

ANALYSIS OF EFFECTS OF VOLATILITY IN OIL PRICES ON OTHER FINANCIAL INSTRUMENTS IN DEVELOPING COUNTRIES: A STUDY ON INDIAN AND CHINESE STOCK INDICES

Umang Rabadiya¹, Jeevan Nagarkar²

^{1,2}Symbiosis Institute of International Business,
Symbiosis International (Deemed University), Pune, India
² jeevan.nagarkar@siib.ac.in

Abstract

The purpose ongoing study/research is to examine the impact of instability in rates of crude oil on movement in equity markets of developing countries by considering the case of India and Brazil. We are going to understand the relation by using various statistical tools on historical data available. The extent of research includes the past 10 years data of NIFTY 50 (India), Shanghai Composite (SSEC) and Brent crude oil price. By looking at comparative charts of crude oil price and S&P 500 and literature available on that, there exists a considerable relationship between each other during certain critical events. Since fossil oil is considered as one of the highly traded market worldwide and there is quite an uncertainty about the future price there is a huge scope of research in this particular field. As we have seen a very sharp fall in both the equity market and rates of crude oil due to unforeseen situations like Covid-19 and financial crisis of 2008. As both instruments follow the universal concept of demand and supply, there may be some correlation between them as well. The rationale behind choosing India and china is continuous expansions oil supply from US and shifting demand of petrochemicals to developing countries..

Key words: Crude oil price, NIFTY 50, Shanghai Composite, Price Volatility

Problem Statement- Major Part of Energy requirements of emerging economies including India and China are depending on imports of fossil oil. Since we have seen number of price shocks in crude oil, it affected stock market of countries at certain level. In current scenario, there is a need to build a proper relationship between them in order to get better understanding of future forecast.

Introduction

Continuously increased attention of researchers on the correspondence of oil rates and equity market movements indicates importance of oil price for different economies of the world as it has a significant impact on liquidity and earnings of companies that are directly or indirectly linked with Crude Oil market (**Badeeb and Lean, 2018**). As per the article published by Hamilton in 1983, many times Higher Oil price led to recessions in US post world war 2. After that, further research is done by using data analysis techniques as an extension of Hamilton's study-**Harrison and Burbridge in 1984; Goodwin and Gisser in 1986** (Taylor and Francis - Chung-Rou Fang, Chu-Chia Lin, and Hui-Pei Cheng). However, contrary to the availability of vast and quite fruitful literature on theoretical connection of Brent oil rates and equity market, But no more substantial statistical work done yet in decoding the role of changing rates of oil on the movement and unpredictability of stock market in emerging countries including Brazil, China, India and Malaysia.

Despite many countries are putting a lot of efforts in moving towards renewable energy and recycling, there is a strong demand for plastic and petrochemicals nowadays. In 2018, Oil contributed 31.87% of the total World energy consumption and daily consumption was 98.3 MB (IEA, 2019). Demand will continue to grow strongly as the Air travel industry has witnessed enormous growth by increasing the number of passengers. Thus, crude oil is considered as a macro-economic tool that affects the future cash flows of the related firms and ultimately the intrinsic value of its stock by having direct impact cost of production, demand and product price in developing as well as developed countries. The crude oil demand is depended on the global economic strength and especially on the performance of developing countries like the US and China. Fundamentally, instability in

rates of oil have a negative influence on equity index values, but to make relation one need to do in-depth analysis and consider other factors as well. There should be positive culmination of increasing oil price on OPEC and other exporting countries and negative effect on oil importing countries (Dimitras & Lendewig, Asteriou, 2013).

India and China are net importers of crude-oil and are very sensitive to high volatility of crude oil market. India has imported 4543.64 (Th) Barrels/day crude oil in year 2018 worth \$111.91 billion. While China has imported 9261.44 (Th) Barrels/day crude oil in year 2018 worth \$238.7 billion (CEI Data, 2019).

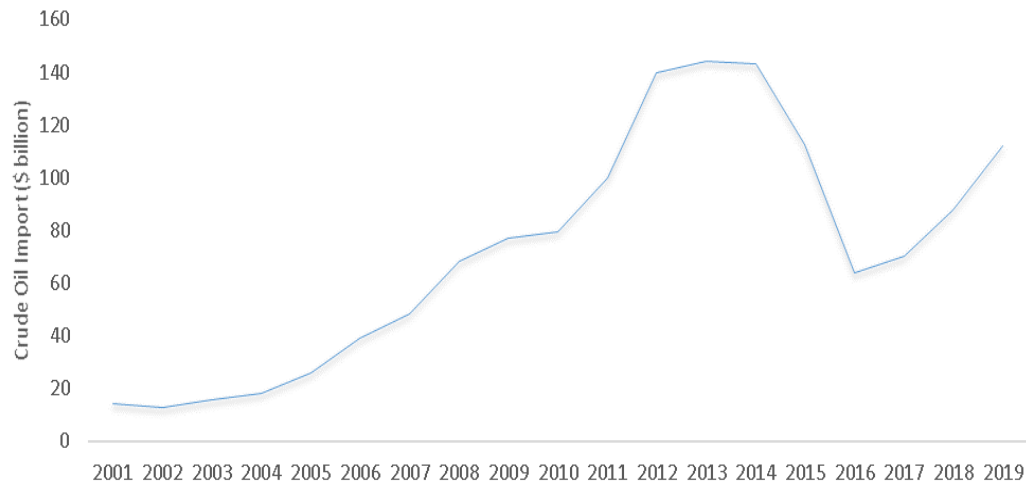


Fig 1. Historical data of Crude Oil import by India (Source: Database of imports from Directorate General of Foreign Trade, <https://dgft.gov.in/>)

Central banks control the inflationary pressure of rising oil price by raising interest rates of government bonds that lead to decrease in price of stocks. Also, the relation depends on the business environment of company, whether it is a producer of oil and petroleum products or buyer of the same.

This study is being done to build the relation of shocks in rates of oil and its consequences on various indices of equity market.

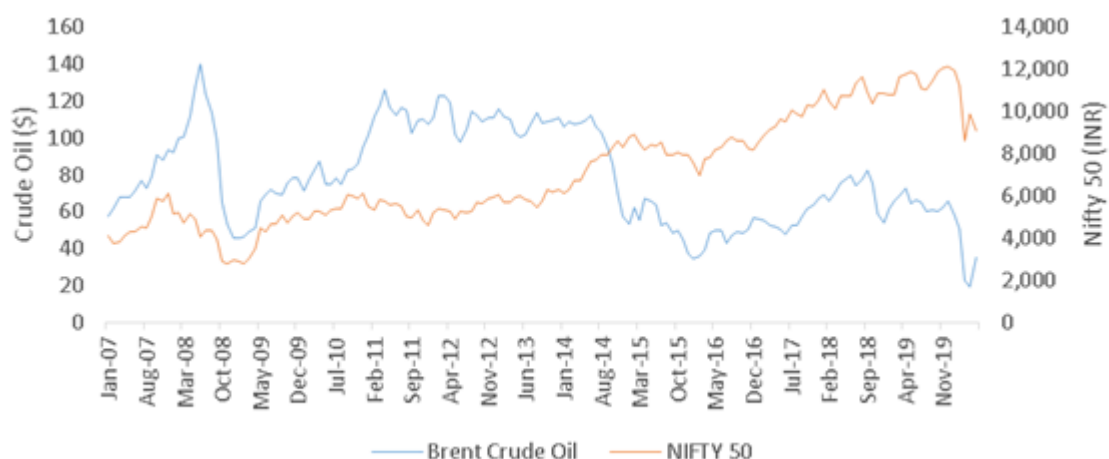


Fig 2. Comparative Price trends of Brent Crude Oil and Shanghai Composite (Source: Investing.com)

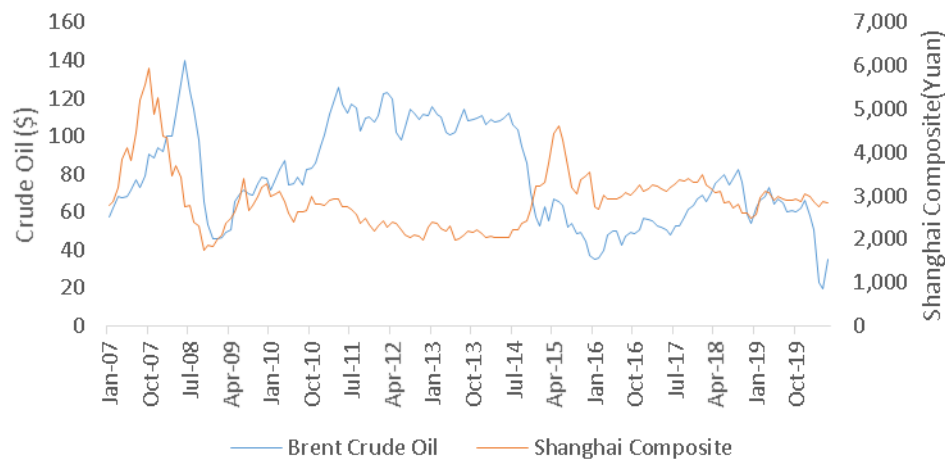


Fig 3. Comparative Price trends of Brent Crude Oil and NIFTY50 index (Source: Investing.com)

By looking at above charts, the negative relation of movement in equity market on rates of crude oil price can be observed. But in April, 2020, both are falling because of demand shock of Covid-19 outbreak. It is also observed that Chinese stock market is less volatile as compared to Indian market. Price movement in crude oil has important consequences on asset allocation and portfolio diversification. We can also infer that there will be a greater impact of oil demand and shocks in rates on oil exporters as compared to importing countries.

LITERATURE REVIEW

Recent crash in oil market where the rates of Brent or non-purified oil falls to near zero due to shock in demand as a result Covid-19 outbreak has reignited the interest in research about significant effects of oil prices on Equity market and other macro-economic factors that includes inflation, employment rate, exchange rate and GDP growth.

Variety of literature focused on the culmination of rise and instability in crude oil rates and its impression on equity market and overall economy of different countries.

Jones and Kaul (1996), proved the detrimental effect on output in the US, Japan, Canada, and the UK during the postwar period by evaluating the current scenario and near future variations in cash flow and anticipated returns of the market.

Sadorsky (1999), studied the significance of instability of rates of fossil on economic actions of US with the usage of unrestricted VAR model. Also, **Raphael and Awerbuch (2006)**, cited that increased rudimentary oil price and its fluctuations will decrease the economic upturn of oil importing country as a result of increased inflation.

Literatures proved the association of volatility in crude oil rates on equity returns

Before 1996, some researchers were in dilemma about the existence of relationship of shocks in oil prices with other variables of macroeconomy. **Et al. Huang** has investigated the relationship of oil futures with stock returns during 1980s and didn't find any correlation with overall indices and concluded that Oil price do have a lead or lag with related companies depending on whether it is buyer or seller of oil products in 1996. While, **Sadorsky (2001)** indicated the sensitivity of Canadian equity return of oil and gas sector that consider factors of risk like oil rates, rate of exchange and term premium. In contrast, **Chen (2010)** proved the high chances of negative impact of increasing oil price with the evidence from S&P 500 index. **O'Neill et al. (2008)** investigated reduced stock return with increase in crude oil price. Also, **Ratti and Perk (2008)** anticipated hikes in oil rates have negative impact on equity return in developed economies.

Hamilton examined the nonlinear connection of changes in valuations of oil on GDP development in the US economy and proved a nonlinear connection of the two components. Further outcomes appeared that an expansion in oil cost has a more prominent effect than oil value diminishes, and oil costs are very little of utilization for estimating of the GDP (2003). He had indicated the concern about valuation of energy in future and availability whose significance on user expenditure or department of monetary policy are as vital as the movements in oil prices themselves because of Wars.

Many researchers intended to do sector analysis to comprehend the effect of shocks in price of oil. **Haltiwanger and Davis (2001)** observed that price shocks of oil comprise 20 to 25% changes in growth of employment, that is almost twice to monetary shocks. Employment advancement responds lopsidedly to ups/ downs in prices of crude-oil, and shocks generate considerable job resection commotion.

Niand Lee (2002) estimated the impact of shocks related to supply and demand in oil for different sectors and concluded that for industries for which oil constitute large part of total cost, shocks in value of oil mainly diminish supply, but for industries which are not heavily dependent on it, shocks in price primarily decrease demand. **Gogineni (2007) and Zahor and Yurtsever (2007)** statistically proved the positive association of Oil price and equity return in case of demand shock and negative association in case of supply shock in oil price. **Ready (2013)** had also stated that supply and demand shocks correlated to oil in positive and negative manner respectively with stock returns.

Bhat and Sonal, Samad, Roselee, Fazilah, (2009) surveyed the effect of movement in price of oil on the valuations of equity of companies operating in oil/gas sector in three different markets (US, India & UK) observed the presence of variables of time series as a statistical property in between oil and gas sector stocks, interest rates, industrial production, index returns and price/valuation of oil as well as there is a significant longer-term and short-run connection between them which concluded the co-integrating relationships between mentioned variables.

Christensen (2011) examined the impact on equity market by shocks in oil prices where the author implemented linear, nonlinear & asymmetric co-relation models and estimated the dependency of respective countries on oil will have excessive influence on real time equity indices responses.

Dhaoui and Naceur (2014), observed a strong contradictory correlation of oil price with equity market return where both variables were controlled by considering short-run interest rates and industrial production as independent variables.

Literatures investigated non-correspondence of crude oil price volatility on stock market

Et Bernanke stated in 1997 that tight monetary policies were more responsible for oil price shock in china. Adding to the argument, **Rogoff (2006)** identified better efficiency of energy, higher consumption concentration of oil in ultimate demand, strengthened monetary policy, extensive financials and better flexibility in labor regulations as a probable causes of oil price shocks after a decade.

Jungwook and Ronald (2008) estimated the effect on the purchasing power for equity of 13 European countries and of the US over 1986-2005 and observed the considerable effect on real stock price within the month or in the same month that also results in vigorous changes in additional variables of model and proved the 6 percent volatility in stock return as a result of crude oil price shocks. **Aktamand Maghyereh (2004)** negated the view of Ronald and Jungwook (2008) by utilizing VAR models furthermore, reasoned that the rough value stuns have insignificant effect on return of index.

K.C. Chen and Lifan Wu (2009) utilized directed acyclic graphs (DAG) to estimate VAR and decode shock transmission. They concluded that China does not cause the price innovations to outside market and internal shocks of Chinese market are the result of price innovations from external markets.

Chang, Hale (2011) studied the consequences of oil price instability on volatility on equity markets on Japan, Singapore, South Korea and Malaysia. Results from study indicated the relative equity market return and oil price fluctuations are not noteworthy enough statistically although they pre-assumed a relationship in some reasonable areas of Japan. They concluded the different response from different countries to oil price shock where equity market three countries except Japan took time to get impacted from oil price shock that indicated the presence of inefficiency in stock market.

Subarna K. Samanta, Ali H. M. Zadeh (2012) analyzed the presence of common trend, co-integration, volatility spillover and Granger causality to state rate of exchange and price variations in oil can be influenced by other variables while gold price and stock price have odds-on to move independently.

Factors influenced by oil price fluctuations: Research done on India and China

Huang, Guo (2007), by using 4 dimensional structural vector auto regression (SVAR) suggested that although with surging demand of imported oil, shock in value of oil would lead to minor sensitivity of the real rate of exchange as a long-run scenario because of China's very less dependency on abroad sourced oil than on its swapping partners and demonstration of less harmonization of the movements in real pricing of domestic oil with the global markets due to rigorous government energy regulations.

Zaouali (2007) directed a quantifiable investigation regarding the behavior of Chinese economy on rising oil rates. China's GDP fell to 0.5 from 0.9 percent annually because of relatively modest and consistently increasing oil rates. But the large foreign capital flow and investment potential of China were sufficient enough to counterpoise the negative influence of these higher values.

Et. al. Cong, (2008), did not find the significant relationship of global oil rates fluctuations and Chinese macro-economy by using VAR model as there was not strong correlation of domestic oil rates and global one because of strict government regulations. While, unlike other oil importing countries, his linear impact model indicated the positive relation of both GDP of China and CPI with the global oil rates and argued that the US and EU's economic strategies and actions are responsible for these diverse results as they have power to stimulate the oil prices.

Imarhiabel (2010) hypothesized vector-error correlation model to study on oil extracting and absorbing countries like Mexico, Russia, Saudi Arabia, India, China and the US considering nominal rate of exchange as additional element. Results from study confirmed that in all countries decomposition of variance and impulse response tests proved the existence of rates of oil and exchange rates influenced over equity prices.

Ono (2011) understood the effect of crude rates on equity market of BRIC countries and concluded the positive relation of return from investing in equity in India, China and Russia and found no relation for Brazil. **Chittedi, K. (2011)** seen the reverse long-run relationship that indicates that stock price volatility has significant impact on oil price while crude oil rates volatility does not have noteworthy weightage on price valuation of equity in Indian stock market.

Hidhayathulla and Rafee (2012) proposed that continuously increased import of oil in India will increase the demand of dollar which weakens the Indian rupee against US dollar. This will eat away the purchasing power of Indian currency. They recommended demand control and augmentation of domestic supply of oil to settle down the exchange rate depreciation. **Bhunia (2013)**, investigated that exchange rates of different countries and gold price (domestic), crude oil rates and movement in index of equity market are unified as a long-term aspect.

As China is net importer of oil, there should be a negative association between export supply and crude oil price in China. However, **Faria and Mollick (2009)** observed a positive correlation of exports from China and worldwide crude oil rates in equilibrium.

Bhattacharya and Batra (2009), underwrites about relationship of international crude oil rates to few factors related to macroeconomy such as supply of money, exchange rate, industrial production and WPI. **Aparna**

(2014) considered other macro-economic variables including Index of Industrial Production (IIP), Gross Domestic Product (GDP), and Wholesale Price Index (WPI) and found that increase in rates of oil reacts inversely on GDP and IIP and positive impact on WPI. Srithar et al. (2015) have attempted three variables; inflation, the stock market and GDP to look at the effect of crude oil rates. The result of the investigation exposed a positive effect on all three components. In contrast, Jain (2013) observed a moderate relationship of the crude oil rates on inflation.

As per research presented by Kodak security (2018), current account deficit will be increased by 0.55% and CPI will be increased by 0.3% with every US\$10/bbl. increase in oil price. So, companies profit sustainability will depend on its ability to take viable price hike because companies profit margins may be affected by higher price of crude oil derivatives because of increase in raw material and transportation cost.

Research Gap:

However, in contrast of vast availability of literature on relationship of macro-economic variables and oil rates on developed economies and some of emerging countries, no empirical work done on net importing countries like India and China that create huge scope in building a perfect relationship between them. Also, some of studies did not find significant evidence to reach to satisfactory conclusion. So, the sole purpose of ongoing research is to separate the effect of oil price shocks on equity market from the effect of other macro-economic tools. The current research tries to analyze the historical movement in both variables and examine the association between them. For this, we are going to use data of returns of NIFTY50 and Shanghai composite as a proxy along with past years Brent crude oil price data.

RESEARCH OBJECTIVES

Ongoing research is to fulfil following objectives:

1. To understand the phenomena of demand and supply shock responsible for fluctuations in Brent Crude oil.
2. To estimate the effects of changes in oil prices on NIFTY 50 and Shanghai Composite Index.

Sampling:

The current study emphasizes on investigation of the relationship of crude oil rates with real equity market return for emerging economies like India and China.

Hypothesis:

H_0 = Non-existence of relationship of instability in rates of crude oil with NIFTY50 and Shanghai composite stock returns.

H_1 = There exists an important relation of volatility in crude oil rates with NIFTY50 and Shanghai composite stock returns.

The absolute difference of continuously compounded returns on indices of various equity market and inflation rate is considered real stock return here.

RESEARCH METHODOLOGIES

The current study going to build relationship between two variables by using Hypothesis techniques in SPSS and Microsoft Excel by taking other proxy macroeconomic variables as a part of equations. The research will do regression and trend analysis to examine the relationship. If that models fail in building linear relationship between two independent variables, then current study will figure out non-linear relationship by using structural vector autoregressive model (SVAR) on the historic data taken from investing.com. Time series modeling

(Derya E.K., C. Coşkun Küçüközmen b, A. Sevtap S.K, 2017) can also be performed by using Matlab R2012b software for further analysis.

Time span of study for analysis is financial year 2007-08 to 2018-19. Data frequency for study is on monthly basis.

The ongoing study includes an impactful evaluation in the framework of dependency between Brent crude oil prices as well as equity market indices and rate of exchange for countries that are heavily dependent on import of crude oil and provides rigorous anatomy of the Indian financial instruments regarding their correlation with continuously changing price of crude oil and returns.

Number of studies has proven dependency of value of assets and price of crude oil exponentially increased in current time due to various global economic activities and demand-supply shocks. To counter sign and take into account the literature on this aspect, this study has investigated the time span of July-2014 to April-2016 and independently presented the findings of it.

Data

The latest defrayal prices of Brent crude oil have been extracted from Investing[dot]com database stream. Although NYMEX WTI futures contracts that are heavily traded and are measured to be a benchmark globally, Brent crude oil is considered only because importing countries including India and China are heavily dependent on Brent and it will become more helpful in finding proper relation between them.

Secondary research has been done to get data of several national and international stock market. Here, in case of India and China, equity market historical data is taken from National Stock Exchange (NSE) and Yahoo Finance respectively. This research has given priority to government websites. In case of its absence, it has explored widely referred websites.

Tools used for Data Analysis:

Trend Analysis

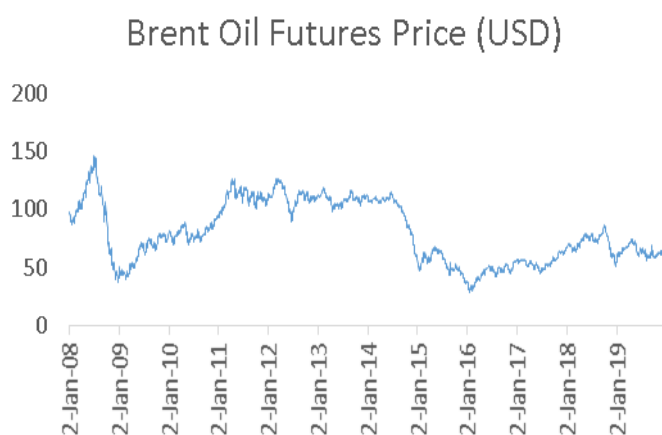


Fig 4: Monthly crude oil price between Jan-2007 and Jan-2020 (Source: Investing.com)

Historical research on economics investigated the shock of supply and demand in crude oil rates that are imperative for the understanding of long-run and short-run movements. Particularly, fundamental changes help us to get more information about estimation for investors to make decision about profitable or potential investments. The primary indicators of fluctuations in rates of oil are disruptive supply or precautionary demand

of oil, but not from speculations in various financial instruments—expectations regarding disruption in supply of a kind that going concerns about disturbed oil productions in Iran results insignificantly different economic effects.

Although number of oil price shocks due to supply disturbance has been observed historically, these disruptions are generally for short-term basis due to changes in production in the world to get profit from changes in price. However, collective demand shocks had a long-term impact on countries which are importer of fossil during the 2000s. In ongoing study, Global historic events like sub-prime crisis 2014 of USA followed by recession worldwide had a negative effect on rates of oil as the overall demand of fossil came down which ultimately resulted in downfall in frequency of extraction in the phase of recession, but it also depends on which model is used by particular study. The same is the case with enormous declination in rates of Brent in mid 2008 after a previous era of consistency in growth. Similarly, global socio-political events like Iraq war (2003), Arab Spring (2011-), etc. concluded in threats of decrease in oil production that results in hike in oil price world-wide.

Correlation

Significance:

Correlation coefficient can be indicated as ρ and there can be 8 types of relationship between 2 variables. Value of correlation coefficient will always be between -1 and 1.

If,

$\rho = -1$, Variables are inversely proportional / Perfect negative linear relationship

$-1 < \rho < -0.7$ indicates that the linear relation of two variables is strong negative

$-0.7 < \rho < -0.3$, indicates that the linear relation of two variables is moderately negative

$-0.3 < \rho < 0.0$, indicates that the linear relation of two variables is weakly negative

$\rho = 0$, Variables are independent or not in relationship

$0.0 < \rho < 0.3$, indicates that the linear relation of two variables is weakly positive

$0.3 < \rho < 0.7$, indicates that the linear relation of two variables is moderately positive

$0.7 < \rho < 1.0$, , indicates that the linear relation of two variables is strong positive

$\rho = 1$, Variables are directly proportional / Perfect positive linear relationship

	<i>Brent Crude Oil</i>	<i>NIFTY 50</i>
Brent Crude Oil	1	0.217404535
NIFTY 50	0.217404535	1
	<i>Brent Crude Oil</i>	<i>Shanghai Composite</i>
Brent Crude Oil	1	0.12992
Shanghai Composite	0.12992	1

By looking at above analysis found from historical data (on Daily basis) from Jan-2008 to Dec-2019, There exists a considerable but weak correlation ($n=3097$, $p<0.05$) between absolute rates of oil (Brent Crude) and NSE Nifty-50 as well as Chinese Shanghai Composite. Correlation for India is almost double than China, that indicates Indian stock market is facing more volatility as compared to Chinese stock market in relation to price

shock or volatility in Brent crude oil price. This indicates movement in Chinese stock market is difficult to get elaborated by relative changes in rates of crude worldwide.

Regression

Regression Analysis for Nifty-50 Index

<i>Regression Statistics</i>	
Multiple R	0.217404535
R Square	0.047264732
Adjusted R Square	0.046956901
Standard Error	0.012895081
Observations	3097

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.0255313	0.025531	153.5414	1.9E-34
Residual	3095	0.5146462	0.000166		
Total	3096	0.5401776			

	<i>Coefficient</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	0.00027	0.00023	1.18	0.23
Daily Return - Brent Crude Oil	0.1323782	0.0106832	12.39	1.89E-34

Regression Analysis for Shanghai Composite Index

<i>Regression Statistics</i>	
Multiple R	0.12992
R Square	0.016879

Adjusted R Square	0.016562
Standard Error	0.015283
Observations	3097

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	1	0.012411281	0.01	53.1	3.9278E-13
Residual	3095	0.722883471	0.00		
Total	3096	0.735294752			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	-9.6E-05	0.000274626	-0.3508	0.7257
Brent Crude Oil	0.09229	0.012661458	7.2896	3.93E-13

Regression analysis for both stock exchanges suggests that dependent variables of regression (NSE Nifty 50 and Shanghai Composite) are not satisfactorily affected by movement in dependent variable, that is up to a little extent but significant one. Thus, changes in variable X will be able to explain changes in variable Y but not at great extent. Variance calculated by model as a whole was 4.6%, $F(3096) = 153.51$, $p < .05$ and 1.6%, $F(3096) = 53.13$, $p < 0.05$ i.e. at 95% level of significance. Thus, it was depicted that there was considerable culmination of rates of crude on both Nifty 50 and Shanghai Composite, therefore the **H₀ was rejected**.

conclusion

On the basis of literature reviewed and correlation and regression analysis done on the historical data, the ongoing study can imply that countries like India and China whose energy requirements are dependent on the import of crude oil, the movement in equity market returns are not at a great extent but significantly related to instability in movement of crude oil rates. The same analogy can be proven by application of various statistical models and results can be compared, but countries cannot take strategic decisions only on the basis of statistical conclusions as the movement in crude oil rates are heavily dependent on geo-political relations and economic activities of oil producing countries as well..

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