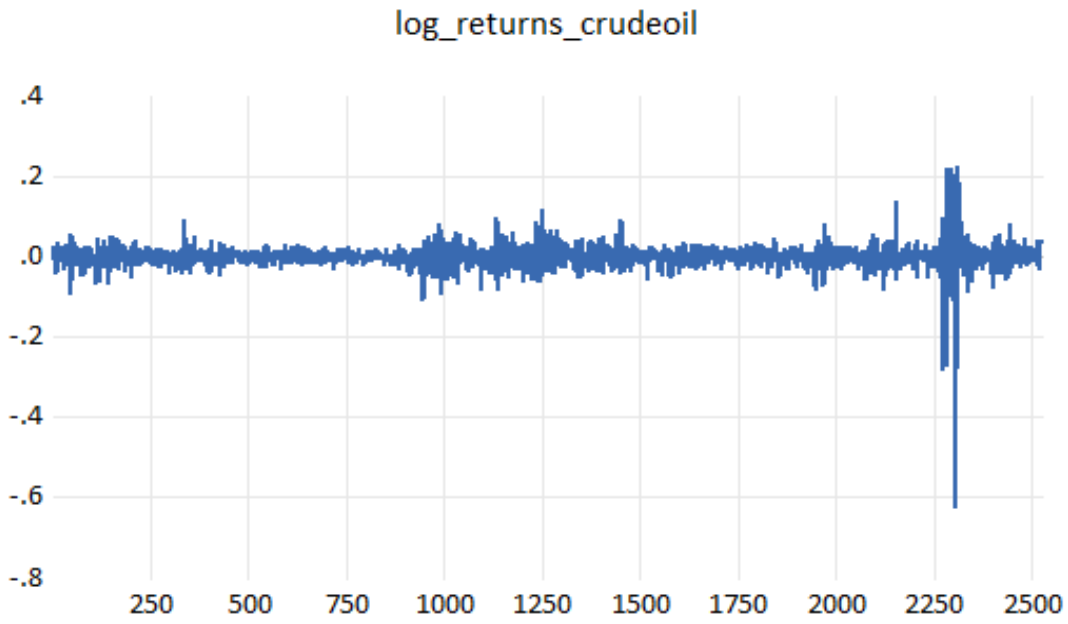
- Y = the variable that is being predicted i.e., the dependent variable.
- X = the variable that is used to predict Y, i.e., the independent variable.
- a = the intercept.
- b = the slope.
- u = the regression residual.

(Beers, 2020)

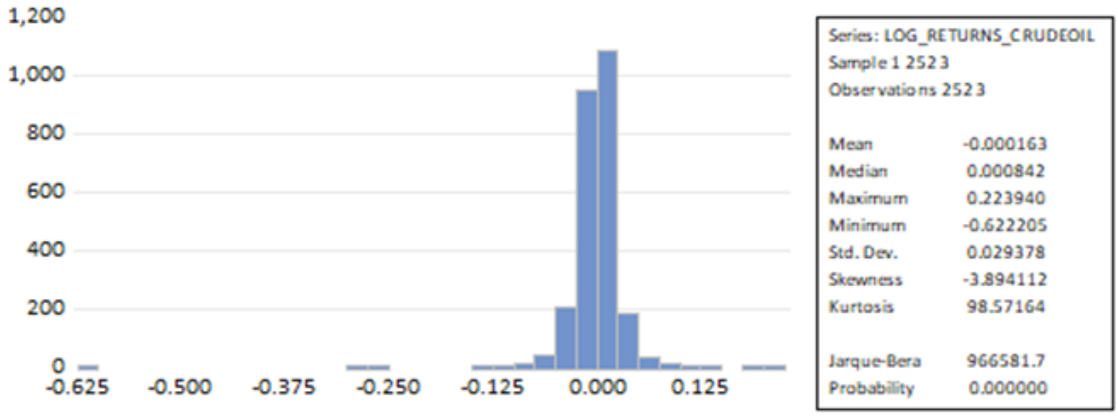
Here, the Y variable taken is the predicted volatility of the returns from the selected indices, and the X variable is the predicted volatility of the returns of crude oil prices, obtained by running the GARCH (1, 1) model on their log normal returns.

ANALYSIS PROCEDURE

i. On plotting the logarithmic returns of crude oil for visualization, instances of volatility clustering can be observed i.e., periods of large changes followed by large changes and periods of small changes followed by small changes. Hence, the data is suitable for running a GARCH (1, 1) Model.



ii. The data when plotted on a histogram, is leptokurtic and has fat tails (as is seen in most financial data).



From (i) and (ii), we can surmise that it is suitable to use the GARCH (1, 1) procedure on the selected data as it meets the criteria of the model.

All the data was gathered and cleaned- date formats were standardized for all sets of data. On this cleaned data, the logarithmic daily returns were calculated. These returns were then uploaded onto the EViews software, and the GARCH (1, 1) equation coefficients for all the separate sets of returns (for each of the indices and crude oil) were obtained.

These coefficients were then used to form the GARCH (1, 1) equation and to forecast the conditional volatility for all the indices and crude oil. The conditional volatility for each index was then matched with the conditional volatility of crude oil using the common dates.

An OLS Regression procedure was then run on these sets of conditional volatility, using the conditional volatility of crude oil as the independent (X) variable and the conditional volatility of the index as the dependent (Y) variable.

The effect of the volatility of crude oil on the volatility of all these indices was then studied through the obtained regression output.

HYPOTHESIS

H1: The volatility of crude oil prices has a significant effect on the volatility of a country's indices.

H0: The volatility of crude oil prices does not have a significant effect on the volatility of a country's indices.

DATA ANALYSIS

UNITED STATES OF AMERICA

The United States of America is one of the world's largest producers of crude oil; however, the domestic demand is always higher than the domestic supply and hence ends up importing the balance from various other countries. The total domestic demand has been on a rise for decades now and is expected to increase further. From 6.46 Million Barrels per day of domestic consumption across the nation in 1950, the current rate of consumption has increased by 4 times to 20.50 million barrels per day in 2019 (Oil and petroleum products explained, 2020). The price has also risen from $28.76 in Jan of 1950 to $65.61 in March of 2021 (Macrotrends, 2021). Hence, oil has always been a major expense to the country's economy.

S&P 500

Regression Analysis

OVERALL FIT			
Multiple R	0.5441	AIC	-39433.91
R Square	0.2961	AICc	-39433.9
Adjusted R Square	0.2958	SBC	-39422.25
Standard Error	0.0004		
Observations	2517		

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.0002	0.0002	1057.8102	0.0000	yes
Residual	2515	0.0004	0.0000			
Total	2516	0.0006				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0001	0.0000	8.5761	0.0000	0.0001	0.0001
Predicted Conditional Volatility_CrudeOil	0.0682	0.0021	32.5240	0.0000	0.0641	0.0724

The regression results show that 29.61% of the variability in the index can be explained by the model, as is shown by the R square value. With a P value of less than 0.05, it can be clearly stated that both the model and the coefficient are significant. Increased volatility in crude oil by 1% leads to an increase in volatility of the index by 6.82%. This can be justified as oil is a major expense in the domestic market. Almost all companies use crude oil directly or indirectly as either fuel or power, especially the

automotive and transport industry which happens to have a huge consumer base in the US. Hence every company gets affected by the volatility in the prices of crude oil. The same goes for the economy as the effect on its companies, in turn, affects the economy.

JAPAN

The Japanese economy is a heavy importer of all energy types and one of the world's largest energy consumers. Its domestic production meets less than 15% of its demand for primary energy use. It is the world's largest importer of liquefied natural gas (LNG), the second-largest coal importer, and the third-largest net crude oil importer. From 2011 through 2012 Japan lost around 10 of its nuclear power plants due to natural disasters and this resulted in a total import of fuel worth $250 billion, a third of its total imports in 2012. Currently, oil is the major energy carrier in Japan, as it consumes up to 4.7 million barrels per day. Studying the trends, crude oil consumption in Japan is a pro-cyclical variable. It means that an increase in gross domestic product (GDP) growth rate increases the oil consumption and a decrease in GDP has resulted in reduced oil consumption. (Taghizadeh-Hesary, 2015)

In the 21st century, due to the increase in foreign direct investment (FDI) from Japan to other Asian countries, industrial production moved from Japan to other countries, and ever since then, transportation has been the major consumer of crude oil. However, in recent years, due to the rise in the market share of electric vehicles (EVs) and hybrid cars and higher energy efficiency in Japanese automobiles, the demand for crude has decreased in that sector. The industrial sector has a negative demand slope for oil and the demand for oil for power generation has also decreased due to an increase in the use of LNG. In 2013, the Government of Japan and Bank of Japan set a target of 2% of the inflation rate. When prices of oil decrease, production becomes cheaper and the aggregate supply increases, and therefore prices decrease. Therefore, fluctuations in the prices of oil have a major impact on Japanese macroeconomic variables, including inflation. (Yoshino, 2016)

NIKKEI 225

Regression Analysis

OVERALL FIT	
Multiple R	0.5613
R Square	0.3150
Adjusted R Square	0.3148
Standard Error	0.0005
Observations	2476

AIC	-37843.843
AICc	-37843.834
SBC	-37832.215

ANOVA					Alpha	0.05
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.0003	0.0003	1137.8287	1.5E-205	yes
Residual	2474	0.0006	2.3003E-07			
Total	2475	0.0008				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0001	1E-05	12.8129	0.00	0.0001	0.0001
Predicted Conditional Volatility_CrudeOil	0.0919	0.0027	33.7317	0.00	0.0866	0.0972

The regression analysis shows that, out of the total volatility of the index, more than 31% of movements have been caused by volatility in crude oil prices. The understanding is this number is high considering the variety of sectors included in the index also along with the fact that the service sector takes up most of the index driving companies. The main sectors which impact both the Japanese economy, and the Nikkei 225 Index are retail, banking, insurance, and telecommunications which led to the high R square. Another prominent reason is that the impact of crude oil price fluctuations will be seen with the changes in the index, i.e., all the companies in all the sectors in the index will experience changes in their stock prices with the change in crude oil price. This is verified by the P-value of both regression equation and coefficient of regression is less than 5%. The regression results also show that an increase in volatility of crude oil by 1% will lead to an increase in the volatility of Nikkei 225 by 0.0919%.

SOUTH KOREA

South Korea is popular for its astounding ascent from perhaps the least fortunate country on the planet to a high-earning country in one generation. During the worldwide monetary emergency of 2007-2008, the nation kept a steady economy and experienced financial development. In any case, the South Korean economy is on target for one of its most noticeably awful two-year development periods in the greater part of a century, battered by China's monetary log jam and vulnerabilities over the exchange battle among Beijing and Washington, and the worldwide impacts of the COVID-19 pandemic. As per the IMF's estimate GDP development projections for South Korea to 3.1% in 2021 and 2.9% in 2022. (The economic context of South Korea, n.d.).

KOSPI

Regression Analysis

OVERALL FIT			
Multiple R	0.550597	AIC	-38910.9
R Square	0.303157	AICc	-38910.9
Adjusted R Square	0.302874	SBC	-38899.3
Standard Error	0.000372		
Observations	2464		

ANOVA				Alpha	0.05
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.000148	0.000148317	1071.078	2.3E-195	yes
Residual	2462	0.000341	1.38475E-07			
Total	2463	0.000489				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	7.2E-05	7.8E-06	9.226929371	0.00	5.67E-05	8.73E-05
Predicted Conditional Volatility_CrudeOil	0.070663	0.002159	32.72733045	0.00	0.066429	0.074896

After obtaining the results of the regression analysis, a significant relationship between the South Korean economy and the volatility in crude oil prices is noticeable. This is proven by the P-value of the regression equation and the coefficient of regression, both being less than 5%. A 1% increase in the volatility of crude oil prices can lead to a 0.0706% increase in the volatility of the South Korean economy. Approximately, 30% of the total volatility is explained by the model as shown by the R square value. This may be due to the country's dependency on crude oil. South Korea relies on imports to meet nearly all its fossil fuel consumption because of insufficient domestic resources. South Korea ranks among the world's top 5 importers of liquefied natural gas (LNG), coal, and total petroleum liquids. The country has no international oil or natural gas pipelines and relies exclusively on shipments of LNG and crude oil. Petroleum and other liquids, including derivatives of coal and natural gas, accounted for the largest portion (43%) of South Korea's primary energy consumption in 2019, however, the share has been declining since the mid-1990s. (South Korea, 2020)

CHINA

China is a major crude oil-producing nation in the world, but it became an importer of crude oil in 1993 for the first time in history as the demand for crude oil was increasing at a greater pace as compared to the domestic production of the nation. In 2002, the domestic crude oil production was 129.8 million

barrels while the consumption was 167 million barrels. In 2006, it imported 145 million tons of crude oil accounting for 47% of the consumption of the nation. In 2013, the pace of Chinese economic growth exceeded that of domestic oil capacity as the floods damaged the oil fields in the middle of the year which resulted in China importing more crude oil to cater to the demand for crude oil in the nation which made China surpass the USA in 2013 to become the world's largest importer of crude oil. By 2015, China was importing 6.7 million barrels of crude oil per day and was expected to overtake the USA as the world's biggest crude oil importer by 2016. (Petroleum industry in china, n.d.)

SSE Index

Regression Analysis

OVERALL FIT			
Multiple R	0.4747841	AIC	-34161.7
R Square	0.2254199	AICc	-34161.7
Adjusted R Square	0.2251014	SBC	-34150.1
Standard Error	0.0008956		
Observations	2434		

ANOVA					Alpha	0.05
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.000568	0.000567691	707.7657	4.3E-137	yes
Residual	2432	0.001951	8.02089E-07			
Total	2433	0.002518				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0001576	1.89E-05	8.360418123	0.00	0.000121	0.000195
Predicted Conditional Volatility_CrudeOil	0.1326061	0.004984	26.60386616	0.00	0.122832	0.14238

According to the regression analysis, a 1% increase in volatility of crude oil prices will lead to a 0.1326% increase in volatility of the Chinese economy (Shanghai Stock Exchange Composite Index). So, therefore, it can be said that the volatility in crude oil prices has a significant impact on China's economy which can further be confirmed by the P-value of both the regression equation and coefficient of regression which are less than 5%. Out of the total volatility of the index, 22.54% of it can be explained by the model as stated by the R Square value.

The reason for this kind of impact of volatility of crude oil prices on the Chinese economy can be due to their massive consumption of crude oil. And China is the manufacturing hub of the world that requires crude oil to produce various products and thus whenever the price of crude oil increases or decreases the Chinese economy gets affected.

INDIA

The Indian economy is heavily dependent on imports of crude oil with an 82.8% import dependence on the commodity. India imports 3 million barrels of crude oil per day and 1.5 billion barrels of crude oil each year. A rise in crude oil prices by $10 per barrel could lead to an increase of $2.5 billion in fuel subsidies. The surge in crude oil prices could increase India's expenditure, thus adversely affecting India's fiscal deficit. The fall in crude oil prices was a major contributing factor in the reduction of India's fiscal deficit between 2014 and 2016. (6 Effects of Rising Crude Oil Prices On The Indian Economy, n.d.). Another impact of changing crude oil prices is domestic inflation. First, the direct channel where crude products themselves appear as constituents in the CPI. In the short run, a change in prices of crude products will affect the CPI directly due to their weighted contribution to the index. Second, over time the retail prices of all other commodities manufactured using crude as an input will also increase due to this shock and in turn affect the CPI again, which is the indirect effect. (Ankit Gohel, 2021). A lot of Indian companies depend on healthy crude oil prices. This includes tires, lubricants, and footwear, refining, and airline companies. The profitability of these companies is adversely affected due to higher input costs. This could negatively impact stock prices in the near term. On the other hand, oil exploration companies in the country could greatly benefit from a rise in oil prices. (6 Effects of Rising Crude Oil Prices On The Indian Economy, n.d.). A fall in crude oil prices is perceived to be a positive for the Indian economy as well as stock markets. The relationship between the Sensex and crude has mostly been inversely proportional. Eight out of ten times when crude has fallen by more than 20%, Indian stock markets have offered average returns of 19% in the following six months. (Rajesh Mascarenhas, 2020)

NIFTY 50

Regression Analysis

OVERALL FIT	
Multiple R	0.6021
R Square	0.3626
Adjusted R Square	0.3623
Standard Error	0.0004
Observations	2475

AIC	-38386.89
AICc	-38386.88
SBC	-38375.27

ANOVA					Alpha	0.05
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.0003	0.0003	1406.6978	0.0000	yes
Residual	2473	0.0005	0.0000			
Total	2474	0.0007				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0001	0.0000	8.4447	0.0000	0.0001	0.0001
Predicted Conditional Volatility_CrudeOil	0.0900	0.0024	37.5060	0.0000	0.0853	0.0947

The regression results show that volatility in crude oil prices will have a significant impact on the benchmark index i.e., all the sectors in the Indian economy will also experience changes in the volatility of their share prices. This is confirmed by the P-value of both the regression equation and the coefficient of regression being below 5%. The regression results also show that an increase in volatility of crude oil by 1% will lead to an increase in the volatility of NIFTY 50 by 0.090%. Out of the total volatility of the index, 36% of it can be explained by the model as is shown by the R square value. The reason for this degree of impact could be that the index comprises industries like Transportation, Plastics, and Chemicals that are heavily dependent on crude oil as an input. When prices of crude oil go up or down, it significantly drives their input costs, which affects their financial performance, and hence their share prices. Hence, they are subject to volatility due to changes in the volatility of oil prices. There is also the factor of the import dependency of the economy on the crude oil commodity.

AUTOMOTIVE SECTOR

The Automobile industry in India is currently worth $118 billion & is expected to reach $300 million by 2026. India's annual production has increased 6.26% in 2019 as compared to that of 2018. In 2018-2019, the overall Commercial Vehicle segment registered a growth of 17.55%. The Automobile sector contributes 7% of India's total GDP which makes it a significant sector in the nation. This sector also contributes to 4.3% of the total exports of the nation. India holds a strong position in the international heavy vehicles market as it is the largest producer of the tractor, second-largest bus manufacturer & third-largest heavy trucks manufacturer in the world. This sector generates 35 million jobs in the nation. And as the Electronic Vehicle market is emerging in the nation, it is expected that the EV market in the nation will grow at a CAGR of 44% in 2020-2027 will create Rs. 5 crore direct and indirect jobs in the nation by the year 2030 (Automobile sector, n.d.).

NIFTY Auto

Regression Analysis

OVERALL FIT			
Multiple R	0.219405	AIC	-35183
R Square	0.048139	AICc	-35183
Adjusted R Square	0.047739	SBC	-35171.5
Standard Error	0.000624		
Observations	2384		

ANOVA				s	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	4.69E-05	4.69022E-05	120.4655	2.24E-27	yes
Residual	2382	0.000927	3.89341E-07			
Total	2383	0.000974				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.000207	1.32E-05	15.5996222	0.00	0.000181	0.000233
Predicted Conditional Volatility_CrudeOil	0.04267	0.003888	10.97567843	0.00	0.035047	0.050294

The regression analysis shows that a 1% increase in volatility of crude oil prices will lead to a 0.0427% increase in volatility of the Automobile sector of India. The P-value of the regression equation and coefficient of regression it is seen that both the values are less than 5% which indicates a significant impact of volatility of crude oil prices on the volatility of the Automobile sector. Out of the total volatility, 4.8% can be explained by the model as stated by the R Square value. A 1% increase in volatility of crude oil prices leads to a 0.0427% increase in volatility of the Automobile sector. This kind of impact of volatility of crude oil prices on the Automobile sector is since petrol/diesel are petroleum-based products and a slight change in the price of crude oil affects the prices of petrol/diesel which consequently affects the automobile sector as these gasoline products are used in cars and two-wheelers Long term changes in prices can either encourage or dissuade consumers to either prepone or postpone their automobile purchases. However, demand for certain industrial automobiles remains constant as they are necessary. The automobile sector also includes ancillary industries like parts and tools that are unaffected by crude oil prices. Hence the impact, though significant is not great in magnitude.

PHARMACEUTICAL SECTOR

India is a prominent and rapidly growing presence in global pharmaceuticals. It is the largest provider of generic medicines globally, occupying a 20% share in global supply by volume, and also supplies 62% of global demand for vaccines. India ranks 3rd worldwide for production by volume and 14th by value. India is the only country with the largest number of US-FDA compliant Pharmaceutical plants (more

than 262 including APIs) outside of the USA. India has more than 2000 WHO-GMP-approved Pharmaceutical Plants, 253 European Directorate of Quality Medicines (EDQM) approved plants with modern state-of-the-art technology. India is the source of 60,000 generic brands across 60 therapeutic categories and manufactures more than 500 different Active Pharmaceutical Ingredients (APIs). The API industry is ranked third largest in the world contributing 57% of APIs to prequalified list of the WHO. The country is home to more than 3,000 pharmaceutical companies with a strong network of over 10,500 manufacturing facilities. The domestic pharmaceuticals market turnover reached $20.03 billion in 2019, up 9.3% from 2018, growing as penetration of health insurance and pharmacies rise. (Pharmaceuticals, n.d.)

Government sources say that expenditure on medicines in India will grow at least 9 to 12% in the next five years or say, making India one of the top 10 countries in terms of medical spending. That places a lot of responsibility on all the stakeholders; private pharmaceutical companies, the government, regulators, and international cooperation to maintain the general health of the public. The future of the industry depends on the medical infrastructure's ability to fight against chronic diseases and any other challenges that the industry is faced with. (An Overview of the Pharma Industry in India, 2020)

NIFTY Pharma

Regression Analysis

OVERALL FIT			
Multiple R	0.508092	AIC	-37023.3
R Square	0.258158	AICc	-37023.3
Adjusted R Square	0.257858	SBC	-37011.6
Standard Error	0.000566		
Observations	2476		

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.000276	0.000275854	860.94	1.2E-162	yes
Residual	2474	0.000793	3.20411E-07			
Total	2475	0.001069				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.000126	0.00	10.6705906	0.0000	0.000103	0.000149
Predicted Conditional Volatility_CrudeOil	0.093013	0.00	29.34177855	0.0000	0.086797	0.09923

According to regression output, a 1% increase in volatility of crude oil prices leads to a 0.0930% increase in the volatility of the pharmaceutical sector of the country. There is a significant impact of volatility of crude oil prices on the Indian pharmaceutical sector as the P values of both the regression

equation as well as the coefficient of regression as both the values are less than 5%. Out of the total volatility, 25.81% can be explained by the regression model as stated by the R Square value. This impact of volatility of crude oil prices on the Indian pharmaceutical sector is because most pharmaceutical drugs are made via chemicals that involve the use of organic molecules. Crude oil is a major input for the drug synthesis process. So, the prices of crude oil directly affect the pharmaceutical sector as it is the input required in the manufacturing process for the drug and for the packaging it comes in (which is mostly plastic- made of oil byproducts) which contributes to rising prices of the medicine and directly affects firm performance. (Nandita Vijay, 2021)

BANKING SECTOR

Bank Nifty, or Nifty Bank, launched in 2003, comprises India's 12 of the most liquid and large capitalized banking stocks. This captures the performance of the capital market of India and Indian banking stocks. The banking sector is an industry and is an economic sector dedicated to managing the assets of others and investing those assets as a means of building more wealth. This category includes the regulation of banking activities by government agencies, insurance, loans, investor services, and credit cards (Saghal, 2016).

NIFTY Bank

Regression Analysis

OVERALL FIT	
Multiple R	0.6093
R Square	0.3713
Adjusted R Square	0.3710
Standard Error	0.0007
Observations	2476

AIC	-35793.61
AICc	-35793.6
SBC	-35781.98

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.0008	0.0008	1460.9195	0.0000	yes
Residual	2474	0.0013	0.0000			
Total	2475	0.0021				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0002	0.0000	11.7252	0.0000	0.0001	0.0002
Predicted Conditional Volatility_CrudeOil	0.1553	0.0041	38.2220	0.0000	0.1473	0.1633

The regression output shows that 37.13% of the volatility in the index can be explained by the volatility of crude oil, as per the R square value. A positive relationship can be seen between the index and the crude oil volatility significantly by the P-Value of the regression equation and coefficient of regression being less than 5%. Increased volatility in crude oil leads to an increase in volatility of the index by 0.1553%. Global crude oil prices play a significant role in determining the level of inflation in India since fuel is an important item in the national consumption basket. A sustained movement of crude oil prices in a particular direction impacts inflation accordingly. I.e., if crude oil prices rise sustainably for over a month, there is a rise in inflation. This is because of - a direct impact on fuel price rise, which has about 10% weight in wholesale price inflation, and a second-round and third-round impact on prices since many sectors are dependent on crude oil as an important input. A sustained drop in crude oil prices results in lower inflation in the country. Since the central bank's main mandate is to control inflation at a pre-decided level, it does so mainly through the repo rate or the rate at which it lends money to commercial banks in the event of any shortfall of funds. It needs to factor in crude oil prices while setting interest rates due to the linkage of crude oil prices with inflation. The repo rate dictates the intensity with which people in a country will take loans. This means with an increase in the repo rate increases the cost of funds for banks affecting their profits. Hence, crude oil has a direct impact on the performance of the banking industry. (Here's how global crude oil prices impact your EMIs, 17)

REALTY SECTOR

The Indian Realty sector is one of the most globally recognized sectors and it consists of four sub-sectors – housing, retail, hospitality, and commercial. It is expected that it will reach a market capitalization of $1 trillion by 2030 and contribute up to 13% to the country's GDP by 2025. The construction sector has the third-largest foreign direct investment (FDI) inflow in the country. The Government of India has been encouraging the growth of the realty sector. The promotion of smart cities, affordable housing for all, and Atmanirbhar Bharat has immensely increased the growth of the realty sector. Along with this, SEBI has given its approval for Real Estate Investment Trusts (REITs) which will invite all kinds of investors and help reach a $1.25 trillion market size.

NIFTY Realty

Regression Analysis

OVERALL FIT			
Multiple R	0.4851	AIC	-35922.1
R Square	0.2353	AICc	-35922.1
Adjusted R Square	0.2350	SBC	-35910.5
Standard Error	0.0007		
Observations	2476		

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.0004	0.0004	761.2702	2.5E-146	yes
Residual	2474	0.0012	4.99865E-07			
Total	2475	0.0016				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0004	0.00	26.1844	0.00	0.0004	0.0004
Predicted Conditional Volatility_CrudeC	0.1092	0.00	27.5911	0.00	0.1015	0.1170

The realty sector has a significant impact from the changes in prices of crude oil, as the P-value of both regression equation and coefficient of regression is less than 5%. It shows that an increase in volatility of crude oil by 1% will lead to an increase in the volatility of realty stocks by 0.1092%. 23% of the variation in the realty index can be explained by volatility in crude oil prices as per the R square value. As Oil Prices go up, real estate prices go up. This is caused primarily because an increase in Real Oil prices results in more profits for oil companies, which attract more investments in the city, which increase jobs, which increase migration into the city and thus effectively increase the demand for housing and vice versa. Oil prices also affect housing prices directly. This can be explained because an increase in oil prices would generate prosperity and wealth. This increases the consumer's ability to buy housing or upgrade their current house. Oil prices also affect housing prices directly. (Padilla, 2005)

FAST-MOVING CONSUMER GOODS SECTOR

The FMCG sector is India's fourth-largest sector with personal and household care accounting for more than 50% of FMCG sales. The urban segment has been the larger contributor however, in recent years the rural sector has grown at a faster pace than the urban sector. The retail market in India is estimated to

reach $1.1 billion in the year 2020 and has been growing at a rapid pace of 20-25% and is expected to grow at the same pace. The Government of India has allowed 100% FDI in food processing and single-brand retail and 51% FDI in multi-brand retail. The unorganized sector in FMCG is falling and the organized sector is rising and an estimated 40% consumption of FMCG goods is expected to move online. (FMCG Industry in India, 2021)

NIFTY FMCG

Regression Analysis

OVERALL FIT

Multiple R	0.2526	AIC	-45965.6
R Square	0.0638	AICc	-45965.6
Adjusted R Square	0.0634	SBC	-45954
Standard Error	9.3E-05		
Observations	2476		

ANOVA Alpha 0.05

	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	1.46E-06	1.45967E-06	168.6763	2.33E-37	yes
Residual	2474	2.14E-05	8.65368E-09			
Total	2475	2.29E-05				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	3.93E-05	1.94E-06	20.2601	0.00	3.55E-05	4.31E-05
Predicted Conditional Volatility_CrudeC	0.0068	0.0005	12.9875	0.00	0.0057	0.0078

The regression shows that crude oil prices significantly impact the prices of FMCG companies as the P-value of both the regression equation and coefficient of regression are less than 5%. The model also shows that increase in volatility of oil prices by 1% will affect the FMCG stock prices by 0.0066%. Out of the total volatility in the index 6.4% can be estimated from the movements in crude oil prices as seen by the R square value. This is because of the nature of FMCG goods. They are essentials to every home and their purchase does not depend on oil prices. Hence, the volatility of FMCG stocks is largely immune to the volatility of crude oil. However, sometimes, when the prices of crude oil rally drastically, the crude by-products which are used in the FMCG sector also rise which increases the price of input costs and therefore a rise in the price of FMCG goods. A rise in input prices results in FMCG companies spending less on advertisements and promotion which is a big market capturing the event for them.

SERVICES SECTOR

India's services sector covers a wide variety of activities such as trade, hotel and restaurants, transport, storage and communication, financing, insurance, real estate, business services, community, social and personal services, and services associated with construction. The services sector is a key driver of India's economic growth. The Government of India recognizes the importance of promoting growth in the services sector and provides several incentives across a wide variety of sectors like health care, tourism, education, engineering, communications, transportation, information technology, banking, finance, and management, among others. Under the Mid-Term Review of Foreign Trade Policy (2015-20), the Central Government increased incentives provided under the Services Exports from India Scheme (SEIS) by 2%. (Services Sector in India, 2021)

NIFTY Services

Regression Analysis

OVERALL FIT			
Multiple R	0.618288	AIC	-37668.4
R Square	0.38228	AICc	-37668.3
Adjusted R Square	0.38203	SBC	-37656.7
Standard Error	0.000497		
Observations	2476		

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.000378	0.000378048	1531.049	4.2E-261	yes
Residual	2474	0.000611	2.46921E-07			
Total	2475	0.000989				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	9.13E-05	1.04E-05	8.802203472	0.00	7.09E-05	0.000112
Predicted Conditional Volatility_CrudeOil	0.108888	0.002783	39.12862142	0.00	0.103431	0.114345

The regression equation and the coefficient of regression have a P value of less than 5%, implying that there is a significant relationship between the volatility of crude oil prices and the volatility of stock prices of service sector companies. A 1% increase in the volatility of crude oil prices can lead to a 0.1088% increase in the volatility of the NIFTY Service Index. The R square value suggests that out of the total volatility of the index, 38% of it can be explained by the model. Oil prices affect the economy because of their use in the transportation of goods and services. A rise in oil prices leads to an increase in the prices of all goods and services. (5 ways falling oil prices affect India, n.d.). The prices of energy-intensive goods and services are linked to energy prices, of which oil commands the single most important share. (Kar, 2017). The oil industry in India is not only relegated to upstream exploration, but also to midstream services (processing, storing, transporting, and marketing of oil, natural gas, and

natural gas liquids). And downstream services (refining crude oil into gasoline, natural gas liquids, diesel, and a variety of other energy sources). (Beattie, 2021).

INFORMATION TECHNOLOGY SECTOR

The global sourcing market in India continues to grow at a higher pace compared to the IT-BPM industry. India is the leading sourcing destination across the world, accounting for a 55% market share of the US$ 200-250 billion global services sourcing business in 2019-20. Indian IT & BPM companies have set up over 1,000 global delivery centers in about 80 countries across the world. India has become the digital capabilities hub of the world with around 75% of global digital talent present in the country. Indian IT's core competencies and strengths have attracted significant investment from major countries. The sector ranked 2nd in FDI inflows as per the data released by the Department for Promotion of Industry and Internal Trade (DPIIT). Leading Indian IT firms like Infosys, Wipro, TCS, and Tech Mahindra are diversifying their offerings and highlighting leading ideas in the blockchain and artificial intelligence to clients using innovation hubs and research and development centers to create differentiated offerings. (IT & BPM Industry in India, 2021)

NIFTY IT

Regression Analysis

OVERALL FIT			
Multiple R	0.511238	AIC	-39024.8
R Square	0.261364	AICc	-39024.8
Adjusted R Square	0.261066	SBC	-39013.1
Standard Error	0.000378		
Observations	2476		

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.000125	0.000124985	875.4182	5.6E-165	yes
Residual	2474	0.000353	1.42772E-07			
Total	2475	0.000478				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.000141	7.89E-06	17.82349587	0.00	0.000125	0.000156
Predicted Conditional Volatility_CrudeOil	0.062609	0.002116	29.58746619	0.00	0.058459	0.066758

These regression results show a significant relationship between the volatility of crude oil prices and the volatility NIFTY IT Index due to the regression equation and coefficient of regression being less than 5%. A 1% increase in the volatility of crude oil prices leads to a 0.063% increase in the volatility of the NIFTY IT Index. Also, out of the total volatility, 26% of it can be explained by the model, meaning that the companies in the IT sector are dependent on the prices of crude oil. Since the companies under the IT sector provide software and hardware solutions to oil producers, a fall in the prices of crude oil will lower the oil exploration companies' IT expenditure. Companies like Infosys, TCS, and L&T will suffer a huge reduction in their profit margin if the crude oil prices decrease.

MEDIA SECTOR

The Indian Media & Entertainment industry is projected to grow at a pace of 14% over the period 2016-2021, outshining the global average of 4.2% CAGR, with advertising revenue expected to increase at a compounded Annual Growth Rate (CAGR) of 15.3% during the same period. (The Global Entertainer, 2021). The Indian M&E industry is on an impressive growth path. The industry is expected to grow at a much faster rate than the global average rate. The GOI (Government of India) also increased the FDI limit from 74% to 100%. They have also introduced the National Digital Communications Policy 2018 for affordable digital communications infrastructure and services. Growth is expected in retail advertisement on the back of several players entering the food and beverages segment, E-commerce gaining more popularity in the country, and domestic companies testing out the waters. The rural region is also a potentially profitable target. (Media and Entertainment, 2020)

NIFTY Media

Regression Analysis

OVERALL FIT			
Multiple R	0.111395	AIC	-33943.8
R Square	0.012409	AICc	-33943.7
Adjusted R Square	0.011991	SBC	-33932.2
Standard Error	0.000769		
Observations	2367		

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	1.76E-05	1.75652E-05	29.71543	5.52E-08	yes
Residual	2365	0.001398	5.91115E-07			
Total	2366	0.001416				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.000305	1.64E-05	18.61450106	0.00	0.000273	0.000337
Predicted Conditional Volatility_CrudeOil	0.026116	0.004791	5.451185663	0.00	0.016721	0.03551

The regression analysis results show that volatility on crude oil prices will have a significant effect on the volatility of the stocks of media companies. I.e., their relationship is significant. This is confirmed by the P-value of the model is less than 5%. The coefficient estimate is also significant in the same regard. It shows that an increase in volatility of crude oil by 1% will lead to an increase in the volatility of media stocks by 0.0261%. Out of the total volatility in the index, only 1.2% of it can be explained by the model, as shown by the R square value. The reason could be that the Indian media industry is not very dependent on crude oil. The growth and performance of the industry are dependent on Foreign Direct Investments, tie-ups and collaborations with international brands, and the growing virtual presence of the industry- with online gaming and streaming. Accounting for 80% of the revenue of the sector, the online gaming segment will drive enormous engagement and another addition of another 100 million smartphones and continued conversion of 2G and 3G connections to 4G will drive a 3X growth in this segment by 2022. (The Global Entertainer, 2021)

POWER & ENERGY SECTOR

Power is among the most critical component of infrastructure, economic growth, and the welfare of nations. The existence and development of adequate infrastructure are essential for the sustained growth of the Indian economy. India's power sector is one of the most diversified in the world. Sources of power generation range from conventional sources such as coal, lignite, natural gas, oil, hydro, and nuclear power to viable non-conventional sources such as wind, solar, and agricultural and domestic waste. In 2018, in the Asia Pacific region out of 25 nations on an index that measured their overall power, India ranked fourth in wind power, fifth in solar power and fifth in renewable power installed capacity. India ranked sixth in the list of countries to make significant investments in clean energy at US$ 90 billion. India is the only country among the G20 nations that are on track to achieve the targets under the Paris Agreement. The Indian power sector is undergoing a notable change that has redefined the industry outlook. Sustained economic growth continues to drive electricity demand in India. (Power Sector in India, 2021)

NIFTY Energy

Regression Analysis

OVERALL FIT	
Multiple R	0.5353
R Square	0.2865
Adjusted R Square	0.2862
Standard Error	0.0004
Observations	2476

AIC	-38237.6
AICc	-38237.6
SBC	-38226

ANOVA					Alpha	0.05
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.0002	0.0002	993.4006	0.0000	yes
Residual	2474	0.0005	0.0000			
Total	2475	0.0007				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0001	0.0000	14.3616	0.0000	0.0001	0.0002
Predicted Conditional Volatility_CrudeOil	0.0782	0.0025	31.5183	0.0000	0.0733	0.0830

The regression results show that both the folded F test and the regression coefficient have a P value of less than 5 %. This indicates that both the model and the coefficient of the X variable are significant. The volatility of crude oil prices can significantly affect the volatility of the NIFTY Energy Index. An increase in volatility of crude oil prices of 1% will lead to an increase in volatility of the NIFTY Energy Index by 0.078%. Out of the total volatility of the Index, 28.65% of it can be explained by the model as is shown by the R square value.

Though India depends a lot on imports of crude oil for its industrial growth and expansion, the energy sector does not depend too much on the commodity as an input. As of 2021, only 6.6% of the total energy output was generated using crude oil and has never exceeded 10% in prior years. There is a heavier dependency on coal, hydropower, and other renewable energy sources like Small Hydro Project, Biomass Gasifier, Biomass Power, Urban & Industrial Waste Power, Solar, and Wind Energy. As a country, our dependence on crude oil for energy generation has been reducing over the years as the government is attempting to switch to more environmentally friendly alternatives. (IBEF, 2021). Hence, the impact of volatility in crude oil on the NIFTY Energy Index, though significant, is smaller in magnitude. While crude prices do have a strong correlation with gas prices, they also indirectly impact the trend in coal prices, being alternative sources of energy for several applications. With declining crude prices, international coal prices have also remained subdued. (ICRA- Petrofed, 2016)

PUBLIC SECTOR ENTERPRISES SECTOR

In India, a public sector enterprise (PSE) is a company in which the Union Government or State Government, or any Territorial Government owns a share of 51 % or more. Currently, there are just three sectors left reserved only for the government i.e., Railways, Atomic energy, and explosive material. Private sectors/players are not allowed to operate in these sectors. Some public sector enterprises were started specifically to produce goods that were formerly imported and thus to save foreign exchange. The Hindustan Antibiotics Ltd., the Indian Drugs and Pharmaceuticals Ltd. (IDPL), the Oil and Natural Gas Commission (ONGC), the Indian Oil Corporation Ltd., the Bharat Electronics Ltd., etc., have saved foreign exchange by way of import substitution. (Singh, 2016)

Public enterprises in India constitute a major National capability in terms of their scale of operations, coverage of the national economy, technological capabilities, and stock of human capital. They include departmental undertakings (e.g., railways, post and telecommunications, financial institutions, and non-departmental enterprises or government companies or corporations which are either incorporated under the Company Law (e.g., the Steel Authority of India and the Indian Petrochemical Corporation Ltd.) or statutorily created by Acts of Parliament (e.g., Coal India, Air India, Indian Airlines, and the National Thermal Power Corporation). As far as the share in national production is concerned, public sector enterprises play a pivotal role in the production of fuels, basic metal industries, non-ferrous metal industries, fertilizers, and communication equipment. They contribute the entire output in the case of petroleum, lignite, copper and primary lead, zinc, coal, aluminum, and fertilizers. (S, n.d.). Producers Oil and Natural Gas Corp (ONGC) and Oil India Ltd NSE -0.42 % as well as gas utility GAIL NSE -3.10 % were in past asked to bear between one-third to half of the under-recovery fuel retailers incurred on selling LPG and kerosene below market rate. (Government may ask oil companies to share LPG, kerosene subsidy burden, 2018)

NIFTY PSE

Regression Analysis

OVERALL FIT	
Multiple R	0.5283
R Square	0.2791
Adjusted R Square	0.2788
Standard Error	0.0005
Observations	2476

AIC	-38079.1
AICc	-38079.1
SBC	-38067.5

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.0002	0.0002	957.6965	0.0000	yes
Residual	2474	0.0005	0.0000			
Total	2475	0.0007				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0001	0.0000	13.2204	0.0000	0.0001	0.0001
Predicted Conditional Volatility_CrudeOil	0.0793	0.0026	30.9467	0.0000	0.0742	0.0843

The regression output shows that both the folded F test and the regression coefficient have a P value of below 5%. This implies that both the model as well as the relationship between the two variables is significant. A 1% increase in volatility in crude oil will lead to a 0.079% increase in volatility of the NIFTY PSE Index. Out of the total volatility of the index, 27.91% of it can be explained by the model, as is shown by the R square value. This can be attributed to the fact that most companies listed on NSE PSE belong to the oil exploration sector, oil refining, energy generation, and metals. They do depend on oil imports. However, the nature of the industries, being public, are safe to shocks in oil prices. Hence it does not affect their performance to a colossal extent. These companies also provide subsidies on fuels to keep their prices low, hence reducing the impact they face from such shocks as their revenue and sales remain constant.

METALS SECTOR

The Indian Mining sector contributes around 3% and the steel sector is contributing 2% of the GDP (Gross Domestic Product) and employs over 15 lakh people. A rapid rise in steel production has resulted in India becoming the 4th largest producer of crude steel and the largest producer of sponge iron in the world. For global players, India is a big market for mineral resources, as metals and power demand are expected to have robust growth in the long term. The country is endowed with huge resources of many metallic and non-metallic minerals. The mining sector is an important segment of the Indian economy. Since independence, there has been a pronounced growth in mineral production both in terms of quantity

and value. India produces as many as 87 minerals, which includes 4 fuel, 10 metallic, and 47 non-metallic, 3 atomic, and 23 minor minerals. (Sector: Minerals & Metals, 2021)

NIFTY Metals

Regression Analysis

OVERALL FIT	
Multiple R	0.1237
R Square	0.0153
Adjusted R Square	0.0149
Standard Error	0.0008
Observations	2384

AIC	-33716.2
AICc	-33716.2
SBC	-33704.7

ANOVA				Alpha	0.05	
	df	*SS*	*MS*	*F*	*p-value*	*sig*
Regression	1	0.0000	0.0000	37.0117	0.0000	yes
Residual	2382	0.0017	0.0000			
Total	2383	0.0017				

	coeff	*std err*	*t stat*	*p-value*	*lower*	*upper*
Intercept	0.0004	0.0000	20.2270	0.0000	0.0003	0.0004
Predicted Conditional Volatility_CrudeOil	0.0322	0.0053	6.0837	0.0000	0.0218	0.0425

The results of the regression are unexpected, given the direct relationship of metals and crude oil, as the R-Square shows that only 1.53% of the total volatility Nifty Metal can be accounted for by the model. However, the P-Value of the regression equation signifies that the movement is still significant and cannot be completely discarded. The coefficient of regression is less than 0.05. The analysis predicts a positive relationship in the movement of variables as an increase in volatility of crude oil leads to an increase in volatility of Nifty Metals by 0.0322%. According to studies conducted on the metal industry in India, there exists moderate co-movement between WTI crude oil and the Indian metal market. The reason for the co-movement of the metals market with the WTI crude oil market is due to a strong dependency on crude oil in the production process of metal. Metal extraction is a complex process and requires high energy input; hence the change in oil prices has a direct impact once metal index prices. Precious metals gold and silver do not show either upward or downward trend even in the global financial crisis 2008–2009, while industrial metals aluminum, copper, and zinc are weakly correlated to crude oil prices. (Kaushik, 2018). The low volatility in the metals industry caused by volatility in crude oil prices could be attributed to a few reasons- The fact that the metals sector is strategic and is protected by the government of India. The industry is also core to the functioning of the economy and is indispensable as it is crucial for military, industrial, or commercial purposes that are essential to the economy, defense, medicine, infrastructure, etc. (Strategic & Critical Metals, n.d.)

FINDINGS

The findings of the study are detailed below:

Country	Regression Coefficient	Significance of coefficient
China	0.132606055	Significant
Japan	0.091898213	Significant
India	0.089993585	Significant
South Korea	0.070662552	Significant
United States	0.068245045	Significant

1. **China-** A 1% change in the volatility of crude oil will lead to a 0.1326% change in the volatility of the SSE Index. This is due to China is one of the largest consumers and producers of crude oil in the world. The country is also one of the world leaders in oil refining and trading.

2. **Japan-** A 1% change in the volatility of crude oil will lead to a 0.0919% change in the volatility of the Nikkei 225 Index. This is due to Japan is a heavy importer of all energy types and relies heavily on imports of crude oil as its domestic production meets less than 15% of its consumption.

3. **India-** A 1% change in the volatility of crude oil will lead to a 0.0899% change in the volatility of the NIFTY 50 Index. This is due to India has an import dependency of crude oil of up to 80%. Most industries in India include tires, lubricants, and footwear, refining, and airline companies have a heavy dependence on imports of oil.

4. **South Korea-** A 1% change in the volatility of crude oil will lead to a 0.0706% change in the volatility of the KOSPI Index. This is due to South Korea relies on imports to meet all its fossil fuel consumption because of insufficient domestic resources. South Korea ranks among the world's top five importers of liquefied natural gas (LNG), coal, and total petroleum liquids. South Korea has no international oil or natural gas pipelines and relies exclusively on tanker shipments of LNG and crude oil.

5. **The United States-** A 1% change in the volatility of crude oil will lead to a 0.0682% change in the volatility of the S&P 500 Index. The US is one of the largest producers of crude oil in the world; however, the domestic demand has always been higher than the domestic supply and the balance is imported from various other countries like Canada, Mexico, Saudi Arabia, Russia, and Columbia.

Sector of the Indian Economy	Regression coefficient	Significance of coefficient
Banking	0.155315565	Significant
Realty	0.10924504	Significant
Services	0.108887824	Significant
Pharmaceuticals	0.093013485	Significant
Public Sector Enterprises	0.079263937	Significant
Energy	0.078184726	Significant
Information Technology	0.062608689	Significant
Automobiles	0.04267043	Significant
Metals	0.032171137	Significant
Media	0.026115777	Significant
Fast Moving Consumer Goods	0.006766023	Significant

1. **Banking-** A 1% change in the volatility of crude oil will lead to a 0.1553% change in the volatility of the NIFTY Bank Index. This is due to the RBI (Reserve Bank of India) needs to factor in crude oil prices while setting repo rates due to the linkage of crude oil prices with inflation. The repo rate dictates the intensity with which people in a country will take loans. A high repo rate leads to higher interest rates charged by commercial banks to borrowers, which discourages people from borrowing. This will negatively affect the impact of banks and vice versa

2. **Realty-** A 1% change in the volatility of crude oil will lead to a 0.1092% change in the volatility of the NIFTY Reality Index. This is due to, one of the predictors of inflation is a rise or decrease in oil prices. An increase in fuel costs would depress the consumer aspect of the economy while a decrease would raise consumer spending. A decrease in fuel prices should increase housing prices since more people would be able to enter the house-buying market.

3. **Services-** A 1% change in the volatility of crude oil will lead to a 0.1088% change in the volatility of the NIFTY Services Sector Index. This is due to, the industry for downstream and midstream services for the oil industry in India is tremendous. Refineries, storage units, transportation, marketing for oil companies, are all services related to the oil industry and depend completely on prices of oil remaining stable.

4. **Pharmaceuticals-** A 1% change in the volatility of crude oil will lead to a 0.0930% change in the volatility of the NIFTY Pharma Index. This is due to; the Indian Pharmaceuticals industry is heavily reliant on crude oil as an input. Different challenges across the value chain like the rising crude prices cause hikes in raw material cost and a slump in sales growth. In packaging too, the rise in crude prices has resulted in an unprecedented rise in the cost of PVC (Poly Vinyl

Chloride) foils and corrugated boxes. Hence, lower oil prices will lower the cost of raw material, directly and indirectly as well as the running costs with manufacturing. (Macdonald, 2015)

5. **Energy-** A 1% change in the volatility of crude oil will lead to a 0.0781% change in the volatility of the NIFTY Energy Index. This is due to, the Indian energy sector does not depend too much on the commodity directly as an input, reverting to coal, hydropower, and natural gas more, which is why the sector falls 5th on the list and not higher up. There is an indirect effect that crude oil has on the price of coal- With declining crude prices, international coal prices have also remained subdued- which explains the significance.

6. **Information Technology-** A 1% change in the volatility of crude oil will lead to a 0.0626% change in the volatility of the NIFTY IT Index. This is due to a lot of domestic and international oil companies avail software and hardware solutions from tech companies. They also rely a lot on IT companies in India, forming partnerships and ventures together, use their enterprise software and use their operating systems.

7. **Automobiles-** A 1% change in the volatility of crude oil will lead to a 0.0426% change in the volatility of the NIFTY Auto Index. This is due to, Prices of crude oil affect prices of fuel like petrol and diesel used by vehicles. Long-term rises in prices of crude oil can thus dissuade the purchase of automobiles as consumers will delay or postpone their decisions, and vice versa. However, the demand for certain automobiles for industrial transportation remains inelastic. There are also ancillary industries like the manufacture and selling of parts which are considered a part of the auto industry and remain unaffected by oil prices.

8. **Metals-** A 1% change in the volatility of crude oil will lead to a 0.0321% change in the volatility of the NIFTY Metals Index. This is because metals are a strategic sector to the Indian economy and their survival and performance are vital to the functioning of many other industries, which contributes to its protection from global oil shocks. Though the metals industry is highly dependent on the energy sector for its functioning, it is less affected by shocks in crude oil prices due to government protection and consistency of demand.

9. **Media-** A 1% change in the volatility of crude oil will lead to a 0.0261% change in the volatility of the NIFTY Media Index. The Indian media industry comprises various segments like television, print, films, radio, music, out-of-home advertising, etc. Though the correlation coefficient is not as quantitatively large compared to that of other industries, the little volatility that crude oil causes in this industry could be due to indirect dependencies of the different segments on oil and oil by-products.

10. **Fast Moving Consumer Goods-** A 1% change in the volatility of crude oil will lead to a 0.0067% change in the volatility of the NIFTY FMCG Index. This can be attributed to the

inelastic nature of FMCG goods. They are essentials always required regardless of crude oil prices, hence the performance of FMCG companies does not depend much on that of crude oil.

LIMITATIONS

- The volatility in crude oil prices can be caused by independent market conditions, policy changes, etc. exogenous factors that are not considered by the model. These can also affect the volatility of the variables studied.
- Variations in trade patterns can affect the impact that the volatility of crude oil prices can have on the economy.
- A more precise study can be done to figure out the impact of crude oil price volatility on individual states.
- Comparing the impact of volatility in the prices of other commodities can help in finding out the importance of volatility in crude oil prices.

CONCLUSIONS

Hypothesis:

Accepted- H1: The volatility of crude oil prices significantly affects the volatility of a country's indices.

Rejected- H0: Volatility of crude oil prices does not significantly affect the volatility of a country's indices.

From the research and analysis conducted in this study, we conclude that the crude oil price volatility has a significant impact on the volatility of all the sectors of the Indian economy, as well as the economies of the United States of America, Japan, South Korea, and China. Hence, we accept the Alternate Hypothesis and reject the Null Hypothesis.

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