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DO CRUDE OIL PRICE FLUCTUATIONS AFFECT THE SECTORAL STOCK RETURNS? EVIDENCE FROM INDIA

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Abstract *Crude oil is a vital energy source for industrialised and developing countries. Both investors who trade crude oil derivatives and firms that use oil as raw material for production monitor oil supply and demand. Disruption in the flow of oil in the commodity markets, therefore, leads to oil price volatility that affects major economies worldwide. Often, geopolitical and natural conditions could adversely impact the oil price and the financial markets react to such fluctuations in oil prices. This paper analyses the effects of oil price changes on sectorial stock returns in India. Using daily returns of S&P BSE Sensex, S&P BSE Oil & Gas and S&P BSE-Auto sectoral indices from January 2000 to March 2020, we examined the impact of Brent crude oil price fluctuations on the two major sectorial stock indices and overall market index. The results of the Granger causality test show significant results on S&P BSE-Sensex and S&P BSE-Oil and Gas Index Returns except S&P BSE-Auto Index Returns. Further for contemporaneous association between the oil price changes and sectorial returns, we operationalised the simple regression analysis. The results from the regression analysis show statistically significant impact of crude oil price fluctuations on the sectorial returns.*

Keywords: *Oil Price Changes, Sectorial Stock Returns, S&P BSE-Auto Sectorial Indices and S&P BSE-Oil and Gas and S&P BSE-Sensex*

INTRODUCTION

Oil is a significant economic and industrial activity driver; thus, policymakers and investors actively track its price fluctuations. Crude oil, which is often called "Black Gold" is the natural resource and commodity that is most important. In June 2015, India passed Japan to become the third largest country in the world to buy crude oil, according to the EIA[12]. It is a key part of modern industry, and because of how volatile it is, it has a big effect on the Indian economy. According to a recent estimate by the Central Bank of India, India's annual current account balance will improve by about USD 9 billion or 0.5% of GDP for every USD 10 drop in the price of crude oil per barrel. In a similar way, a country's stock market is an important part of how its economy works. They are often seen as a sign of a country's economic health, and level of development (Hamilton, 1983, 1996, 2004; Kilian, 2009; Mork et al., 1994). India is always a popular place to invest because it is an emerging economy, and so are its stock markets, especially after a recession. These markets give investors the chance to spread their money across many different sectors, from consumer durables to metals. Since there is now evidence that oil prices negatively impact economic growth through a variety of channels, including rising production costs, inflation and investor confidence (Hamilton, 2003; Kilian, 2008; Lardic & Mignon, 2008), one would anticipate a degree of interdependence between oil prices and stock market performance (Huang et al., 1996). Indian markets appear to have a close relationship with worldwide crude oil. Almost all industries use oil as a natural resource in some capacity. From the viewpoint of the industries, rising oil prices are predicted to increase overall costs of goods, leading earnings to plummet, negatively impacting stock market performance. From the standpoint of investors, rising oil prices cause inflation, which causes the Central Bank to raise interest rates, causing a shift in investment away from stock markets. Despite the fact that the stock market, crude oil and their interactions have a crucial influence in creating the economy, there are few research on the subject, particularly in the Indian context (Maghyereh, 2004; Gay, 2011; Bhar & Nikolova, 2009; Ono, 2011; Wang et al., 2013). The studies described above are mostly concerned with developing markets as a whole, and they also ignore volatility links.

[1] https://247wallst.com/energy-economy/2015/06/19/india-displaces-japan-as-worlds-third-largest-oil-importer/
[2] https://www.orfonline.org/expert-speak/indias-oil-imports/

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As a vital energy source for industrialised and developing countries crude oil plays an important role in a globalised stock market. Three-to-four decades ago the only thing we really understood about the oil market was its role in contributing to recessions in the United States (Hamilton, 1983). Since then, extant literature has emerged that studies the impact of oil price changes on a number of micro and macro-economic variables (Bachmeier, 2008; Hamilton, 2003; Lee & Chiu, 2011; Lee et al., 2017). Most initially the study conducted in 1996, by Jones and Kaul, found that changes in oil prices had a negative association with returns on stock in the United Kingdom, Japan, United States and Canada. Huang et al. (1996) are unable to show a substantial link between oil futures returns and stock returns at the aggregate level using US data, contradicting this result. In contrast, in a more recent study, Sadorsky (1999) examines the effect of oil price shocks on a number of economic variables, including real aggregate stock returns in the United States, which are represented by the difference between the continuously compounded returns on the S&P 500 index and the inflation rate. The author demonstrates that oil price fluctuations and volatility have a considerable detrimental effect on stock returns. After 1986, the oil impact on stock returns was discovered to be more significant than the T-bill interest rate. The empirical results of following studies concentrating on industrialised nations are globally consistent with those of Sadorsky (1999). For instance, Park and Ratti (2008) study the oil-stock market link for the United States and thirteen European nations from 1986 to 2005 and demonstrate that oil prices considerably impact real stock returns contemporaneously and/or within the next month. In addition, there is evidence that stock markets in oil-importing nations are more susceptible to oil price fluctuations than those in oil-exporting nations. Using a nonlinear adjustment framework, Jawadi et al. (2010) examine the link between stock and energy markets and offer evidence of regime-switching behaviour for stock-oil price deviations and a non-linear mean-reverting adjustment mechanism in the joint dynamics of oil and stock prices.

As oil is an important input for most of the firms, higher oil prices lead to an increase in the cost of production, a reduction in future cash flows, dividends and earnings, hence there is a reduction in stock returns. Higher oil prices might result in overestimation of expected inflation and higher nominal interest rates. This is because interest rates are used to discount the expected future cash flows, which depresses earnings, dividends, therefore, returns on stock. Another channel suggests a positive or negative relationship as well. As volatility in oil price can impact the effect of sensitivity of changes in oil prices on the component of risk premium, the discount rate on cash flow through demand side consequences.

Diversification is the phenomenon of matured markets, hence, aggregate stock indices reflect the average across most sectors, however, other markets are concentrated only in a few industries. Therefore, the overall association between changes in oil prices and returns on stock in studies that use overall aggregate stock returns is most likely to be dependent on the sector wise composition of the market (Arouri, 2011; Narayan & Sharma, 2011). In response to this, a number of studies exist which examined the oil price-stock returns association at the sector level. Most of these are for the United States (Elyasiani et al. 2011, 2013; Narayan & Sharma, 2011), Europe (Arouri & Nguyen, 2010; Moya et al., 2014, Xu, 2015) or the G7 economies (Lee et al., 2012). Apart from China, for which there are multiple studies at the sector level (Caporale, Ali & Spagnolo, 2015; Cong et al., 2008; Zhao et al., 2017; Li et al., 2012; Peng et al., 2017, 2018; Chen et al., 2016), there are few studies for emerging or transition markets. Perhaps, one of the most comprehensive studies, with regards to the geographical breadth, by Nandha and Faff (2008). Their study investigated the relationship between 35 global industry indices and oil prices. One major conclusion from these studies is that oil price rises have a positive effect on the stock returns of firms in the oil and gas sector (Boyer & Filion, 2007; Cong et al., 2008; Gupta, 2016; Zhao et al., 2017; Nandha & Faff, 2008; Sadorsky, 2001). El-Sharif et al. (2005) finds a positive, but weak, effect of oil prices on oil and gas returns in the UK. Kang et al. (2017) distinguish between oil supply shocks and aggregate demand shocks. They study oil price shocks and economic policy uncertainties on oil and gas stock returns. The result of the study suggests that an oil demand-side shock boosts oil and gas company return, while policy uncertainty hurts them. Kilian and Park (2009) framework, on oil and gas firms. Disentangling the different shocks, they find that oil supply shocks, which generate disruptions to supply, tend to have a negative effect, while aggregate demand shocks have a positive effect on oil and gas stock returns. Another major finding is that the industries in which oil is important from the perspective of cost of production—(manufacturing and transport) oil price rises generally have a negative effect on their stock returns. It has been demonstrated that the response of real stock returns in the United States to a shock in the price of oil varies substantially depending on whether the change in the price of oil is driven by demand or supply shocks in the oil market. This finding was reached by analysing historical data. Nandha and Faff (2008) found that oil prices were negatively correlated with the returns of manufacturing firms. In a dedicated study of the issue, Aggarwal et al. (2012) record that transportation firm returns were negatively influenced by oil price rises. The results are consistent with Cameron and Schnusenberg (2009), who find an inverse relationship between rising oil prices and stock returns of automobile manufacturers with most of the impact concentrated on manufacturers of SUVs. Amongst the studies that reach to a different conclusion is that of Kristjanpoller and Concha (2016). They found that oil price rises had positive effects on stock returns of airline industry. While fuel represents a considerably large cost for airlines, the authors explain their result in terms of increasing oil prices being associated with higher economic growth as well as higher demand for air travel. The implicit assumption is that aggregate demand shocks dominate, but it is diffcult to know if this is so because the authors do not separate out the type of shock. Another crucial finding is that oil prices could explain movements in the stock returns of alternative energy companies (Henriques & Sadorsky, 2008). There is some evidence that this relationship is nonlinear and that it has strengthened over time (Managi & Okimoto, 2013), in particular, since the GFC (Broadstock et al., 2012). It is important to study sector-based industries across more countries to reach a common conclusion. Most such studies are country or region specific or focus on a limited set of high-income countries (Lee et al., 2012). Apart from China, very little is known about oil prices affecting stocks in different sectors in developing or transitioning nations. Exceptions are Mohanty et al. (2010) who examine the effect of oil prices on gas and oil stocks in CEE and Gupta (2016) who does likewise for a sample of emerging markets as part of his multi-country study. The co-movement between the equity markets and oil prices leads me to examine the behavior of oil price shocks and sectorial equity returns.

REVIEW OF LITERATURE

The literature contains a large body of work on the links between oil prices and macroeconomic variables. The findings of all these research are heterogeneous. However, a number of studies (Hamilton, 2003; Cunado & Gracia, 2005; Gronwald, 2008; Cologni & Manera 2009; Kilian, 2008) have noted negative impact of oil price changes on economic activities, for many developed and developing nation's net oil- importing.

In contrast, the work done on the relationship between oil price variations and stock markets is relatively scant, probably because there is no unequivocal evidence of a relationship between oil price changes and economic activity. There have been quite a few papers investigating the links between oil price movements and stock market. The Previous studies is about oil prices and stock returns can be classified into two categories, one at the market and another at the industry (sector) levels. At the market level, the research on the impact of oil price changes on stock markets was pioneered by Jones and Kaul (1996), who used 1947-1991 quarterly data for Canada, Japan, the U.K. and the U.S., to investigate the reaction of stock returns in four developed markets (Canada, Japan, the U.K. and the U.S.) to oil price fluctuations on the basis of the standard cash flow dividend valuation model. They find that the oil price had a negative impact on the aggregate stock returns. Huang et al. (1996) used a vector auto-regression VAR approach to investigate the relationship between daily oil futures returns and daily US stock returns. They found that oil futures returns do lead to some individual oil company stock returns, but oil future returns do not have much impact on broad-based market indices like the S&P 500. In addition, Sadorsky (1999) presented an unrestricted VAR model using 1947–1996 monthly data of oil prices, stock returns, short-term interest rate and industrial production to examine the links among these variables. In contrast to the results of Huang et al. (1996), Sadorsky (1999) identified that oil price shocks played an important role in explaining US broad-based stock returns. He suggests that changes in oil prices impact economic activity but, changes in economic activity have little impact on oil prices. Using impulse response functions shows that oil price movements are important in explaining movements in stock returns. The estimated results suggest that positive shocks to oil prices depress real stock returns while shocks to real stock returns have positive impacts on interest rates and industrial production however, applying an unrestricted VAR model with GARCH effects to American monthly data and shows a negative short-term effect of oil price volatility on the aggregate stock returns**.** Similarly, Papapetrou (2001), using 1989–1999 monthly data of the Greek stock market, also found that oil price was an important component in explaining stock price movements and positive oil price shocks depressed real stock returns. Applying a multivariate threshold regression model, Huang et al. (2005) found oil price changes could negatively impact stock returns only when the price increase in the previous period exceeded a threshold value. The ensuing impact lasts for one period for Canada, Japan and the U.S. Agren (2006) uses an asymmetric version of the BEKK–GARCH (1, 1) model to study the volatility transmission from oil prices to stock markets in five major developed countries (Japan, Norway, Sweden, the U.K. and the U.S.). The author shows strong evidence of volatility spillover from oil to all stock markets studied, except for Sweden. However, the news impact surfaces, which illustrate the estimated one-period ahead forecast impact of an oil shock, reveal only small effects. In 2007, Malik and Hammoudeh (2007) operationalised the same model to analyse the volatility transmission among the equity markets of United States, three Gulf equity markets (including Bahrain), the global crude oil market and Kuwait and Saudi Arabia. Their study postulated that equity markets in the Gulf receive volatility from the oil market. However, in the case of Saudi Arabia, stock market volatility spilled over into the oil market. Bjornland (2008) used a structural VAR model to find that higher oil prices had a stimulating effect on the Norwegian economy as is expected of an oil exporting country. In contrast, Park and Ratti (2008) show that oil prices have a negative impact on stock returns in the US and in 12 European countries; stock markets in Norway, an oil exporting country, on the other hand, respond positively to rises in the price of oil. Miller and Ratti (2009) employ a structural change-robust VEC (Vector Error Correction) model to investigate the long-run relationship between world oil price and national stock indexes of the six OECD (The Organisation for Economic Co-operation and Development) countries. Their results indicate stock market indexes respond negatively to increases in the oil price in the long run. Apergis and Miller (2009) empirically tested the effects of structural oil-market shocks on stock prices in eight developed countries. They found that international stock market returns do not respond significantly to oil price shocks. Their results show the different roles of oil regarding the determination of the transport sector returns for developed countries but indicate no such evidence in Asian and Latin American countries. Nandha and Brooks (2009) look into the reaction of the transport sector to oil prices in 38 countries and find that, in developed economies, oil prices have a negative influence on the returns to the sector. However, there appears to be no evidence of a significant role for oil in Asian and Latin American countries. Taken together, the results from the works on the relationships between oil prices and sector stock returns differ from country to country and from sector to sector. Le and Chang (2015) they investigate how oil prices affect stock markets. This study employed Toda and Yamamoto's (1995) causality technique to examine the long-term and short-term impact of oil and stock prices. From January 1997 to July 2013, impulse response functions were applied to monthly data. Three Asian economies were studied to compare oil refining, exporting and importing. At the industry level, Faff and Brailsford (1999), making use of several industry returns in the Australian stock market, found that oil, gas and diverse resources industries had positive responses from oil price increase, while papermaking, packing and transportation industries reacted negatively. Also, Sadorsky (2001) found evidence that a rise of the stock market index and oil price had a positive effect on oil industries' returns. However, Hammoudeh and Li (2005) discovered a negative relationship between returns of the US transportation industry and oil prices. Employing a multifactor (mainly two-factor) model, El-Sharif et al. (2005) explored the relationship between the sector returns of the oil and gas industry and oil price. As expected, they found a positive relationship and reached an equivalent conclusion for oil and gas returns in the UK. However, the authors show that non-oil and gas sectors are weakly linked to changes in the price of oil. Boyer and Filion (2007) show that increases in the price of oil affect the stock returns of Canadian oil and gas companies positively. In a paper, Nandha and Faff (2008) investigated the oil price sector index relationship via a market factor market model using Data Stream global equity indices (April 1983 to September 2005) and 35 global industry indices and oil prices. With the exception of mining and oil-gas industries, there is significantly negative relationships between stock returns and oil price change. Malik and Ewing (2009) examine the volatility transmission between oil prices and five US sector indices by adopting bivariate BEKK–GARCH (1, 1) models. The sectors considered include Financials, Industrials, Consumer Services, Health Care and Technology, and the empirical results support the existence of significant transmission of shocks and volatility between oil prices and different stock market sectors. Arouri and Nguyen (2010) operationalised a distinct econometric technique to test short-term links between change in oil prices and stock prices at the aggregate and sector by sector level in Europe. Their findings reveal two interesting facts: (i) the reactions of stock returns to oil price changes differ greatly depending on the activity sector; (ii) the out of sample analysis postulates that adding oil assets into a diversified portfolio of stocks significantly improves the characteristics of risk-return. To date, little is known about the volatility spillover effects between oil and stock markets**.** In a similar vein, Elyasiani et al. (2011) studied the causal relationship between oil price shocks and 13 industry stock returns of the US from the perspective of the volatility of a GARCH model. Fang and you (2014) they investigate how shocks in oil prices affect three large NIE's stock returns. Even though several empirical research have studied the association between changes in oil prices and economic activities, little research has concentrated on the association of oil price shocks and the large newly industrialised economies. This study therefore modifies the method of Kilian and Park (2009) to investigate how the explicit structural shocks impact three large NIEs' stock-market returns. They find that the impact of oil price shocks on stock prices in these large NIEs is mixed, partly in contrast to the effects on the U.S. and developed countries' stock markets. Sakaki (2019) study investigates the impact of demand and supply shocks in the oil market on the different sectors of the U.S. stock market. The author finds that U.S. oil production and aggregate demand shocks have a significantly positive impact on U.S. stock market returns. Moreover, oil-market-specific demand shocks reduce U.S. stock market return for all industries except energy and utilities. The study also investigates the effect of oil price volatility on stock returns. Oil price volatility is found to have a significantly negative effect on all industries.

Using quarterly data from 1947 to 1991, Jones and Kaul 1996 found that oil prices do have an effect on aggregate stock returns. In contrast, Huang et al. 1996 used daily data from 1979 to 1990 and found no evidence of a relationship between oil futures prices and aggregate stock returns.

Most literature so far has focused on the impact of oil prices on aggregate stock returns for specific nations or groups of nations. To sum up, most of such studies have showed a negative association (Basher et al., 2012; Basher & Sadorsky 2006; Chen, 2009; Filis, 2010; Gjerde & Saettem, 1999; Jones & Kaul, 1996; Kling, 1985; Papapetrou, 2001; Park & Ratti 2008; Sadorsky, 1999; Tripathi et al., 2015). However, some studies have found a positive relationship (Narayan & Narayan, 2010; Silvapulle et al., 2017; Zhu et al., 2014; Zhu et al., 2011). There are also studies for which results are mixed or found no relationship between oil prices and stock returns (Apergis & Miller, 2009; Cong et al., 2008; Hatemi et al. 2017; Huang et al., 1996; Miller & Ratti, 2009; Habib & Islam, 2017).

Few studies in the Indian context have investigated the relationship between stock markets at the aggregate level and fluctuations in oil prices. Ghosh and Kanjilal (2016) suggests there is no link between worldwide oil prices and the Indian stock market, but they did discover causality from changes in crude oil prices to the stock market. Using weekly data, Singhal and Ghosh (2016) discovered no substantial volatility spillovers from the international crude oil market to the Indian stock market. Oil price spillovers were reported at the sectoral level in three of the ten industries studied (automotive, power and finance). Furthermore, there is time-varying and persistent co-movement between oil price fluctuations and all ten sectoral indices. Mishra (2014) and Ali and Masih (2014) investigated the volatility spillover from changes in oil prices to several industrial sectors.

The previous studies mainly focused on market-level volatility transmissions rather than sector-level ones (Jain & Biswal, 2016). Depending on whether oil and related products represent an input or an output for a given sector of the economy, those sectors may react to changes in the price of crude oil in different ways. While cash flows will decrease for businesses that utilise oil as an input, they will grow for companies whose primary product is oil. In order to better appreciate investors' concerns about portfolio diversification, hedging and better risk management methods, it is crucial to understand the dynamics of time-varying volatility between crude oil and various businesses. Therefore, this study attempts to fill this gap and investigate the causal linkage and dynamic correlation between oil returns and Indian sector stock returns. For this purpose, the study uses Granger causality test and simple regression analysis.

In a similar manner very few studies have investigated the impact of oil price changes on the stocks of individual sectors. In addition, most of these studies are country specific and thus do not provide a global perspective. As the results from the previous studies are mixed, we intend to examine the relationship among oil price returns, S&P BSE Auto index returns, S&P BSE Oil and Gas index returns and S&P BSE Sensex returns using simple OLS regression analysis after establishing the Granger causality test.

OBJECTIVES

The main objective of this paper is to empirically examine the relationship between crude oil price fluctuations, sectorial index returns of BSE S&P Sensex, BSE S&P-Oil & Gas and BSE S&P-Auto over the entire sample period.

The paper is organised as follows: Section 2 discusses the time series data and variables sources; Further in Section 3 discusses the hypothesis formation and in Section 4 we present the methodology of Granger causality between crude oil price fluctuation and sectorial stock returns. Section 4 presents the test statistics and G-causality results for crude oil price fluctuations and sectorial indices stock returns; while Section 5 reports the implications; and last Section 6 discusses the concluding remarks.

Hypothesis Formation

It has been found that in many countries crude oil price volatility has an impact on stock returns at the market as well as industry level. Singhal and Ghosh (2016) suggest crude oil prices don't have a uniform effect on the sectors. For sectors like cement, electricity, iron and steel, chemicals, textiles and transportation. In contrast, the study of Fariz et al. (2016) suggests that there is a positive impact of crude oil prices on all sectors. Therefore, it is important to examine the relationship between S&P BSE Sensex and crude oil price fluctuations.

H1: The crude oil price fluctuations have no impact on S&P BSE-Sensex returns.

There are ample studies which investigate the relationship between oil price fluctuations on the sectorial returns. For example, Kang et al. (2017) examine how oil and gas stock prices react to changes in oil prices and economic policy uncertainties. On average, they find that a demand-side shock for oil increases the stock price of oil and gas businesses, but a policy-uncertainty shock decreases the stock price. Similarly, Gupta (2016) investigates the relationship between systematic asset price risk of oil & gas and oil price shocks using oil & gas index as a performance benchmark of oil & gas firms. The author suggests that oil price shocks have a positive impact on firm-level returns, particularly for firms that are located in high oil producing countries and are more sensitive to global uncertainty and oil price shocks. Firms that are located in non-competitive industries are less sensitive to oil price shocks; and firms that are located in non-competitive industries are less affected by the drop in oil price, in comparison to firms that are located in highly competitive industries. Therefore, it is interesting to find the relationship between oil price fluctuations and oil and gas index (S&P BSE-Oil and Gas Index) returns in emerging economies like India.

H2: The crude oil price fluctuations have no impact on S&P BSE-Oil & Gas returns.

Cong et al. (2008) by employing multivariate vector auto-regression, they investigate how oil price shocks affect the Chinese stock market. Except for the manufacturing index and a few oil businesses, real stock returns on the Chinese stock market do not demonstrate a statistically significant impact from oil price shocks. Stock prices of oil companies tend to drop in response to "significant" drops in oil prices. Tiwari et al. (2018) they investigate the relationship between the oil price shocks and 13 non-oil and gas industries. By separating the oil price shock into positive and negative shocks, they use the Quantile Regression Model to examine the scope and structure of the impact of oil price shocks on 13 non-oil and gas industries. There are ample of studies on the sectorial returns and market risks (Kour, 2022; Gupta, 2020; Reboredo et al., 2014; Caporale et al., 2015) but there is dearth of studies investigated the impact of oil price fluctuations on automobile industry (S&P BSE-Auto index) in emerging economy like India therefore, it is important to examine the relationship between oil price fluctuations and automobile industry.

H3: The crude oil price fluctuations have no impact on BSE S&P- Auto returns.

In this paper we examine the effect of oil price fluctuation on sectorial stock returns in India; for 20 years from January 2000 to March 2020. We will use Granger causality to capture the bidirectional relations between the oil price fluctuation and sectorial indices returns. The body of the literature concentrated on oil price shocks, considers the effect of oil price shocks on real stock returns Sadorsky (1999). Within a similar framework to that in their paper, Jones and Kaul (1996) incorporate industrial production as a proxy for cash flow. This study examines the causal relationship between daily oil price fluctuations and individual sectorial index stock returns (S&P BSE Auto index, S&P BSE Oil and Gas index and S&P BSE Sensex). The Granger causality approach is useful for investigating the causal relationship between oil prices and other sectorial stock indices.

RESEARCH METHODOLOGY

In order to examine the causal relationship between oil prices and Sectorial stock returns, we operationalised Granger causality test. It uses empirical data sets to find patterns of correlation. We also checked for stationarity of the returns of the sectorial returns using ADF (Augmented Dickey-Fuller) test following Joshi et al. (2022) and Joshi et al. (2023).

The general form of equations are as follows:

$$y_t = \beta_{1,0} + \sum_{i=1}^{p} \beta_{1,i} y_{t-1} + \sum_{j=1}^{p} \beta_{1,p+j} x_{t-j} + e_{1t}$$

$$x_t = \beta_{2,0} + \sum_{i=1}^{p} \beta_{2,i} y_{t-1} + \sum_{j=1}^{p} \beta_{2,p+j} x_{t-j} + e_{2t}$$

$$y_t = \beta_{3,0} + \sum_{i=1}^{p} \beta_{3,i} y_{t-1} + \sum_{j=1}^{p} \beta_{3,p+j} x_{t-j} + e_{3t}$$

$$z_t = \beta_{4,0} + \sum_{i=1}^{p} \beta_{4,i} y_{t-1} + \sum_{j=1}^{p} \beta_{4,p+j} x_{t-j} + e_{4t}$$

$$y_t = \beta_{5,0} + \sum_{i=1}^{p} \beta_{5,i} y_{t-1} + \sum_{j=1}^{p} \beta_{5,p+j} x_{t-j} + e_{5t}$$

$$m_t = \beta_{6,0} + \sum_{i=1}^{p} \beta_{6,i} y_{t-1} + \sum_{j=1}^{p} \beta_{6,p+j} x_{t-j} + e_{6t}$$

In the given set of equations yt represents oil prices and xt, zt, mt refers to S&P BSE Sensex, S&P BSE-Oil and Gas index and S&P BSE-Auto index, where i = 1, 2, 3……p and j = 1, 2, 3 …. p. we have checked that all these time series data is stationary using ADF test. Causality tests aims to answer some simple questions of the type, 'Do changes in x_t cause changes in y_{it}?' The argument follows that if causes y_{it} lags of X_t should be significant in the equation for y_{it}. If this is the case and not vice versa, it would be said that x_t 'Granger causes' y_{it} or that there exists unidirectional causality from X_t to y_{it}. Further I operationalised the two sets of equations simultaneously.

DATA ANALYSIS AND RESULTS

In this paper we examine the effect of oil price fluctuation on sectorial stock returns in India from January 2000 to March 2020. We used a Granger causality to capture the bidirectional relationship between the sectorial indices returns and crude oil price.

We extract data for BSE sectorial indices data from BSE website and for brent crude oil price data are from EIA[3]. Our data includes the daily data for the following indices: S&P BSE Sensex, S&P BSE-Oil & Gas and BSE S&P-Auto and Brent crude oil prices. There are three motivations for choosing this period. First, the oil price fell dramatically in 1998 and recovered after that. Second, this study period includes the recent financial crisis in 2008 and 2009. Third, this period includes the sharp decline in oil prices in 2014[4] (Baumeister et al., 2016). Moreover, the monthly stock price of S&P 500 indices is available from 2000 on the BSE website. An increase in this index captures the higher demand for shipping services resulting from increased economic activities around the world.

Table 1: The Data and Variable Represented

Variables	Proxy	Abbreviation	Definitions
Independent			
Brent crude oil	Crude oil price	Rt-Oil	We have calculated returns of the oil prices.
Dependent			
BSE-Sensex	S&P BSE-Sensex	Rt-Sensex	We have calculated returns of the S&P BSE-Sensex from 2000-2020.
BSE-Oil and Gas	S&P BSE-Oil & Gas	Rt-Oil &	We have calculated returns of the S&P BSE-Oil & Gas index returns from 2000-2020.
BSE-Auto	S&P BSE -Auto	Gas Rt-Auto	We have calculated returns of the S&P BSE-Auto from 2000-2020.
Control			
Market Cap	MCAPINDEX	MCAP	We have calculated the market cap of index by multiplying the outstanding share with daily closing price.
Volume	VOLUME	VOLUMEINDEX	We have calculated the volume of index by multiplying the number of shares traded with daily closing price.

The summary statistics of the data is represented in Table 2.

Table 2: Descriptive Statistics for the Given Variables

Variables	RT_SENSEX	RT_OIL__GAS	RT_AUTO	RT_OIL	MCAPINDEX	VOLUME
Mean	0.000342	0.000389	0.000415	-9.73E-05	23398487	1.84E+11
Median	0.000781	0.000508	0.000901	0.000366	20343472	1.39E+11
Maximum	0.159900	0.174845	0.106266	0.181297	73722620	1.22E+13
Minimum	-0.141017	-0.233233	-0.143339	-0.256389	1658067.	1.19E+08
Std. Dev.	0.014938	0.018086	0.015559	0.023858	19429462	3.65E+11
Skewness	-0.457631	-0.794959	-0.508429	-0.868150	0.791772	25.38149
Jarque-Bera	20213.66	38892.22	7367.034	24281.19	537.9362	1.22E+08
Kurtosis	12.89780	16.69586	8.914046	13.75506	2.650983	772.4027
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1.680209	1.911559	2.038854	-0.477968	1.15E+11	9.01E+14
Sum Sq. Dev.	1.095456	1.605688	1.188458	2.794268	1.85E+18	6.55E+26
Observations	4910	4910	4910	4910	4910	4910

[3] https://www.eia.gov/dnav/pet/hist/rbrteD.htm

[4] https://blogs.worldbank.org/developmenttalk/what-triggered-oil-price-plunge-2014-2016-and-why-it-failed-deliver-economic-impetus-eight-charts

The variable in the study is statistically significant at 95% confidence level. The result of the ADF test shows the series of all sectorial returns are stationary.

We also check the proper lag using Akaike information criterion (AIC) to examine the causal relationship among oil price fluctuations and all sectorial returns using Granger causality test.

Table 3: Presents the Results of Granger-Causality

Pairwise Granger Causality Tests (Lag-8)			
Sample: 1/04/2000 3/31/2020			
Null Hypothesis:	Obs	F-Statistic	Prob.
RT_OIL does not Granger Cause RT_SENSEX	4902	1.70994	**0.0908**
RT_SENSEX does not Granger Cause RT_OIL		2.04249	**0.0380**
Pairwise Granger Causality Tests (Lag-8)			
Sample: 1/04/2000 3/31/2020			
Null Hypothesis:	Obs	F-Statistic	Prob.
RT_OIL does not Granger Cause RT_OIL__GAS	4902	2.36794	**0.0153**
RT_OIL__GAS does not Granger Cause RT_OIL		1.33237	0.2221
Pairwise Granger Causality Tests (Lag-1)			
Sample: 1/04/2000 3/31/2020			
Null Hypothesis:	Obs	F-Statistic	Prob.
RT_OIL does not Granger Cause RT_AUTO	4909	1.49462	0.2216
RT_AUTO does not Granger Cause RT_OIL		2.23457	0.1350

The study regarding Granger causality suggests that there is bidirectional relationship between oil price fluctuations and S&P BSE-Sensex, which state that oil price fluctuation leads to S&P BSE-Sensex and S&P BSE-Sensex leads to oil price fluctuations. Whether there is no bidirectional relationship between oil price fluctuations and S&P BSE-oil and Gas index returns, which state that oil price fluctuations lead S&P BSE-Oil and Gas index returns. With regard to oil price fluctuations and S&P BSE-Auto there is no causal relationship. Hence, we operationalised contemporaneous regression analysis to examine the impact of the oil price fluctuations on the: S&P BSE Sensex, S&P BSE-Oil & Gas and BSE S&P-Auto. The equations for the contemporaneous regression model as follows:

Model - 1 $$RtSensex_{it} = \beta_1 + \beta_2 RtCrudeOil_2 + \beta_3 Mcapindex_{it} + \beta_4 Volume_{it} + u_{it}$$

Model - 2 $$RtOil\&Gas_{it} = \beta_1 + \beta_2 RtCrudeOil_2 + \beta_3 Mcapindex_{it} + \beta_4 Volume_{it} + u_{it}$$

Model - 3 $$RtAuto_{it} = \beta_1 + \beta_2 RtCrudeOil_2 + \beta_3 Mcapindex_{it} + \beta_4 Volume_{it} + u_{it}$$

Where RtSensex, RtOil&Gas and RtAuto refers to the returns of the Sensex, oil and gas index and Auto index respectively. RtCrudeoil refers to oil price returns, Mcapindex and Volume are the sectoral market cap and volume u_t represents disturbance term.

Our first intention was to examine the causal relationship between these variables: oil price fluctuations, S&P BSE Sensex, S&P BSE-Oil & Gas S&P BSE-Auto over time. Therefore, initially we did a Granger causality test which showed statistically significant relationships among them except the S&P BSE-Auto index returns. The results of contemporaneous regression analysis are as follows:

Table 4 (a): Represents Significance Impact of Crude Oil Returns on S&P BSE-Sensex Returns

Dependent Variable: RT_SENSEX				
Method: Least Squares				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.000479	0.000367	1.306033	0.1916
RT_CRUDEOIL	0.089526	0.019202	4.662240	0.0000
MCAPINDEX	-7.67E-12	1.06E-11	-0.725441	0.4682
VOLUME	2.80E-16	2.55E-16	1.097082	0.2727
R-squared	0.020637	Mean dependent var		0.000342

As per the first model we examined the impact of the crude oil prices fluctuations on S&P BSE Sensex returns. The results of the regression analysis suggested that the crude oil price changes have significant positive impact on S&P BSE Sensex.

Other things remain constant: the model explains 2.06% variation in the average value of the returns of the BSE Sensex with R square value of 0.0206. The coefficient of crude oil shows one unit change in crude oil prices and 0.089 unit change in S&P BSE-Sensex returns. The model is significant at 1% level of significance.

Table 4 (b): Represents Impact of Crude Oil Returns on S&P BSE Oil and Gas Index Returns

Dependent Variable: RT_Oil and Gas				
Method: Least Squares				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.000821	0.000460	1.786374	0.0741
RT_CRUDEOIL	0.081376	0.020574	3.955249	0.0001
MCAPINDEX	-1.98E-11	1.35E-11	-1.465768	0.1428
VOLUME	2.19E-16	4.63E-16	0.472195	0.6368
R-squared	0.012115	Mean dependent var		0.000389

Similar to the second model we examined the impact of the crude oil prices returns on S&P BSE Oil and Gas index returns. The results of the regression analysis suggested that the crude oil price changes have significant positive impact on the S&P BSE Oil and Gas index.

Other things remain constant: the model explains 1.21% variation in the average value of the returns of the S&P BSE Oil and Gas index returns with R square value of 0.0121. The coefficient of crude oil shows one unit change in crude oil prices and 0.081 unit change in S&P BSE-Oil & Gas index returns. The model is significant at 1% level of significance.

Table 4 (c): Represents Impact of Crude Oil Returns on S&P BSE-Auto Index Returns

Dependent Variable: RT_AUTO				
Method: Least Squares				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.001069	0.000422	2.536091	0.0112
RT_OIL	0.066820	0.016615	4.021676	0.0001
MCAPINDEX	-2.78E-11	1.33E-11	-2.095100	0.0362
VOLUME	1.94E-17	2.63E-16	0.073816	0.9412
R-squared	0.011989	Mean dependent var		0.000415

Similarly, to the 2nd model we have also examined the impact of the crude oil prices returns on S&P BSE-Auto Index returns. The results of the regression analysis suggested that the crude oil price changes have significant positive impact on the S&P BSE-Auto index after controlling the impact of market cap and volume of the index.

The coefficient of crude oil shows one unit change in crude oil prices and 0.066 unit change in S&P BSE-Auto index returns. The model is significant at 1% level of significance. Further, the model explains 1.19% variation in the average value of S&P BSE-Auto with R square value of 0.0119.

CONCLUSION

Oil price movements are an important and interesting topic to study because increases in oil prices are often indicative of inflationary pressure in the economy which in turn could indicate the future of interest rates and investments of all types. The vast literature establishing robust results across many countries on the connection between oil price shocks and aggregate activity implies that connections should also be held between oil price shocks and stock markets. This study estimates the effects of oil price fluctuations or oil price volatility on the sectorial indices returns of India over 2000–2020 using Granger causality. We find that oil price fluctuations have a statistically significant impact on sectorial stock returns over an entire period. Results from a Granger-causality was not able to confirm that oil price volatility/price fluctuations have causal relationship with other sectorial indices for the study. This result is consistent with the findings of Lee et al (2012). The results of the three-regression model suggest the statistically positive and significant impacts of the crude oil price fluctuation on the sectorial index returns (Rt-Auto and Rt-Oil & Gas) as well as the whole market index (BSE-Sensex).

Implications

This paper provides useful information for traders to execute optimal portfolios across both sectors. As Brent crude oil price fluctuations have a positive impact on auto and oil and gas sector index it gives useful insights for investors to maintain a proper portfolio accordingly.

REFERENCES

Aggarwal, R., Akhigbe, A., & Mohanty, S. K. (2012). Oil price shocks and transportation firm asset prices. *Energy Economics*, *34*(5), 1370-1379.

Agren, M. (2006). *Does oil price uncertainty transmit to stock markets?* (No. 23). Working Paper.

Apergis, N., & Miller, S. M. (2009). Do structural oil-market shocks affect stock prices? *Energy Economics*, *31*(4), 569-575.

Arouri, M. E. H., & Nguyen, D. K. (2010). Oil prices, stock markets and portfolio investment: Evidence from sector analysis in Europe over the last decade. *Energy Policy*, *38*(8), 4528-4539.

Arouri, M. E. H. (2011). Does crude oil move stock markets in Europe? A sector investigation. *Economic Modelling, 28*(4), 1716-1725.

Bachmeier, L. (2008). Monetary policy and the transmission of oil shocks. *Journal of Macroeconomics, 30*(4), 1738-1755.

Basher, S. A., & Sadorsky, P. (2006). Oil price risk and emerging stock markets. *Global Finance Journal, 17*(2), 224-251.

Basher, S. A., Haug, A. A., & Sadorsky, P. (2012). Oil prices, exchange rates and emerging stock markets. *Energy Economics, 34*(1), 227-240.

Baumeister, C., & Kilian, L. (2016). Understanding the decline in the price of oil since June 2014. *Journal of the Association of Environmental and Resource Economists, 3*(1), 131-158.

Bjornland, H. C. (2009). Oil price shocks and stock market booms in an oil exporting country. *Scottish Journal of Political Economy, 56*(2), 232-254.

Boyer, M. M., & Filion, D. (2007). Common and fundamental factors in stock returns of Canadian oil and gas companies. *Energy Economics, 29*(3), 428-453.

Broadstock, D. C., Cao, H., & Zhang, D. (2012). Oil shocks and their impact on energy related stocks in China. *Energy Economics, 34*(6), 1888-1895.

Cameron, K., & Schnusenberg, O. (2009). Oil prices, SUVs, and Iraq: An investigation of automobile manufacturer oil price sensitivity. *Energy Economics, 31*(3), 375-381.

Caporale, G. M., Ali, F. M., & Spagnolo, N. (2015). Oil price uncertainty and sectoral stock returns in China: A time-varying approach. *China Economic Review, 34,* 311-321.

Chen, H., Liu, L., Wang, Y., & Zhu, Y. (2016). Oil price shocks and US dollar exchange rates. *Energy, 112,* 1036-1048.

Chen, S. S. (2009). Oil price pass-through into inflation. *Energy Economics, 31*(1), 126-133.

Cologni, A., & Manera, M. (2009). The asymmetric effects of oil shocks on output growth: A Markov–Switching analysis for the G-7 countries. *Economic Modelling, 26*(1), 1-29.

Cong, R. G., Wei, Y. M., Jiao, J. L., & Fan, Y. (2008). Relationships between oil price shocks and stock market: An empirical analysis from China. *Energy Policy, 36*(9), 3544-3553.

Cunado, J., & de Gracia, F. P. (2014). Oil price shocks and stock market returns: Evidence for some European countries. *Energy Economics, 42,* 365-377.

El-Sharif, I., Brown, D., Burton, B., Nixon, B., & Russell, A. (2005). Evidence on the nature and extent of the relationship between oil prices and equity values in the UK. *Energy Economics, 27*(6), 819-830.

Elyasiani, E., Mansur, I., & Odusami, B. (2011). Oil price shocks and industry stock returns. *Energy Economics, 33*(5), 966-974.

Faff, R. W., & Brailsford, T. J. (1999). Oil price risk and the Australian stock market. *Journal of Energy Finance & Development, 4*(1), 69-87.

Fang, C. R., & You, S. Y. (2014). The impact of oil price shocks on the large emerging countries' stock prices: Evidence from China, India and Russia. *International Review of Economics & Finance, 29,* 330-338.

Filis, G. (2010). Macro economy, stock market and oil prices: Do meaningful relationships exist among their cyclical fluctuations? *Energy Economics, 32*(4), 877-886.

Gjerde, O., & Saettem, F. (1999). Causal relations among stock returns and macroeconomic variables in a small, open economy. *Journal of International Financial Markets, Institutions and Money, 9*(1), 61-74.

Gronwald, M. (2008). Large oil shocks and the US economy: Infrequent incidents with large effects. *The Energy Journal, 29*(1).

Gupta, K. (2016). Oil price shocks, competition, and oil & gas stock returns—Global evidence. *Energy Economics, 57,* 140-153.

Hamilton, J. D. (2003). What is an oil shock? *Journal of Econometrics, 113*(2), 363-398.

Hammoudeh, S., & Li, H. (2005). Oil sensitivity and systematic risk in oil-sensitive stock indices. *Journal of Economics and Business, 57*(1), 1-21.

Hammoudeh, S., & Yuan, Y. (2008). Metal volatility in presence of oil and interest rate shocks. *Energy Economics, 30*(2), 606-620.

Hatemi-J. A., Al Shayeb, A., & Roca, E. (2017). The effect of oil prices on stock prices: Fresh evidence from asymmetric causality tests. *Applied Economics, 49*(16), 1584-1592.

Henriques, I., & Sadorsky, P. (2008). Oil prices and the stock prices of alternative energy companies. *Energy Economics, 30*(3), 998-1010.

Huang, R. D., Masulis, R. W., & Stoll, H. R. (1996). Energy shocks and financial markets. *Journal of Futures Markets, 16*(1), 1-27.

Jawadi, F., Arouri, M. E. H., & Bellalah, M. (2010). Nonlinear linkages between oil and stock markets in developed and emerging countries. *International Journal of Business, 15*(1), 19-31.

Kang, W., de Gracia, F. P., & Ratti, R. A. (2017). Oil price shocks, policy uncertainty, and stock returns of oil and gas corporations. *Journal of International Money and Finance, 70,* 344-359.

Kilian, L., & Park, C. (2009). The impact of oil price shocks on the US stock market. *International Economic Review, 50*(4), 1267-1287.

Kilian, L. (2008). The economic effects of energy price shocks. *Journal of Economic Literature, 46*(4), 871-909.

Kling, J. L. (1985). Oil price shocks and stock market behavior. *The Journal of Portfolio Management, 12*(1), 34-39.

Kristjanpoller, W. D., & Concha, D. (2016). Impact of fuel price fluctuations on airline stock returns. *Applied Energy, 178,* 496-504.

Lardic, S., & Mignon, V. (2008). Oil prices and economic activity: An asymmetric cointegration approach. *Energy Economics, 30*(3), 847-855.

Le, T. H., & Chang, Y. (2015). Effects of oil price shocks on the stock market performance: Do nature of shocks and economies matter? *Energy Economics, 51,* 261-274.

Lee, B. J., Yang, C. W., & Huang, B. N. (2012). Oil price movements and stock markets revisited: A case of sector stock price indexes in the G-7 countries. *Energy Economics, 34*(5), 1284-1300.

Lee, C. C., & Chiu, Y. B. (2011). Oil prices, nuclear energy consumption, and economic growth: New evidence using a heterogeneous panel analysis. *Energy Policy, 39*(4), 2111-2120.

Lee, C. C., Lee, C. C., & Ning, S. L. (2017). Dynamic relationship of oil price shocks and country risks. *Energy Economics, 66,* 571-581.

Li, S. F., Zhu, H. M., & Yu, K. (2012). Oil prices and stock market in China: A sector analysis using panel cointegration with multiple breaks. *Energy Economics, 34*(6), 1951-1958.

Malik, F., & Ewing, B. T. (2009). Volatility transmission between oil prices and equity sector returns. *International Review of Financial Analysis, 18*(3), 95-100.

Malik, F., & Hammoudeh, S. (2007). Shock and volatility transmission in the oil, US and Gulf equity markets. *International Review of Economics & Finance, 16*(3), 357-368.

Managi, S., & Okimoto, T. (2013). Does the price of oil interact with clean energy prices in the stock market? *Japan and the World Economy, 27,* 1-9.

Miller, J. I., & Ratti, R. A. (2009). Crude oil and stock markets: Stability, instability, and bubbles. *Energy Economics, 31*(4), 559-568.

Mohanty, S., Nandha, M., & Bota, G. (2010). Oil shocks and stock returns: The case of the Central and Eastern European (CEE) oil and gas sectors. *Emerging Markets Review, 11*(4), 358-372.

Moya-Martínez, P., Ferrer-Lapeña, R., & Escribano-Sotos, F. (2014). Oil price risk in the Spanish stock market: An industry perspective. *Economic Modelling, 37,* 280-290.

Nandha, M., & Faff, R. (2008). Does oil move equity prices? A global view. *Energy Economics, 30*(3), 986-997.

Narayan, P. K., & Narayan, S. (2010). Modelling the impact of oil prices on Vietnam's stock prices. *Applied Energy, 87*(1), 356-361.

Narayan, P. K., & Sharma, S. S. (2011). New evidence on oil price and firm returns. *Journal of Banking & Finance, 35*(12), 3253-3262.

Papapetrou, E. (2001). Oil price shocks, stock market, economic activity and employment in Greece. *Energy Economics, 23*(5), 511-532.

Park, J., & Ratti, R. A. (2008). Oil price shocks and stock markets in the US and 13 European countries. *Energy Economics, 30*(5), 2587-2608.

Peng, C., Zhu, H., Guo, Y., & Chen, X. (2018). Risk spill-over of international crude oil to China's firms: Evidence from granger causality across quantile. *Energy Economics, 72,* 188-199.

Peng, C., Zhu, H., Jia, X., & You, W. (2017). Stock price synchronicity to oil shocks across quantiles: Evidence from Chinese oil firms. *Economic Modelling, 61,* 248-259.

Sadorsky, P. (1999). Oil price shocks and stock market activity. *Energy Economics, 21*(5), 449-469.

Sadorsky, P. (2001). Risk factors in stock returns of Canadian oil and gas companies. *Energy Economics, 23*(1), 17-28.

Sakaki, H. (2019). Oil price shocks and the equity market: Evidence for the S&P 500 sectoral indices. *Research in International Business and Finance, 49,* 137-155.

Silvapulle, P., Smyth, R., Zhang, X., & Fenech, J. P. (2017). Nonparametric panel data model for crude oil and stock market prices in net oil importing countries. *Energy Economics, 67,* 255-267.

Smyth, R., & Narayan, P. K. (2018). What do we know about oil prices and stock returns? *International Review of Financial Analysis, 57,* 148-156.

Xu, C., & Xie, B. (2015). The impact of oil price on bank profitability in Canada.

Zhao, Y., Li, J., & Yu, L. (2017). A deep learning ensemble approach for crude oil price forecasting. *Energy Economics, 66*, 9-16.

Singhal, S., & Ghosh, S. (2016). Returns and volatility linkages between international crude oil price, metal and other stock indices in India: Evidence from VAR-DCC-GARCH models. *Resources Policy, 50,* 276-288.

Rahmanto, F., Riga, M. H., & Indriana, V. (2016). The effects of crude oil price changes on the Indonesian Stock Market: A sector investigation. *The Indonesian Capital Market Review, 8*(1), p. 2.

Kang, W., de Gracia, F. P., & Ratti, R. A. (2017). Oil price shocks, policy uncertainty, and stock returns of oil and gas corporations. *Journal of International Money and Finance, 70,* 344-359.

Gupta, K. (2016). Oil price shocks, competition, and oil & gas stock returns—Global evidence. *Energy Economics, 57,* 140-153.

Cong, R. G., Wei, Y. M., Jiao, J. L., & Fan, Y. (2008). Relationships between oil price shocks and stock market: An empirical analysis from China. *Energy Policy, 36*(9), 3544-3553.

Tiwari, A. K., Jena, S. K., Mitra, A., & Yoon, S. M. (2018). Impact of oil price risk on sectoral equity markets: Implications on portfolio management. *Energy Economics, 72,* 120-134.

Joshi, N. A., Sharma, N., & Khanuja, A. S. (2022). Relation between open interest and volatility in commodities markets. *Journal of Commerce and Accounting Research*, *11*(3), 10-16.

Joshi, A., & Mehta, D. (2023). Random walk and price convergence in the commodities market in India. *Journal of Commerce and Accounting Research, 12*(2), 18-26.

Tripathi, V., & Kumar, A. (2015). Do macroeconomic variables affect stock returns in BRICS markets? An ARDL approach. *Journal of Commerce and Accounting Research, 4*(2) 1-15.

Habib, M., & Islam, K. U. (2017). Impact of macroeconomic variables on Islamic stock market returns: Evidence from Nifty 50 Shariah Index. *Journal of Commerce and Accounting Research, 6*(1), 37-44.

Kour, M. (2022). Comparative risk-returns analysis of stocks in the Indian stock market. *Journal of Commerce and Accounting Research, 11*(3), 66-73.

Gupta, H. (2020). Stability of beta in various sectors in different phases of stock market. *Journal of Commerce and Accounting Research, 9*(3), 25-32.

Reboredo, J. C., & Rivera-Castro, M. A. (2014). Wavelet-based evidence of the impact of oil prices on stock returns. *International Review of Economics & Finance, 29,* 145-176.

Caporale, G. M., Ali, F. M., & Spagnolo, N. (2015). Oil price uncertainty and sectoral stock returns in China: A time-varying approach. *China Economic Review, 34,* 311-321.

APPENDIX – LAG SELECTION CRITERIA (AIC)

VAR Lag Order Selection Criteria Endogenous Variables: RT_SENSEX						
Exogenous Variables: RT_OIL						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	13707.74	NA	0.000218	-5.592306	-5.590981	-5.591841
1	13712.72	9.954339	0.000218	-5.593930	-5.591279*	-5.593000
2	13714.64	3.830435	0.000218	-5.594303	-5.590327	-5.592908
3	13714.72	0.173041	0.000218	-5.593931	-5.588629	-5.592071
4	13715.09	0.739242	0.000218	-5.593674	-5.587046	-5.591349
5	13715.93	1.678000	0.000218	-5.593609	-5.585656	-5.590818
6	13722.35	12.80851	0.000217	-5.595817	-5.586539	-5.592562
7	13726.18	7.658029	0.000217	-5.596974	-5.586370	-5.593254
8	13728.85	**5.315675***	**0.000217***	**-5.597652***	-5.585723	-5.593467*
VAR Lag Order Selection Criteria Endogenous Variables: RT_OIL__GAS						
Exogenous Variables: RT_OIL						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	12744.87	NA	0.000323	-5.199458	-5.198132	-5.198993
1	12752.04	14.33086	0.000322	-5.201974	-5.199323*	-5.201044
2	12754.54	4.990250	0.000322	-5.202585	-5.198608	-5.201190*
3	12754.74	0.417805	0.000322	-5.202262	-5.196960	-5.200402
4	12754.91	0.340479	0.000322	-5.201924	-5.195296	-5.199599
5	12755.48	1.130708	0.000322	-5.201747	-5.193794	-5.198957
6	12756.40	1.839097	0.000322	-5.201714	-5.192436	-5.198459
7	12761.66	10.49404	0.000322	-5.203451	-5.192847	-5.199730
8	12765.10	**6.880766***	**0.000322***	**-5.204449***	-5.192520	-5.200264
VAR Lag Order Selection Criteria Endogenous Variables: RT_AUTO						
Exogenous Variables: RT_OIL						
Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	13480.64	NA	0.000239	-5.499648	-5.498323	-5.499183
1	13508.66	56.02175	**0.000237***	**-5.510673***	**-5.508022***	**-5.509743***
2	13508.66	0.007662	0.000237	-5.510267	-5.506290	-5.508872
3	13508.72	0.114248	0.000237	-5.509882	-5.504580	-5.508022
4	13508.79	0.137740	0.000237	-5.509502	-5.502875	-5.507177
5	13508.80	0.020829	0.000237	-5.509098	-5.501146	-5.506308
6	13508.87	0.142992	0.000237	-5.508720	-5.499441	-5.505464
7	13513.11	8.453034*	0.000237	-5.510039	-5.499435	-5.506319
8	13513.44	0.671001	0.000237	-5.509768	-5.497839	-5.505583

* Indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion