Assessing The Impact of Energy Price Volatility on Indian Stock Market: Evidence from Energy Intensive Firms

Thesis

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by

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June, 2022

DECLARATION

(By the PhD Research Scholar)

I hereby declare that the Research Thesis entitled "**Assessing the Impact of Energy Price Volatility on Indian Stock Market: Evidence from Energy Intensive Firms**" which is being submitted to the National Institute of Technology Karnataka, Surathkal, in partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy in Management, is a *bonafide report of the research work carried out by me.* The material contained in this Research Thesis has not been submitted to any University or Institution for the award of any degree.

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CERTIFICATE

This is to certify that the Research Thesis entitled "**Assessing the Impact of Energy Price Volatility on Indian Stock Market: Evidence from Energy Intensive Firms**" submitted by Bhagavatula Aruna (Register Number: 165024SM16F02), as the record of research work carried out by her, is *accepted as the Research Thesis submission* in the partial fulfillment of the requirements for the award of the degree of Doctor of Philosophy.

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ABSTRACT

Since 1970s, it was only understood that oil price shock contributed to recession in various economies. But 1986 oil price fall episode made it noticeable realization of the asymmetric impact it holds on the macroeconomic variable in general and stock returns in specific. Various studies examined whether an increase or decrease in oil price has any asymmetric impact on stock returns. Researchers started exploring theoretical justification for the asymmetric impact of oil price shock on stock returns. Further, the relationship between stock returns and oil price shock has been time-varying and accommodated various events which resulted in structural breaks. The present study focuses on impact of various oil price shock on stock returns at firm-level. Data period covered in the study was from January 1995 to December 2020. The four objectives covered in the study includes the asymmetric impact of various oil price shock on stock returns at firm level, the impact of various sources of various oil price shock on stock returns. Further, study examines the time-varying effect of oil price shock on stock returns at firm-level. It also examines whether oil prices can be substituted by coal and electricity.

The current study employs P-SAVR model to examine the asymmetric impact of various oil price shocks on stock returns at firm-level. Also, to investigate the impact of sources of various oil price shocks, study employs P-SVAR. Also, in order to test the relationship between various oil price shocks and stock returns at various time periods, the present study employs Lluis Carrion-i-Silvestre et al. (2005). For structural breaks with cointegration study employs Westerlund and Edgerton (2008), Banerjee and Carrion-i-silvestre (2017). Empirical results suggests that net oil price increase has asymmetric impact on stock returns. On the other hand, the relation between oil price decrease and stock returns is symmetric. The results of second objective suggests that there is a negative relationship between oil supply shock and stock returns, so any disruptions in the supply of oil make oil price uncertain, which, in turn, has a negative impact on stock returns. Third objective results reveal long-run relationship between various oil price shock and stock returns at various structural breaks. The findings of the fourth objective suggest that there is a possibility of inter-fuel substitution in the long run. Further it indicates that oil demand is largely influenced by coal price. This means oil consumption can be substituted by coal consumption.

Keywords: Oil price shock, Asymmetry**,** P-SAVR.

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ABBREVIATION

ARDL - Autoregressive Distributed Lag

BSE - Bombay Stock Exchange

CAPM - Capital Asset Pricing Model

CMIE - Centre for Monitoring Indian Economy

CPI - Consumer Price Index

E-GARCH - Exponential Generalized Autoregressive Conditional Heteroskedasticity

FAVAR - Factor Augmented Vector Autoregrssion

RFF - Federal funds overnight rate

GDP - Gross Domestic Product Dickey-Fuller

GLS - Generalized Least Square

GNP - Gross National Product

HML - High mius Low

IEA - International Energy Agency

IRF - Impulse Response Functions

KPSS - Kwiatkowski–Phillips–Schmidt–Shin

MS-AR - Markov Switching Autoregressive

MSCI - Morgan Stanely Capital International

NSE - National Stock Exchange

OPEC - Oil and Petroleum Exporting Countries

P-SVAR - Panel Structural Vector Autoregression

SMB - Small minus Big

STVAR - Structural Threshold VAR

TBR - Treasury Bonds rate

VAR - Vector Auto-Regressive

VARMA - Vector Autoregressive Moving Average models

WML	-	Wninners minus Losers
WPI	-	Wholesale Price Index
WTI	-	West Texas Intermediate

CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

Oil plays a key role in influencing the economic environment of both developed and emerging economies. Yum Kippur War of 1973, Oil and Petroleum Exporting Countries (OPEC) oil embargo of 1973 and Gulf war of 1991 give evidence to how oil price played a vital role in driving the economy. Being one of the inevitable inputs for production, volatility in oil price can lead to recession, fluctuating inflation and lower economic growth. The increase in the oil price leads to a rise in import bills which results in higher production costs of the firm, which inflates the consumer price index and lead to lower Gross Domestic Product (GDP) (Elyasiani et al. 2011). Volatility in the oil price also affects the performance of the firm as it depends upon macroeconomic status of the country and oil is also a major input in production. By far, the social scientists have studied the impact of oil prices and its fluctuations on the macro economy as well as stock returns for the developed countries because industrialized countries are heavily dependent on oil. Further, political actions, namely, oil embargoes, and formation of cartels by exporting nations can have an adverse effect on these nations. Since 1974, oil prices were extremely volatile affecting the macroeconomic variables such as economic growth, inflation, and balance of payments. The study done by Hamilton (1983) revealed that oil price increase leads to decline in real Gross National Product (GNP). Traditionally, the policymakers and financial investors are very alert regarding the linkage between the price of crude oil and financial volatility for effective designing and implementation of macroeconomic and oil policies as there are no concrete factors which define the relationship between changing oil prices and stock returns (Zeina, 2016).

Oil prices affect stock markets as oil is a fundamental driver of economic activity. Jones et al. (2004) made an interesting point that the magnitude of the impact that oil price shock has on GDP is approximate -0.06 in terms of elasticity. The linkage between crude oil and financial markets has been a crucial issue over the past decade, oil price shocks influence the economic environment to a larger extent, higher oil costs will affect the firm earnings, household balances and overall economic growth. Oil prices can also affect the economy through two channels: first, it will have a drastic effect on the balance of payments of oil importing countries if there is an increase in oil price. Second, through substitution effect, the consumption of households will change. When economy witnesses tremendous volatility in crude oil prices, it can fall into a depression which affects the asset prices. Stating about the relationship between stock market and economic growth and inflation, it was back in the 20th century many researchers have shown interest in determining the relationship between macroeconomic variables and stock returns. For example, Fama (1981) found a positive relationship between stock returns and economic growth of the United States and Japanese, on the contrary negative relationship was observed between the same in the European and South Asian market.

The direction of the reaction of the business firms to the changes in the price of energy resources such as oil is an extensively documented issue in the literature, for example several studies investigated the consequence of the oil price volatility on the investment of the firms (Davis and Haltiwanger, 2001; Edelstein & Killian, 2007; Lee et al. 2011; and Sadath and Acharya, 2015). There are also authors who concentrated on the effect of oil price changes on the stock market (Huang et al. 1996; Jones and Kaul, 1996; Cong et al. 2008; Aloui and Jammazi, 2009; Arouri and Nguyen, 2010). But very few studies such as Acharya and Sadath (2016), Morenor (2017), Kristjanpoller & Concha (2016), Aggaarwal et al. (2012) have focused on whether the size of the firm as a channel in determining its response towards changes in the energy prices such as oil price.

The recent downward trend in crude oil price (2015 to 2018 and 2020) is a testimony to the oil price volatility over the years and volatility in oil price has a substantial effect on the economies as it serves as the major production factors in most of the countries. Oil price shocks can bring about changes in expected cash flows, by affecting the overall economy as well the discount rate used to value equities by changing inflationary expectations. If oil is a crucial factor for an economy, then there can be a correlation between oil prices and the stock prices. According to Huang et al. (1996), if a market is inefficient, it could lead or lag the other market. For example in an efficient market, oil price shocks will have the contagion effect on economic growth of the country and hence earnings are affected. If the market is not efficient then oil market could lag the financial markets.

India stood to be one of the fastest- growing economies in the world, taking GDP and purchasing power parity as a concern, India’s GDP is eleventh largest and third largest in the world, respectively[1]. In the past two decades, Indian stock market has grown tremendously in terms of volume of investment from domestic and international investors.

1 IMF, World Development Indicators database, 2015

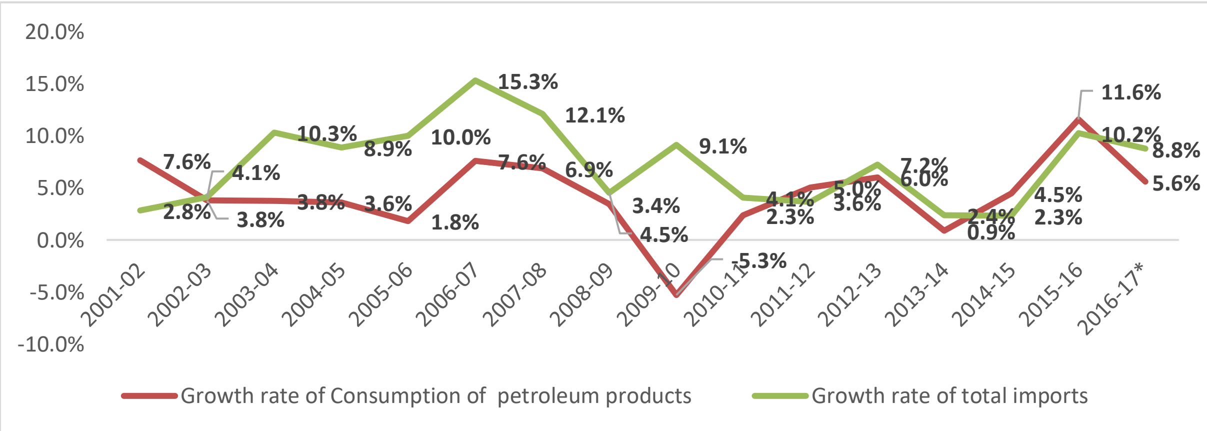
For example, in 2020, India`s total market capitalization stood around Rs. 2.3 trillion. Indian stock market is also now exposed to commodity price volatility, especially crude oil prices. Being primary importer of crude oil, and widening the gap between huge oil demand and a shortage in supply has worsened the current account deficit (CAD). During the low price of crude oil, India`s balance of payments has improved drastically for example, during high price regime (2012-13) the balance of payment deficit was Rs. 479610 crores, an all-time high of 4.8% to GDP. During low price regime (2014-15 and 2015-16). India`s balance of payments deficit was Rs. 162950 crores and Rs. 92481 crores, respectively, reflecting India`s current account deficit to GDP as 1.31 and 1.1 respectively[2]. Reduction in the crude oil price in the international market has revealed both direct and indirect effects on the economy. Direct effect demonstrates in the form of reform measures in fiscal policy by reducing petroleum subsidy. The total amount of petroleum subsidy has come down from Rs. 96880 crores in 2012-13 to Rs. 63427 crores in 2014-15 (Budget estimates) accounting a decrease by 0.47% of GDP. As shown by Acharya and Sadath (2017), a complete removal of energy subsidy would have resulted in an additional inflation of 3.8% during high oil price in 2014, whereas 1.38% inflation during low oil price in December 2015. Indirect effect exhibits in the form of high inflationary pressure in the economy due to a reduction in subsidy given by the government. Measuring the factor that determines stock market returns, serves as useful information to policy makers and investors. Higher oil prices usually have positive impact on most of the oil industry firms, but it has negatively impacted oil refineries and oil-sensitive industries. For these reasons study on the impact of oil price has on stock returns has become wider in financial and energy economics. Crude oil is one of the inevitable inputs in terms of production, there is no concrete factors which influence the oil price shocks, oil price volatility led to recession, excess inflation and lower economic growth. Increase in the oil price leads to rise in import bills which results in higher production costs of the firm, which inflates the consumer price index, and higher import bills lead to lower GDP. By far, social scientists have studied relationship between energy prices and stock returns on the developed countries because industrialized countries are heavily dependent on oil. Further, political actions, namely, oil embargoes, and cartels by exporting nations can have adverse effect on these nations.

1.2 OIL SECTOR IN INDIA:

2 Economic Survey 2016-17.

India`s energy sector had dramatic change over the last twenty-five years since 1991. According to Indian Energy Outlook 2021, India holds the central position in global energy affairs. Energy developments in India transformed the international energy system, and India, in turn, has been increasingly exposed to changes in international markets. For about 80% of India`s energy demand is met by oil. In last two decades, oil consumption and imports in India increased rapidly due to increase in demand from industries. Looking at the consumption pattern of the petroleum products in India, one can observe that consumption of petroleum products has almost doubled in two decades and even imports (only crude oil) rose substantially from 2.5 million barrels per day (mb/d) in 2000-01 to 4.5 mb/d in 2019-20. Ultimately resulting in increase in import dependence growth from 65% to 76%. Increase in population along with a shift from agriculture to industrial economy increased the demand for crude oil. This gives testimony to India's dependence on import of crude oil, hence any volatility in oil price may cause a disturbance in the economy. Increase in demand for oil has led to increase in imports, the growth in the consumption of petroleum products and total imports more or less follows the uniform pattern (Figure 1), except in the year 2009-10, when the consumption of petroleum products showed negative growth (-5.3%), whereas the growth rate of total imports rose to 9.1%.

Figure 3.1: Growth Rate of Oil Price and Total Returns



1.3 THEORETICAL BACKGROUND

This section provides the theoretical support to the relationship between oil prices and stock prices. To explain how stock prices are discounted values of expected cash flows, discounted cash flows valuation is employed. It states that the current price of a stock is the present value of the expected future cash flows discounted at an expected discount rate.

$$P = \frac{E(c)}{E(r)}$$

where P is the stock price, c is the cash flow stream, r is the discount rate, and E is the expected value. Oil prices can have a substantial impact on expected cash flows either through the cost channel or revenue channel. For instance, oil resources being an important input to the production, any unanticipated change in oil price affects the cash flow of the firm. If oil price increases, it leads to an increase in the cost of production and reduces the cash flow of the firm leading to a reduction in the stock price. On the contrary, a reduction in the oil price leads to an increase in the stock price. On the other hand, in terms of the revenue channel, oil resources are also a complementary product for various products, for example, automobiles. If there is an increase in the oil price, it may lead to decline in the revenue of the firm due to decline in the demand for the products of the firm and thereby reducing the cash flow. Therefore, based on both cost and revenue channel, an inverse relationship between oil price and stock price is expected.

Further, oil price affects the stock prices through the discount rates. An increase in the oil price leads to a rise in general price level which prompts the central banks to raise the interest rate. As interest rate is a major factor determining the discount rate, higher interest rate leads to higher discount rate and lower stock prices and vice versa. Further, India being an importer of crude oil, higher oil prices would adversely affect the balance of payments, causing the rupee value to depreciate and increasing the domestic inflation rate. Therefore, the inflation rate is positively linked to the discount rate and negatively related to stock prices. Higher interest rate discourages the investors to expand the business activities and in turn, leads to decline in the stock price. Further, volatility in the oil price increases the riskiness of the oil-intensive companies, leading to higher discount rates and lower stock prices.

Thus, fluctuations in the oil price affect both the numerator and denominator of the present value formula. Higher oil prices lead to lower stock prices and increase in the volatility lead to lower stock prices.

1.4 MOTIVATION FOR THE RESEARCH

According to India Energy Outlook (2015), India has contributed to almost 10% of the increase in global demand since 2000. More than half of the projected increase in global energy consumption from 2012-2040 occurs among the nations of non-OECD Asia, which accounts 83% of energy demand. As a major consumer and importer of oil, fluctuation in oil price can have a drastic impact on the Indian financial markets. For example, India has also been benefited with the fall in the price since 2014; the international crude oil price has reduced to $60 per barrel in 2015 from $135 per barrel in March 2012-2013, which has helped India reduce inflation. Sectors such as chemical, plastic and transportation have benefited from crude oil decrease. The importance of oil to economic growth and financial market has motivated to take up research to study the oil price volatility and its impact on Indian financial market. Stock markets are usually seen as bellwethers of the economy. Hence all these events give testimony that unlike other commodity prices, oil price fluctuation affects the macroeconomic stability of the country.

There is a dearth of research on energy price volatility impact on the Indian stock market. It is obvious from the literature that oil price volatility is usually bad for economic growth, but the direction of the impact on stock returns might vary due to various factors. For example, the impact would be different based on whether oil is an input or an output for a firm. To measure and understand whether oil price negatively or positively affects the different sectors of the stock market, this study needs to be carried. A very few studies have done to measure the impact of oil price volatility on Indian stock market at sectoral level except study done by Lee, Yang and Huang (2012). Thirdly, the findings of the research can be useful for policymakers to switch to energy-efficient resource and reduce the heavy dependence on imported energy.

1.5 THE KNOWLEDGE GAP

From the literature surveyed, it can be concluded that any volatility in oil price affects the production of a firm and ultimately its profitability. Firstly, in the Indian context, to the best of the researcher`s knowledge, very few studies have focused on time-varying factor to analyze the impact of oil price volatility on the Indian Stock market. The findings of the study can also be compared with other emerging economies as how differently they are affected by oil price shock (Baumeister et al., 2010; Cunado et al., 2015; Jimenez-Rodriguez and Sanchez, 2005; Kilian, 2008a). Second, to the best of author`s knowledge, this is the first study which will cover the low oil price period, otherwise study period of previous studies covered the high oil price period in explaining how oil price volatility

3 India Energy Outlook (2015), World Energy Outlook special report.

affected stock market. Third, from the literature review, oil price volatility can influence various aspects of the stock markets, but firm-wise analysis is yet to be performed in the Indian context. Therefore, results obtained will provide sectoral insight into the oil price effect. Authors like El-Sharif et al. (2005); Ghouri (2006); Boyer and Filion (2007) studied oil price shocks on oil-dependent industries like oil and gas sectors. It is revealed that oil price shock is positively related to transportation sector but whether the results are similar to other sectors is not discovered yet. Fourth, very few studies have focused on whether oil can be substituted by electricity and coal. Despite electricity being principal factor of production, there is high dependence on oil especially in emerging countries like India, the main objective is to capture how each energy resource oil and electricity`s price will impact the stock returns in India. This finding will be helpful to identify the energy resource which is less volatile in price, integrates well with financial markets and renewable in nature and can replace the other energy resource in firms. The findings of the study can help investors to hedge against the risk which can be sensed through the volatile price of energy resource and helpful to diversify their portfolio. Lastly, focus on asymmetric responses of economic growth to oil price shocks are traced back to late 1980s.

Most of the literature has focused on gasoline markets e.g., Bettendorf (2009) and Godby et al. (2000). To the best of author`s knowledge, no authors have studied on the asymmetry impact of the oil price at the firm level. The aim of the objective is to measure the oil price asymmetry to various sub-sectors of Indian stock market. According to Killian & Park (2009) mechanism behind these asymmetries is that oil price increases and decreases with oil price volatility which affects the market structure, real consumption growth, and investment decision.

1.6 RESEARCH QUESTIONS

1. Are there any asymmetric effects of oil price shocks on the stock returns?

2. Do different sources of oil price shock impact the stock returns at firm-level?

3. Whether the oil price volatility has an impact on the stock return and does the impact varies over- time?

4. Does oil resource can be substituted by coal and electricity?

1.7 OBJECTIVES OF THE STUDY

This study aims to investigate the oil price volatility impact on Indian stock returns. Additionally, this study aims to observe how firms react to different energy price in India. Following are the objectives of the study:

1. To measure the asymmetric effect of oil price shocks on the stock returns at firm-level.
2. To assess different sources of oil price shock`s impact on stock returns at firm-level.
3. To examine time varying effect of oil price shocks on stock returns at firm-level.
4. To examine whether oil can be substituted by coal and electricity.

1. **To Measure the Asymmetric Effect of Oil Price Shocks on the Stock Returns at Firm-level:**

   This objective attempts to examine whether the impact of oil price volatility resulting from oil price increase and decrease affects the stock market differently. In other words, oil price decline is considered positive for the stock market whereas, an increase is negative. Therefore, this objective analyses the asymmetric effects of large oil price volatility on a stock market.

2. **To Assess Different Sources of Oil Price Shock`s Impact on Stock Returns at Firm-Level**:

   This study analyses the impact of real oil price and decomposition of oil price shock (crude oil supply shock; shock to the global demand for all industrial commodities; and oil specific demand) on Indian stock market. Following the literature, this study recognizes three types of oil shocks in the oil industry. First, the study looks into oil supply shocks which reflect unforeseen changes in quantity. The second type is the aggregate demand shock for industrial commodities arising from business cycle fluctuations. The third is the speculative demand which refelects change in oil inventories. Following Kilian and Murphy (2014), this study distiniguishes from previous works by using shock in oil inventory, and by denoting it as specualitve demand and forward-looking behaviour.

3. **To Examine Time Varying Effect of Oil Price Shocks on Stock Returns at Firm-Level:**

   Third objective of this study is to investigate how the volatility in oil price can impact the stock market in India, the study will cover different time periods, from high oil price to low price period so that one can measure the behaviour of oil price during high and low oil price so that investors can invest wisely during oil price volatility.

4. **To Examine Whether Oil can be Substituted by Coal and Electricity**:

   This study investigates the substitution effect of various energy resources. Specifically, the response of the stock market may not be uniform, different sectors may behave differently depending on the extent of use of the oil products in production and consumption. The substitution effect between energy resources largely depends on whether energy demand is sensitive to other related energy resources' prices. If there is a substitution effect between energy resources, what is the substitution effect's sign and magnitude? Investigating the substitution effect from oil to coal and electricity consumption can provide valuable insight into several facts: first, it allows one to test the substitution between oil, coal, and electricity consumption demand and gives way to adapt a national energy plan, which conserves carbon-intensive energy resources.

1.8 METHODOLOGY

Appropriate panel and time series econometrics techniques will be used in the analysis. In the first stage, panel unit root tests like Levin and Lin (1992) and Levin, Lin and Chu (2002) will be used to test the stationary of the variables. Statistically, the existence of unit root can be problematic because OLS estimates can be biased and in the multivariate framework, one can get spurious regression results. The objective wise methodology proposed for the study is as follows:

1. **To Measure the Asymmetric Effect of Oil Price Shocks on the Stock Returns:**

   With the objective of exploring the asymmetric paradox across firms, Panel Structural Vector Autoregression (P-SVAR) model is employed. First, study the distinguishes between oil price increase and decrease by taking the maximum and minimum of oil price returns. Second, Exponential Generalized Autoregressive Conditional Heteroskedasticity (E-GARCH) to model the oil price volatility is used, and again, the residuals obtained from the model are separated by negative volatility and positive volatility by taking the maximum and minimum of volatility. Third, P-SVAR model involving the oil price changes, stock returns and inflation is constructed. Finally, this study uses impulse response functions (IRF) to solve asymmetry. Study also considers Fama-French variables and inflation as control variables.

2. **To Assess Different Sources of Oil Price Shock`s Impact on Stock Returns at Firm-Level:**

   In order to assess the role of different sources of oil price shock on stock returns, the study proposes the PSVAR methodology. In order to identify structural shocks coming from exogeneous variables (Oil supply, aggregate demand, oil specific demand and oil inventory shock) restrictions on each variable are imposed. These restrictions are imposed based on economic theory so that identification purpose is fulfilled.

3. **To Examine Time Varying Effect of Oil Price Shocks on Stock Returns at Firm-Level:**

   The relationship between various oil price shocks and stock returns at various time periods are tested using Lluis Carrion-i-Silvestre et al. (2005). For structural breaks with cointegration, the study employs Westerlund and Edgerton (2008), Banerjee and Carrion-i-silvestre (2017).

4. **To Examine Whether Oil can be Substituted by Coal and Electricity:**

In this objective, for substitution effect, the study employs Auto-Regressive Distributed Lag (ARDL) and Error Correction Models (ECM) for short and long-run estimation. Before estimating ARDL model, some pre-tests are done so that the data series become suitable for further estimation. The Study analyses using the Augmented Dickey Fuller (ADF) Test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test to analyse the stationary of the variables.

1.9 RESEARCH HYPOTHESES

Hypothesis 1

H0: The relation between various oil price shock and stock returns is symmetric.

H1: The relation between various oil price shock and stock returns is asymmetric.

Hypothesis 2

H0: Different sources of oil price shock do not have significant impact on stock returns.

H1: Different sources of oil price shock do have significant impact on stock returns.

Hypothesis 3

H0: There is no time varying relationship between various oil price shock and stock returns relationship.

H1: There is time varying relationship between various oil price shock and stock returns relationship.

Hypothesis 4

H0: Electricity and coal resource cannot be substituted for oil.

H1: Electricity and coal price can be substituted for oil price.

1.9 DATA

To test the impact of oil price shock stock market at the firm level, the present study considers the companies listed on the Indian stock exchanges. In India, there are two leading stock exchanges, namely, National Stock Exchange (NSE) of India and Bombay Stock Exchange (BSE). Although BSE has more listed companies than NSE based on turnover, the latter is the leading stock exchange in India. Therefore, the study is based on the companies listed in the NSE, covering the period from January 1995 to December 2020. There is a large unbalanced panel of 1768 firms listed in the NSE in which the data has a natural nested grouping. This study selects only those firms which are 'manufacturing energy intensive' and 'non-manufacturing energy intensive'. The following industries are considered 'manufacturing energy-intensive': food, pulp and paper, basic chemical refining, iron & steel, non-ferrous metals, (primarily aluminum and nonmetallic minerals (primarily cement). 'Non-manufacturing energy intensive' industry consists of agriculture, mining and construction. According to the International Energy Agency (IEA), India`s growth in output in manufacturing and non-manufacturing energy intensive firms together amounted to 9.4% in 2016. Therefore, this study considers the closing price of stock returns of 1168 energy intensive firms.These 1168 firms could be hetergeneous in nature (Narayan and Sharma, 2011). In order to avoid any constraint arising from heterogenity of firms, the firms are divided into 23 different energy-intensive sectors. Hence, this study rekons these 24 sectors (Abrasives, Agricultural machinery, Crude oil & natural gas, Diversified automobile, Industrial machinery, Mining & construction equipment etc.) as representative of listed firms. The study used Centre for Monitoring Indian Economy (CMIE) prowess database for extracting underlined stock returns. The study considers the WPI number for oil as a proxy for real oil price[4]. Domestic oil price is used as representation for real oil price. There are two prime reasons for using domestic price of oil as representation for real oil price. The study also uses core inflation as one of the dependent variables, which excludes certain items such as energy prices. Inflation and oil prices data are extracted on a monthly frequency from the Handbook of Statistics of Reserve Bank of India. Before proceeding to any pre-tests, data series about energy price are brought under one constant price of 2004-05 prices, using splicing method. These variables are also termed as 'real oil price' as values are adjusted to inflation. The study also uses Fama-French variables viz. index returns, Small minus Big (SMB), High mius Low (HML) and Wninners minus Losers (WML) as control variables. The data analysis is conducted using statistical analysis software viz. Stata and Gauss.

1.10 SIGNIFICANCE OF THE STUDY

The asymmetric phenomena which were realised in 1986 oil price fall, play very important role in determining the relationship between oil price shock and macroeconomic variables, specifically stock returns. The understanding of asymmetric response of stock returns to oil price shock in India is novel. Hence, assessing the asymmetric relationship between various oil price shock and stock returns will help investors in understanding that shock due to

4Wholesale Price Index (WPI) is broad based measure of inflation in India. For more details about WPI are available at WPI Manual office http://www.eaindustry.nic.in/WPI_ manual.pdf.

decline in oil price may not result in economic boom. As many studies found that the reason for asymmetric response of stock returns towards oil price shock could be that when there is decline in oil price, firms do not switch their current low-cost investments immediately and therefore decline oil price has less effect on stock returns. The study will also contribute in analysing the relationship between oil price shock and stock returns at various time periods. This analysis help policy regulators by giving them insights into events which caused structural breaks in time period.

CHAPTER 2

REVIEW OF LITERATURE

Literature review plays an important role in mapping various research areas in energy scenario of India and other countries, methodology and finally results and policy implications. In order to grasp the various themes, methodology, results and research gaps, this section gives detailed picture of literature covering various aspects of role of energy prices in determining stock market. Impact of oil price shock on Indian stock returns has not been explored much. This further gives motivation to further explore this area.

This section discusses elaborate literature covering various areas related to objectives of the thesis. Section 2.1 provides detailed literature survey on asymmetric impact of oil price shocks on the stock market across firms. Section 2.2 discusses energy consumption response towards energy price change. Section 2.3 gives detailed account on various sources of oil price shock and their relationship with stock returns. Section 2.4 deals with time-varying relationship between various measures of oil price shock and stock returns.

2.1 ASYMMETRIC IMPACT OF OIL PRICE SHOCKS ON STOCK RETURNS

Asymmetric phenomena were understood when the oil price rise in 1979 contributed to recession, but a sharp decline in oil price in 1986 did not result in noticeable economic expansion. It was observed that increase in oil prices has resulted in reallocation of capital and labour from energy-intensive firms. Uncertainty effect and reallocation effect creates asymmetric response of macroeconomic variables to unanticipated change in oil price. This is because these effects escalate response of macroeconomic variables to energy price increase and at the same time oil price decrease of the same magnitude does not amplify response from macroeconomic variables. This section reviews the studies which connect the asymmetric impact of oil price shock and its impact on the stock market of both developed and developing countries. The common perception in energy literature that the impact of unexpected changes in oil price on economy is asymmetric. The increase in oil price could lead to a recession, and at the same time, a decrease in oil price has no stimulating effect or boom. There is a large body of literature that has examined the asymmetric impact of oil price shock on stock returns and the economy.

The initial work by Hamilton (1983) was to examine the whether oil price increase led to recession in the United States, using the sample period from 1948 to 1972. This was the first study which introduced linear measure of oil price shock into existing literature. The aim of the study was to analyse whether oil price increase or decrease influenced as exogeneous explanatory variable. The Study used ordinary least square technique on GNP and unemployment variables. The empirical outcome indicated that an increase in oil price resulted in a significant impact (recession) in the United States than oil price decrease. On the other hand, decline in oil price did not result in expansion.

Mork (1989) extended the study done by Hamilton (1983) by investigating the correlation between oil price decrease and increase and GNP on the United States data from the period 1949 to 1988. The variables used in the study consist of real GNP, treasury bill, unemployment rate and real oil price change. Empirical results have found that there is convincing evidence of the asymmetric impact of an oil price change on economy.

Further, Mork (1994) investigated whether there is any correlation between oil price change and GDP fluctuations for seven countries viz. The United States, Canada, Japan, Germany, France, the United Kingdom and Norway. Study uses the sample period starting from March 1967 to 1992 April across all countries and series. In order to fulfil the purpose, study employed bivariate correlation on variables such as GDP, inflation and net oil price increase. The empirical outcome suggests that there is significant correlation between oil price increases and GDP for most of the Countries except for Germany. There is presence of asymmetry arising from net oil price decrease impact on GDP, as the sign of oil price decrease shows the opposite sign towards GDP.

Similarly, Lee et al. (1995) investigated the impact of oil price change on macroeonomy variables in a period when oil price reported to be stable. The study covers the period from January 1949 to March 1992. This study argue that oil price movement does not predict the stock returns symmetrically. To fulfill the objective, a univariate regression with GARCH is used on real GNP, treasury bill rate, unemployment rate, wage inflation, import price inflation and real oil price changes. The results obtained from time-varying conditional variance suggested that oil price change had significant impact on economic growth at different sample periods.

By making use of Vector Auto-Regressive (VAR) model, Blanchard and Gali (2007) examined impact of oil price increase on inflation and economic activity. The study covers the data period from March 1973 to March 2005. Variables used in the study consists of data on nominal price of oil, Consumer Price Index (CPI), GDP deflator, GDP and employment. Results revealed that effect of oil price shock on GDP, wages, inflation and employment varied over time. However, the oil price showed smaller effect on GDP, wages, inflation and employment.

Hamilton (2008) explored the relationship between oil price increase and the United State`s GDP at various episodes. These episodes stretched from Q1 1974 to Q4 2008, this period coincided with economic recession of the United States. In order to fulfill the objective, study made use of price elasticity of demand and income on consumer price index on services, durables and non-durables and real GDP. The empricial findings suggest that oil price shock contributed to 2007-08 recession in the United States

In order to study an aysmmetric relation between oil and stock returns, An et al. (2014) analysed the asymmetric impact of oil price shock on macroeconomic variables on nonlinear framework. This study not only examines the magnitude of asymmetric effect of oil price shock, but also explained the transmission channels of the oil price shocks. To fulfill the objective, study considered sample period from Q1 1995 to Q6 2006. Study employed Factor Augmented Vector Autoregrssion (FAVAR) model. The study considered balanced panel of 114 quarterely data of real economic activity (GDP, gross savings, private resendial fixed investment, employees on nonfarm payrolls, fed funds rate, housing start, foreign exchange rate, producer price index and consumer price index) and West Texas Intermediate (WTI) crude oil price as independent variables. Empirical results indicate the presence of both positive and negative oil price shock impact. Further, macroeconomic variables are more sensitive to negative impacts of higher oil prices than positive impacts of lower oil price.

Kim et al. (2017) analysed the impact of positive oil price shock on China`s economy. The study focuses on variable of interest as response of China`s interest rate to oil price shock. The data used in the study consisted oil production, real oil price, industrial production, CPI, real exchange rate and interest rate for the period from January 1992 to May 2014. In order to fulfil the objective, study used different econometric approach such as Time-Varying Parameter (TVP), a SVAR model with the short-run identifying restrictions, and a VAR model with ordering free Generalized Impulse Response VAR (GIRF VAR). Empirical results indicate that response of interest rate to oil price shock is time varying. In earlier sample sub-period (April 1992 to October 2001) interest rate was negatively impacted by oil price shocks. Whereas, in the second sub period (November 2001 to May 2014), the response of interest rate is positive towards oil price shock.

Similarly, Acharya and Sadath (2019) examined the oil price shock on macroeconomic variables for the period from Q1 1996 to Q4 2017. The aim of the study was to revisit the relationship between oil price shocks and macroeconomic parameters. In order to fulfil the objective, study considered oil price-change and examined its impact on macroeconomic variables such as real GDP, interest rate and WPI inflation. The empirical results derived out of ARDL and SVAR indicated that GDP is negatively related to oil price shock. On other hand, impact of oil price shock on inflation is not clear.

There are several studies, which examined relationship between oil price shock and stock returns at aggregate, sectoral and at firm-level. For example, Huang et al. (1996) had focused on whether the oil price futures contract had an impact on stock returns covering the period starting from October 1979 to April 1983. The variables used in the study consists of stock returns proxied by the New York Stock Exchange (NYSE) closing prices of 12 sectors and S&P 500index, treasury bill, crude oil and heating oil. In order to fulfill the objective, the study employed VAR framework to account the simultaneous relation between oil price futures, interest rate and stock returns. If the market is inefficient, one market could lead or lag the other market. For example in an efficient market, oil price shocks will have the contagion effect on economic growth of the country and hence earnings are affected. If the market is not efficient then oil market could lag the financial markets. Results suggested that there is no correlation between oil futures and stock market returns.

Later Sadorsky (1999) using VAR on monthly data of the United States industrial production, interest rates, and real oil prices from January 1947 to April 1996, found that oil price and oil price volatility impacted economic activity, but changes in economic activity had little impact on oil prices. These results were later extended by Lee et al. (1995) who found evidence of asymmetry in positive normalized shocks, these have a powerful effect on growth while negative normalized shocks do not.

Clements (2001) using quarterly data of GNP and oil price shock during the period 1952 to 1999, investigated whether there is any asymmetric relation between oil price shock and GNP. Markov Switching Autoregressive (MS-AR) results suggested that asymmetries captured in business cycle were not explicitly caused by a change in oil prices.

Using GARCH effect, Hammoudeh et al. (2004) investigated links between the United States markets of oil prices and S&P oil sector stock indices covering the period from July 17th 1995 to October 10th 2001. This study documented the impact of crude oil prices on different sector stock indices, specifically examining whether there is long-run relationships or co-movements between United States oil prices and the United States oil industry`s sector. This study considered spot WTI crude oil price and future prices consist of New York Crude Oil Price For month 1 (NYCOF1), NYCOF2, NYCOF3, and NYCOF4. To fulfil the objective, univariate Auto-regressive Conditional Heteroskedasticity (ARCH) ARCH/GARCH model is used, based on which results indicated that oil futures had significant effect on the stocks of some oil sectors, whereas it showed insignificant volatility on other sectors.

Focusing on sector, El-Sharif et al. (2005) investigated the associations between the price of crude oil and equity values of oil and gas sectors of U.K stock market for the period from 1st January 1989 to 30th June 2001. Based on the multi-factor model, results indicated that oil and gas stock returns were sensitive to factors such as changes in crude oil prices, movement in the the aggregate stock market and exchange rate. Further, the study found that a rise in oil prices lead to increase in equity returns of the U.K. oil and gas sectors, on the other hand, increase in exchange rate shrinked the equity returns.

Some studies analysed the effect of oil price shock on stock returns across firms. Major studies indicated that oil price shock had an adverse impact on the stock market. For example, a study done by Nandha and Faff (2007) examined the intensity of oil price volatility impact on stock market returns from April 1983 to September 2005, covering 35 sectors. Based on the two-factor 'market and oil' pricing model (Faff and Brailsford, 2000), they found that, in general, oil price volatility negatively impacts equity returns of all the industries leaving some industries such as on mining, and oil and gas. It was surprising to see that sectors such as banking, health care, and insurance sectors were majorly affected by higher oil prices. Overall, the study reveals that international diversified portfolios tend to be risky unless some assets are positively sensitive to oil price changes.

Similarly, Cong et al. (2008) investigated the linkage between oil price volatility and the Chinese stock market for the period from 1996 to 2007. This study reports the non-linear transformations of oil price variables in order to assess the asymmetric relation. The study employed Multivariate VAR framework on United Kingdom Brent crude oil price, exchange rate and Shanghai stock market. Shanghai stock market is represented by two composite indices and 10 classification indices and four oil companies. Based on multivariate VAR, it was found that oil price shock had an adverse impact on manufacturing and oil index the study drew following conclusions: other than manufacturing and oil index, oil price shocks did not fetch any impact. Further study found that though the volatility of oil price did not affect the stock market at the aggregate level as much as it affected at the sectoral level.

There are notable studies that investigated relationship between oil price shock and stock prices of firms of different sectors, A unique study on this line was done by Sadorsky (2008) who examined the impact of oil price on the firms of different size based on a panel dataset of 1500 companies registered in the United States stock market during 1990-2006. Using a multifactor model with Generalized Least Square (GLS) approach, the study had found that bigger firms or oil price negatively affected the stock return, whereas, increase in the market return, interest rate spreads and oil price volatility positively affected the stock return. Oil price volatility was found to have an asymmetric impact on stock returns, a rise in price had a greater impact on stock prices compared to a fall in the price. Further, the impact of oil price volatility was more prominent in the case of medium size firms compared to large and small firms as medium firms do not have either the efficiency of large firms or flexibility of small firms.

Oberndorfer (2009) analyzed the impact of energy market developments and energy stock returns of Eurozone countries for the period January 1, 2002 to August 15, 2007. In order to fullfil the objective, the variables used in the study consists of market return, interest rate, exchange rate, Dow Jones Euro Stoxx oil, coal and gas. Based on GARCH, energy stock returns were not just determined by systematic risk, but also by macroeconomic variables. Further, the study found that oil price affected the oil and gas stock returns positively, while oil volatility affected the oil and gas returns negatively.

Similarly, Edelstein and Kilian (2009) shed light on whether impact of energy price shock became less significant on United States economy, covering the period from February 1970 to July 2006. This study disclosed that monetary and fiscal policy intervention for controling fluctuations in energy price made the United States economy less responsive to energy price shocks. The empricial strategy identified in the study consists of Bivariate VAR model. The analysis suggested that energy price shocks led to shifts in precautionary savings and cost of energy. Study further found that until 1979, linear oil price shocks demonstrated symmetric impct on real consumption. But 1986 oil price drop did not result in economic boom.

Arouri and Nguyen (2010) analyzed the linkages between oil and stock prices at aggregate and sectoral levels for the period from January 01, 1998 to November 13, 2008. The variables included the Dow Jones Stoxx 600 and twelve European sector indices. Based on ARCH effect, the study showed that there was a strong linkage between oil price changes and stock markets. However, the intensity of oil price shock varied from sector to sector.

These findings can give a new approach to researchers, policy makers, and investors to choose those sectors which are less sensitive in nature when oil prices are in turmoil.

Using SVAR methodlogy, Tang et al. (2010) examined the impact of oil price shocks on advanced economies during the period from June 1998 to August 2007. This study gave empirical validation to theory which states supply-side shock effect, inflation effect, real balance effect and unexpected effect can short-term and long-term effect on economic performance of a country. To fulfill the objective, the study employed above mentioned model on real oil price proxied by WTI spot crude oil price, producer price index, real rate of return for industrial companies, real interest rate, real investment toward industry and real industrial added value. Results derived from SVAR framework suggested that oil price increase had negative impact on output and investment, whereas it affected positively on inflation and interest rate.

Exploring sectorwise, Elyasiani et al. (2011) examined the impact of oil returns and oil return volatility on stock returns of 13 United States industries for the period from December 11, 1998, to December 29, 2006. At first, the Fama-French model with conditional volatility as risk determinants were used. The results show that nine out of thirteen sectors were exposed to systematic asset price risk due to oil price volatility. By employing GARCH (1,1) methodology, the study found that oil-substitutes and related industries were more sensitive to oil price return, while oil-user sectors were more sensitive to oil price return volatility. The financial sector was affected by both oil price returns and volatility of oil price returns. Further, the study reveals that variance in industry returns was highly dependent on time.

Examining the oil price volatility in transportation sector, Aggarwal et al. (2012) examined the oil price volatility on 71 major transportation firms of the United States from January 1986 to July 2008. By considering WTI crude oil price, S&P transportation, industry data, study assessed the exposure of firms to oil price uncertainity and the asymmetric impact of oil price shock on stock returns. The Study used Capital Asset Pricing Model (CAPM) on mentioned data from January 1986 to July 2008. Based on the CAPM, results revealed that firms were negatively influenced by oil price volatility.

Ahmed and Wadud (2011) examined the impact of oil price shocks on Malaysian macroeconomic performance. Study documented two measures of oil price shocks: conditional volatility derived from EGARCH and Hamilton`s net oil price increase. To fulfill the objective, study utilized T-bill rate, CPI, federal fund rate, excahnge rate, industrial production index and finally oil price for the sample period from 1986 to 2009. These variables were fit into SVAR framework based on identification and contemporaneous restriction imposed on them. Results obtained from SVAR indicated the presence of asymmetric impact of oil price shocks on condtional oil price volatility. Dynamic IRF show that CPI negatively impacted by oil price shock.

Similarly, Lee et al. (2012), stressed on four variables namely, interest rate, oil price, industrial production index and stock prices from the year 1999 to 2009 for the G7 countries. Based on Sup F testing procedure (Bai et al. 1998), results showed that oil price shocks did not affect the stock prices at the composite level. However, when individual sectors of the stock market were taken into consideration, oil price change did influence some sectors of some G-7 countries. The most affected sectors were information technology sector index followed by consumer staples and transportation sector. Sectors which did not get impacted by oil price shocks were healthcare, industrials, materials, and telecommunication sectors.

Chang and Yu (2013) examined the asymmetric impact of oil price shocks on the stock market. Study documented the nonlinear effects of oil price during high and low volatitlity regimes in stock market. This study utilized MS-AR jump framework, focusing on the response of the S&P 500 composite stock price index with WTI spot oil price shocks. The study considers the time period from January 2^{nd,} 2001 to April 17th, 2012. Study disclosed the response of stock returns to simultaneous and one-period lagged oil shocks. Empirical results derived out of MS-Auto Regressive Jump Intensity (MS-ARJI-GJR-GARCH-X) indicated the existence of asymmetric GARCH effect, this effect also gives scope for better forecasting performance of oil price. Results also indicated the presence of structural shifts while assessing impact of oil price volatility. Further, it was observed that current oil price shock had immediate effect on stock returns, whereas oil price shock at lagged one showcased effect on stock returns through transition probabilities.

Similarly, the study done by Ramos and Veiga (2013) exmined how oil price change can have asymmetrical impact on both oil-importing and oil-exporting countries. The study used data from December 1988 to June 2009 covering 18 Countries, 13 were oil importing and five oil exporting. The results showed that oil price changes had non-linear effects that run in opposite directions for oil-importing and oil-exporting countries. Increase in oil price has a negative impact on the stock market of oil- importing countries, on the other hand, for oil-exporting countries the effect is positive. Any drop in the price of oil had a negative impact on stock markets of oil-importing countries, but the stock market returns of oil-exporting countries fall to an even greater extent.

Managi and Okimoto (2013) also have found positive relationship between oil prices and clean energy prices. The study examined relationships among oil prices, clean energy stock prices and technology stock prices with structural changes in the economy. Based on Markov-Switching Vector Auto-Regressive (MS-VAR) model estimated on data from January 3, 2001, to February 24, 2010, the study identified structural changes in the market during November and December 2007. Further, study has found that there was a positive relationship between oil prices and clean energy prices after structural breaks. The unanticipated structural change affected the associations between oil prices and clean energy markets.

Asteriou & Bashmakova (2013) analyzed the relationship between oil price risk and stock market returns for Czech Republic, Estonia, Hungary, Lithuania, Latvia, Romania, Poland, Russia, Slovakia and Slovenia period covering the period from 22 October 1999 to 23 August 2007. To fulfil the objective, the study employed Threshold Generalised Autoregressive Conditional heteroskedasticity (TGARCH) in CAPM framework. Based on International CAPM, the estimated coefficient of the market beta is positive which showed that positive trade-offs between market risk and stock market returns, further, estimated coefficients for the oil is negative, revealing that increase in oil price decreases stock returns. The impact of oil price changes may not be symmetric across sectors, oil price can have an adverse impact on some sectors.

Similar results were found when Aye et al. (2014) investigated the effect of oil price volatility on the South African manufacturing production sector covering the period from 1974:02 to 2012:12. Based on GARCH-in-Mean VAR (Elder, 1995,2004), the study found a negative and statistically significant coefficient identifying oil price volatility, in other words, negative coefficients suggested oil price negatively impacted on South Africa`s manufacturing production. Further, estimation of IRF showed that positive oil price shock drastically reduced the production of a manufacturing firm in the first month, whereas a negative oil price shock reduced production of the firm slightly.

Analysing asymmetric impact of oil price shock on stock market, Gosh and Kanjilal (2014) explored the nonlinear co-integration between international crude oil price and Indian stock market from the period January 2, 2007 to July 29, 2011. To obtain accurate results, data period was classified into three sub-phases; prior (phase 1), volatile phase (phase 2), and post phase (phase 3). The study employed nonlinear threshold co-integration tests with endogenous structural breaks using (General Heteroskedasticity and Hansen-Jagannathan, 1997) GH and HJ. Further, the study used non-causality by employing Todo and Yamamoto (1995) version of Granger causality tests. Based on these tests, it was found that there was no co-integration among variables for the entire sample period. However, for sub-phases, it was proved that co-integration (GH and HJ) persisted between Indian Stock market, international crude oil price and exchange rate in phase 3 only. The study showed that oil price shocks have an asymmetric impact on the stock market. Further, crude oil price movements indirectly impacted the Indian stock market through inflation, fiscal deficit, and depreciation of rupee.

Similarly, Narayan and Gupta (2015) contributed to energy literature by examining the role of oil price in forecasting stock returns. This study documented nonlinearity of oil price while predicting United States stock returns. To fulfil the same, Granger and Yoon (2002) cointegration technique was employed to differentiate the positive and negative oil prices. The variables used in the study consists of S&P 500 stock market index, and WTI spot crude oil price covering the historical data period from September 1859 to December 2013. In order to predict the stock returns, study used bivariate predictive regression model by Westerlund and Narayan (2012, 2014). Results indicated that oil price shock does predict the United States stock returns. Study also discovered that negative oil price shock predicted stock returns more significantly than positive oil price shock.

To explore how individual country`s stock market responds to change in oil prices, Kumar and Gupta (2014) examined the relationship between oil price and aggregate United States stock returns for over 150 years (1859:10-2013:12). Based on GLS estimation, the study found that oil price predicted the stock returns of the United States. Further, nonlinear nature of oil price was found to be significant, in other words, in the case of prediction, the United States stock returns were more sensitive to negative change in oil prices than to positive change.

The study by Alsalman and Herrera (2015) examined the effect of oil price volatility on the United States stock market for the 49 industry-level portfolios between January 1973 and July 2013. Based upon Kilian and Vigfusson`s (2011) impulse response, the study observed that no asymmetric impact of oil price was found on aggregate stock returns, however, asymmetry was found only in the textile industry. Therefore, sign only determined the direction of the effect on stock returns and in the case of the size of the shock, most of the sectors witnessed the asymmetric effect of oil price volatility.

Focusing on one particular sector, Wan and Kao (2015) elucidated the non linear relationships between oil price and financial sector of the economy. While examining the relatioship between the same, the study considered two financial variables: short-term interest rate and US dollar exchange rate. The interest of the study is to assess whether nonlinear oil price plays any role in financial stress and whether these shocks are uniform in all regimes. This article employed Structural Threshold VAR (STVAR) model of Balke (2000) on lagged oil price, two proxies for short-term interest rate: effective Federal funds overnight rate (RFF) and 3-months Treasury Bonds rate (TB3M), the US dollar exchange rate and a financial stress index. These variables are obtained on monthly basis from 1975M01 to 2014M06. Results indicated that there is negative relationship between oil price shock at all the regimes, confirming the presence of threshold effect of oil price shock on financial variables.

While testing a hypothesis on why the stock market would respond negatively to volatility in oil prices, Le and Chang (2015) examined the impact of oil price volatility on the performance of stock markets in Singapore, Japan and Malaysia from January 1997 to July 2013. The variables used in the study are Dubai crude oil spot price, government treasury returns as proxy for the short-term interest rate and stock price index. Based on causality test results the study showed that at 5% significance level there is no causality running between oil price volatility and stock returns in Japan. Whereas Singapore and Malaysia had positively responded to shocks in oil prices.

In order to explore gasoline, oil and natural gas market, Cochran et al. (2015) analyzed the role of market volatility in calculating the returns and return volatility of oil, gasoline, and natural gas. This study documented Implied Volatility index (VIX) threshold regime to determine the impact of oil price induced VIX on commodity return. Data on energy includes WTI crude oil, heating oil price, gasoline, unleaded regular gas, natural gas and Morgan Stanely Capital International (MSCI) world index, exchange rate and lastly implied VIX covering the period from January 2, 2007 to December 31, 2009. On the basis of Double Threshold (DT) –GARCH (1,1) model, the estimation results showed that volatility in the energy market lead to volatility in the commodity market. Further, VIX was time-varying and witnessed volatility during the financial crisis period of 2007-2009. On the whole, natural gas was less affected by volatility in equity market than rest of the energy commodities.

Bouri (2015) examined the return and volatility linkages between international crude oil price and Lebanese stock market from 02 February 1998 to 30th May 2014. For in-depth analysis, the sample period was further divided into three sub-periods: the pre-crisis period (02 February 1998-28 December 2007), the crisis period (02 January 2008 to 30th June 2009), and the post-crisis period (01 July 2009 to 30 May 2014). Based on bivariate VAR-GARCH model, the study revealed that the interaction between oil price and stock market varied from one sub-period to the other. Further, empirical results showed unidirectional volatility from oil price to stock market return and had a positive impact on stock market returns.

Taking account of manufacturing firms, Sadath and Acharya (2015) investigated impact of oil price increase on manufacturing firms. The study reported that inelastic response demand for energy recources motivated to conduct the study on how energy price had impacted investment of manufacturing firms. To fulfill the objective, this study includes sales revenue, total assests, expenditure on fuel and power of 10989 manfacturing firms, wholesale price index, and GDP. The study considered Generalized Method of Moments (GMM) and Error Correction Model framework. Empirical findings suggested that there is negative impact of energy price on investment of manufacturing firms as a result of caution taken by firms due to rise in energy price.

Bouri et al. (2016) investigated the causality between world oil prices and sectoral equity returns in Jordan from December 2010 to March 2014. The main contribution of this study is that it analysed the impact of oil price on Jordan economy unlike focusing on oil-exporting countries. To fulfill the objective, Vector Autoregressive Moving Average models (VARMA) BEKK-GARCH model is used on Brent crude oil spot prices and three sectoral indices namely: financial, industrials, and services. Based on VARMA BEKK-AGARCH process, results revealed that impact of oil shocks were asymmetric in nature, oil return shocks significantly affected the financial and service sectors but its effect was insignificant in the industrial sectors. The industrial sector was most affected by oil volatility information spills.

By exploring on oil exporting and importing countries, Rafiq et al. (2016) attempted to examine the symmetric and asymmetric impact of oil price shock on trade blalance, oil trade balance and non-oil trade balance of oil exporting and oil importing countries. The study documentated the linear and non-linear panel data econometrics covering the period from 1981 to 2013. Three second generation heterogeneous linear panel models on 28 major oil exporting and 40 oil importing countries. Empirical results suggests that oil price hike increased the oil trade balance of oil exporting countries, but at the same time it increased expenditure which caused decrease in totoal trade and non-oil trade balnces. On the contrary, oil price decline proved benficial for oil exporting countries as the demand for exports increased from importing countires. On the whole, with oil price decline, exporting countries are benefited due to increase in exports.

In order to explore the relationship between crude oil prices and stock market indices for both developed and developing economies, Kayalar et al. (2016) analyzed the relationship between crude oil prices, stock market indices and exchange rate in developed and emerging economies such as Canada, Norway, Australia, Japan, Russia, Brazil, China, India, Turkey and South Africa respectively during 2005-2016. To serve the objective, Auto-Regressive Integrated Moving Average (ARIMA) and GARCH with copula measures were used. Based on this estimation, the study found that among selected countries, most of their stock markets were positively affected by world trade intermediate prices because these countries were energy exporters in nature. For importer countries, stock market indices dependence was less on oil price. Special attention was given to Turkish stock market, results showed that dependence on oil prices found to be positive, however negative relation was reflected between Turkish stock indices and exchange rate. This study was helpful for investors for hedging against the risk and depending upon negative or positive relation, long and short strategies can be designed.

To conclude whether firm size determines the impact of oil price impact, Acharya & Sadath (2016) investigated whether the size of the impact matters in the formulation of the response to the oil price changes by Indian manufacturing firms from the year 1998-99 to 2014-15. Based on the Fama-French model, results showed that firm`s profitability was insulated from the negative impact of the supply side of the shocks brought about by the oil price increases. Therefore there was a positive relationship between the size of the firm and stock return which means that as the firm becomes larger in terms of sales, its stock returns also increase. The study also examined the presence of volatility of energy price and its impact on the stock. The study results showed that there was a negative relationship between the volatility of the price of energy. Hence, most of the studies reported asymmetric impact running from oil price shock to either macro-economic variable, stock prices at aggregate, and firm-level.

A study by Reboredo et al. (2016) investigated the co-movement and causality between oil and renewable energy stock prices using continuous and discrete wavelets. The Study documented dependence of new energy stock returns on oil price shock across several sectors. To fulfill the objective, variables used in the study are spot prices for WTI and three sectoral renewable energy indices (Wilder Hill Clean Energy Index, S&P Global Clean Energy Index, European Renewable Energy Index and NYSE Bloomberg Global Wind Energy Index) covering the period from 2006 to 2015. By using discrete wavelets, estimation results showed that in short-run the interactions between the oil and renewable energy stock returns were weak but eventually became strong during long-run.

Bastianin et al. (2016) examined the effects of crude oil volatility on the stock market of G-7 countries from February 1973 to January 2015. Study disclosed the importance of selecting G7 countries, as these seven are the most advanced economies which account for 64% of net global wealth. The variables used in the study consist of oil supply, aggregate demand, real economic activity. The study also calculated realized volatility from Morgan Stanley Capital International (MSCI) country indices. Based on SVAR, the study found that all countrie`s stock return were volatility resistant towards oil supply shock, on the other hand, aggregate demand shock influenced the stock returns. From policy implication perspective, investors, risk managers, and local policymakers need not pay more attention to oil supply shocks, but immediate action should be taken if economies witness aggregate demand oil shock.

Looking at both aggregate and sectoral level, Alsalman (2016) examined the effect of change in oil price on the United States stock returns at the aggregate and sectoral level. This study examines the response of stock returns to negative and positive oil price to assess the asymmetric response of stock returns to positive and negative oil price shocks. Study considered bivariate GARCH-in mean VAR framework on variables such as real oil price and United States stock returns. Estimation results suggests that volatility in oil price does not significantly affect the stock returns at aggregate level. Even at sectoral level, uncertainty in oil prices has no significant effect on stock returns across almost all industries. The findings reported the reason for companies to hedge against fluctuations in oil price by transferring the higher cost of oil to customers.

Joo & Park (2016) investigated the marginal effect of uncertainty between oil prices and stock index of Japan, Korea, and Hong Kong from 1996-2015. This study documented time-varying relationship between oil price movement and stock index condtioned upon variances into conditional mean equations. Study considered VAR-Dynamic Conditional Correlation (DCC) -Bivariate GARCH-in-Mean framework on stock index prices of mentioned countries and two crude oil prices (WTI and Dubai crude oil prices). Estimated results suggest that oil price uncertainty had a negative impact on stock return which was time-variant, but also indicated the time varying effect of oil price movement on stock returns which higly depend on correlation between stock and oil returns.

In order to examine the causality between the oil market and equity market Maghyereh et al. (2016) examined the volatility connectedness of the same for eleven countries (USA, Canada, United Kingdom, India, Mexico, Japan, Sweden, Russia, South Africa, Germany, and Switzerland) from 2008 to 2015. This study documented risk transfer between oil and equities during the period where shale production played important role in the oil market. VAR-Granger Causality was applied on data consisting of crude oil and equity market of 11 countries. Based on VAR-Granger Causality tests, the study found that for two markets bi-directional between oil and equity was established, however, there was a uni-directional relationship between oil and equity markets.

Bouri et al. (2016) investigated the causality between world oil prices and sectoral equity returns in Jordan from December 2010 to March 2014. Based on GARCH process, results revealed that impact of oil shocks were asymmetric in nature, oil return shocks significantly affected the financial and service sectors but its effect was insignificant in the industrial sectors. The industrial sector was the most affected by oil volatility information spills.

Considering cross-country analysis, Degiannakis et al. (2016) examined the time-varying correlation between stock prices and oil prices for oil-importing countries such as USA, Germany, Netherlands and oil-exporting countries such as Canada, Mexico, Brazil for the period from January 1987 to September 2009. According to DCC-GARCH - Glosten-Jagannathan Runkle (GJR) approach, results showed that due to the business cycle, the precautionary demand side of oil price shocks caused negative or positive correlations, whereas, supply-side shocks does not impact the relationship between the two markets. The presence of the lagged variable in correlation showed that there exists negative cause and effect relationship from oil price shocks to stock markets, an exception to this was observed in 2008 global financial crisis.

Similarly, focusing on airline industry, Kristjanpoller & Concha (2016) analyzed the impact of fuel price volatility on equity returns of airlines between 2008 to 2013. This study documented stock returns of 56 airlines industry as variable of interest and claimed to be first study to examine the impact of oil price movement on airline industry. To capture the impact, the study considered GARCH model on WTI and jet fuel crude oil price. Based on the results obtained from GARCH, the study concluded that fuel price volatility had an impact on airline prices on a daily basis, indicating that volatility in fuel price leads volatility in airline stock prices. Further, it was found that when a market was a bull, increased in oil price lead to increase in asset prices.

Baumeister and Kilian (2016) explored the impact of decline in oil price on the United States real GDP after 2014. This study tried to answer three puzzles: decline in real oil price did not lead to economic boom; decline in oil price resulted a dip only in nonresdential investment; and finally, ecnomic slowdown in the United States led to decline in oil price and ultimately resulted in decline in the United State`s real exports. This study tried to assess the magnitude of oil price shock on economy. To give empirical validation of these above made conjectures, study employed ordinary least square model. Results suggested that decline in oil price stimulated real GDP by 0.7%. Further, study found no evidence of shale oil production deviating the transmission of oil price to the United States economy.

To assess forward-looking nature of oil price shock, Dutta et al. (2017) investigated whether crude oil volatility index impacts the realized stock returns of the Middle East and African stock market. Study documented oil volatitlity index (OVX) and volatility index of S&P 500 (VIX) as forward-looking measure to capture the volatitlity in oil price. In order to validate the impact the oil price uncertainity on stock reurns, study used modified form of the GARCH. Instead of using coventional oil price index, study considered OVX and VIX along with stock prices of five Middle East and seven African stock market indices covering the period from May 10, 2007, to December 31, 2014. OVX and VIX results indicate that there is significant links between oil price uncertainity and stock market volatitlity. Based on GARCH model, the oil market had substantial effects on S&P 500. Additionally, results revealed that stock returns of sample markets are impacted by fluctuations.

Moreno et al. (2017) examined the long-run and short-run relationship between fuel price and the European Union (EU) carbon emissions allowances price changes and value of iron and steel industry in Spanish. Based on Vector Error Correction Model (VECM) estimated on data from 1st January 2013 to 15th September 2015, results of the study found a negative relationship between gas prices and stock prices of metallurgy sector. Further, the study found a weak relationship between gas price and stock price of Iron and steel industry.

Study done by You et al. (2017) considered 14 industries to investigate the impact of oil price shocks and economic policy of China on stock returns. Study also examined the effect of oil price shocks and economic uncertainity on stock returns before and after effects of crisis. This study documented conditional distribution of stock returns. The variables used in the study consists of stock prices of fourteen industries (agriculture, mining, manufacturing, production and supply of power, Heat, Gas and water, construction, wholesale and retail trade, transportation, accomodation and catering etc) from January 1995 to March 2016. The study used dstributional hetergeneity in a panel quantile regression framework. The results suggested that negative oil price shocks brought greater variations in stock returns that positive oil price shock. Further, shock due to oil price increase had significant and negative impact before crisis and eventually becomes negative and significant effect after crisis. Whereas stock returns variations are bullish before the crisis.

2.3 DIFFERENT SOURCES OF OIL PRICE SHOCK IMPACT THE STOCK RETURNS

Fluctuations in oil stock prices are often considered as consequence of change in real oil price. Researchers and investors can find it relevant to potential predictive reasons for oil price change. The importance of decomposition of oil price into oil demand and supply shocks for understanding the transmission of oil price shocks has been propagated by Kilian (2009). The study decomposed real oil price into oil supply shocks, oil demand shocks, and aggregate demand shock covering the period from January 1973 to December 2012. The study reveals that different source of oil price shock have different effects on oil price itself. For example, an increase in precautionary demand for oil immediately increases oil prices. On the other hand, an increase in aggregate demand caused a delayed response in oil price. The shift in oil production caused a small increase in real oil price.

Studying in detail of determinants of oil demand and supply, Hamilton (2009) examined various sources responsible for the increase in crude oil prices. The study uses oil price change, the United States bill rate, and GDP growth rate for four years. Estimation results suggest that oil supply shock does not contribute to macro-economic developments. Extending the work of Killian and Park (2009), Kang et al. (2016) investigated the impact of world supply shocks on the United States stock returns. The study uses variables viz. oil production, index of real economic activity, real oil price and the United States stock returns covering the period from January 1973 to December 2006. Findings suggest that there is a positive association between an increase in oil production and stock returns. Results also reveal that relationship between oil supply shocks and aggregate demand shocks and United States stock returns has changed over time.

Kilian and Murphy (2014) revisited the study on impact of structural shocks by oil supply and aggregate demand by introducing a speculative component of the real oil price. To fulfil the objective, the study uses oil production, economic activity, real oil price, and oil inventories variables. Findings of the SVAR model suggests that speculative oil price shock causes oil price shock at different episodes. Abhyankar et al. (2013) examined various causes leading to oil price shock by employing SVAR. Results show that oil price shock is caused by changes in global demand and positively related to Japanese stock returns. Whereas, oil price increase caused by oil specific demand has a negative impact on stock returns.

Analyzing the effect of oil price volatility on countrywide data, Apergis and Miller (2009) investigated the structural shock of oil price volatility impact on stock market returns in a sample of 8 countries: Australia, Canada, France, Germany, Italy, Japan, U.K., and the United States covering the period from 1981 to 2007. Based on Kilian (2008) methodology and VAR, the study found that oil supply shocks, aggregate demand shocks, and idiosyncratic demand shocks played a vital role in explaining the disturbance in stock market returns from the variance decomposition analysis, but each shock factor had a different level of impact for each country. For example, oil supply shock and aggregate demand shock do not explain the stock returns in Australia, whereas idiosyncratic demand shocks affected the stock returns in Canada at the weaker level. Further, based on Granger temporal causality tests, the study suggested idiosyncratic demand shocks lead to a permanent change in stock market returns, on the other hand, oil supply shock and aggregate demand lead to the temporary change in stock market returns.

Some studies focused on macroeconomic variables in determining the relationship between oil prices and stock prices. For example, Basher et al. (2011) investigated the relationship between the sources of oil price shock, exchange rate, and stock prices at the macroeconomic level for the period of 24 years on the EU. To fulfill the objective, the SVAR model was used on variables such as oil production, real economic activity, real emerging market stock prices, real oil prices, a trade-weighted exchange rate index in US dollars, and an interest rate spread. The study found that dynamic interactions between oil price and exchange rate took place only in the short-run, in other words, increase in oil price had a negative impact on traded-weight exchange rate. Further, the study showed that an increase in oil supply resulted in a decline in oil prices, and on the other hand, an increase in oil demand lead to an increase in oil prices. The global demand shock has a volatile impact on the Indian stock market: it neither has a persistent, positive impact nor a negative impact throughout the horizon, although the effect is statistically significant. This result is not in line with the studies done by Kilian and Park (2009) for the US economy.

VAR methodology was applied by Guntner (2011) to examine the impact of real oil supply and demand shocks on stock market returns for the United States, Japan, Germany, Canada, France, and Norway (OECD Countries) from 1974 to 2011. Above mentioned model is estimated on global supply of crude oil, index of world real activity which is proxied by cargo ocean shipping freight rates, real oil price and real stock returns consisting of S&P 500. Based on the methodology adopted by Kilian and Park (2009), results showed that shortfall in oil supply had no impact on any stock returns, on the other hand, unexpected increase in oil demand increases real oil price which impacts the stock returns of all mentioned countries of OECD.

On the same note, Study done by Gupta and Modise (2013) assessed the impact of different oil price shock on South African stock returns. In order to capture the forward-looking element, study introduces speculative demand shocks which includes shock in oil inventory. To fulfil the objective, study estimated five variables viz. real oil price, global oil production, crude oil inventories, global activity index, and real stock prices for the period 1973 to 2011. Study suggests that there is positive impact of stock returns and global economic activity. But study finds that there is an inverse relation between oil supply shock, speculative demand shock, and stock returns and real oil price.

2.4 TIME-VARYING EFFECT OF OIL PRICE SHOCKS ON STOCK RETURNS

Recently, there have been a growing number of empirical works on regime shifts, applying a MS model to capture nonlinearity and asymmetries which are present in oil price shocks in particular. Many studies showed a non-linear relationship between oil prices and macroeconomic variables, but restricted time series.

Raymond and Rich (1997) analysed the relationship between oil price shock and business cycle fluctuations. Study explicitly addressed the behaviour of output due to changes in oil price. The study used quarterly data on the net real oil price and the United States real GDP for the sample period of 1951 to 1995. In order to measure the shift in the mean group of GDP series and forecast switches between high- and low- growth phases, study applied a Generalized Markov Switching (G-MS) framework. Results indicated that low- growth phase in business cycle is caused by movements in oil price. But generally, oil price did not contribute in determining different phases in business cycle.

Similarly, an analysis done by Clements and Krolzig (2001) assessed the behavior of oil price shock during the recession from January 1953 to April 1994. To fulfil the objective, study considered the oil price, net oil price increase, Lee, Ni, and Ratti (LNR) measure, and GNP variables. Ms-VECM is considered which distinguishes between contractions, normal expansion, and rapid growth. Estimated results suggest that oil prices are not the sole reason for regime-switching behaviour and also asymmetries captured in business cycle are not explicitly caused by oil prices. These results are in line with Raymond and Rich (1997).

To elucidate on the debate as to whether two regimes of oil price shocks in 1973-1974 and 1979 -1980 is cause of recessions witnessed in 1970 and 1980, Holmes and Wang (2001) examined the impact of oil price on growth in the United Kingdom GDP. The study documented the asymmetry from supply side of oil price. The study considered real oil price and GDP covering the sample period from quarter 1 1960 to quarter 1 2000. Results of Hamilton`s regime-switching estimation suggest that asymmetries arising from positive oil price shock reduce the duration of the expansionary phase of the business cycle.

A study was done by Aloui and Jammazi (2009) on how the Crude oil price volatility has an impact on equity markets behavior for Japan, the United Kingdom, France by employing monthly data covering the period from January,1989-Deceber 2007. The main objective is to asses the impact of crude oil at various regimes. To fullfill the objective, study used MS-EGARCH using the variables such as Japan, the United Kingdom and France, and the closing price US price of West Texas Intermediate and European Brent. The results of MS-EGARCH(1,1) suggested that a rise in oil price had a significant impact on stock returns showing low mean-high variance. Further, two episodes of series behavior were observed, one is low mean/high variance regime and the other is high mean/low variance.

Chen (2009) investigated stock return behaviour with movements of oil price. In order to investigate whether higher oil prices push stock returns into bear territory, the study categorized the market into bear and bull. This division may help in capturing the cyclical variations in stock market. Study considers S&P 500 stock price index and various measures of oil price shock variables such as oil price increase, net oil price increase and scaled oil price increase for the period 1957 to 2009. Results of the time-varying transition probability (TVTP) MS model suggests that higher oil price switches stock market from bull to bear market. Also, higher oil prices result in the market staying in the bear market for a longer period.

Some studies focused on the relationship between oil price and overall stock returns across countries to compare findings of one country with the other. To start with, Miller and Ratti (2009) analyzed the long-run relationship between international crude oil price and stock markets of Canada, France, Germany, Italy, United Kingdom, and the United States using data from 1971 to 2008. Applying Co-Integrated VCM with structural breaks after 1980:5, 1988:1 and 1999:9, the study found that there was a long-run relationship between real stock prices of six OECD countries and international oil prices from January 1971 to May 1980 and again from February 1988 and September 1998. The study showed there were positive co-integrating coefficients, in other words, stock prices increased with a decrease in oil price and vice versa. Some studies focused on macroeconomic variables in determining the relationship between oil prices and stock prices.

Chang and Yu (2013) examined the impact of spot crude oil price shocks on stock returns at the composite level from January 2, 2001, to April 17, 2012. To measure the five distinct characteristics of stock returns: high volatility, Glosten, Jagannathan and Runkle (GJR) volatility effect, jump effect, asymmetric distribution, and structural change, MS-AR jump intensity was used. Based on ARJI-GJR-GARCH-X, the study found that GARCH and jump factors behave distinctly during stable periods and crisis periods. The current oil price shock impacts the stock returns differently from that of one-lagged oil price shock.

Balcilar et al. (2015) investigated the relatioship between stock market and US crude oil price in two-regimes. Basically the study divided the data into high and low regimes to suit the MS error correction model. The Study disclosed the importance of conditioning the high and low volatitlity regimes in sample. Sample period takes into account of the episode of drilling of first oil well in September 1958 and stretching to Decemeber 2013. Variables used in the study consist of stock market index (S&P 500) and WTI spot oil price. Empricial results derived out of MS Error correction model suggest that there is cointegration between stock market index and crude oil price. Also, the frequency of high volatitly regime was high prior to great depression of 1973. Whereas, low volatility regime occurred more frquently during first oil price shock from OPEC. IRF analysis reports that there is negative relation between oil price shock and stock prices in high voltility regime and low regime exhibits no relationship.

Caporale et al. (2014) investigated the impact of oil price shock on stock prices of China. This study reported the impact of oil price on stock returns both at sectoral level and individual firms covering the period from January 1, 1997 to February 24 2014. Multivariate dynamic heteroscedastic framework was considered along with bivariate VAR-GARCH-in mean model and finally dynamic conditional correlation on weekly data of stock prices of ten sectors (healthcare, telecommunications, basic materials, consumer services, consumer goods, financials, industrials, oil and gas, utilities, and technology). Estimated results indicated that oil price uncertainity due to demand side pressure impacted stock returns positively for most of the sectors. Whereas, oil price uncertaity owing to supply-side shock had negative impact on only two sectors (consumer services, financials, and oil and gas sectors).

In order to capture the responses of stock returns to oil price shocks, Zhu et al. (2016) analysed the asymmetric impact of different sources of oil price shocks viz. global oil production, real economic activity and real oil prices on the sample period from July 1997 to November 2015. The study considered monthly data consisting of WTI oil spot price, and the stock market price indices in China, India, Japan, South Korea, the US, Brazil, Canada, Mexico, Russia and United Kingdom. Study discussed in detail the results derived out of two- regime Markov Regime-Switching (MRS) panel model and MRS time-series model. Empirical findings suggest that structural oil shock has minimal impact on stock returns at low regime; on the other hand, it has a significant impact during the high regime.

Mensi et al. (2016), examining the impact of macroeconomic factors and country risk ratings on stock returns of six oil rich countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the U.A.E) used a dynamic panel threshold model with two and four regimes on data from November 2005 to July 2014. The data consists of individual stock market indices of the six countries, composite risk rating, political risk rating (PR), global stock price index, Islamic stock price, short and long-term United States interest rate, gold, and oil price. The results show evidence that financial risk ratings have a significant positive effect on stock returns in the prevailing regimes. There is also evidence of short-term asymmetry between Gulf Cooperation Council (GCC) returns at lag one and present GCC stock market

In order to assesee the movements in the variance in various structural shocks in the crude cruel oil market at various time periods, Kang et al. (2016) using the time-varying parameter VAR examined the effects of oil price shock on stock market. For empirical analysis, study uses oil production, index of real economic activity, real oil price, and United States stock returns covering the sample period from January 1968 to December 2012. Study employed SVAR model and imposed identification restrictions for interpretation. Results suggest that the behaviour of shocks are changing over time. The contribution of a global economic shock to stock returns variation in 2009 was the highest among all other shocks (22%). In case of variations of stock returns due to change in oil specific demand gradually rose from 5-12% from 1983 to 2008. Whereas, the contribution of oil supply shock to variation in stock returns showed downtrend from 17% in 1973 to 5% in 2012.

Mohaddes and Pesaran (2016) evaluated the impact of recent falls in oil prices on economy, using inflation and interest rates as variables of interest. The study also re-examined the impact of oil price decline on equity prices. The Study documented different sub-periods of variables such as real oil prices, real equity prices and dividends. The study estimated global VAR on 27 country- specific comprising of net exporters and importers and from Q2 1979 to Q4 2016. The study finds that the relationship between oil price and equity prices has been subjected to turbulence. Whereas stable negative relationship between oil prices and real dividends was showcased throughout sample period.

A similar study was done by Pal and Mitra (2017) who empirically analyzed co-integration between international crude oil price and Indian stock market for the period from January 2, 2003, to July 29, 2011. To test the cointegration, threshold co-integration test was used which permits for the regime shifts due to one endogenous structural break. Co-integration among the variables for the entire sample period was rejected based on GH and HJ tests. Taking alone phase 3, the threshold co-integration test of GH and HJ suggested the presence of a long-run relationship between Indian stock market, International crude oil price, and exchange rate. The subprime financial crisis and extreme volatility in crude oil price gave the testimony of changing empirical relationships of Indian stock market and international crude oil price. Based on Granger Causality test, study showed that there existed unidirectional causality running from oil price to exchange rate in Phase 1. Regarding Phase 2, causality run from oil price to stock market and stock market to exchange rate and while in phase 3, the causality runs from crude oil price to stock market with no feedback effect indicating that global oil price is exogenously determined. In India, the movement of crude oil price indirectly impacted the stock market via the channel of fiscal deficit, inflation, and depreciation of Rupee.

2.4 SUBSITUTION OF OIL WITH COAL AND ELECTRICITY

Recently, substitution between energy fuels grabbed interest in the research community. Researchers have employed various models to analyse the substitution between energy resources. There has been debate on energy and capital substitutability. Although some of the econometric studies have discussed energy structure in the production process, there have been mixed results in inter-factor and inter-fuel substitution. For example, an early study by Hicks and Allen (1934)`s elasticity of substitution shows that energy and capital are perfect substitutes. Some researchers attempted to find whether factors of production can be substituted for each other. Berndt and Woods (1975)`s investigation was an initial study to explore the substitutability between energy and capital covering the period from 1947 to 1971, empirical results suggest that energy and capital are complimentary. Caloghirou et al. (1997) employed the trans-log function to find the trace of substitutability between labour, capital, electricity and non-electrical energy in Greece`s manufacturing industry. Allen elasticities estimation suggests that in short-run all inputs exhibit substitutability. But in the long-run capital and electricity, labour and non- electrical energy form as complementary.

Initial work by Serletis et al. (2010) analysed substitution between energy resources in industrial and residential sectors of selected developing and industrialized countries. Unlike other works, this study only analysed inter-fuel substitution for policy formulation seeking restrain in carbon emissions. In order to fulfil the objective, the study has considered oil, natural gas, coal and electricity for China, India, Italy, South Africa, Thailand, Canada, Venezuela and Turkey on normalized quadratic functional form for the period 1980 to 2006, study gives evidence that inter fuel substitution between coal, oil, gas, and electricity is less than unity indicating weaker substitution.

Similarly, using capital-labor energy and materials (KLEM) translog function on a panel of more than 3000 firms in Italy, Bardazzi et al. (2009) explored substitution between energy and capital on manufacturing firms for the period 2000-2005. Study estimated large and negative own price elasticities for energy by employing trans-log production model. Estimation results indicated that substitutability between energy (diesel, electricity, natural gas, and fuel oil) and labor and complementarity between energy and capital (investment in new technologies). The complementarities between energy and capital deserve some attention, because an increase in energy prices, may discourage capital accumulation by an investor.

Taking technological advancement, Sahu and Narayanan (2011) tried to understand the profitability of firms at various clusters in terms of energy consumption. The motivation stated to carry out the study came from the fact that due to technological advancement, substitution to primary energy consumption has led to difference in profitability of firms. Moreover, this study used different firm size. The variables used in the study consists of manufacturing firms reports in 7 broad categories covering the period from 2000-2008. The primary source of energy consumption consists of natural gas, petroleum and coal, secondary energy sources consist of electricity and capital. The study validates the law of supply and demand using structure-conduct-performance. Estimated results indicated that capital input is positively related to profits of the firms. It is also observed that those firms adopting petroleum and coal are earning more profit than those consuming other energy resources.

Brigida (2014) tried to capture the long-run relationship between natural gas and crude oil prices from October 2004 to September 2012. This study documented cointegrating vector by estimating cointegrating equation and incorporating endogeneneous shifts. This study considered MS co-integrating model with ECM and variables used in this study are prices of natural gas and oil prices. Based on MS co-integrating model, estimation results revealed that there was a stronger relationship between crude oil price and natural gas, indicating energy markets are strongly integrated.

A study done by Bardazzi et al. (2015) analysed substitution methods in electricity, gas oil, fuel oil, and natural gas among small, medium, and large firms. This study claimed the contribution in energy literature by shedding light on response of manufacturing sector to energy prices from 2000 to 2005. To investigate inter-factor and inter-fuel substitution, study employed own, cross and Morishima elasticity model on gas oil, electricity, fuel oil, natural gas on 3425 firms. These firms are categorized into low technology, medium technology, medium technology, high technology. According to estimates, energy demand from small and medium firms are not sensitive to relative energy price change. However, cross-price elasticity suggests complementarity in energy product mix.

Fiorito and Van den Bergh (2015) studied the issue of modelling the substitution between capital and energy. The objective of the study was to investigate the long-run relationship between energy and capital during the period from 1970 to 2005. In order to fulfil the objective, the study considered own, cross and Morishima elasticities (MES) in translog production function framework. The variables in the study consists of energy, materials and services. Empirical findings suggest that there is weak substitutability between energy and capital. Results also suggested that there is general complementarity between the energy and capital.

Batten et al. (2016) focusing on two countries, the study examined the relationship between energy prices and stock market of Japan and China from January 1990 to December 2015. To fulfill the objective, the study employed Internation Capital Asset Pricing Model (ICAPM) on data consisting of portfolios of three energy companies (coal, natural gas and oil) and WTI crude oil price. Using asset pricing and portfolio theory, the study identified linkages between individual and markets and the energy portfolio which was time-varying. Similarly, Lin & Tian (2017) investigated whether China`s light industry witnesses any substitution or complementary between different input factors and fuel sources. This study argued that in order to mitigate energy consumption of non-renewable energy sources, it is important to examine the substitution effect among various energy resources. The study has used the translog function model on variables viz. capital, labor, fuel sources, prices of factor, and energy inputs. The data covers the period from 1980 to 2013. The study found a substitution effect on energy resources.

Ulusoy and Demiralay (2017) investigated the impact of stock market development on oil and electricity demand in OECD members from 1996 to 2011. This study contributed to energy literature by examining the nexus between oil and electricity demand and stock market. The study employed Partial Adjustment Model (PAM) and GMM on income proxied by GDP per capita, oil consumption, electric power consumption and stock market. Based on PAM, the study found that long-run elasticities were larger than short-run elasticities suggesting energy demand is not impacted by price, income, and the stock market. Additionally, GMM results revealed that energy demand is sensitive to income, size and liquidity variables. Therefore two of the stock market developmental factors, namely size and liquidity is the reason behind an expansion of energy demand in OECD Countries.

2.6 CONCLUDING REMARKS

From the literature survey, it is realised that asymmetric relation between oil price shock and stock returns does exist at global level, but in Indian context many studies are still exploring the asymmetric relation between oil price shock and stock returns and various factors which contribute to this. Consequences of asymmetric impact of oil price shock on Indian stock returns also leave room for concrete policy implications to stabilize Indian economy. Therefore, this study examines the asymmetric impact of oil price shock on Indian stock returns across firms. Regarding reaction of energy consumption to its prices, most of the studies examined inter-factor substitution effect at global level, but present study analyses solely on inter-fuel substitution taking an account of energy resources such as oil, electricity and coal. Third objective is about whether different sources of oil price shock hold a significant impact on stock returns. Most of the studies, whether analysing single or cross country had consensus that different sources of oil price shock had significant impact on variable of interest. The present study takes into account of oil inventory variable as forward-looking shock, which most of the studies ignored. Last objective deals with time-varying impact of oil price shock on stock returns, studies so far employed Markov Switching methodology to capture the impact at various regime. Most of the studies considered time-series data, the present study considers panel data employing third generation panel models in order to capture structural breaks. In the following chapters, detailed methodology for each objective is explained.

CHAPTER 3

ASSYMETRIC IMPACT OF OIL PRICE SHOCKS ON THE INDIAN STOCK RETURNS AT FIRM-LEVEL

3.1 INTRODUCTION

The dramatic increase in oil price could depress economies and lead to recession, but there is no significant study which showed that oil price decrease could stimulate the economy. This episode is academically defined as the asymmetric effect of oil price shocks. For example, Hamilton (2003) explained that in the short-run, oil price decrease might not bring a boom in the economy. An increase in oil price depresses the demand for some goods in the short-run; it is very much likely that an oil price decrease also decreases demand for some other sectors. Oil price shock can make consumers and investors unsure of future and postpone the consumption and investment in automobiles and other energy-intensive sectors. This gives evidence of irreversible investment.

There have been some episodes of oil price turbulence from 2010 to 2014. For example, the events of the Libyan uprising in 2011 led to a hike in oil price, followed by tensions in Iran in 2012. There was also a widening of the gap between the prices of Brent and West Texas Intermediate (WTI) prices. In the year 2014 and 2015, there were events of a drastic decline in oil price. The recent phenomenon of low international oil price is attributed to various factors: first, the shale production which started in 2010 led to a rise in the production level of oil and natural gas. As a result, the United States entered the market in 2016 by exporting crude oil and natural gas. Second, there was a decline in the global real economic activity from 2014, and third, there was an unexpected emergence of oil production from other countries such as Canada and Russia. As a result, the oil price reduced to $60 per barrel in 2015, the lowest price since July 2002. The traditional analysis states that the lower oil price is beneficial for importing countries, but this theory is only applicable to oil-based industries such as transportation sector, chemical companies, rubber, and plastic producers.

Oil plays a key role in influencing the economic environment of both developed and emerging economies. As the stock market which is a forerunner of the economy and also it correlates with macroeconomic factors such as the interest rate and inflation, it is interesting to know the theoretical relation between oil price and the stock market. First, an increase in oil price increases the cost of petroleum products, therefore increases the cost of production and reduces the cash flow of the firm leading to a reduction in the stock price.

Second, an increase in oil price increases transportation costs and leads to inflation especially when a country is an oil importer. On the other hand, in terms of the revenue channel, oil resources are also a complementary product for various products; for example, automobiles. If there is an increase in the oil price, it may lead to decline in the revenue of the firm due to decline in the demand for the products of the firm and thereby reducing the cash flow. Therefore, based on both cost and revenue channel, an inverse relationship between oil price and stock price is expected.

The present study reconsiders the asymmetric impact of oil price shocks on stock returns at the firm level. The present study analyzes whether stock returns are asymmetric towards oil price shock in the presence of inflation, hence to record how stock returns at firm level reacts to oil price shock keeping inflation as the catalyst. This study considers the impact of various linear and non-linear measures of oil price shocks on firm-level stock returns using PSVAR. India is chosen as an example because it is one of the rapidly growing economies in the world. Taking the example of GDP and GDP on purchasing power parity (PPP) as a concern, India's GDP is sixth and third largest in the world, respectively[5]. According to the Indian Energy Outlook (2015), India holds a central position in global energy affairs. Energy developments in India have transformed the international energy system, which in turn has increasingly exposed India to changes in the international markets. India accounts for almost 10% of the increase in global oil demand since 2000, which motivates to carry out the research. The present study attempts to explore the possible asymmetric influence of oil price on the firms listed in the Indian stock market.

The present study gives insights on whether oil price shock could cut through at firm-level stock returns, and if so, what is the sign of the oil price shocks towards stock returns. Examining the relation between the stock market and oil price using firm-level data can provide valuable insight from several facts. First, it allows one to test the significance of the asymmetric impact of oil price. Second, the comparison of firm-level return and its determinants on their sensitives towards oil price fluctuation can give valuable insights to the firm`s features. Therefore, such conjecture cannot be made using an aggregate market or sectoral level data. From the discussion on the role of oil price in stock markets, the previous empirical analysis was conducted mainly with the asymmetric impact of oil price shock on macroeconomic variables. Also, interestingly, several studies have empirically

[5] Economic Survey 2016-17, prepared and released by Ministry of Finance, Government of India.

evaluated the asymmetric impact of oil price on stock returns on oil exporting and importing countries. The present study aspires to highlight two key issues, the asymmetric impact of different weights of oil price shocks on stock returns and its determinants using inflation as the catalyst. In particular, the study intends to explore the panel framework employing the panel Structural VAR model. The findings will help to assess whether inflation being catalyst reacts more to increase than to decrease in the price of energy resource. With the objective of exploring the asymmetric paradox across firms, the study combines the GMM and P-SVAR. Oil price increase and decrease is distinguished by taking the maximum and minimum of oil price returns. Second, the study uses E-GARCH to model the oil price volatility, and again the residual obtained from the model are separated by negative volatility and positive volatility by taking the maximum and minimum of volatility. Third, PSVAR-X model is used involving the oil price changes, stock returns, and inflation. Finally, the study employs impulse response functions to assess the asymmetry.

3.2 DATA DESCRIPTION

To test the asymmetric effect of oil price shocks on the stock market at firm level, the present study uses companies listed on the Indian stock exchanges. In India, there are two leading stock exchanges, namely, National Stock Exchange (NSE) of India and Bombay Stock Exchange (BSE). Although BSE has more listed companies than NSE, based on turnover, the latter is the leading stock exchange in India. Therefore, the study is based on the companies listed on the NSE during January 1995 to December 2020.

There is a large unbalanced panel of 1768 firms listed on the NSE in which the data has a natural nested grouping. The present study selects only those firms which are 'manufacturing energy-intensive' and 'non-manufacturing energy-intensive'. Food, pulp and paper, basic chemical refining, iron and steel, non-ferrous metals (primarily aluminum and nonmetallic minerals (primarily cement) are considered as manufacturing energy-intensive industries. Non-manufacturing energy-intensive industries include agriculture, mining and construction. According to the International Energy Agency (IEA), "India's growth in output in manufacturing and non-manufacturing energy-intensive firms together amounted to 9.4% in 2016." The present study considers the closing price of stock returns of 1168 energy-intensive firms, which could be hetergeneous in nature (Narayan and Sharma, 2011). In order to avoid any constraint arising from the heterogenity of firms, firms are divided into 24 different energy-intensive sectors such as abrasives, agricultural machinery, crude oil and natural gas, diversified automobile, industrial machinery, mining and construction equipment, etc. These 24 sectors include abrasives, agricultural machinery, air-conditioners & refrigerators, aluminium & aluminium products, bakery products, boilers & turbines, cement, commercial vehicles, conventional electricity, copper & copper products, crude oil & natural gas, diversified automobile, diversified machinery, engines, industrial machinery, inorganic chemicals, machine tools, mining & construction equipment, miscellaneous electrical machinery, organic chemicals, other ferrous metal products, other non-ferrous metals & metal products, refinery, steel. The present study uses the WPI number for oil as a proxy for real oil price[6] and domestic oil price as a representation of the real oil price.

There are two reasons for using domestic price of oil as a representation for real oil price. First, the performance of Indian firms depends on the change in or shock to domestic oil prices rather than to global oil prices such as West Texas Intermediate (WTI) and European Brent spot price. The cost of production of domestic firms depends upon domestic oil price. Increase in domestic oil price leads to higher cost of production and reduces the cash flow of the firm, leading to a reduction in the stock price. Second, even though covid-19 pandemic led to catastrophic impact on the global oil price, India did not witness any downtrend in oil price. As domestic oil prices are totally engineered by the government, high domestic prices are entirely due to imposition of high taxes. Third, any change/shock witnessed in oil prices represented by WTI or European Brent spot price is not reflected in oil prices represented by domestic WPI number. This is because oil distributors are liable to pay heavy taxes apart from import price as also because of subsidy termination by the Indian government.[7]

The present study uses core inflation as one of the dependent variables, which excludes certain items such as energy prices. This is because these energy prices tend to show a volatile movement and also because energy prices are highly correlated with inflation (Salisu et al. 2017). Inflation data is extracted from the Handbook of Statistics of Reserve Bank of India at monthly series. Before proceeding to any pre-tests, the data series are brought under one constant price of 2004-05 prices, using splicing method. These variables are also called 'real oil price', as values are adjusted to inflation.

6 WPI is a broad-based measure of inflation in India. More details about WPI are available at http://www.eaindustry.nic.in/WPI_ manual.pdf

7Subsidy on petrol was discontinued by the Indian government on June 25, 2010 and public sector units oil companies were allowed public sector units oil companies to price petrol freely.

3.3 METHODOLOGY

The traditional theory of predicting stock returns, the CAPM was proposed by Lintner (1965), Sharpe (1964), and Mossin (1966). It explains the variation in the return of an individual equity share by measuring its covariance with the market portfolio. Thus, the beta of security measures the risk-reward profile of individual security concerning the broad-based market. However, the single factor standard CAPM soon proved to be inadequate to explain individual security return. Therefore, a multifactor asset pricing model was developed in the 1970s when anomalies in the stock market return which could not be captured by the standard CAPM. For example, Basu (1977) observed that low price-earning (PE) ratio stocks were earning a higher return than the high PE ratio compared with the prediction of the CAPM. Jegadeesh (1990) gave much more clarity to stock market anomalies by explaining the momentum effect, stating that stocks which fetched more returns in the past continued to do so and vice versa. Considering that CAPM failed to capture these anomalies, a multifactor model was developed by Fama and French (1993). Later, discussing the momentum effect on the stock market, Carhart (1997) extended the original three-factor Fama-French model. Major determinants of stock returns from an asset pricing model perspective, the Fama-French model gave a theoretical background for analyzing the relationship between stock prices and oil prices. Hence, Fama-French four factors viz. Index returns, SMB, HML, and WML, are included in the GMM and Panel SVAR model.

Present study employs the Fama-French (1993) and the Carhart (1997) four-factor model to specify the stock returns determinants as follows:

$$(R_{it}-RF_t)=C+\beta_1\left[R_{Mt}-R_{Ft}\right]+\beta_2 SMB_{mt}+\beta_3 HML_{mt}+\beta_4 WML_{mt}+\varepsilon_{it} \qquad ...(3.1)$$

Where R_{it} stands for daily return on stock i at time t, return on stock is calculated by taking first difference of natural log of stock prices, RF_t is the daily interest rate of government securities at time t and R_{Mt} stands for calculated return on the market index at time t. SMB_{mt} (small minus big) imitates the difference between the returns on portfolios of small and big stocks. HML_{mt} (high minus low) imitates the difference between the portfolio of stocks with a high book to the market value of equity and the return on a portfolio of stocks with low book to market values. WML_{mt} (winners minus losers) imitates the difference between the return on the portfolio of stocks with high momentum and the return on a portfolio of stocks with low momentum. The ε_{it} in regression stands for error term. The time frame from January 1995 to December 2020 has been considered for monthly stock returns and index returns.[8]

To obtain SMB and HML, the book value and market capitalization are extracted for the financial year closing, i.e., 31st March for companies listed on the NSE. The size category is formed based on the market capitalization using certain breakpoints starting from the bottom 30% termed as small, middle-sized 40% termed as medium (M), and topmost 30% termed as big (B). Following the above notion, SMB is formed by taking the simple average difference between three small stock portfolios and three big stock portfolios. The BE/ME category is formed by dividing the book value per share by the market value per share, and then breakpoint was formed by denoting the top 30% as high (H), the middle 40% as medium (M), and the bottom 30% as low (L). The HML is obtained by taking the simple average difference between the three high BE/ME and the three low BE/ME companies. Last, the WML is calculated on the momentum of stock returns. The present study categorizes the momentum on breakpoints of the bottom 30% as low momentum (LM), the middle 40% as medium momentum (MM), and the top 30% as high momentum (HM). So, the simple average difference between the three winners and the three losing portfolios provided the WML. The SMB, HML, and WML are expected to mimic the return difference in portfolios based on size, BE/ME ratio, and momentum, respectively. Considering the anomalies in the standard CAPM, these variables are expected to have explanatory power in the asset pricing model.

3.3.1 Measuring Oil Price Shocks

There are some measures of oil price shocks that are used in the energy economics literature. The work of Hamilton (1983) assessed the energy price shock, particularly the oil price using the log difference of oil price at a nominal rate. Mork (1989) on the other hand, treated oil price increase and decrease by differentiating between positive and negative changes in oil price. Hamilton (1996) propagated that net oil price increase or decrease is calculated as maximum or minimum of oil price in the previous 12 months. Following Hamilton (1996), net oil price increase is calculated in the following way:

$NOILPI_t = \text{Maximum}\ \{0, (\ln(OILP_t) - \ln(OILP_{t-12})\}$ ...(3.2)

$NOILPD_t = \text{Minimum}\ \{0, (\ln(OILP_t) - \ln(OILP_{t-12})\}$ ...(3.3)

[8] The data about stock prices and Index returns are taken from CMIE prowess database every month. Stock prices are converted into stock returns by converting the log of the first difference.

3.3.2 Oil Price Shock-Modelling

There was a traditional method of modeling oil price shock by Ferderer (1996). He modeled oil price shock by taking the standard deviation of the oil price. Some authors opposing the standard deviation of oil price used the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) (1,1) for modeling oil price shock (Lee et al. 1995). In the present study, the Exponential-GARCH (E-GARCH) introduced by Nelson (1991) is adopted. The coherence of preferring E-GARCH over GARCH is two-fold, first, while modeling oil price shock, GARCH (1,1) treats the positive and negative error terms symmetric on shock, but oil price shock may turn out to be asymmetric due to its behaviour. In other words, in the GARCH (1,1) model, both the good news and the bad news does not make any difference. Second, the parameter restrictions imposed on the models to ensure non-negative of condition of variance is violated by the coefficients. On the other hand, E-GARCH is stated in log form for variables, which means the model is free from parameter restrictions and E-GARCH is specified as:

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} + \sum_{k=1}^{m} \theta_k \ln(\sigma_{t-k}^2) \qquad ...(3.4)$$

$$\ln(h_t) = \alpha_0 + \beta_1 \ln(h_{t-1}) + \alpha_1 \left(\left| \frac{u_{t-1}}{h_{t-1}} \right| + \gamma \left| \frac{u_{t-1}}{h_{t-1}} \right| \right) \qquad ...(3.5)$$

Where h_t is specified as the conditional volatility of the oil price and α_0 is the unconditional variance with constant mean. So, the shocks due to oil price decrease will have an influence on α_1-γ and in the present study, this has been specified as Oil price Shock-Negative, and shock due to increase in oil price increase will influence α_1+γ and has been specified as Oil price shock-Positive.

The shock into positive and negative are categorized in the following way:

$$\text{OILSHOCK-P} = \text{Max}\left(0, \frac{u_{t-1}}{h_{t-1}}\right) \ \& \ \text{OILSHOCK-N} = \text{Min}\left(0, \frac{u_{t-1}}{h_{t-1}}\right) \qquad ...(3.6)$$

Thus, six dimensions of oil price shocks as Oil Price-Change, Oil Price Shock, Oil Price Shock due to increase in oil price, shock due to oil price decrease, Net Oil Price Increase and Net Oil price decrease are constructed.

3.3.3 Econometric Analysis

This section describes the econometric estimation and identification of the structural dynamics of the panel data. Before proceeding to the main model, in empirical research, it is inevitable to do some pre-tests so that the data series becomes suitable for further estimation. Regarding micro panel data with large N, correcting the non-stationarity of panel data series is very crucial. The pre-tests are begun by testing the stationarity of variables by using panel unit root tests such as Levin and Lin (LLC, 1992) I'm, Pesaran and Shin W- Stat (IPS) and Hadri tests. The null hypotheses of LLC and IPS assume that the panel data series has unit root against the alternative hypothesis of no unit root. What distinguishes LLC from IPS is that the former test assumes common unit root covering all cross-sections. Whereas, heterogeneity in the unit root procedure of individual data is allowed in the IPS unit root tests. The present study uses Levin and Lin (1992), and I'm, Pesaran and Shin W- Stat.

Further, the present study employs the Durbin-Wu-Hausman tests to detect the presence of endogeneity in the explanatory variables. According to the econometric theory, explanatory variables should not correlate with the error term. A Durbin-Wu-Hausman test is generally used on OLS to detect for the same reason. In the present study, the standard model was estimated with various oil price shocks, and is expressed in the following equations:

$$(R_{it}-RF_t)=C+\beta_1\left[R_{Mt}-R_{Ft}\right]+\beta_2 SMB_{mt}+\beta_3 HML_{mt}+\beta_4 WML_{mt}+\beta_5 WPI_t+\varepsilon_{it} \quad ...(3.7)$$

$$(R_{it}-RF_t)=C+\beta_1\left[R_{Mt}-R_{Ft}\right]+\beta_2 SMB_{mt}+\beta_3 HML_{mt}+\beta_4 WML_{mt}+\beta_5 WPI_t+\beta_6 Oilprice+\varepsilon_{it}$$

..(3.8) $$(R_{it}-RF_t)=C+\beta_1\left[R_{Mt}-R_{Ft}\right]+\beta_2 SMB_{mt}+\beta_3 HML_{mt}+\beta_4 WML_{mt}+\beta_5 WPI_t+\beta_6 Oilprice_t+\beta_7 Oilshock_t+\varepsilon_{it}$$

...(3.9)

To test whether each explanatory variable is endogenous or exogenous, the regression on each explanatory variable is estimated to diagnose residuals from it. In the process, the independent variable has become a dependent variable. The next step is to diagnose whether the coefficients of residuals are significant. The null hypothesis assumes the individual explanatory variables as exogenous in the system. From the test results, explanatory variables such as SMB, HML, index return, inflation, oil shock, shock due to an oil price increase and shock due to oil price decrease were found to be endogenous, and the rest of the variables were found to be exogenous. To correct endogeneity, instrument variables for the lagged dependent variables and other non-exogenous variables are used in the study. The present study considers GMM, developed by Arellano and Bond (1991). So, in the standard model, a dependent variable with a lag is treated as one of the independent variables, i.e., stock returns. The lagged values of the dependent variable is treated as an instrument variable so that these internal variables corrects the issue of correlation between the explanatory variables and the error term. The present study follows the two-step estimation because the first difference transformation could lead to loss of the degrees of freedom. On the other hand, in the two-stage least square estimators, from a particular variable, the average of all future variables is subtracted. GMM takes care of data loss, and also provides efficient and consistent estimates. It is suitable when the N (Cross-section) dimension is larger than the T (Time series) dimension.

The two-step GMM has been specified in equations 10 and 11:

$$(R_{it}-RF)_t = C + (R_{it-1}-RF_{t-1}) + (R_{it-2}-RF_{t-2}) + \beta_1\left[R_{Mt}-R_{Ft}\right] + \beta_2 SMB_{mt} + \beta_3 HML_{mt} + \beta_4 WML_{mt} + \beta_5 WPI_t + Oilprice_t + \varepsilon_t$$

(3.10)

$$(R_{it}-RF)_t = C + (R_{it-1}-RF_{t-1}) + (R_{it-2}-RF_{t-2}) + \beta_1\left[R_{Mt}-R_{Ft}\right] + \beta_2 SMB_{mt} + \beta_3 HML_{mt} + \beta_4 WML_{mt} + \beta_5 WPI_t + oilshock_t + \varepsilon_{it}$$

(3.11)

Here, $oilvol_t$ stands for an oil price shock and the lagged values of the dependent variable (stock returns) is treated as instruments to take care of endogeneity. Regressors with deeper lags have also are used as instruments.

3.3.4 Panel Structural Vector Autoregressive Model

While various studies have used the SVAR model for assessing the asymmetric impact of oil price shock on macroeconomic performance, there is no study that assesses the asymmetric impact of oil price shocks along with inflation and other determinants of stock returns at firm level. Asymmetric influence of oil price shock (volatility) can be traced back to the 1980s and 1990s (Lee et al. 1995). Back then, the episodes of hike in oil price led to recession, but the decrease in oil price did not result in a boom in the economy. To study the same in the context of stock market, following Kilian (2009), the SVAR model in a panel data framework is considered accordingly, the panel approach should apply to a wide range of panel data types. In short, the technique is viable for any panel that includes a time series that is long enough to cover at least minimally estimated member-specific VAR coefficients.

The present study uses a reduced form of panel SVAR-X to record responses of the dependant variable to shocks. In the model, PSVAR has been used to estimate six endogenous variables, namely, stock returns, index returns, SMB, HML, WML and inflation, and one exogenous variable, namely oil price shock. PSVAR can be estimated by specifying the following structural panel equation:

$$A_0 Y_{it} = L_{io} + \mathring{a}_i^k B_1 Y_{it-1} + B_2 Y_{it-2} + \dots B_n Y_{it-n} + fX_t + \varepsilon_{it} \qquad (3.12)$$

In the equation, the matrix specifying the contemporaneous relationship among variables is represented by A. Y_{it} is a Kx1 vector of two endogenous variables such that $Y_{it} = Y_{1t}, Y_{2t}, \ldots Y_{nt}$ (stock returns). L_{io} is a Kx1 vector of constants constituting firm-specific intercept terms. The matrix of coefficients with lagged endogenous variables (for every i=1….P) ϕ is represented by B_i. In the present model restrictions on endogenous variables such as stock returns, inflation and Fama-French factors are imposed. Exogenous variables are represented by X_t. ε_{it} represents the error term. While employing SVAR model, sufficient lag length helps in reflecting the long-term impact of independent variables on dependent variables. The present chooses lag two as the appropriate lag length.

Equation 3.13 describes the imposed SVAR restrictions based on economic theory. India is a major importer of crude oil in the international market. It is assumed that a change in the domestic variables such as stock returns and Fama-French factors do not have a direct impact on oil price. Therefore, row 7 measures the impact of oil price shock on a firm's stock return, keeping C_{61}, C_{62}, C_{63}, C_{64}, C_{65} and C_{66} as zero. Second, the study assumes that oil price shock and inflation determine the performance of the stock market, and that oil price shocks affect the stock market through inflation. Therefore in row 6, C_{51}, C_{52}, C_{53}, C_{54}, and C_{55} are kept zero. Third and final assumption is that oil price has an impact on Fama-French factors, but Fama-French factors do not have a direct impact on oil price, and so, their 2nd, 3rd, 4th, and 5th rows are kept zero.

$$\begin{bmatrix} 1 & C_2 & C_3 & C_4 & C_5 & C_6 & C_7 \\ 0 & 1 & 0 & 0 & 0 & 0 & C_{17} \\ 0 & 0 & 1 & 0 & 0 & 0 & C_{27} \\ 0 & 0 & 0 & 1 & 0 & 0 & C_{37} \\ 0 & 0 & 0 & 0 & 1 & 0 & C_{47} \\ 0 & 0 & 0 & 0 & 0 & C_{56} & C_{57} \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} v_{it}^{S.returns} \\ v_{it}^{IR} \\ v_{it}^{SMB} \\ v_{it}^{HML} \\ v_{it}^{WML} \\ v_{it}^{inflation} \\ v_{it}^{logoilshock} \end{bmatrix} = \begin{bmatrix} a_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & a_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & a_4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & a_5 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & a_6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & a_7 \end{bmatrix} \begin{bmatrix} \varepsilon_{it}^{S.returns} \\ \varepsilon_{it}^{IR} \\ \varepsilon_{it}^{SMB} \\ \varepsilon_{it}^{HML} \\ \varepsilon_{it}^{WML} \\ \varepsilon_{it}^{inflation} \\ \varepsilon_{it}^{logoilshock} \end{bmatrix} \quad (3.13)$$

3.4 RESULTS

The summary statistics of firms' stock return, index return, inflation, Fama-French factors and various dimensions of oil price shocks is presented in Table 3.1. The positive mean of stock return, index return, inflation, oil price, oil price shock, shock due to an increase in oil price, shock due to a decrease in oil price, and NOILPI is on expected lines. Whereas NOILPD and WML has a negative mean. Regarding kurtosis, all variables, except stock returns and various measures of oil price shock are above 3, which means that these variables are leptokurtic. Skewness determines the positive or negative outcome of the variables. In the present case, stock returns are positive, implying that large positive stock returns are more common than negative returns. The standard deviation of oil price, NOILPI, and NOILPD are much more than other oil-related variables (oil price shock, shock due to an oil price increase, and shock due to oil price decrease), indicating that there is a higher fluctuation in oil price change.

Table 3.2 presents the unit root test results of the Levin, Lin and Chu test and I'm, Pesaran and Shin W-Stat. The stock returns of all firms are already in the first difference in natural log. As a result, they are stationary. The Fama-French factors (index returns, SMB, HML and WML) are also found to be stationary at level, whereas the linear measure of oil price shock, viz., oil price change, oil price shock, shock due to increase in oil price, shock due to decrease in oil price, NOILPI and NOILPD, is non-stationary at level and becomes stationary at the first difference.

3.4.2 Generalized Method of Moments

The present study first discusses, GMM as an efficient estimator to reduce endogeneity biases. The results of the test are presented in table 3.3 to table 3.8 with various oil price specifications. The results show that stock returns with lag one positively influences the dependent variable and are statistically significant. Whereas, lag two of stock returns are negatively related to the dependent variable and statistically significant. Similarly, on the macroeconomic front, inflation is positively related to stock returns and highly significant. As expected, the index return shows a positive and statistically significant coefficient indicating that stock return is positively related to market return. SMB and HML also have a positive coefficient which is statistically significant, whereas WML has a negative and statistically significant influence on stock returns. Oil price-change shows a positive sign, which shows that oil price has a positive effect on stock returns. In Tables 3.4 to 3.8, the various dimensions of oil price shock measures (oil price shock, oil price shock due to increase in oil price, shock due to oil price decrease, net oil price increase, and net oil price decrease) have been introduced to look into the dynamics of cause-and-effect relationship. In Table 3. 4, the oil price shock has a positive and highly significant effect on a firm`s stock returns, which means that the oil price fluctuation has brought positive outcome in stock returns. Similarly, inflation has a positive influence on stock returns.

Table 3.5 presents the relationship between shock due to an oil price increase (oil price shock-positive) and stock returns. Both, shock due to an oil price increase and inflation is positively influencing the stock returns. According to Kollias et al. (2013), positive relation between stock returns and oil price shock is due to the investors' optimistic view as they associate it with a booming economy.

In Table 3.6, shock due to oil price decrease negatively affects stock returns. The coefficient of shock due to oil price decrease is negative and significant, which means that negative shock in oil price causes a decline in the firm's stock returns. Similarly, inflation has negative influence on stock returns and statistically significant. In Table 3.7, the relationship between net oil price increase (increase in returns on real oil price) and stock returns is reported. The coefficient of net oil price increase shows a negative sign, which means that net oil price increase has a negative effect on stock returns; the coefficient of inflation shows a positive sign, which confirms its positive influence on stock returns.

Table 3.8 reports the empirical relationship between net oil price decrease (decrease in returns on real oil price) and stock returns. The coefficient sign confirms that net oil price decrease has a negative effect on stock returns. In other words, net oil price decrease and stock returns are moving in opposite directions, the sign of the coefficients suggests that when oil price decreases, stock returns increase. This kind of empirical evidence is on expected lines and similar to the economic theory, which states that decrease in oil price reduces inflation and boosts stock returns. Similarly, inflation has a positive effect on stock returns.

Overall, with all oil price specifications, it can be observed that the relationship between oil price shocks, inflation, and stock returns is never constant. For example, all three oil price shocks (oil price shock, shock due to increase, and decrease in oil price) shows mixed influence on stock returns, whereas net oil price increase and decrease have a different relation with stock returns. In the case of the relation of inflation with stock returns in the presence of oil price specifications, it changes with each specification. For example, the response of a firm`s stock returns to inflation in the presence of oil price shock and shock due to oil price increase is positive and with shock due to an oil price decrease, the relation is negative. There are studies which found the symmetric impact of oil price shock towards stock returns; for instance, a study done by Acharya and Sadath (2016) revealed that energy price volatility negatively affected the firm`s stock returns. Past studies have found that based on the size of the firm, oil price-change has its effects. It was recognized that medium-sized firms witness asymmetry of oil price-change than small and large firms (Sadorsky, 2008).

3.4.3 Panel Structural VAR-X

Table 3.9, presents results of PSVAR. The empirical analysis is divided into two sections, namely PSVAR-X with and without asymmetry. The results of the short-run dynamics of the symmetric and asymmetric impact of oil price shock on stock returns, its determinants and inflation are reported in Table 3.9. The coefficient of net oil price increase is a positive number and net oil price decrease is a negative number. The estimated coefficients of panel one show that the direction of response of the dependent variables is on expected lines and is statistically significant. Oil price change has a positive effect on stock returns, which means that oil price and stock return move in the same direction. Among Fama-French variables, index returns negatively affected by oil price change. On the other hand, SMB, HML and WML is positively related to oil price change. The coefficients of oil price change show negative repercussion on inflation. Oil price shock has a negative impact on the dependent variables except stock returns and HML, which means that oil price shock has an asymmetric impact on the portfolio earnings of the firm. Shock due to increase in oil price has a negative impact on stock returns, index returns, and SMB. Similarly, shock due to oil price increase has negative impact on inflation. Similarly, shock due to oil price decrease and net oil price (increase and decrease) has an asymmetric effect on stock returns. To summarize, the symmetric effect of oil price shocks on stock returns, Fama-French factors and inflation makes economic sense as all the dimensions of oil price shocks are showing the expected effect on the stock market and inflation. For example, shock due to increase in oil price has a negative effect on the stock market and positive effect on inflation while the shock due to oil price decrease has a positive effect on stock returns.

The coefficient of NOILPI is positive and statistically significant. This means that an appreciation in the net oil price has a positive effect on stock returns. On the other hand, NOILPD has a negative coefficient with respect to stock returns and a positive coefficient with respect to inflation, which means that a drop in the net oil price has a positive impact on stock returns and negative impact on inflation.

The coefficient of NOILPI is positive and that of NOILPD is negative, and both variables are statistically significant. The sign of the coefficients suggests that when oil price soars, stock market returns do not drop; in the same way, decline in oil price leads to increase in stock returns. This confirms the asymmetric response of stock returns towards net oil price increase, as stock returns normally decrease with increase in oil price, whereas with net oil price decrease, stock returns increase: this confirms the symmetric relation. Net oil price decrease has a symmetric impact on stock returns and SMB as the price decrease shows the opposite effect. The sign of coefficient of net oil price increase with respect to inflation is positive, which means that net oil price increase has inverse relation with inflation. On the other hand, net oil price decrease has a positive effect on inflation, showing that there is decrease in oil price results in increase in inflation.

Appendix 3.1 shows the result of asymmetric impact on stock returns of firms at different sectors. At the firm level, stock returns of most of the sectors (37 sectors) are positively affected by oil price change and oil price shock, and statistically significant. The probability values for other firms are statistically insignificant. On the other hand, shock due to oil price increase (oil price shock-positive) has a negative impact on stock returns of firms in most of the sectors, but certain sectors such as bakery products, boilers and turbines and diversified machinery showed positive response. In case of shock due to oil price decrease (oil price shock-negative), the stock returns of firms in sectors such as engines, machine tools, mining & construction equipment, miscellaneous electrical machinery, organic chemicals, other ferrous metal products, other non-ferrous metal products and steel are positively affected (and are statistically significant). On the other hand, rest of the firms in different sectors are negatively affected, giving evidence of the presence of the asymmetry between the shock due to oil price decrease and these stock returns.

Similarly, the coefficients of NOILPI are positive and statistically significant for firms in most of the sectors. This means that appreciation in the net oil price has a positive effect on stock returns at the firm level. On the other hand, the variable NOILPD had a positive coefficient with respect to stock returns for some firms of the sectors (agricultural machinery, air- conditioners & refrigerators, bakery products etc.) and for other sectors it has negative impact (aluminium & aluminium products, cement, commercial vehicles), which means that a drop in net oil price has a negative impact on stock returns.

Figure 3.1 and 3.2 show the impact of one standard deviation shock in net oil price increase and decrease on stock returns. It is clear that the impact of net oil price decrease follows the same pattern as net oil price increase. For some sectors (abrasives, agricultural machinery, air-conditioners & refrigerators) it causes a negative impact for the first five months and then stay flat. Whereas for some sectors (commercial vehicles, crude oil & natural gas and inorganic chemicals) it has a positive impact till 5^{th} monthly period and then remains stagnant till end of the period. This confirms the asymmetric impact of both net oil price increase and decrease on stock returns of some crucial sectors such as crude oil and natural gas, commercial vehicles, cement, mining and construction equipment, diversified automobile, industrial machinery, etc.

The relation between oil price increase and stock returns is negative because Indian economy is a major importer of oil and an increase in oil price increases the cost of production and depresses cash flow and earnings (Fisher, 1930). The oil price increase can also have a positive effect on the stock returns because oil price increase is a sign of a booming economy (Kollias et al., 2013). Previous studies have found that oil price shock shows a symmetry towards macroeconomic variables. For example, Ahmed and Wadud (2011) found that oil price shock caused uncertainty in business circles because of the decline in Malaysian output and consumer price index. Tsai and Chun-Li (2015) found that oil price shock did not have an asymmetric effect on stock returns before the global financial crisis (GFC).

Previous researchers, including Wan (2005), have given a theoretical justification for the asymmetric impact of oil prices on stock returns. During high oil price, firms decide not to pay dividends, and hence stock prices decrease. On the contrary, during a decline in oil price, firms pay a higher dividend, and so stock prices increase. But the stock prices are more sensitive to increase in oil price than they are to decrease. Even then, there are a number of studies with mixed empirical findings showing that stock returns are asymmetric towards oil price shocks (e.g., Arouri 2011; Aggarwal et al. 2012; Killian, 2008), and those providing empirical evidence show no asymmetric effects (Asalman & Herrera, 2015; Cong et al., 2008).

3.5 SUMMARY

The present study has analysed whether various oil price shocks exhibit any asymmetric impact on stock returns of firm. For analysis, the study has used PSVAR-X with firm level data on variables viz stock returns, inflation and Fama-French factors. The empirical findings from the PSVAR-X model show the asymmetric impact of shocks emerging from the net oil price decrease for most of the sectors. The impulse response function from the PSVAR-X model reveals that the various dimensions of oil price shock lead to volatility in the response variables. It can also be observed that negative oil price shock has a radical impact on the stock market. These results shed some light on whether the Indian stock market is immune to oil price shocks, given that India is a net oil importing country.

From the results, it can be observed that a change in net oil price has a direct asymmetric impact on stock returns. Observing asymmetries in net oil price increase and their effect on Indian stock returns may be economically counter-intuitive, but asymmetries in oil price shock occur due to adaptation of new technologies by firms so that during a high oil price regime, firms can conserve oil by switching to alternative energy sources such as coal, natural gas or solar power. So, when the oil price decline, firms do not straightway cut the sunk costs and decline their investments. Hence, reduction in oil price does not fetch the desired boom in the economy. This could be the main source of asymmetry in oil price shock. Also, as stated by Wan (2005), a negative impact of oil price increase is higher than the positive impact of oil price decrease. Salisu et al. (2017) suggested that depending on how monetary policy reacts to oil price change, the discount rate may indirectly affect the stock prices.

The results validate two theories: the irreversible investment theory and the reallocation effect. First, according to the irreversible investment theory, an increase in oil price results in withdrawal of investment from firms, and so the stock return retards. This scepticism among consumers and investors prevails over the short-run, so a decrease in oil price need not bring about a boom in the economy (Hamilton, 2009). This is what the results show: net oil price decrease still has a negative influence on stock returns. Second, the results are in line with the reallocation effect where recession due to increase in oil price results in displacement of labour, but due to oil price decrease, the economy need not show full employment (a boom).

Table 3.1: Summary Statistics of the Variables Used in the Study

Variable	Mean	Standard Deviation	Skewness	Kurtosis
Stock return	1.713	2.071	0.695	2.337
Index Return	6.242	32.467	-0.616	3.653
SMB	-0.888	8.732	0.713	7.436
HML	-0.136	4.837	-0.402	7.308
WML	-6.013	6.011	-1.288	4.319
Inflation	1858.284	5388.314	3.192	8.256
Oil price-change	4.707	4.260	-0.507	-0.951
Oil price shock	0.412	0.611	-0.547	-0.917

Oil price shock-Positive	0.303	0.598	-0.636	-0.793
Oil price shock-Negative	0.458	0.580	-0.604	-0.862
NOILPI	127.793	65.758	-0.042	-1.005
NOILPD	-105.193	54.634	0.189	-0.647

*The above table describes the measure of location, statistical dispersion and measure of the shape of the distribution

Table 3.2: Panel Unit Root Tests of the Variables Used in the Study

Note: Table 2 exhibits panel unit root tests of Levin, Lin & Chu t and Im, Pesaran and shin W-stat on dependent (stock returns) and

Method:	**Unit root with common Process**				**Unit with individual unit root process**			
	Levin, Lin & Chu t				Im, Pesaran and Shin W-stat			
	Level		**First Difference**		**Level**		**First Difference**	
Variable Name	**t-Statistics**	**Prob.**	**t-Statistics**	**Prob.**	**t-Statistics**	Pr **Prob.**	**t-Statistics**	**Prob.**
Stock returns	-667.693	).000	-		-514.297	0.000	-	
Oil Price-Change	25.463	1.000	557.805	0.000	.160	1.000	-413.345	0.000
Oil Price shock	26.678	1.000	674.762	0.000	.658	1.000	-487.493	0.000
Oil Price-Positive	41.630	1.000	649.225	0.000	.613	1.000	-478.252	0.000
Oil price-Negative	83.404	1.000	665.747	0.000	.801	1.000	-462.469	0.000
NOILPI	1.262	).896	-878.141	0.000	3.659	0.000	-370.314	0.000
NOILPD	56.470	1.000	-835.954	0.000	.176	0.000	- 345.863	0.000
Index Returns	-759.593	0.000	-		19.376	0.000	-	
Inflation	9.010	1.000	-836.008		.094	0.000	-590.473	0.000
SMB	-760.519	0.000	-		15.108	0.000	-	
HML	-619.031	0.000	-		66.500	0.000	-	
WML	148.975	0.000	-		13.210	0.000	-	

independent variables (oil price and its shocks specifications and Fama-French factors).

Table 3.3: Effect of Oil Price-Change on Stock Returns

Variable	**Coefficient**	**Std. Error**	**t-statistics**	**Prob.**
Stock returns (-1)	0.037	0.040	0.911	0.000
Stock returns (-2)	-0.050	0.041	-1.211	0.000

Inflation	0.002	0.004	0.369	0.024
Oil Price- change	20.526	24.000	0.855	0.000
Index Returns	0.002	0.001	1.262	0.000
SMB	0.001	0.016	0.044	0.000
HML	0.022	0.023	0.995	0.000
WML	-0.001	0.022	-0.029	0.000
Test order	**m-Statistic**	**rho**	**SE(rho)**	**Prob.**
AR(1)	-3.029	-24066.630	7944.702	0.003
AR(2)	-0.913	-5855.855	6410.434	0.361

Note: Instrument validity is tested using Sargan test J statistics which has a null hypothesis of 'test of over identifying restrictions are valid'. It returns the value of 22.96 and a probability value of 0.114.

Table 3.4: Effect of Oil Price Shock on Stock Returns

Variable	Coefficient	Std. Error	t-statistics	Prob.
Stock returns (-1)	0.024	0.040	0.595	0.000
Stock returns (-2)	-0.061	0.040	-1.533	0.000
Inflation	0.001	0.004	0.326	0.000
Oil Price shock	19.573	23.297	0.840	0.000
Index Returns	0.001	0.001	1.017	0.000
SMB	0.000	0.016	-0.028	0.000
HML	0.022	0.023	0.955	0.000
WML	-0.001	0.021	-0.063	0.000
Test order	**m-Statistic**	**rho**	**SE(rho)**	**Prob.**
AR(1)	-3.288	-24127.773	7338.196	0.001
AR(2)	-0.746	-4446.550	5959.945	0.456

Note: Instrument validity is tested using Sargan test J statistics which has a null hypothesis of 'test of over identifying restrictions are valid'. It returns the value of 23 and a probability value of 0.113.

Table 3.5: Effect of Oil Price Shock-Positive on Stock Returns

Variable	Coefficient	Std. Error	t-statistics	Prob.
Stock Returns (-1)	0.062	0.086	0.718	0.000

Stock Returns (-2)	-0.045	0.085	-0.527	0.001
Inflation	0.003	0.008	0.356	0.007
Oil Price Shock-Positive	0.478	1.017	0.470	0.000
Index Returns	0.000	0.002	-0.002	0.000
SMB	-0.012	0.018	-0.695	0.000
HML	0.030	0.026	1.173	0.000
WML	0.005	0.022	0.234	0.000
Test order	**m-Statistic**	**rho**	**SE(rho)**	**Prob.**
AR(1)	-3.735	-27062.076	7245.415	0.000
AR(2)	-1.147	-7185.344	6262.130	0.251

Note: Instrument validity is tested using Sargan test J statistics which has a null hypothesis of 'test of over identifying restrictions are valid'. It returns the value of 22.03 and a probability value of 0.142.

Table 3.6: Effect of Oil Price Shock-Negative on Stock Returns

Variable	Coefficient	Std. Error	t-statistics	Prob.
Stock Returns (-1)	0.069	0.024	2.870	0.000
Stock Returns (-2)	-0.006	0.035	-0.164	0.000
Inflation	-0.001	0.008	-0.068	0.000
Oil Price Shock-Negative	-40.314	101.434	-0.397	0.000
Index Returns	0.001	0.002	0.346	0.000
SMB	-0.014	0.028	-0.489	0.000
HML	0.035	0.054	0.655	0.000
WML	0.011	0.014	0.765	0.000
Test order	**m-Statistic**	**rho**	**SE(rho)**	**Prob.**
AR(1)	-1.760	-19264.057	10945.796	0.078
AR(2)	-0.052	-245.465	4747.838	0.959

Note: Instrument validity is tested using Sargan test J statistics which has a null hypothesis of 'test of over identifying restrictions are valid'. It returns the value of 22.26 and a probability value of 0.134.

Table 3.7: Effect of Net Oil Price Increase on Stock Returns

Variable	Coefficient	Std. Error	t-statistics	Prob.
Stock Returns (-1)	0.050	0.086	0.577	0.000
Stock Returns (-2)	-0.048	0.083	-0.574	0.884
Inflation	0.003	0.008	0.346	0.000

Net Oil Price Increase	-0.006	0.028	-0.208	0.000
Index Returns	0.000	0.002	0.080	0.000
SMB	-0.013	0.017	-0.715	0.000
HML	0.032	0.025	1.263	0.000
WML	0.009	0.022	0.434	0.000
Test order	**m-Statistic**	**rho**	**SE(rho)**	**Prob.**
AR(1)	-1.760	-19264.057	10945.796	0.078
AR(2)	-0.052	-245.465	4747.838	0.959

Note: Instrument validity is tested using Sargan test J statistics which has a null hypothesis of 'test of over identifying restrictions are valid'. It returns the value of 20.51 and a probability value of 0.151.

Table 3.8: Effect of Net Oil Price Decrease on Stock Returns

Variable	**Coefficient**	**Std. Error**	**t-statistics**	**Prob.**
Stock Returns (-1)	0.091	0.026	3.502	0.000
Stock Returns (-2)	0.017	0.037	0.477	0.384
Inflation	-0.001	0.008	-0.177	0.000
Net Oil Price Decrease	-0.921	3.044	-0.303	0.000
Index Returns	0.001	0.002	0.768	0.000
SMB	-0.009	0.028	-0.334	0.000
HML	0.027	0.055	0.500	0.000
WML	0.016	0.014	1.124	0.000
Test order	**m-Statistic**	**rho**	**SE(rho)**	**Prob.**
AR(1)	-3.738	-26551.876	7104.181	0.000
AR(2)	-1.101	-7106.186	6452.464	0.271

Note: Instrument validity is tested using Sargan test J statistics which has a null hypothesis of 'test of over identifying restrictions are valid'. It returns the value of 22.67 and a probability value of 0.141. Tables 3.3 to 3.8 exhibits the estimation results of Generalised Methods of Moments; we treat dependent with lags as independent variable along with other regressors. The values of coefficient are in scientific form. The last two rows exhibit the post estimation results of Arellano-Bond serial correlation test.

Table 3.9: Results of the Panel Structural Vector Auto-Regressive (P-SVAR) Model

Panel Regression Results-Without Asymmetry						
Short-run estimates	**Stock returns**	**Index returns**	**SMB**	**HML**	**WML**	**Inflation**
Oil Price-Change	-	-0.203**	-	-	-	-23.927
Oil price shock	-	-0.004***	-0.077***	-0.061***	-0.028***	30.369*
Oil price shock-positive	-0.057**	-0.005***	-0.089**		-	
Oil price shock -Negative	-	-	-0.442***	-0.077**	0.024***	-
Net oil price increase	-	-	-0.395***	-		
Net oil price decrease	-0.051**	-	-0.239***	-	-0.157**	30.096**
Panel Regression Results-With Asymmetry						
Short-run estimates	**Stock returns**	**Index returns**	**SMB**	**HML**	**WML**	**Inflation**
Oil Price-Change	0.145***	-	0.024*	-0.036	-0.141	-
Oil price shock	0.127***	-	0.031	-	-	-
Oil price shock-positive	-	-	-	0.502*	0.400***	-8.504**
Oil price shock -Negative	-0.105***	0.298**	-	-	0.021*	0.581***
Net oil price increase	0.033***	1.999*	-	0.382***	0.220***	-2.126**
Net oil price decrease	-	0.275**	-	0.044**	-	-

Appendix -3.1: Results of the Panel Structural Vector Auto-Regressive (P-SVAR) ModeL

Short-run estimates	Firms level stock returns	Firms level stock returns	
		Coefficient	**Probability**
Oil Price-Change	Abrasives	0.099	0.000
	Agricultural machinery	0.166	0.000
	Air-conditioners & refrigerators	0.195	0.000
	Aluminium & aluminium products	0.129	0.000
	Bakery products	0.192	0.000
	Boilers & turbines	0.118	0.000
	Cement	0.266	0.000
	Commercial vehicles	0.095	0.000
	Conventional electricity	0.081	0.000
	Copper & copper products	0.052	0.001
	Crude oil & natural gas	0.104	0.000
	Diversified automobile	0.147	0.000
	Diversified machinery	0.038	0.074
	Engines	-0.109	0.000
	Industrial machinery	-0.095	0.000
	Inorganic chemicals	0.008	0.000
	Machine tools	-0.082	0.000
	Mining & construction equipment	-0.038	0.106
	Miscellaneous electrical machinery	0.024	0.246
	Organic chemicals	-0.111	0.000
	Other ferrous metal products	0.163	0.000
	Other non-ferrous metals & metal products	0.079	0.000

	Refinery	-0.167	0.000
	Steel	0.137	0.000
Oil Price Shock	Abrasives	0.102	0.000
	Agricultural machinery	0.156	0.000
	Air-conditioners & refrigerators	0.182	0.000
	Aluminium & aluminium products	0.112	0.000
	Bakery products	0.160	0.000
	Boilers & turbines	0.093	0.000
	Cement	0.267	0.000
	Commercial vehicles	0.074	0.000
	Conventional electricity	0.074	0.000
	Copper & copper products	0.042	0.007
	Crude oil & natural gas	0.085	0.000
	Diversified automobile	0.140	0.000
	Diversified machinery	0.037	0.081
	Engines	-0.110	0.000
	Industrial machinery	-0.096	0.000
	Inorganic chemicals	0.007	0.000
	Machine tools	-0.083	0.000
	Mining & construction equipment	-0.040	0.091
	Miscellaneous electrical machinery	0.024	0.000
	Organic chemicals	-0.113	0.000
	Other ferrous metal products	0.163	0.000
	Other non-ferrous metals & metal products	0.078	0.000
	Refinery	-0.168	0.000
	Steel	0.138	0.000
Oil Price Shock-positive	Abrasives	-0.021	0.017
	Agricultural machinery	0.018	0.038
	Air-conditioners & refrigerators	0.115	0.000
	Aluminium & aluminium products	-0.026	0.023

	Bakery products	0.002	0.000
	Boilers & turbines	0.104	0.000
	Cement	0.033	0.000
	Commercial vehicles	-0.076	0.000
	Conventional electricity	-0.004	0.805
	Copper & copper products	-0.016	0.309
	Crude oil & natural gas	0.009	0.064
	Diversified automobile	-0.060	0.000
	Diversified machinery	0.056	0.010
	Engines	-0.119	0.000
	Industrial machinery	-0.119	0.000
	Inorganic chemicals	-0.058	0.007
	Machine tools	-0.032	0.000
	Mining & construction equipment	-0.115	0.000
	Miscellaneous electrical machinery	-0.099	0.000
	Organic chemicals	-0.044	0.037
	Other ferrous metal products	-0.215	0.000
	Other non-ferrous metals & metal products	-0.144	0.000
	Refinery	-0.108	0.000
	Steel	-0.237	0.000
Oil Price Shock-Negative	Abrasives	-0.218	0.000
	Agricultural machinery	-0.061	0.003
	Air-conditioners & refrigerators	-0.201	0.000
	Aluminium & aluminium products	0.123	0.000
	Bakery products	-0.137	0.000
	Boilers & turbines	-0.037	0.067
	Cement	-0.168	0.000
	Commercial vehicles	-0.127	0.000
	Conventional electricity	-0.084	0.000
	Copper & copper products	-0.090	0.000

	Crude oil & natural gas	-0.041	0.029
	Diversified automobile	-0.048	0.003
	Diversified machinery	-0.097	0.000
	Engines	0.231	0.000
	Industrial machinery	0.115	0.000
	Inorganic chemicals	-0.042	0.048
	Machine tools	0.191	0.000
	Mining & construction equipment	0.064	0.008
	Miscellaneous electrical machinery	0.166	0.000
	Organic chemicals	0.108	0.000
	Other ferrous metal products	0.045	0.044
	Other non-ferrous metals & metal products	0.155	0.000
	Refinery	-0.017	0.000
	Steel	0.129	0.000
NOILPI	Abrasives	0.028	0.074
	Agricultural machinery	0.028	0.000
	Air-conditioners & refrigerators	-0.174	0.000
	Aluminium & aluminium products	0.102	0.000
	Bakery products	0.075	0.000
	Boilers & turbines	0.106	0.000
	Cement	-0.081	0.012
	Commercial vehicles	0.030	0.000
	Conventional electricity	0.019	0.000
	Copper & copper products	0.032	0.046
	Crude oil & natural gas	0.039	0.035
	Diversified automobile	-0.003	0.000
	Diversified machinery	0.125	0.000
	Engines	0.054	0.011
	Industrial machinery	-0.327	0.000
	Inorganic chemicals	0.057	0.008

	Machine tools	0.063	0.005
	Mining & construction equipment	0.038	0.000
	Miscellaneous electrical machinery	-0.003	0.000
	Organic chemicals	0.034	0.000
	Other ferrous metal products	-0.033	0.000
	Other non-ferrous metals & metal products	-0.012	0.000
	Refinery	-0.044	0.049
	Steel	-0.091	0.000
NOILPD	Abrasives	-0.123	0.000
	Agricultural machinery	0.015	0.000
	Air-conditioners & refrigerators	0.154	0.000
	Aluminium & aluminium products	-0.100	0.000
	Bakery products	0.016	0.000
	Boilers & turbines	0.010	0.000
	Cement	-0.137	0.000
	Commercial vehicles	-0.049	0.013
	Conventional electricity	0.001	0.000
	Copper & copper products	-0.046	0.004
	Crude oil & natural gas	-0.008	0.000
	Diversified automobile	0.036	0.027
	Diversified machinery	-0.232	0.000
	Engines	0.082	0.000
	Industrial machinery	-0.078	0.002
	Inorganic chemicals	-0.068	0.002
	Machine tools	-0.017	0.000
	Mining & construction equipment	-0.104	0.000
	Miscellaneous electrical machinery	0.003	0.000
	Organic chemicals	0.107	0.000
	Other ferrous metal products	0.025	0.000
	Other non-ferrous metals & metal products	0.122	0.000

	Refinery	-0.157	0.000
	Steel	0.133	0.000

Appendix-3.2: Classification of firms into Different sectors

SI.NO.	Firms	Sectors
1	Carborundum Universal Ltd.	Abrasives
2	Grindwell Norton Ltd.	Abrasives
3	Orient Abrasives Ltd.	Abrasives
4	Escorts Ltd.	Agricultural machinery
5	V S T Tillers Tractors Ltd.	Agricultural machinery
6	Amber Enterprises India Ltd.	Air-conditioners & refrigerators
7	Blue Star Ltd.	Air-conditioners & refrigerators
8	Johnson Controls-Hitachi Air Conditioning India Ltd.	Air-conditioners & refrigerators
9	Leel Electricals Ltd.	Air-conditioners & refrigerators
10	Voltas Ltd.	Air-conditioners & refrigerators
11	Whirlpool Of India Ltd.	Air-conditioners & refrigerators
12	Alicon Castalloy Ltd.	Aluminium & aluminium products
13	Century Extrusions Ltd.	Aluminium & aluminium products
14	M M P Industries Ltd.	Aluminium & aluminium products
15	National Aluminium Co. Ltd.	Aluminium & aluminium products
16	Sundaram-Clayton Ltd.	Aluminium & aluminium products
17	Britannia Industries Ltd.	Bakery products
18	Dangee Dums Ltd.	Bakery products

19	Jubilant Foodworks Ltd.	Bakery products
20	Bharat Heavy Electricals Ltd.	Boilers & turbines
21	Inox Wind Ltd.	Boilers & turbines
22	Suzlon Energy Ltd.	Boilers & turbines
23	Thermax Ltd.	Boilers & turbines
24	Triveni Turbine Ltd.	Boilers & turbines
25	A C C Ltd.	Cement
26	Ambuja Cements Ltd.	Cement
27	Andhra Cements Ltd.	Cement
28	Anjani Portland Cement Ltd.	Cement
29	Barak Valley Cements Ltd.	Cement
30	Birla Corporation Ltd.	Cement
31	Burnpur Cement Ltd.	Cement
32	Century Textiles & Inds. Ltd.	Cement
33	Deccan Cements Ltd.	Cement
34	Gujarat Sidhee Cement Ltd.	Cement
35	Heidelberg Cement India Ltd.	Cement
36	India Cements Ltd.	Cement
37	J K Cement Ltd.	Cement
38	J K Lakshmi Cement Ltd.	Cement
39	K C P Ltd.	Cement
40	Kesoram Industries Ltd.	Cement
41	Mangalam Cement Ltd.	Cement
42	N C L Industries Ltd.	Cement
43	Orient Cement Ltd.	Cement
44	Prism Johnson Ltd.	Cement
45	Ramco Cements Ltd.	Cement
46	Sagar Cements Ltd.	Cement
47	Sanghi Industries Ltd.	Cement
48	Shree Cement Ltd.	Cement

49	Star Cement Ltd.	Cement
50	Ultratech Cement Ltd.	Cement
51	Ashok Leyland Ltd.	Commercial vehicles
52	S M L Isuzu Ltd.	Commercial vehicles
53	Tata Motors Ltd.	Commercial vehicles
54	Gujarat Industries Power Co. Ltd.	Conventional electricity
55	J S W Energy Ltd.	Conventional electricity
56	Jaiprakash Power Ventures Ltd.	Conventional electricity
57	N H P C Ltd.	Conventional electricity
58	N L C India Ltd.	Conventional electricity
59	N T P C Ltd.	Conventional electricity
60	Rattanindia Power Ltd.	Conventional electricity
61	S J V N Ltd.	Conventional electricity
62	Tata Power Co. Ltd.	Conventional electricity
63	Torrent Power Ltd.	Conventional electricity
64	Bhagyanagar India Ltd.	Copper & copper products
65	Cubex Tubings Ltd.	Copper & copper products
66	Hindalco Industries Ltd.	Copper & copper products
67	Hindustan Copper Ltd.	Copper & copper products
68	Madhav Copper Ltd.	Copper & copper products
69	Hindustan Oil Exploration Co. Ltd.	Crude oil & 0tural gas
70	Oil & Natural Gas Corpn. Ltd.	Crude oil & 0tural gas
71	Oil India Ltd.	Crude oil & 0tural gas
72	Selan Exploration Technology Ltd.	Crude oil & 0tural gas
73	Mahindra & Mahindra Ltd.	Diversified automobile
74	A B B India Ltd.	Diversified machinery
75	Siemens Ltd.	Diversified machinery
76	Cummins India Ltd.	Engines
77	Greaves Cotton Ltd.	Engines
78	Kirloskar Oil Engines Ltd.	Engines

79	Swaraj Engines Ltd.	Engines
80	G M M Pfaudler Ltd.	Industrial machinery
81	Kabra Extrusion Technik Ltd.	Industrial machinery
82	Lakshmi Machine Works Ltd.	Industrial machinery
83	Manugraph India Ltd.	Industrial machinery
84	Mazda Ltd.	Industrial machinery
85	Praj Industries Ltd.	Industrial machinery
86	Rollatainers Ltd.	Industrial machinery
87	V A Tech Wabag Ltd.	Industrial machinery
88	Windsor Machines Ltd.	Industrial machinery
89	Alkali Metals Ltd.	Inorganic chemicals
90	Andhra Sugars Ltd.	Inorganic chemicals
91	Excel Industries Ltd.	Inorganic chemicals
92	Hindcon Chemicals Ltd.	Inorganic chemicals
93	Linde India Ltd.	Inorganic chemicals
94	Navin Fluorine Intl. Ltd.	Inorganic chemicals
95	Omkar Speciality Chemicals Ltd.	Inorganic chemicals
96	Phillips Carbon Black Ltd.	Inorganic chemicals
97	Sree Rayalaseema Hi-Strength Hypo Ltd.	Inorganic chemicals
98	Vishnu Chemicals Ltd.	Inorganic chemicals
99	Emkay Taps & Cutting Tools Ltd.	Machine tools
100	Lokesh Machines Ltd.	Machine tools
101	Macpower C N C Machines Ltd.	Machine tools
102	Premier Ltd.	Machine tools
103	Wendt (India) Ltd.	Machine tools
104	Action Construction Equipment Ltd.	Mining & construction equipment
105	B E M L Ltd.	Mining & construction equipment
106	Eimco Elecon (India) Ltd.	Mining & construction equipment
107	Gujarat Apollo Inds. Ltd.	Mining & construction equipment
108	Hercules Hoists Ltd.	Mining & construction equipment

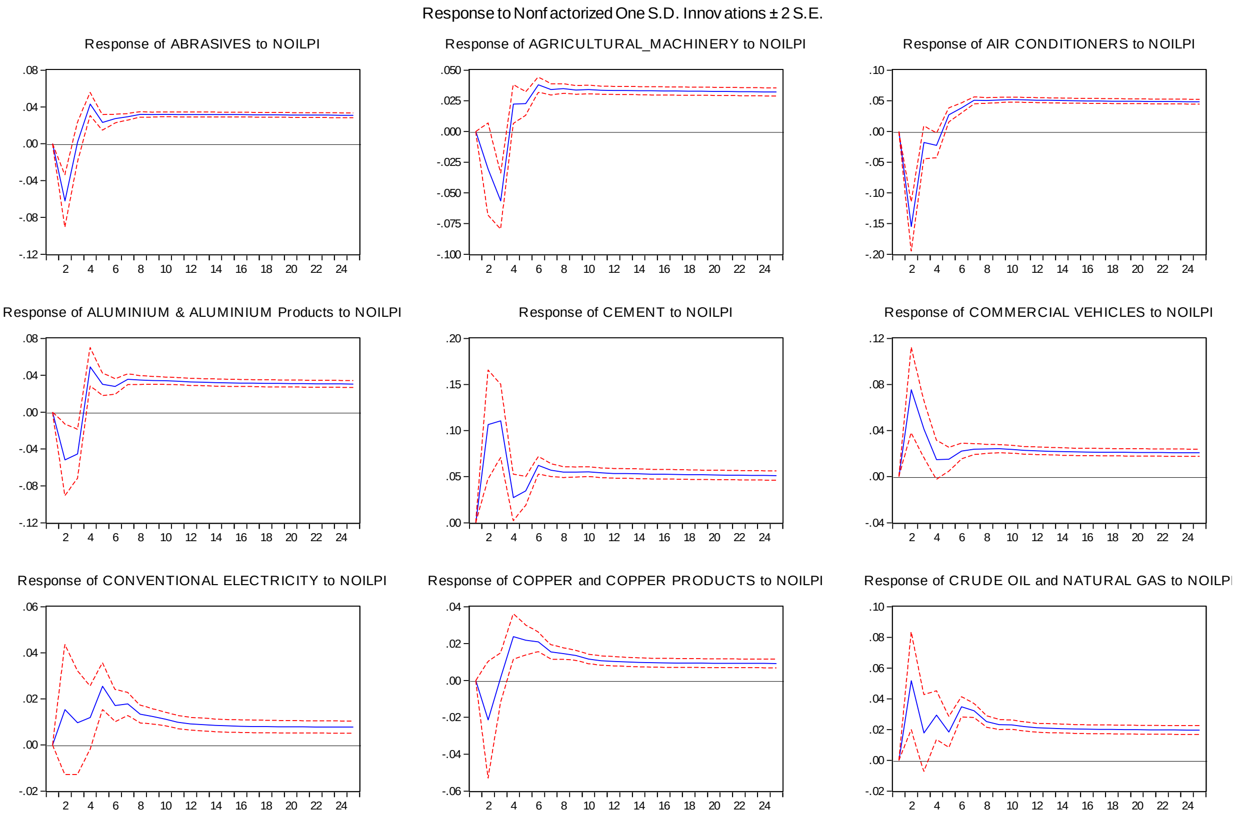
109	Mcnally Bharat Engg. Co. Ltd.	Mining & construction equipment
110	Revathi Equipment Ltd.	Mining & construction equipment
111	Ador Welding Ltd.	Miscellaneous electrical machinery
112	Esab India Ltd.	Miscellaneous electrical machinery
113	Havells India Ltd.	Miscellaneous electrical machinery
114	Olectra Greentech Ltd.	Miscellaneous electrical machinery
115	Veto Switchgears & Cables Ltd.	Miscellaneous electrical machinery
116	W S Industries (India) Ltd.	Miscellaneous electrical machinery
117	Alkyl Amines Chemicals Ltd.	Organic chemicals
118	Aurangabad Distillery Ltd.	Organic chemicals
119	Balaji Amines Ltd.	Organic chemicals
120	Bhageria Industries Ltd.	Organic chemicals
121	Bodal Chemicals Ltd.	Organic chemicals
122	Godrej Industries Ltd.	Organic chemicals
123	Gulshan Polyols Ltd.	Organic chemicals
124	I F B Agro Inds. Ltd.	Organic chemicals
125	I G Petrochemicals Ltd.	Organic chemicals
126	Jocil Ltd.	Organic chemicals
127	Manali Petrochemicals Ltd.	Organic chemicals
128	Pioneer Distilleries Ltd.	Organic chemicals
129	Tamilnadu Petroproducts Ltd.	Organic chemicals
130	Thirumalai Chemicals Ltd.	Organic chemicals
131	Vinati Organics Ltd.	Organic chemicals
132	Bharat Wire Ropes Ltd.	Other ferrous metal products

133	Electrotherm (India) Ltd.	Other ferrous metal products
134	Everest Kanto Cylinder Ltd.	Other ferrous metal products
135	Geekay Wires Ltd.	Other ferrous metal products
136	Godawari Power & Ispat Ltd.	Other ferrous metal products
137	Jai Balaji Inds. Ltd.	Other ferrous metal products
138	Jindal Steel & Power Ltd.	Other ferrous metal products
139	Jyoti Structures Ltd.	Other ferrous metal products
140	Lakshmi Precision Screws Ltd.	Other ferrous metal products
141	Lloyds Steels Inds. Ltd.	Other ferrous metal products
142	Monnet Ispat & Energy Ltd.	Other ferrous metal products
143	Ramsarup Industries Ltd.	Other ferrous metal products
144	Salasar Techno Engg. Ltd.	Other ferrous metal products
145	Sarda Energy & Minerals Ltd.	Other ferrous metal products
146	Sintercom India Ltd.	Other ferrous metal products
147	Skipper Ltd.	Other ferrous metal products
148	Sterling Tools Ltd.	Other ferrous metal products
149	Surya Roshni Ltd.	Other ferrous metal products
150	Technofab Engineering Ltd.	Other ferrous metal products
151	Ultra Wiring Connectivity System Ltd.	Other ferrous metal products
152	Usha Martin Ltd.	Other ferrous metal products
153	Arcotech Ltd.	Other non-ferrous metals & metal products
154	Gravita India Ltd.	Other non-ferrous metals & metal products
155	Hindustan Zinc Ltd.	Other non-ferrous metals & metal products
156	K A Wires Ltd.	Other non-ferrous metals & metal products
157	Tinplate Co. Of India Ltd.	Other non-ferrous metals & metal products

158	Vedanta Ltd.	Other non-ferrous metals & metal products
159	Agarwal Industrial Corpn. Ltd.	Refinery
160	Bharat Petroleum Corpn. Ltd.	Refinery
161	Chennai Petroleum Corpn. Ltd.	Refinery
162	Goa Carbon Ltd.	Refinery
163	Hindustan Petroleum Corpn. Ltd.	Refinery
164	Indian Oil Corpn. Ltd.	Refinery
165	Mangalore Refinery & Petrochemicals Ltd.	Refinery
166	Panama Petrochem Ltd.	Refinery
167	Reliance Industries Ltd.	Refinery
168	Adhunik Industries Ltd.	Steel
169	Ahlada Engineers Ltd.	Steel
170	Emco Ltd.	Steel
171	Gallantt Ispat Ltd.	Steel
172	Gallantt Metal Ltd.	Steel
173	Gyscoal Alloys Ltd.	Steel
174	Hisar Metal Inds. Ltd.	Steel
175	J S W Steel Ltd.	Steel
176	Jayaswal Neco Inds. Ltd.	Steel
177	Jindal Stainless (Hisar) Ltd.	Steel
178	Kalyani Steels Ltd.	Steel
179	M S P Steel & Power Ltd.	Steel
180	Mahamaya Steel Inds. Ltd.	Steel
181	Mukand Ltd.	Steel
182	Neueon Towers Ltd.	Steel
183	Pennar Industries Ltd.	Steel
184	Prakash Industries Ltd.	Steel
185	Prakash Steelage Ltd.	Steel
186	Shah Alloys Ltd.	Steel

187	Steel Authority Of India Ltd.	Steel
188	Sunflag Iron & Steel Co. Ltd.	Steel
189	Supreme Engineering Ltd.	Steel
190	Tata Steel B S L Ltd.	Steel

Figure 3.2: Response of Stock Returns at firm level to Innovations in NOILPI



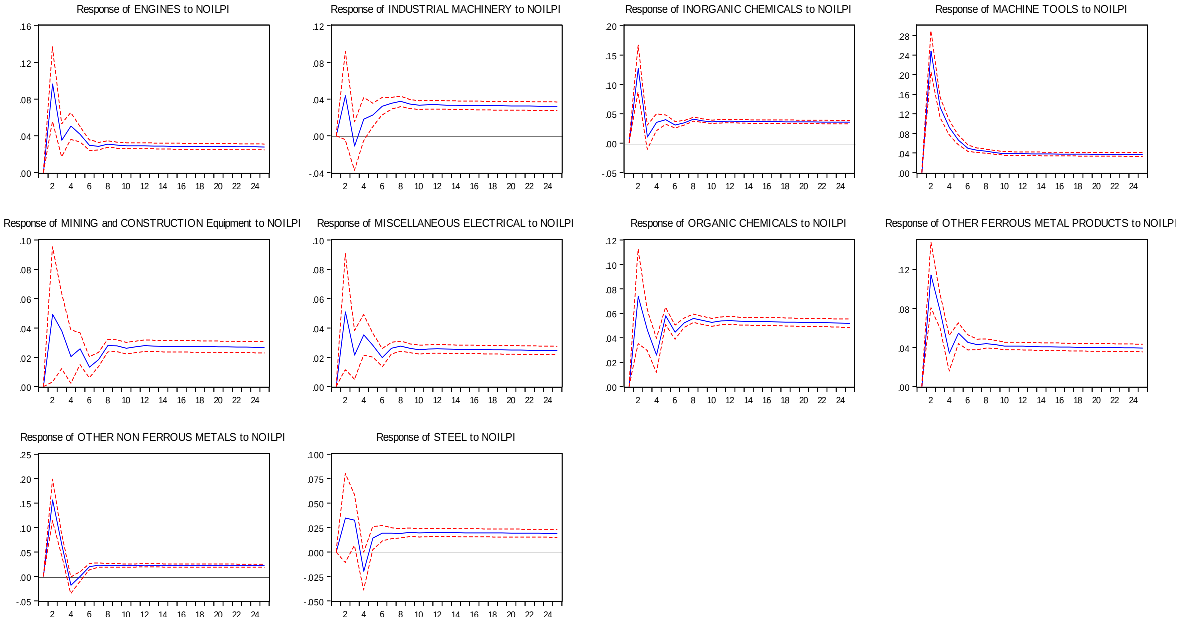
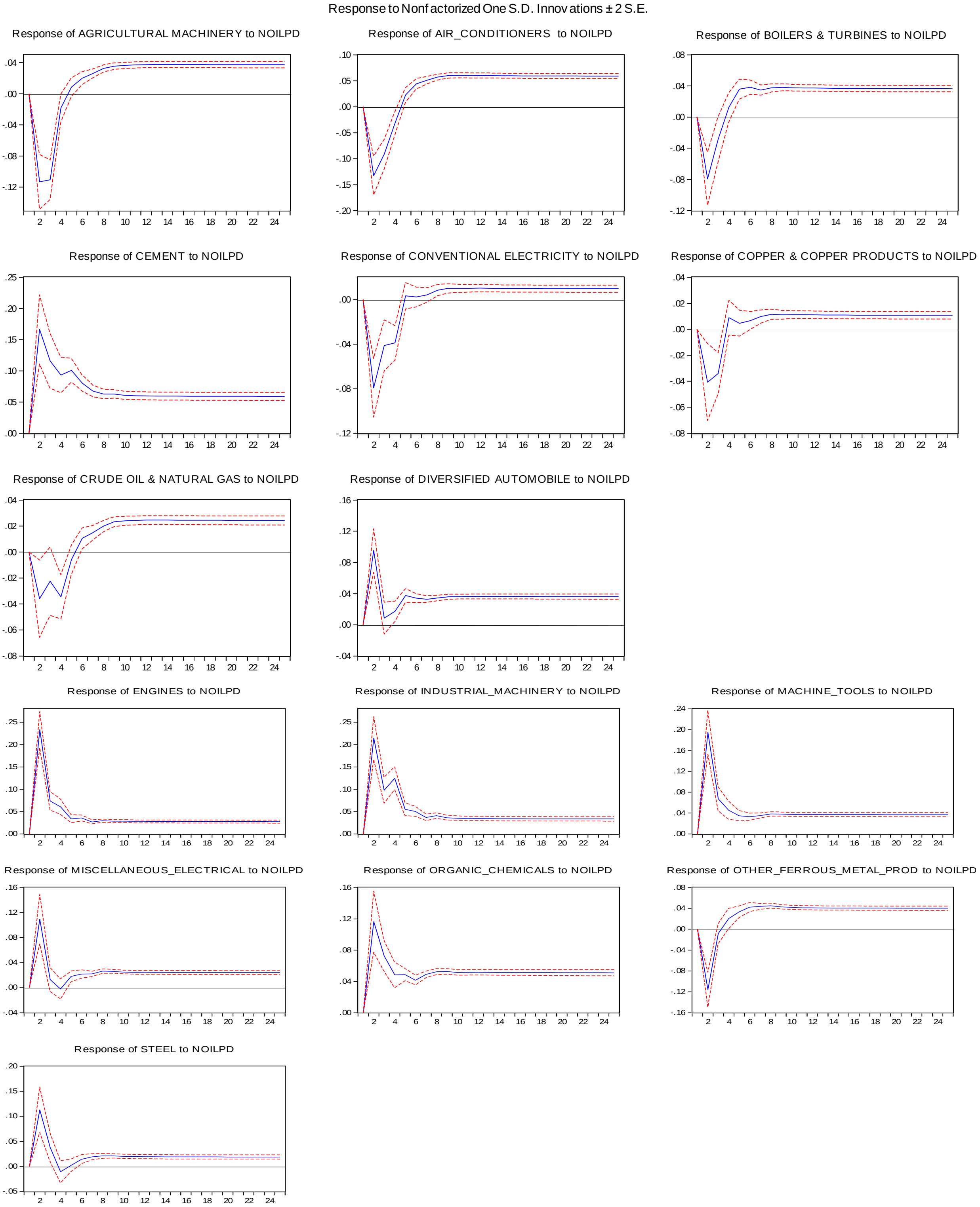

Response of ENGINES to NOILPI
Response of INDUSTRIAL MACHINERY to NOILPI
Response of INORGANIC CHEMICALS to NOILPI
Response of MACHINE TOOLS to NOILPI
Response of MINING and CONSTRUCTION Equipment to NOILPI
Response of MISCELLANEOUS ELECTRICAL to NOILPI
Response of ORGANIC CHEMICALS to NOILPI
Response of OTHER FERROUS METAL PRODUCTS to NOILPI
Response of OTHER NON FERROUS METALS to NOILPI
Response of STEEL to NOILPI

Figure 3.3: Response of Stock Returns at firm level to Innovations in NOILPD



*Dynamic responses of Stock Returns to NOILPI. The solid line gives the mean responses to a one standard deviation shock, while the dotted lines indicate ± 2 standard deviations of the responses. The impulse response function are statistically significant as interval bounds are jointly above or below the zero line.

CHAPTER 4

DO DIFFERENT TYPES OF OIL PRICE SHOCKS AFFECT THE STOCK RETURNS DIFFERENTLY

4.1 INTRODUCTION

It is quite commonly acknowledged that global oil price changes are impacting the stock market, but unprecedented increase in oil price in recent times is attributed to shortage of oil supply. From the literature review below, one can discern that a lot of research has been devoted to study the impact of oil prices on macroeconomic variables such as inflation, exchange rates, etc. in long-term. However, very little attention has been given to study the impact of oil price shocks on aggregate stock market, and stock market reaction to different oil price shocks in energy finance literature. Hamilton (2003) and Kilian (2009) argued that there should be some study on decomposition of oil price, and the way it impacts oil price and stock returns. Moreover, such studies give more relevant insights for policy making and financial risk management by assessing the stock market reaction to different shocks affecting international oil market and commodity market. For example, various assessments of the relationship between oil price shock and stock returns have fetched mixed results. There are some studies which have found negative relationship between oil price shocks and aggregate stock returns (Basher, Haug, and Sadorsky, 2011; Chen, 2009), whereas some other studies have found positive relationship between the same (Narayan and Narayan, 2010; Zhu, Li and Yu, 2011). These jumbled responses could be because these studies failed to decompose oil price shock while examining the relationship between oil price shock and stock returns. Also, as rightly noted by Smyth and Narayan (2018) in their literature survey work, using panel data leads to greater observation and greater degree of freedom. A very few studies have examined the relationship between oil prices and stock returns using firm-level data (Demirer et al. 2015; Gupta, 2016; Narayan & Narayan 2014).

The recent volatility in global oil price affected the Indian economy through a number of channels such as exchange rate depreciation, inflation and financial markets. Fluctuations in oil prices are often considered as consequence of change in real oil price. Researchers and investors can find it relevant to potential predictive reason in oil price change. The importance of decomposition of oil price shock into oil demand and supply shocks for understanding the transmission of oil price shocks has been propagated by Kilian and Park (2009). The present study analyses the impact of real oil price and decomposition of oil price shock (crude oil supply shock; shock to the global demand for all industrial commodities; and oil specific demand) on Indian stock market. First, oil supply shocks which reflect unforeseen changes in quantity are considered. The second type is the aggregate demand shock for industrial commodities arising from business cycle fluctuations. The third is the speculative demand which refelects change in oil inventories. Following Kilian and Murphy (2014), the study distiniguishes itself from previous works by using shock in oil inventory, and by denoting it as specualitve demand and forward-looking behaviour. The reason for using oil inventory shock as proxy for speculative demand shock is that previous studies (Kilian, 2009 and Bastianin et al. 2016) looked only at the impact of demand and supply shocks on economy, ignoring the speculative component of global oil market.

The present study assesses the impact of different oil price shocks on Indian stock market at firm-level, by using the methodology propogated by Kilian (2009). Extending the previous studies that considered oil price shock proxy for oil specific demand, study considers oil inventories for measuring speculative demand. While using oil inventories, it is treated as tool to identify the forward-looking component for oil price shocks. The idea of using speculative demand is to separate speculative component from demand and supply shocks of oil. Hence, this study will be assessing the impact of speculative demand on oil price and Indian stock returns, along with oil supply and aggregate demand shock at firm level. This is the first study to assess the dynamics between different global oil market shocks and Indian stock returns at firm level, using GMM and PVAR-X model.

4.2 DATA DESCRIPTION

The present study estimates a 5 variable GMM and panel PSVAR-X model using monthly panel data for the period 1995:01 to 2020:12. Following Kilian (2009a), the real price of oil is expressed in log-levels. The data for the global oil production is obtained from U.S Energy Information Adminstration measured in millions of barrels of oil. Following Killian and Murphy (2012), petroleum inventories are extracted from

U.S EIA[9]. Present study considers OECD countries as proxy for global petroleum inventories. Global Index of Industrial production (IIP) are considered as proxy for global real economic activity provided by OECD database. The index is based on the data from 34 OECD countries.[10] The present study estimate E-GARCH in order to measure the shock in production, global real economic activity and petroleum inventories, referred to as 'supply shock', 'global demand shock' and 'speculative demand shock' respectively.

4.3 METHODOLOGY

This section describes the econometric estimation and identification of the structural dynamics of the panel data. Before proceeding to the main model, in empirical research, it is inevitable to do some pre-tests so that the data series becomes suitable for further estimation. Regarding micro panel data with large N, correcting the non-stationarity of panel data series is very crucial. The pre-tests are begun by testing the stationarity of variables by using panel unit root tests such as Levin and Lin (LLC, 1992) I'm, Pesaran and Shin W- Stat (IPS) and Hadri tests. The null hypotheses of LLC and IPS assume that the panel data series has unit root against the alternative hypothesis of no unit root tests. What distinguishes LLC from IPS is that the former test assumes common unit root covering all cross-sections. Whereas, heterogeneity in the unit root procedure of individual data is allowed in the IPS unit root tests. The present study uses Levin and Lin (1992), and I'm, Pesaran and Shin W- Stat.

Further, the present study employs the Durbin-Wu-Hausman tests to detect the presence of endogeneity in the explanatory variables. According to the econometric theory, explanatory variables should not correlate with the error term. A Durbin-Wu-Hausman test is generally used on OLS to detect for the same reason. In the present study, the standard model was estimated with various oil price shocks, and is expressed in the following equations:

$$(R_{it}-RF_t)=C+\beta_1 Oilprice_t+\beta_2 GOP_t+\beta_3 REA_t+\beta_4 Inventories_t+\varepsilon_{it} \qquad (4.1)$$

9EIA includes crude oil as well as unfinished oils, natural gas.

10Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Mexico, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

$$(R_{it}\text{-}RF_t)=C+\beta_1 OPS_t+\beta_2 OilSupplyshock_t+\beta_3 ADS_t+\beta_4 SDS_t+\varepsilon_{it} \quad (4.2)$$

In equation 4.1 above, GOP stands for global oil production; in equation 4.1, REA stands for real economic activity; OPS stands for oil price shock, ADS in equation stands for aggregate demand shock; and SDS in equation stands for speculative demand shock.

To test whether each explanatory variable is endogenous or exogenous, the regression on each explanatory variable is estimated to diagnose residuals from it. In the process, the independent variable has become a dependent variable. The next step is to diagnose whether the coefficients of residuals are significant. The null hypothesis assumes the individual explanatory variables as exogenous in the system. From the test results, all independent variables (oil price, oil production, real activity, oil inventories, oil supply shock, aggregate demand shock and speculative demand shock) and control variables such as SMB, HML, index return are found to be endogenous. To correct endogeneity, present study uses instrument variables for the lagged dependent variables and other non-exogenous variables. So, in the standard GMM model, a dependent variable with a lag is treated as one of the independent variables, i.e., stock returns. The lagged values of the dependent variable is treated as an instrument variable so that these internal variables correct the issue of correlation between the explanatory variables and the error term. The present study follows the two-step estimation because the first difference transformation could lead to loss of the degrees of freedom. On the other hand, in the two-stage least square estimators, from a particular variable, the average of all future variables is subtracted. GMM takes care of data loss, and also provides efficient and consistent estimates. It is suitable when the N (Cross-section) dimension is larger than the T (Time series) dimension.

The two-step GMM has been specified in equations 4.3 and 4.4:

$$(R_{it}-RF_t)=C+\beta_1 Oilprice+\beta_2 GOP_t+\beta_3 REA_t+\beta_4 Inventories_t+\varepsilon_{it} \quad (4.3)$$

$$(R_{it}-RF_t)=C+\beta_1 OPS+\beta_2 OilSupplyshock+\beta_3 ADS+\beta_4 SDS+\varepsilon_{it} \quad (4.4)$$

While estimating the above equations, lagged values of the dependent variable (stock returns) and the independent one is treated as instruments to take care of endogeneity. Regressors with deeper lags are also used as instruments.

4.3.1 Panel Structural Vector Autoregressive Model

While various studies have used the SVAR model for assessing the asymmetric impact of oil price shock on macroeconomic performance, there is no study that assesses the asymmetric impact of oil price shocks on stock returns at firm level. To study the same in the context of stock market, the present study, following Kilian (2009), uses the SVAR model in a panel data framework. Accordingly, the panel approach should apply to a wide range of panel data types. In short, the technique is viable for any panel that includes a time series that is long enough to cover at least minimally estimated member-specific VAR coefficients.

The present study uses a reduced form of panel SVAR-X to record responses of the dependant variable to shocks. In the model, PSVAR has been used to estimate six endogenous variables, namely, stock returns, index returns, SMB, HML, WML and inflation, and four exogenous variable, namely oil price shock, oil supply shock, aggregate demand shock and speculative demand shock. PSVAR can be estimated by specifying the following structural panel equation:

$$A_0 Y_{it} = L_{io} + \sum_i^k B_1 Y_{it-1} + B_2 Y_{it-2} + \ldots . B_n Y_{it-n} + fX_t + \varepsilon_{it} \quad (4.5)$$

In the equation, the matrix specifying the contemporaneous relationship among variables is represented by A. Y_{it} is a Kx1 vector of six endogenous variables such that $Y_{it} = Y_{1t}, Y_{2t}, \ldots Y_{nt}$ (stock returns). L_{io} is a Kx1 vector of constants constituting firm-specific intercept terms. The matrix of coefficients with lagged endogenous variables (for every i=1….P) ϕ is represented by B_i. In the model restrictions on endogenous variables stock returns are imposed. Exogenous variables are represented by X_t. ε_{it} represents the error term. While employing SVAR model, sufficient lag length helps in reflecting the long-term impact of independent variables on dependent variables. The present chooses lag two as the appropriate lag length.

Following Amisano and Giannini (1997) ` method 35 restrictions[11] on the A and G matrices collectively (where n is the number of variables) are imposed. As PSVAR-X

11 Based on calculation: 2n2-n(n+1)/2 (where n is the number of variables)

imposes five zero on A, the system is over-identified. Collectively, 15 free parameters in A matrix, and 5 in the G matrix are estimated. Based on economic theory, the present study imposes restrictions, and discuss how each variable is placed for identification purpose. Here, the study assumes that the real price of oil is explained by the current and future supply and demand conditions. Any disturbance in oil production and supply will lead to change in movements in oil price. Any disruptions in oil production will lead to shock in inventories. That is why the model also assumes that any shock in oil supply will lead to disturbance in inventories. Oil price also depends upon the global business cycle, and so, any unanticipated movement in real economic activity (aggregate demand shock) may lead to increase or decrease in oil price, depending upon whether aggregate demand shock is positive or negative. Positive shock will increase oil price, and in turn, will lead to increase in oil production. Since oil is storable, the price of oil may depend on the future inventories. Any speculation regarding oil demand or supply will impact the current volume of inventories, and successively, the current oil price. These developments will dampen real economic activity, and increase oil production. The domestic oil price does not depend just on international oil price and other sources of oil price; it also depends upon the tax. That's why these effects are indirect, and have little influence on oil price. Finally, the model assumes that all the sources of oil price shocks affect the stock returns. So, the focus of this study is to assess the impact of the sources of oil price shock on Indian stock returns at firm level.

The restrictions imposed on five endogenous variables are reported in equation 4.6. All the dependent variables are placed in first row left hand side of the matrix, where REA stands for real economic activity. The first column of the matrix notation consists of shocks in oil price, oil supply, real economic activity and inventories respectively, whereas OPS stands for Oil Price Shocks, oil supply shock, Aggregate Demand shock and speculative demand shock. Real oil price and stock returns are determined by these above-mentioned shocks. All NAs depict the variables to be estimated. For example, oil price can be determined by its own shock, oil supply shock, aggregate demand shock and speculative demand shock, whereas only oil supply is determined by its own shock. Real economic activity is determined by oil price shock, oil supply shock and speculative demand shock, and by its own shock. And finally, stock returns is determined by oil price shock, oil supply shock aggregate demand shock and speculative demand shock.

$$\begin{bmatrix} & OPS & OSS & A.D.S & S.D.S \\ \text{Oilprice} & NA & NA & NA & NA \\ \text{Oilsupply} & 0 & NA & 0 & 0 \\ REA & NA & NA & NA & NA \\ Inventories & 0 & NA & 0 & NA \\ stockreturns & NA & NA & NA & NA \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \quad ...(4.6)$$

4.2 RESULTS

The summary statistics of firms' stock return and various sources of oil price shocks are presented in Table 4.1. Results show that mean of stock return, oil price-change, oil price shock, real economic activity, aggregate demand shock, oil supply-shock and oil inventories are positive. Whereas oil production and speculative demand shock has a negative mean. Regarding kurtosis, some variables (speculative demand shock, oil inventories, oil production and aggregate demand shock) are above 3, which means that these variables are leptokurtic. The rest of the variables are below 3. Skewness determines the positive or negative outcome of the variables. In the present case, stock returns are positive, implying that large positive stock returns are more common than negative returns. The standard deviation aggregate demand shock, oil supply-shock, speculative demand shock and oil inventories are much more than other variables (real economic activity, oil production and oil price shock).

The results of panel unit root tests, GMM estimation and Panel-SVAR are discussed in this section. Table 4.2 shows the results of panel unit root tests, except for oil price-change and oil price shock. The rest of the variables are stationary in nature. The first difference between oil price-change and oil price shock is obtained to bring stationarity. Table 4.3 and 4.4 represent the results obtained from GMM estimation. In order to prevent endogeneity, deeper lags for dependent variable (stock returns) is estimated. Stock returns is negatively influenced by its own two lags. Further, real oil price has positive and statistically significant relation with stock returns. Similarly, global real economic activity also shows positive influence, and is highly significant. This means that strong global economic activity stimulates stock returns as any increase in global oil production decreases real oil price and boosts stock returns. Hence, oil production is positively related to stock returns. On the other hand, coefficient of oil inventories is negative, confirming negative relation between oil inventories and stock returns. This also means that stocking up crude oil hampers firms profit ultimately affecting stock returns. In order to explore the relationship between the various sources of oil price shocks and stock returns, the study has considered basic model using oil price shock, oil supply shock, aggregate demand shock and speculative demand shock. These results are presented in Table 4.4. There is positive and statistically significant relation between oil price shocks and their sources to stock returns. It can be interpreted that any shock in supply and demand side of oil boosts Indian stock returns.

The estimation results of the panel structural VAR model are presented in Table 4.5. Results present responses of the real oil price, world oil production, global real economic activity, crude oil inventories and Indian stock returns to shock in oil price and its sources. On the basis of discussion in section 4.3.1 the blanks in the table reveal that particular variable is not estimated as there is no economic relation. The first row of Table 4.5 shows the response of oil price to oil price shock and its sources. There is positive influence of oil price shock on real crude oil price. The sign of coefficient associated with the oil price shock is in line with economic theory. In other words, the shock due to increase in oil price may not have contemporaneous impact on oil price, but has positive impact on oil price after some lag. Oil supply shock has negative - and statistically significant - influence on oil price shocks. This is on expected lines as shock due to increase in oil supply results in decrease in oil price, and the other way round. Any shock due to increase in real economic activity will increase oil price. However, results show that aggregate demand shock is negatively associated with oil price, which is contrary to expected lines. But as domestic oil price partially depends on international oil price, there is no direct link between global real activity and domestic oil price. In comparison, the coefficients associated with speculative demand shock have negative and statistically significant influence on oil price, and this goes well with economic theory. In other words, any shock due to increase in oil inventories will result in decrease in oil price. The second row measures the impact of sources of oil price shock on that of oil supply. The supply side of oil is not affected by the above-mentioned shocks. Oil supply can be influenced by some other shocks such as political events and cartels, which the model does not consider.

The third row measures the impact of different sources of oil price shocks on global real economic activity. Oil price shock has negative effect on global economic activity: the shock due to oil price may bring some disturbances in economic activity and hence weakens the financial performance of the firms. On the other hand, shock on the supply side of oil has positive and statistically significant impact on real economic activity, which means that higher supply of oil will boost the production of energy-intensive industries, and in turn, improve economic performance globally. Looking from the inflation channel perspective, increase in the supply of oil will lead to decrease in the crude oil price; this will cut down the production cost of majority of industries, and inflation will be brought down, boosting stock market. As stock market is considered to be the barometer of economic performance, wellness of stock market also indicates a strong economy. Real economic activity is positively and statistically affected by its own shock. In the present study, model assumes that any shock in real economic activity will not have contemporaneous effect on global real economic activity, but will have influence with lag. On the other hand, speculative demand shock has negative effect on real economic activities. That means any shock inventories will have negative influence on real economic activity.

The fourth row shows how oil inventories respond to shock endogenous variables. The Model assumes that oil price shock and aggregate demand shock do not affect the inventories. Hence, first and the third rows are kept blank. The coefficients associated with oil supply shock are statistically significant, and are not surprising, as oil supply shock has negative influence on inventories. Thus, it can be interpreted that increase in current oil supply will deplete the current oil inventories. Since oil is storable, depletion in oil inventories will influence the real oil price. Also, any speculation about future oil demand and supply will also influence the current oil inventories, and as a consequence, this will impact the real oil price, and will ultimately affect the stock returns. Next, oil inventories are negatively affected by their own shock.

The last row of the table measures the response of the interest variable (Indian stock returns) to the sources of oil price shocks. Stock return is negatively and statistically significantly affected by oil price shocks. On the other hand, stock return responds negatively to oil supply shock. To put it in another way, responding disruption in oil supply, oil suppliers (producers) will exhaust oil inventories to make up for the loss in production. An increase in the oil price, emerging from the disruption in oil supply shock, cause a decline in the Indian stock returns at firm level. These results are similar to those of the study done by Kilian and Park (2009): the study concluded that the US stock returns reacted similarly to oil supply shock. Likewise, a study done by Ghorbel and Younes (2009) concluded that a negative oil supply shock has negative impact on stock returns of some of the importing countries. On the other hand, the results of the present study are in contrast with the study done by Aktham (2004), which suggested that for short-run, oil price shocks have no significant impact on stock returns in emerging markets. The response of Indian stock returns towards shock in aggregate demand is positive, but statistically, not significant. However, the positive association of stock returns with global demand shock is similar to that with the results obtained by Killian and Park (2009) for the US stock returns. Speculative demand shock has negative - and statistically significant - impact on stock returns. This means that speculative demand shock will lead to higher oil prices. The effect will be inflationary in India, will result in decreased household wealth. These findings are similar to the findings of Guntner (2011), which concluded that stock returns are negatively impacted by a speculative demand shock.

Appendix 4.1 shows the result of asymmetric impact on stock returns of firms at different sectors. At the firm level, stock returns of most of the sectors (17 sectors) are positively affected by oil price shock, and statistically significant. This confirms the asymmetric response of stock returns towards oil price shock, except for a few firms in around seven different sectors. Similarly, oil supply shock has a positive impact on stock returns of firms in most of the sectors, but certain sectors such as agricultural machinery and diversified machinery have negative response. In case of aggregate demand shock the stock returns of firms in sectors such as abrasives, air-conditioners & refrigerators, aluminium & aluminium products, bakery products, commercial vehicles, copper & copper products machine tools, mining & construction equipment, miscellaneous electrical machinery, organic chemicals, other ferrous metal products, other non-ferrous metal products are negatively affected (and are statistically significant). On the other hand, rest of the firms in different sectors are positively affected, giving evidence of the presence of the asymmetry between the aggregate demand shock and these stock returns. Similarly, the coefficients of speculatively demand shock is negatively affected and statistically significant for firms in most of the sectors. This means that any shock in oil inventories has negative impact on stock returns at the firm level.

Figure 1 to 4 show the responses of real oil price, oil production, real economic activity, oil inventories and stock returns to one-standard deviation with four structural shocks. Figure 1 shows that the response to oil price shock results in a decline in real oil price by 0.05% at the second month; however, from the third month, the response becomes positive (0.05%). At the end, (24^{th} month) it reports 0.27% increase. Shock in oil price results in increase in oil production by 0.34% in the first month. As expected, positive shock in oil price triggers higher production, and is statistically significant; as a result, oil production consistently increases till the end. Similarly, oil price shock leads to increase in real activity by 2.60%, which is consistent with the theory. So shock due to increase in oil price leads to increase in production, and boosts economic performance. It also causes temporary reduction of real economic activity, which is statistically significant. The effect of unanticipated increase/decrease in oil price on oil inventories is quite cyclical and significant. It begins with positive but marginal effect until the 18^{th} month, and then begins to decline. The effect of oil price shock on stock returns is again cyclical and significant: there is increase in stock returns till the 9^{th} month, and there is a dip at the 10^{th} month, the effect is vanished at the end.

Figure 2 shows the responses to oil supply shock. An unexpected oil supply disruption causes a decline in real oil price by -1.17% at the first month. This result is consistent with the view that shock due to dip in oil supply will trigger off an increase in the crude oil price. However, the pattern does not remain the same: from the third month on, there is increase in oil price, and that continues to be persistent and statistically significant till the end. Surprisingly, the response of world oil production to oil supply disruption is positive for the first five months. Then the world oil production continues to decrease till the ninth month, and thereafter it recovers. These figures are contrary to the results of the studies done by Kilian (2009) and Gupta and Modise (2013). Oil supply shock also has positive and significant effect on real economic activity and oil inventories. Strong economic performance from unanticipated oil supply shock has positive and significant impact on Indian stock returns. Strong economy leaves potential consumers with more wealth and income, resulting in increase in stock returns. The response of stock returns to oil supply shock in the study has more or less followed cyclical pattern, where the second and the third months show negative response, and then, there is increase in stock returns, and so on.

Figure 3 shows that an unanticipated hike in demand for oil, caused by an enhanced global economic performance, will result in increase in oil prices for most of the months. Aggregate demand shock caused short and significant swings in real oil price as there was decline in real oil price in the third, fifth, 12th months, and so on. Unexpected improvement in economic performance also led to increase in production for the second month, and thereafter, witnessed some decline in the third, fifth, seventh, 12th months, and so on. It is not surprising that decline in real oil price in whichever month also witnessed decline in oil production, which is consistent with the view that international oil price contractions lead to decrease in world oil production. The effect of an unanticipated aggregate demand expansion on global real economic activity is volatile as the response keeps changing in every two months. It begins with positive real economic activity, but later shows negative response. This also indicates that unanticipated increase in real economic activity temporarily offsets oil production, which in turn affects the real economic activity with some delay. The unanticipated increase in aggregate demand results in lower inventories from fifth to ninth month, and then gradually recovers marginally in between. This is because increased global aggregate demand results in higher demand, leads to slightly higher oil production, and also depletes the inventories. However, the impact is not persistent till the end, as oil inventory accumulation takes place to sustain future demand for oil. The global demand shock has a volatile impact on Indian stock market: it neither has a positive impact which is persistent nor a negative impact throughout the horizon, although the effect is statistically significant. This result is not in line with the studies done by Kilian and Park (2009) for the US economy. Study done by Gupta and Modise (2013) chose South African stock returns as variable of interest. The results of the study are not in line with the results obtained from the study done on South Africa. South Africa is an exporting country boosting its own economic performance; and this results in greater income pouring into the economy and households, which then transforms into higher stock returns. India is primarily an importing economy, and so, any turmoil in global economy is going to affect the wealth of the economy in a negative way. Hence, the findings of these two studies are contrary.

Bleak speculative demand shock results in decrease in real oil price for the first four months, and then in a recovery of it to a larger extent. The impact of speculative demand shock on real oil price is persistent after the fourth month. This is rational enough as speculation about oil demand and supply will increase the oil demand and oil price in period t + 1 period. The impact of shock in speculative demand on oil production is negative for the first five months, and then registers positive response. The reaction of global real activity to speculative demand shock is cyclical. That means, speculation about current flow of demand and supply will lead to uncertainty in the economy. Going by positive speculation about future demand for oil would also result in higher oil prices at time t, while global real activity is volatile. As expected, speculative demand shock has positive impact on inventories, except for the first two months. This is in line with the findings of Kilian and Murphy (2014). Although the impact of speculative demand shock is positive for the first four months, it dips down drastically, and continues to do so till the ninth month. Overall, the effect is again cyclical as one could witness ups and downs in stock returns. This is because domestic oil price is partially dependent upon the status of subsidiaries and taxes. Also, inflation does not depend just upon oil price shocks and its sources, but it depends on other shocks such as inflation shock as well.

4.3 SUMMARY

The results show that stock returns at firm-level respond differently to various oil shocks. Oil price shock has positive impact on stock returns. This is due to the fact that the decline in oil price, witnessed over the later years of the present study period, might have triggered higher stock returns. This is in line with Aktham (2004), in whose study results, short-run oil price shocks have no negative impact on stock returns. There is negative relationship between oil supply shock and stock returns, so any disruption in supply of oil makes oil price uncertain, which, in turn, has negative impact on stock returns. Also, an expected higher aggregate demand shock has positive impact on stock returns. The present study results are in line with certain literature which suggests that there is a positive relation between aggregate demand and stock returns. The results of the present study convey that policy makers and investors should look into the sources of oil price shocks before implementing policies or making investment decisions. For example, oil prices are driven by structural demand and supply shocks that may have direct effects on stock returns.

Table 4.1: Summary Statistics of the Variables Used in the Study

Variable	**Mean**	**Standard Deviation**	**Skewness**	**Kurtosis**
Stock return	1.713	2.071	0.695	2.337
Oil price-change	4.707	4.260	-0.507	-0.951
Oil price shock	0.412	0.611	-0.547	-0.917
Real Economic Activity	2.415	0.086	-0.335	2.822
Aggregate Demand Shock	212.971	64.531	1.207	3.377
Oil production	-0.044	0.086	-0.342	2.832
Oil supply-shock	37.236	64.531	1.207	3.377
Oil Inventories	42.058	725.879	-4.752	66.379
Speculative Demand Shock	-24.452	200.654	-4.752	25.328

*The above table describes the measure of location, statistical dispersion and measure of the shape of the distribution

Table 4.2 Panel Unit root tests

Method:	**Unit root with common Process**				**Unit with individual unit root process**			
	Levin, Lin & Chu t				Im, Pesaran and Shin W-stat			
	Level		**First Difference**		**Level**		**First Difference**	
Variable Name	**Statistics**	**Prob.**	**Statistics**	**Prob.**	**Statistics**	**Prob.**	**Statistics**	**Prob.**
Stock returns	-667.693	0.000	-	-	514.297	0.000	-	-
Oil Price-Change	25.463	1.000	557.805	0.000	17.160	1.000	-413.345	0.000
Oil Price shock	26.678	1.000	674.762	0.00	28.658	1.000	-487.493	0.000
Real Economic Activity	-679.612	0.000	-	-	-491.232	0.000	-	-
Aggregate Demand Shock	-399.381	0.000	-	-	-262.468	0.000	-	-
Oil production	-23.9012	0.000	-	-	27.4860	1.000	-1417.32	0.000
Oil supply-shock	-77.8816	0.000	-	-	-4.83980	0.000	-	-
Oil Inventories	-81.2175	0.0000			-74.5954	0.0000		

Speculative Demand Shock	-80.6910	0.0000			-73.6129	0.0000		

Table 4.3 Effect of Real Oil price, Real Economic Activity, Oil production and Inventories on stock returns (GMM)

Variable	**Coefficient**	**Std. Error**	**t-statistics**	**Prob.**
Stock returns (-1)	-0.041	0.138	-0.300	0.0000
Stock returns (-2)	0.016	0.173	0.090	0.0000
Stock returns (-3)	0.050	0.106	0.469	0.0000
Real Oil Price	141.985	101.330	1.401	0.0000
Oil Production	0.013	0.015	0.884	0.0000
Real Economic Activity	0.015	0.023	-0.640	0.0000
Oil Inventories	-12.509	8.920	-1.402	0.0000
Test order	**m-Statistic**	**rho**	**SE(rho)**	**Prob.**
AR(1)	-27.394305	-1650.656172	60.255451	0.0000
AR(2)	6.859029	19.328825	2.818012	0.2043

Note: Instrument validity is tested using Sargan test J statistics which has a null hypothesis of 'test of over identifying restrictions are valid'. It returns the value of 14.86 and a probability value of 0.315.

Table 4.4 Effect of Oil Price-Shock, Aggregate Demand shock and Aggregate Supply shock on stock returns (GMM)

Variable	**Coefficient**	**Std. Error**	**t-statistics**	**Prob.**
Stock returns (-1)	-0.208	0.152	-1.366	0.000
Stock returns (-2)	-0.097	0.123	-0.794	0.000
Stock returns (-3)	0.023	0.093	0.249	0.000
Oil Price shock	71.125	94.844	0.750	0.000
Oil Supply shock	0.003	0.012	0.248	0.000
Aggregate Demand Shock	-0.016	0.015	-1.098	0.000
Speculative Demand Shock	0.099	4.121	0.024	0.000
Test order	**m-Statistic**	**rho**	**SE(rho)**	**Prob.**
AR(1)	-1.429	-557234.505	390014.049	0.015

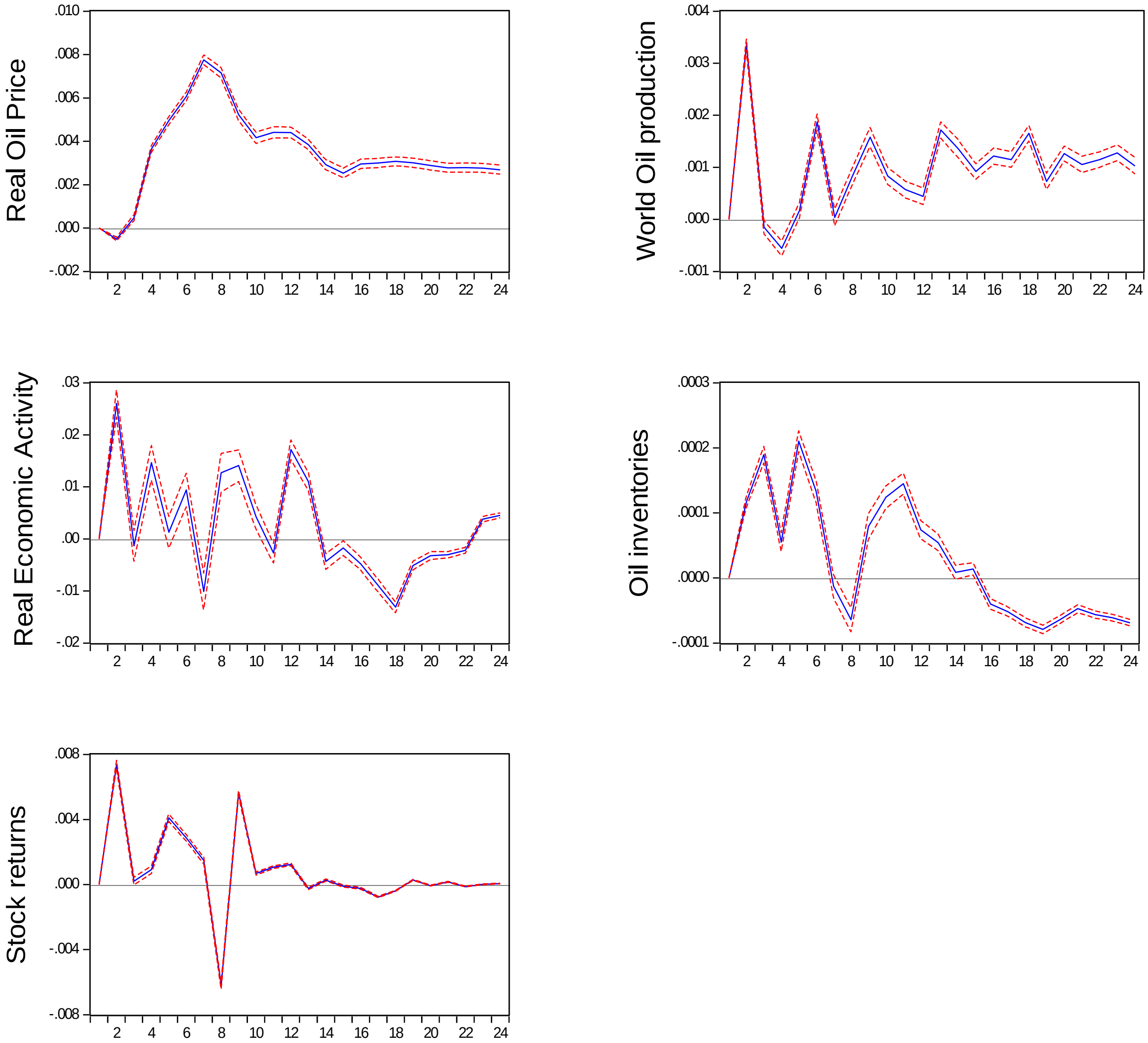
AR(2)	-1.165	-252764.220	216991.997	0.244

Note: Instrument validity is tested using Sargan test J statistics which has a null hypothesis of 'test of over identifying restrictions are valid'. It returns the value of 18.87 and a probability value of 0.127. Tables 1-2 exhibits the estimation results of Generalised Methods of Moments; Dependent variables with lags are treated as independent variable along with other regressors. The values of coefficient are in scientific form. The last two rows exhibit the post estimation results of Arellano-Bond serial correlation test.

Table 4.5 Estimated Matrix with impact of Sources of Oil Price Shock on Oil Price, Real Activity, inventories and Stock Returns (P-SVAR)

Estimated A_0 matrix				
	Oil Price shock	Oil supply shock	Aggregate Demand Shock	Speculative Demand Shock
Oil Price	0.357***	-0.172*	-11.834**	-0.017*
Oil Supply	0.264*	1.206**	-	-
Real Economic Activity	-8.789*	0.238**	0.651***	-3.789*
Oil Inventories	-	-0.028**	-	-10.931
Stock returns	-0.119*	-0.248**	0.176	-12.462*

Figure 1: Oil Price shock



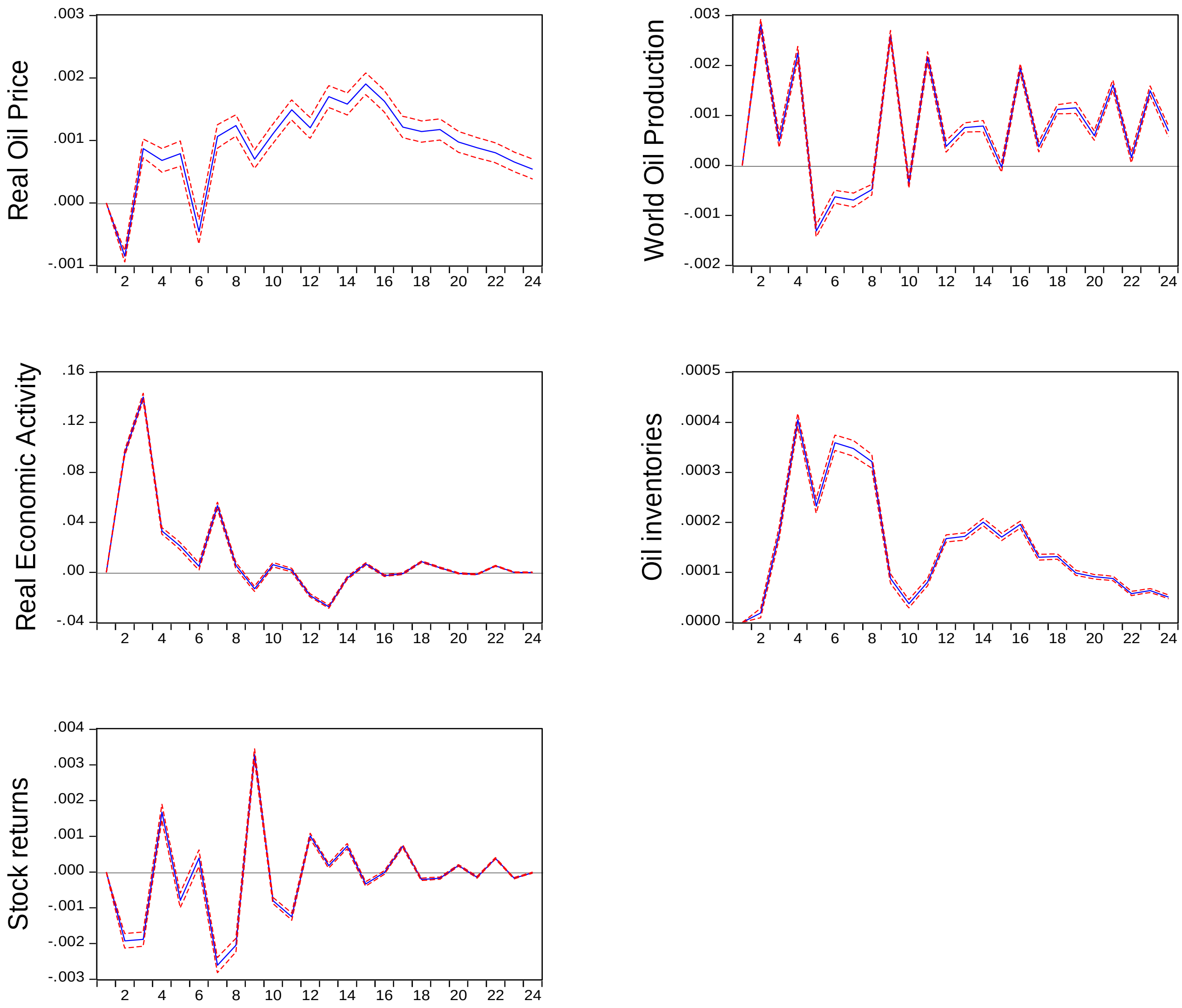
X Axsis: Time(Monthly)

Y Axsis: Mean Responses

Response to Non factorized One S.D. Innovations ± 2 S.E.

*Dynamic responses of Stock Returns, Real economic activity, world oil production, oil inventories and oil price-change to oil Price Shocks. The solid line gives the mean responses to a one standard deviation shock, while the dotted lines indicate ± 2 standard deviations of the responses. The impulse response function are statistically significant as interval bounds are jointly above or below the zero line.

Figure 2: Oil Supply Shock



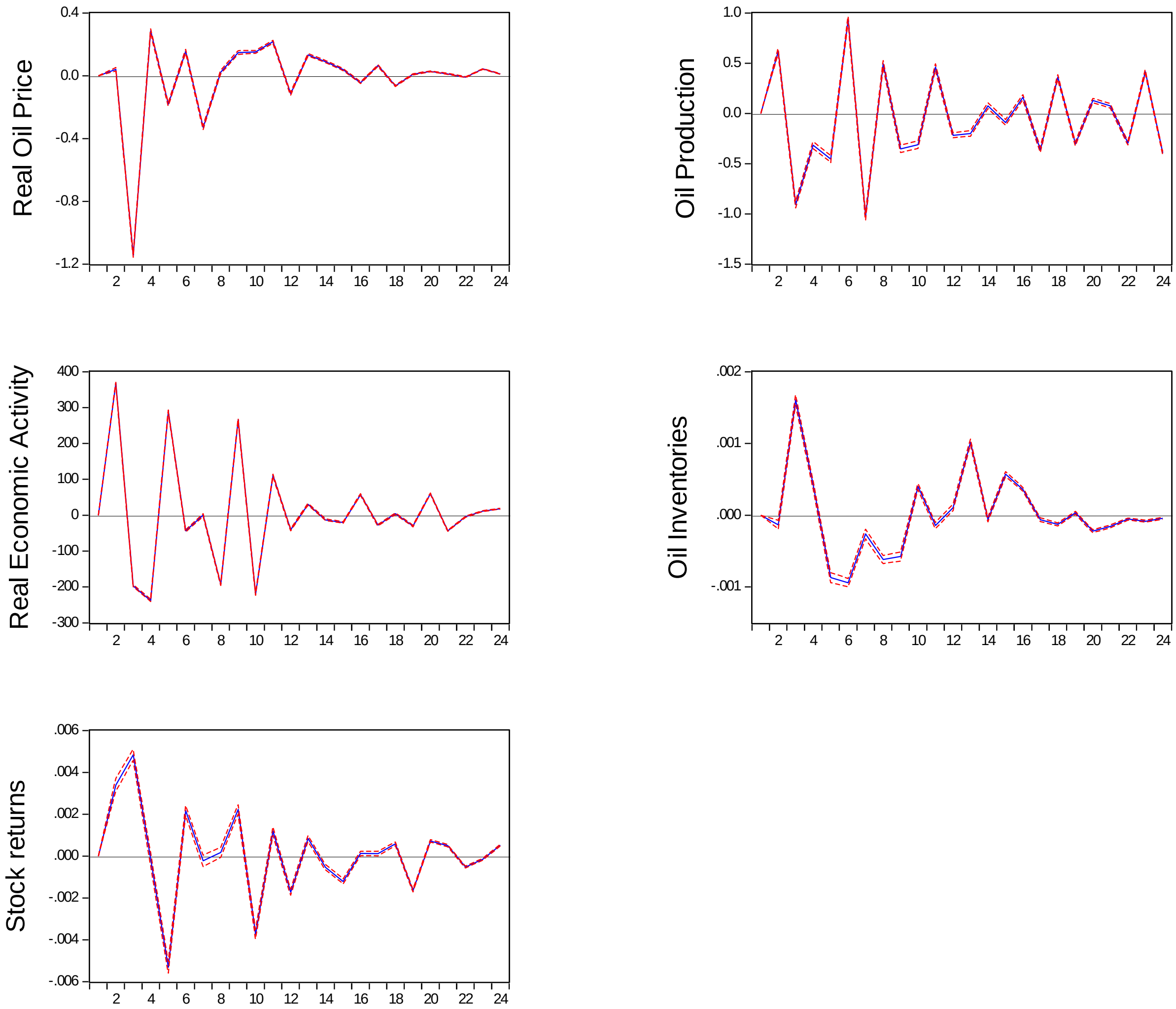
X Axsis: Time(Monthly)

Y Axsis: Mean Responses

Response to Non factorized One S.D. Innovations ± 2 S.E.

*Dynamic responses of Stock Returns, and oil price-change to oil supply shock. The solid line gives the mean responses to a one standard deviation shock, while the dotted lines indicate ± 2 standard deviations of the responses. The impulse response function are statistically significant as interval bounds are jointly above or below the zero line

Figure 3: Global Demand Shock



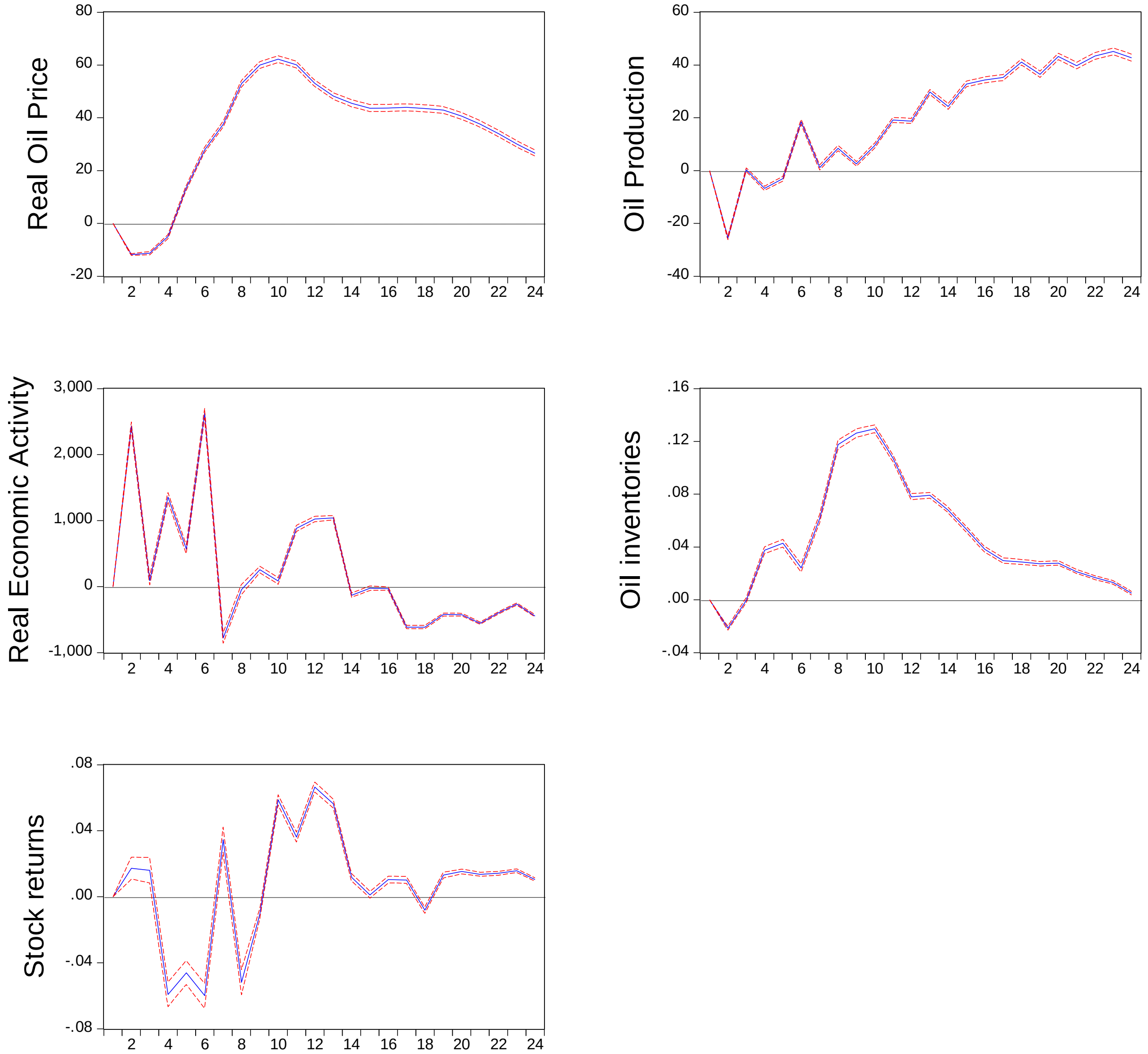
X Axsis: Time(Monthly)

Y Axsis: Mean Responses

Response to Non factorized One S.D. Innovations ± 2 S.E.

*Dynamic responses of Stock Returns, and oil price-change to aggregate Demand shock. The solid line gives the mean responses to a one standard deviation shock, while the dotted lines indicate ± 2 standard deviations of the responses. The impulse response function are statistically significant as interval bounds are jointly above or below the zero line.

Figure 4: Speculative Demand Shock



X Axsis: Time(Monthly)

Y Axsis: Mean Responses

Response to Non factorized One S.D. Innovations ± 2 S.E.

*Dynamic responses of Stock Returns, and oil price-change to speculative demand shock. The solid line gives the mean responses to a one standard deviation shock, while the dotted lines indicate ± 2 standard deviations of the responses. The impulse response function are statistically significant as interval bounds are jointly above or below the zero line.

CHAPTER 5

TIME-VARYING EFFECT OF OIL PRICE SHOCKS ON STOCK RETURNS

5.1 INTRODUCTION

In an increasingly integrated world economy, the dynamics of the relation between oil prices and stock markets are complicated. The impact of oil price shock and its magnitude has been changing from time to time. The same has been addressed in the relevant energy finance literature (inter alia: Ciner, 2001; O`Neil et al. 2008; Papapetrou, 2001; Sadorsky, 1999). It is argued that if oil price shock affects the state of the economy, it is likely that it will affect the stock returns (Chen, 2010). There are several studies which found that there is no stable relationship between oil price shocks and stock returns (Mohaddes & Pesaran, 2017). Although oil price shocks affect stock returns negatively, there has been always mixed evidence of impact of oil price shock on stock returns. For example, some studies found that the relationship between oil price shock and stock returns is negative (Basher and Sadorsky, 2006; Park and Ratti, 2008; Killian and Park, 2009). Whereas, some studies found a positive relationship between oil price and stock returns (Sadorsky, 2001). Early studies like Hamilton (2003) notes that unprecedented change in demand for oil, disruptions in oil production and geopolitical situation, etc. results in instability in oil price. Nonlinearities between oil price shock and stock returns occur when stock returns respond differently at different points in times during recessions and booms. In fact, impact of oil price shock on stock returns was different before, during, and after Global Financial Crisis (GFC) (Mollick and Aseefa, 2013; Tsai, 2015). Similarly, the long-run negative impact of oil price shock on stock returns vanished after September 1999 (Miller and Ratti, 2009). Other than GFC, external shocks have contributed in dynamic relationship between oil prices and stock returns. For example, during Iraq war in 2006, the relationship between the same changed from positive to negative (Zhang, 2017). Some short-term external shocks such as terrorist attacks could have disturbed relationship between oil price and stock returns. And also, recently, Covid-19 crisis followed by stringent lockdowns has shook oil market and led to uncertainty in its relation with stock returns.

Hence, the above incidents prove that relationship between oil price shock and stock returns is time-dependent. In recent times, some studies reported the relationship between oil price shock and stock returns is time-variant and asymmetric (Miller and Ratti, 2009; Chang and Yu, 2013; Zhan and Li, 2014). Even though the relationship between oil price shock on stock returns at disaggregated level or firm-level at different times may have different implications. Yet attention is given to relationship between oil price shocks and aggregate stock returns at different structural breaks (Roboredo, 2010; Fills et al., 2011; Kollias et al. 2013). Examining the impact of oil price on stock returns across firms covers the heterogeneity in stock returns and gives insight into how individual firms react to oil price change (Narayan and Narayan, 2014).

Unfortunately, previous studies have studied relationship at different time periods between oil price and stock returns at aggregate level, while overlooking the impact on disaggregated stock returns (Sadorsky, 2008; Narayan and Sharma, 2013; Phan et al. 2015). Also, before GFC, large and medium-size firms were negatively affected by oil price shock, however, post GFC, the negative effect of oil price shock weakened (Sadorsky, 2008; Narayan & Narayan, 2014; Narayan & Sharma, 2011, 2014). Additionally, previous studies which investigated the relationship between oil price shocks and stock returns are time or regime dependent, ignored asymmetric impact arising out of nonlinear relationship between oil price shock and stock returns (Zhu et al. 2016). To the best of authors knowledge, only Zhu et al. (2016) has examined the relationship between oil price shock and stock returns using regime-switching approach. Considering this gap, the main objective of this study is to examine the time varying asymmetric effect of oil price shock on firm`s stock returns.

5.4 DATA DESCRIPTION

The present study considers six independent variables (oil price-change, oil price shock, oil price shock-positive, oil price shock-negative, net oil price increase, net oil price decrease), inflation and Fama-French factors as control variables and one dependent variable (stock returns). To test the asymmetric effect of oil price shocks on the stock market at the firm level, the present study considers the companies listed on the Indian stock exchanges,covering the period from January 1995 to December 2020. The present study uses the WPI number for oil as a proxy for real oil price[12] and domestic oil price as a representation of the real oil price.

5.4 METHODOLOGY

In order to assess the time varying relation oil price shock and stock returns, present study considers the structural break in the data, for that Lluís Carrion-i-Silvestre et al. (2005) and Bai and Carrion-I-Silvestre (2009) tests is used. The present study also uses structural break with cointegration approach by testing Westerlund and Edgerton (2008).

5.3.1 Measuring Oil Price Shocks

There are some measures of oil price shocks that are used in the energy economics literature. The work of Hamilton (1983) assessed the energy price shock, particularly the oil price shock, using the log difference of oil price at a nominal rate. Mork (1989), on the other hand, treated oil price increase and decrease by differentiating between positive and negative change in oil prices. Hamilton (1996) propagated that net oil price increase or decrease was calculated taking maximum or minimum of oil price in the previous 12 months. In other words, in order to measure the net oil price increase, the study compared the price of oil each month with the maximum value observed during the preceding 12 months. If the value for the current month exceeded the previous month`s maximum, then the series would be defined as net increase in oil price. On the other hand, if the price of oil in month t was lower than in the previous 12 months, the series would be defined to be zero for date t. Following Hamilton (1996), the net oil price increase and net oil price decrease are calculated in the following way:

$NOILPI_t = \text{Maximum } \{(\ln(OILP_t) – \ln(OILP_{t-1} ,....OILP_{t-12})) \text{ otherwise},0$ ...(5.1)

In the same manner, net oil price decrease is computed as follows:

$NOILPD_t=\text{Minimum } \{(\ln(OILP_t) – \ln(OILP_{t-1},....OILP_{t-12}))\text{otherwise},0\}$ ..(5.2)

where the term $NOILPI_t$ or $NOILPD_t$ stands for net oil price increase and decrease.

5.3.2 Oil Price Shock-Modelling

There is a traditional method of modelling oil price shock proposed by Ferderer (1996). He modelled oil price shock by taking the standard deviation of the oil price. Some

12 WPI is a broad-based measure of inflation in India. More details about WPI are available at http://www.eaindustry.nic.in/WPI_ manual.pdf

authors opposing the standard deviation of oil price used the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) (1,1) for modelling oil price shock (Lee et al. 1995). In the present study, the present study uses the Exponential-GARCH (E-GARCH) introduced by Nelson (1991). E-GARCH equation is specified as:

$$\ln(h_t)=\alpha_0+\beta_1\ln(h_{t-1})+\alpha_1\left(\left|\frac{u_{t-1}}{h_{t-1}}\right|+\gamma\left|\frac{u_{t-1}}{h_{t-1}}\right|\right) \qquad ...(5.3)$$

In equation (5.3), h_t is specified as the conditional volatility of the oil price and α_0 is the unconditional variance with constant mean. u_{t-1} is referred to as error term (Nelson, 1991). From the residuals of the error term known as 'shock' or 'volatility', positive and negative oil shocks are calculated. Shocks due to oil price decrease will have an influence on α_1-γ specified as 'oil shock-negative', and shocks due to oil price increase will have an influence on $\alpha_1+\gamma$ specified as 'oil shock-positive'. So, the shocks due to oil price decrease will have an influence on α_1-γ (and in the present study, this has been specified as oil Shock-Negative), and the shock due to increase in oil price increase will influence $\alpha_1+\gamma$(and has been specified as oil shock-positive).

The shock into positive and negative are categorized in the following way:

$$\text{OILSHOCK-P} = \text{Max}\left(u_{t-1}/h_{t-1}, \text{otherwise } 0\right) \,\&\, \text{OILSHOCK-N} = \text{Min}\left(u_{t-1}/h_{t-1}, \text{ otherwise } 0\right) \qquad ..(5.4)$$

Thus, the present study constructs six dimensions of oil price shocks as Oil Price-Change, Oil Price Shock, Oil Price shock due to oil price increase (oil price shock-positive), shock due to oil price decrease (oil price shock- negative), Net Oil Price Increase and Net Oil price decrease.

5.3.3 Estimation Technique

5.3.3a Non-Parametric Model

As the sample period the study covers 303 monthly data points, variables are exposed to structural changes. Hence, the present study uses a non-parametric model in the panel framework. In a non-parametric model, various measures of oil price shock show the nonlinear relationship between oil price and stock returns, over time.

$$LogSt_{it} = f_i(t) + \beta_1(t)\Delta\log(oilprice - c)_{it} + \beta_2(t)\Delta\log(oilpriceshock)_{it} + \beta_3(t)\Delta\log(oilpriceshock - P)_{it} + \beta_4(t)\Delta\log(oilpriceshock - N)_{it} + \beta_5(t)\Delta\log(NOILPI)_{it} + \beta_6(t)\Delta\log(NOILPD)_{it} + \nu_{it} \quad ...(5.5)$$

Where Δ is the difference operator, $f_i(t)$ =, $f_i(t/T)$, for i= 1,2,..., N are unknown individual trend functions, $\beta_j(t) = \beta_j(t/T)$, for j = 1,2,...., N, are time-varying coefficients, St_{it} stands for stock returns for firm i at year t; oil price shock-P is shock due to oil price increase, oil price shock-N is shock due to oil price decrease, NOILPI is net oil price increase and NOILPD is net oil price decrease and ν_{it} is stationary for each i.

Before proceeding to the main analysis, some pre-tests are conducted to the data, which begins by testing cross-sectional dependence (CD) between the units. This test further determines in choosing specific unit root tests. Hence, this study uses first, second and third generation tests to deal with CD. Close association of variables such as various measures of oil price shocks and inflation may result in cross-section. The issue of cross-section if ignored, can lead to spurious regression (Westerlund, 2007). In order to test cross-section dependence, the present study uses the Pesaran (2015) CD test. After analysing the CD test, stationarity and non-stationarity of the panel data is checked. Given that the sample has a long-time span, this study examined the stationarity of the variables which allows for structural breaks. The present study employs panel unit root test by Lluis Carrion-i-Silvestre et al. (2005) and Pesaran (2007). These tests deal with issue of non-stationarity with cross-section dependence. Luis Carrion-i-silvestre et al. (2005) test is used to accommodate the effect of time dimension structural breaks for each cross-section.

5.3.3b. Cointegration Technique

Next, step is to test for slope homogeneity or heterogeneity in the slope or not for dependent variable. To do so, the present test employs Pesaran and Yamagata (2008). This test assumes that null hypothesis homogeneous and alternative as heterogeneous slope parameters. Once the homogeneous and heterogeneous variables are identified, the present study uses heterogeneous estimation methods such as Westerlund and Edgerton (2008), Banerjee and Carrion-i-Silvestre (2017). These third-generation tests help in identifying the structural break for each cross section in the presence of cointegration. What makes these third-generation tests different from first and second ones is that it deals with all three issues of panel data such as: cross-section dependence, heterogeneity and non-stationarity issues in the data. In the next step, the study employs Banerjee and Carrion-Silvestre (2017) which are based on Common Correlated Effects Mean Group (CCEMG).

5.3.3c. Cross-Sectionally Augmented Autoregressive Distributed Lags (CS-ARDL)

In order to investigate the long relationship between stock returns and various oil price shocks, the study employs CS ARDL. With estimation, closely associated variables (oil price shocks) may lead to misleading results. In order to deal with unobserved common factors in the regression, CS-ARDL model is the appropriate model to correct dynamic common correlated effect. In order to correct the disequilibrium in the variables, (ECM-1) is used. The main equation of CS-ARDL specifying long-run coefficients is given as the following:

$$Y_{it} = \sum_{i=0}^{P_y} \lambda_{1,i,} \chi_{i,t-1} + \sum_{i=0}^{P_z} \beta_{1,i} \theta_{t-1} + \sum_{i=0}^{P_x} \alpha_{i,} I \overline{\delta_{t-1}} + \varepsilon_{i,t} \quad ...(5.6)$$

Where, mean of all the variables are represented by $\delta_{t-1} = (\chi_{i,t-1}, \theta_{t-1})$. P_y, P_z, P_x specify lags for each variable. The dependent variable (stock returns) is represented by X_{it} and θ_{it} represents all the independent variables. Also, cross-section averages are specified as $\bar{\delta}$.

5.3.3d. Robustness Test:

In order to validate estimation in the presence of cross-section dependence, slope heterogeneity and structural breaks, study employs, Augmented Mean roup (AMG) by Eberhardt and Teal (2010) and CCEMG by Pesaran (2006). As the present study has unobservable time-variant element, CCEMG is used to overcome this issue. CCEMG takes care of these issues by taking the mean of all variables for all cross-section. The role of AMG is to correct heterogeneity, cross-section dependence in structural break set up.

5.4 RESULTS

Table 5.1 shows the empirical results of Pesaran (2015) CD test. Empirical findings suggest that null hypothesis of no cross-section dependence for all the variables such as stock returns, oil price-change, oil price shock, oil price shock-positive, oil price shock-negative, net oil price increase and net oil price decrease, inflation, index return, SMB, HML and WML is rejected at 1% significance level. Further, Pesaran (2007), and Bai and Carrion-l-Silvestre (2009) panel unit root tests are estimated for confirming whether the series are stationary or non-stationary in the presence of cross-section dependence, heterogeneity and structural breaks.

Table 5.2 provides results of panel unit root test with structural breaks, the null hypothesis assumes no unit root issue whereas, alternative hypothesis supports unit root. Empirical results derived from the model indicate that all variables are stationary at level. For each variable and firms, structural breaks up to five are given. For each series structural breaks associated with some global events. The events which led to structural breaks may have positive and negative effect on stock returns. The study exclusively discusses the implications of structural break caused due to local events and global events. Study obtains various structural breaks: July 1999-2002 is considered to be period where prices doubled; during 2003-2007 period events such global recession followed by 9/11 and Afghanistan war led to oil price boom. There was major turbulence in world economy and oil market specifically from the period 2007-2010. Economic events such as banking events, financial crisis and great GFC in 2009 led to decline in oil price. For the period 2015-2020, series of events led to decline in oil price (shale production increased and Pandemic). Especially, structural break associated in the year 2020 is linked with COVID-19 outbreak. It led to public health emergency, also disrupting stock market. India`s traditional industries such as mining, crude oil & natural gas and machine tools etc.

In terms of variables used in the study, structural breaks in each series is linked with global and local events. For example, oil price crisis in the global market had significant effect on stock returns. In case of local events, for stock returns, structural breaks of July 1999, July 2003, July 2007, July 2015 and May 2020 showed some important events. The structural break in 1999-2002 explains that India was still recovering from balance of payment crisis. There was still a room to implement monetary policy to stabilize the economy. Also, in the year 2000 industrial production witnessed slight set back from the previous year, which might have negative effect on stock returns (Economic survey, 2001). In the year 2009, major economies witnessed drastic fall and it had trickle-down effect on Indian economy, ultimately it had negative effect on stock returns in India. For most of the firms, structural break is uniform with slight variation in case of months. In case of various measures of oil price shock, the structural break for each firm follows same suit. For oil price change, structural break includes January 2000, March 2004, May 2008, August 2012, May 2016. In 1999, domestic oil prices saw major change as the global oil prices doubled up, along with economic privatization and liberalization of Indian economy, focus on expanding trade contributed in stimulating the economy which ultimately bringing a structural change in oil prices. Global events such as recession and 9/11 attack had an impact on domestic oil prices in the year 2004, which led to structural break. In the year 2008-2009, when world economy witnessed major setback due to collapse of Lehman crisis, India`s oil prices saw new trend. When global oil prices fell drastically in the year 2014-15, these events brought structural change in Indian oil price. In the same year, WPI number of oil price fell drastically from Rs.118 in the year 2011-12 to Rs 59 in 2015-16 (RBI report, 2017). Similarly, structural break in 2020, is associated with some important local and global events. For example, COVID 19 followed by stringent lockdowns had drastic impact on oil price and Indian financial sector.

Similarly, other measures of oil price shock (oil price shock, shock due to oil price increase, shock due to oil price decrease, net oil price increase and decrease) had similar structural breaks which coincided with both global and domestic events. The structural breaks are divided into January 2000, February 2004, April 2008, August 2012 and May 2016.

Table 5.3 shows the empirical results of panel unit root analysis with and without structural break by Pesaran (2007). Estimation results suggests the rejection of unit root tests and acceptance of the alternative hypothesis of stationarity or no unit root for all the variables in the presence of heterogeneity and cross-section dependence. Like previous tests, this tests also divides the results in five structural breaks. Hence, the study concludes that variables such as stock returns, oil price-change, oil price shock, shock due to oil price increase, shock due to oil price decrease, net oil price increase and decrease, inflation, index returns, SMB, HML and WML are stationarity at level. Further, this study employs slope homogeneity tests proposed to tests for homogeneity among variables. This test proposed by Pesaran and Yamagata`s (2008). This method checks whether there is any heterogeneity or homogeneous slope coefficients. Null hypothesis assumed that there are homogeneous slope coefficients among variables, whereas the alternative hypothesis assumes there are heterogeneous slope coefficients. Empirical results reported in table 5.4 suggests rejection of null hypothesis at 1%, 5% and 10% levels respectively.

Table 5.5 shows the result for Westerlund and Edgerton (2008), the null hypothesis stated that there is no cointegration exist among the variables. In the presence of no breaks, the mean shift and regime shift, the estimation results indicate the rejection of null hypothesis of no cointegration. Hence, there is presence of cointegrating relationship between stock returns, inflation, Fama-French variables, oil price-C, oil price shock, oil price shock-positive, oil price shock-negative, net oil price increase and decrease. Firm wise results are given in Appendix 5. Table 5.6 describes the results of Banerjee and Carrion-i-Silvestre (2017) in the presence of heterogeneity, cross-section dependence and structural break. The results suggest cointegrating relationship between stock returns and various oil price measures at 1%, 5% and 10% levels of significance for the full sample and for each firm. As it is confirmed that there is cointegrating relationship among variables, so in next step long-run relationship between stock returns and its determinants are estimated.

Table 5.7 shows the empirical results of the cross-sectional augmented autoregressive distributed lags model CS-ARDL. Results indicate that oil price- change has negative effect on stock returns with coefficient of -0.952 and statistically significant at 1% significance level. Which means that change in real oil price by 1% rise results in decrease in stock returns by -0.952. These results are in line with study done by Sadorsky (2008) and Managi and Okimoto (2013).

Similarly, oil price shocks are positvely linked to stock returns. Coeffcient value indicates that with a 1% increase in oil price shock lead to increase in stock returns by 3.637%. From theoretical perspective, oil price shock negatively linked with stock returns. Since uncertainity in oil price brings uncertainity in firm`s cashflow which dampens stock returns. But results in the present study are contradictory to theory, neverthless these emprical outcomes of CS-ARDL are consistent with study done by Bouri (2015). Whereas, emprical results show that shock due to oil price increase (oil price shock-positive) has positive impact and statistically significant at 1% level. The coefficient indicated with one 1% change in oil price shock-positive there is a decline in stock returns by 0.129. Hence, any positive movement in brings distress to a firm`s cash flow ultimately affecting stock returns. These results are consistant with study done by Nandha and Faff (2007) and, Kumar and Gupta (2014).

In case of empirical outcomes of effect of NOILPI on stock returns, results indicate that net oil price increase has positive link with stock returns. Though theoritical background states inverse relationship between net oil price increase and stock returns. The results of the present study are contradictory to stated theoritical approach, clearly indicating asymmetric impact of net oil price increase on stock returns. In other words, stock returns are not sensitive to net oil price increase. Similarly, net oil price decrease exhibit asymmetric impact on stock returns. The coefficient of net oil price decrease is negative and statistically signifiant at 1% significance level. In other words, decrease in oil price has resulted in decline in stock returns. On the contrary, theoretical approach states that reduction in oil price will reduce the cost of production which increases the cash flow of the firm leading to an increase in the stock price. In order to check the robustness in the presence of heterogeneity, cross-section dependence and structural break, estimated AMG and the common correlated effect mean group CCEMG are estimated. AMG and CCEMG results indicate that there is negative relation between oil price shock and stock returns with coefficients of -0.026 and -0.756 respectively. Whereas, AMG and CCEMG outcome indicate that oil price-C, oil price shock-negative and NOILPD are positively associated with stock returns. Other oil price shock measures such as NOILPI and oil price shock-positive have negative impact on stock returns. Regarding, Inflation and Fama-French factors of AMG and CCEMG estimation indicate negative impact on stock returns.

5.4 SUMMARY

The estimated coefficients obtained from cross-sectionally augmented autoregressive distributed lags CS-ARDL test confirmed the asymmetric impact of net oil price increase and decrease on stock returns. Whereas other measures of oil price shock exhibit symmetric impact on stock returns. Based on findings, this study recommends some policy implications: first, given the presence of asymmetry in responses of stock returns towards shock emerging from net oil price increase and decrease, Indian investors could revise their short- and long-term investment plans. Investors and energy-intensive firms should keep a close watch on oil price volatility so that during uncertain oil price increase, they can delay their investment, and during low oil price, they can invest and increase their production at maximum scale so that asymmetric impact of oil price shock is reduced. Second, energy-intensive firms can adopt low-cost technologies which are alternative resource compatible such as coal, electricity and natural or even solar. Finally, fiscal policy, combined with monetary policy, should regulate the information flow which determines the business decision of firms, especially when there is scepticism raised owing to external shocks. Given these implications, formulating the policies of an economy accordingly is essential these days, when the international oil price is very volatile.

Table 5.1

Cross-sectional dependence analysis

Variable	**Test Statistics (P-values)**
Stock returns$_{it}$	128.932 (0.000)
Oil price-C$_{it}$	293.448 (0.000)
Oil Price Shock$_{it}$	290.35 (0.000)
Oil Price Shock-Positive$_{it}$	297.40 (0.000)
Oil Price Shock-Negative$_{it}$	296.46 (0.000)
NOILPI$_{it}$	200.12 (0.000)
NOILPD$_{it}$	212.42 (0.000)
Inflation$_{it}$	312..624(0.000)
Index Returns$_{it}$	225.632(0.000)
SMB$_{it}$	262.245(0.000)
HML$_{it}$	291.236(0.000)
WML$_{it}$	265.000(0.000)

Note: The level of significance is determined by 1,5 and 10% indicated through ***, ** and * respectively, while () contains P values.

Table 5.2

Carrion-i-Silvestre et al. (2005) unit root analysis

Note: The level of significance is determined by 1,5 and 10% indicated through ***, ** and * respectively, while () contains P-

	Break with variance	**Test value (P- value)**
Stock returns$_{it}$	Homogenous	-3.690(1.000)
	Heterogeneous	-3.657(1.00)
Oil price-C$_{it}$	Homogenous	-1.919(0.973)
	Heterogeneous	-1.642(0.950)
Oil Price Shock$_{it}$	Homogenous	3.054(1.000)
	Heterogeneous	3.309(1.000)
Oil Price Shock-Positive$_{it}$	Homogenous	-5.510(1.000)
	Heterogeneous	-5.509(1.000)
Oil Price Shock-Negative$_{it}$	Homogenous	-5.855 (1.000)
	Heterogeneous	-5.854(1.000)
NOILPI$_{it}$	Homogenous	-5.301(1.000)
	Heterogeneous	-6.512(1.000)
NOILPD$_{it}$	Homogenous	-3.834(1.000)
	Heterogeneous	-2.487(0.950)
Inflation$_{it}$	Homogenous	-7.053(1.000)
	Heterogeneous	-7.051(1.000)
Index Returns$_{it}$	Homogenous	9.165(1.000)
	Heterogeneous	9.403(1.000)
SMB$_{it}$	Homogenous	-4.967(1.000)
	Heterogeneous	-4.968(1.000)
HML$_{it}$	Homogenous	3.522(1.000)
	Heterogeneous	3.545(1.000)
WML$_{it}$	Homogenous	20.512(1.000)
	Heterogeneous	20.988(1.000)

values. Structural breaks for each variables and industries are given in Appendix-I

Table 5.3

Panel unit root analysis with & without structural breaks

Pesaran (2007)				
	Level I (0)		First Difference I (1)	
	CIPS	M-CIPS	CIPS	M-CIPS
Stock returns$_{it}$	-6.120*	-6.420**	-	-
Oil price-C$_{it}$	-4.160***	-1.700*	-	-
Oil Price Shock$_{it}$	-4.001*	-1.925**	-	-
Oil Price Shock-Positive$_{it}$	-4.621**	-1.800*	-	-
Oil Price Shock-Negative$_{it}$	-3.624*	-1.742*	-	-
NOILPI$_{it}$	-4.200**	-1.600**	-	-
NOILPD$_{it}$	_-4.236*	-1.500*	-	-

Table 5.4

Slope Heterogeneity analysis

Dependent Variable: Stock returns	
Statistics	Test value (P-value)
Delta tilde	2.464(0.014)
Delta tilde Adjusted	2.521(0.012)

Note: The level of significance is determined by 1,5 and 10% indicated through ***, ** and * respectively, while () contains P values.

Table 5.5

Westerlund and Edgerton (2008) panel cointegration analysis

Westerlund and Edgerton (2008)	**No break**	**Mean Shift**	**Regime Shift**
$Z_{\varphi}(N)$ P_{value}	-62.043 (0.000)	-8.673 (0.000)	-8.368 (0.000)
$Z_{\tau}(N)$ P_{value}	-20.902 (0.000)	-3.242 (0.000)	-2.349 (0.000)

Table 5.6

Banerjee and Carrion-i-Silvestre (2017) cointegration analysis

Industry/model	**With trend**
CCE full sample	-3.775 *
Abrasives	-3.915***
Agricultural machinery	-4.603*
Air-conditioners	-4.098*
Aluminium & aluminium	-3.807**
Bakery products	-1.627*
Boilers & turbines	-4.388*
Cement	-3.495*
Commercial vehicles	-2.895*
Conventional electricity	-5.893*
Copper & copper products	-5.194*
Crude oil & natural gas	-3.638*
Diversified automobile	-2.878*
Diversified machinery	-5.475*
Engines	-4.114**

Industrial machinery	-3.118*
Inorganic chemicals	-4.705**
Machine tools	-3.425**
Mining & construction	-3.418*
Miscellaneous electrical	-2.486**
Organic chemicals	-2.487*
Other ferrous metal products	-5.981**
Other non-ferrous metals & metal products	-3.938**
Refinery	-3.515*
Steel	-1.514***

Table 5.7

CS-ARDL Long-run analysis

Long-Run CS-ARDL Results Dependent Variable (stock returns)	**Coefficients** **[Z-statistics]** **(P-values)**
Oil price-C	-0.952 [-63.46] (0.000)
Oil Price shock	3.637 [7.73] (0.000)
Oil Price Shock-Positive	0.129 [3.78] (0.000)
Oil Price Shock-Negative	-0.157 [-7.01] (0.001)
NOILPI	0.018 [8.24]

	(0.000)
NOILPD	-0.084 [-4.83] (0.001)
Inflation	-0.362 [-0.82] (0.014)
Index Return	0.082 [1.52] (0.129)
SMB	0.208 [-0.84] (0.039)
HML	0.018 [5.26] (0.000)
WML	0.045 [-2.14] (0.014)

Table 5.8

AMG & CCEMG Test for Robustness check

Dependent Variable (stock returns)	**Coefficients$_{AMG}$** **[Z-statistics]** **(p-values)**	**Coefficients$_{ccemg}$** **[Z-statistics]** **(p-values)**
Oil price-C	0.057 [0.01] (0.0920)	0.106* [0.58] (0.052)
Oil Price Shock	-0.026	-0.756

	[-0.04] (0.141)	[-0.72] (0.256)
Oil Price Shock-Positive	-0.085 [2.44] (0.015)	-0.286*** [-0.63] (0.001)
Oil Price Shock-Negative	1.449 [-18.58] (0.000)	0.709*** [1.25] (0.004)
NOILPI	-0.021 [16.63] (0.000)	-0.372*** [-3.452] (0.000)
NOILPD	0.024 [4.13] (0.004)	-0.754*** [5.16] (0.006)
Inflation	-0.057 [-5.40] (0.000)	-0.057 [-5.40] (0.000)
Index Return	-0.054 [16.49] (0.000)	0.653 [16.49] (0.000)
SMB	-0.142 [15.89] (0.000)	-0.258 [15.89] (0.000)
HML	-0.312 [0.09] (0.931)	-0.412 [0.09] (0.931)
WML	-0.227 [15.52] (0.000)	-0.521 [15.52] (0.000)
Wald test	26.73	32.45

(P-value)	(0.001)	(0.000)

Appendix 5. Appendix-I

Lluís Carrion-i-Silvestre et al.(2005) breaks for stock returns

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.047	August 1999-July 2003- November- 2007- July 2011-July 2015- April 2020
Agricultural machinery	0.049	June 2001-June 2005-June 2009-April 2013- February 2017- April 2020
Air-conditioners	0.056	May 2001- May 2005- May 2009- May 2013- February 2017 -April 2020
Aluminium & aluminium	0.057	April 2001- April 2005- April 2009- April 2013- February 2017- April 2020
Bakery products	0.063	March 2001- March 2005- March 2009- March 2013- February 2017- April 2020
Boilers & turbines	0.059	February 2001 – February 2005- February 2009- February 2013- February 2017- April 2020
Cement	0.021	February 2001 – February 2005- February 2009- February 2013- February 2017- April 2020
Commercial vehicles	0.02	February 2001 – February 2005- February 2009- February 2013- January 2017- April 2020
Conventional electricity	0.017	December 2000 – December 2004- December 2008- December 2012- December 2016- April 2020
Copper & copper products	0.018	November 2000 – November 2004- November 2008- November 2012- November 2016 – April 2020

Crude oil & natural gas	0.021	October 2000 – October 2004- October 2008- October 2012- October 2016- April 2020
Diversified automobile	0.021	September 2000 – September 2004- September 2008- September 2012- September 2016- April 2020
Diversified machinery	0.022	August 2000 – August 2004- August 2008- August 2012- August 2016- April 2020
Engines	0.024	August 2000 – August 2004- August 2008- August 2012- August 2016- April 2020
Industrial machinery	0.026	July 2000 – July 2004- July 2008- July 2012- July 2016-April 2020
Inorganic chemicals	0.025	June 2000 – June 2004- June 2008- June 2012- June 2016- April 2020
Machine tools	0.031	May2000 – May 2004- May 2008- May 2012- May 2016- April 2020
Mining & construction	0.034	April 2000 – April 2004- April 2008- April 2012- April 2016- April 2020
Miscellaneous electrical	0.036	April 2000 – April 2004- April 2008- April 2012- April 2016- April 2020
Organic chemicals	0.04	March 2000 – March 2004- March 2008- March 2012- March 2016- April 2020
Other ferrous metal products	0.036	January 2000 – February 2004- February 2008- February 2012- February 2016- April 2020
Other non-ferrous metals & metal products	0.043	January 2000 – February 2004- February 2008- February 2012- February 2016- April 2020
Refinery	0.041	December 1999 – January 2004- January 2008- January 2012- January 2016- April 2020
Steel	0.043	November 1999 – December 2004- December 2008- December 2012- December 2016- April 2020

Lluís Carrion-i-Silvestre et al.(2005) breaks for Oil price-Change

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.024	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.023	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.023	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.023	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.023	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.023	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.023	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.018	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.019	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.013	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Inorganic chemicals	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.018	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.013	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.016	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.016	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.018	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.017	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al.(2005) breaks for Oil price shock

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.052	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.053	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.052	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.052	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Bakery products	0.052	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.052	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.037	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.051	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.051	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.051	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.052	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.053	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.054	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.060	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.036	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Inorganic chemicals	0.046	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.050	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.035	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.037	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.053	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.053	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.053	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.058	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.058	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al.(2005) breaks for Oil price shock-Positive

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Agricultural machinery	0.010	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Diversified machinery	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Inorganic chemicals	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Steel	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al. (2005) breaks for Oil price shock-Negative

Industries	KPSS Bartlett	Break Months and Years
Abrasives	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Copper & copper products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Inorganic chemicals	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Other ferrous metal products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al. (2005) breaks for NOILPI

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.015	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Cement	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Inorganic chemicals	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Mining & construction	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.014	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al. (2005) breaks for NOILPD

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.025	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.025	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Aluminium & aluminium	0.025	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.025	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.026	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.018	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.018	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.018	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.018	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.007	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.008	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.008	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.008	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Industrial machinery	0.008	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Inorganic chemicals	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.019	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.010	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.011	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.012	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Note: The level of significance is determined by 1,5 and 10% indicated through ***, ** and * respectively, while () contains P values

Lluís Carrion-i-Silvestre et al. (2005) breaks for Inflation

Industries	KPSS Bartlett	Break Months and Years
Abrasives	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Crude oil & natural gas	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.007	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Inorganic chemicals	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Other non-ferrous metals & metal products	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.006	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al. (2005) breaks for Index Return

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.160	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.142	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.112	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.154	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.122	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.155	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.110	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Commercial vehicles	0.109	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.117	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.129	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.116	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.159	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.217	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.140	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.111	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Inorganic chemicals	0.158	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.169	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.125	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Miscellaneous electrical	0.170	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.143	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.179	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.186	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.143	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.199	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al. (2005) breaks for SMB

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.022	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.028	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.023	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.033	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Bakery products	0.026	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.022	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.025	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.025	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.024	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.022	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.024	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.026	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.022	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.029	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.019	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Inorganic chemicals	0.024	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.023	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.020	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.022	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.025	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.022	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.025	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.027	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.026	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al. (2005) breaks for HML

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.081	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.083	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.154	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.129	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.092	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.092	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.082	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Commercial vehicles	0.096	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.100	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.096	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Crude oil & natural gas	0.113	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.096	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.095	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.095	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.131	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Inorganic chemicals	0.078	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.099	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.080	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Miscellaneous electrical	0.075	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.081	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.117	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Other non-ferrous metals & metal products	0.102	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.077	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.081	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Lluís Carrion-i-Silvestre et al. (2005) breaks for WML

Industries	**KPSS Bartlett**	**Break Months and Years**
Abrasives	0.279	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Agricultural machinery	0.288	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Air-conditioners	0.302	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Aluminium & aluminium	0.173	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Bakery products	0.268	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Boilers & turbines	0.233	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Cement	0.290	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Commercial vehicles	0.247	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Conventional electricity	0.258	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Copper & copper products	0.270	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Crude oil & natural gas	0.236	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified automobile	0.194	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Diversified machinery	0.211	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Engines	0.281	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Industrial machinery	0.256	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Inorganic chemicals	0.237	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Machine tools	0.267	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Mining & construction	0.238	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Miscellaneous electrical	0.222	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Organic chemicals	0.180	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other ferrous metal products	0.200	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Other non-ferrous metals & metal products	0.264	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Refinery	0.250	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020
Steel	0.253	January 2000-March 2004-May 2008-April 2013-Febreuary 2017-May 2020

Appendix 5. Appendix-II

Structural breaks location for Westerlund and Edgerton (2008)

	Industries	**Mean shift**	**Regime Shift breaks**
	Abrasives	April 2002	April 2002
	Agricultural machinery	January 2015	January 2015
	Air-conditioners	January 2018	January 2018
	Aluminium & aluminium	October 2017	October 2017
	Bakery products	February 2015	August 2016
	Boilers & turbines	April 2015	April 2015
	Cement	June 2009	May 2009
	Commercial vehicles	August 2014	July 2014
	Conventional electricity	December 2015	June 2004
	Copper & copper products	December 2009	December 2009

	Crude oil & natural gas	May 2020	May 2020
	Diversified automobile	July 2003	June 2004
	Diversified machinery	October 2007	February 2015
	Engines	October 2000	July 2003
	Industrial machinery	May 2020	May 2020
	Inorganic chemicals	June 2011	April 2018
	Machine tools	December 2017	December 2017
	Mining & construction	September 2004	September 2004
	Miscellaneous electrical	March 2017	March 2002
	Organic chemicals	March 2015	March 2015
	Other ferrous metal products	September 2015	September 2015
	Other non-ferrous metals & metal products	October 2017	March 2015
	Refinery	August 2020	September 2015
	Steel	July 2004	May 2009

CHAPTER 6

SUBSITUTION OF OIL WITH COAL AND ELECTRICITY

1.6 INTRODUCTION

If the economic system has to reduce of Non-renewable resources, which are carbon-intensive, then according to economic production theory, it is possible to minimize the use of carbon-intensive non-renewable resources, through input substitution and technical change. The substitution method can be estimated by cross-price elasticities. The motivation behind initial studies on substitution in inputs (Kerr 2011; & Friedrich 2013) was developed economies were highly dependent on energy resources for producing the output; this ultimately led to an increase in energy price. Both government`s ‘zero- carbon’ policy and the rise in energy demand contribute to the firm`s decision to switch to non-fossil energy sources.

Given that India is the world`s third-largest consumer of oil, India is highly dependent on oil imports. As one of the fast-growing economies, India is also becoming one of the larger energy consumers in the world. India depends heavily on coal and electricity, as a result of which India`s coal and electricity production stands second in the world after China[13]. India stands third in coal production after China and the US. In 2015, around 612 million tonnes (MT) were produced, which increased to 626 million tonnes in the financial year 2016. Most of the growing economies are dependent on these energy resources for production.

Energy plays a key role in influencing the economic environment of both developed and emerging economies. As the output which is a forerunner of the economy and also it correlates with macroeconomic factors such as the interest rate and inflation, it is interesting to know the theoretical relation between energy price and the output. First, an increase in crude oil prices increases the cost of petroleum products, therefore increasing the cost of production and reduces the output of the industries and the cash flow leading to a reduction in the stock price. Second, an increase in energy price increases transportation costs and leads to inflation especially when a country is an oil importer. On the other hand, in terms of the revenue channel, oil resources are also a complementary product for various products; for example, automobiles. If there is an

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increase in the oil price, it may lead to decline in the revenue of the firm due to decline in the demand for the products of the firm and thereby reducing the cash flow. Therefore, based on both cost and revenue channel, an inverse relationship between oil price and stock price is expected.

Due to stringent environmental policies, most of the advanced countries have opted out of coal in industry. But India relies heavily on coal in its energy mix, compared to developed countries. Coal contributes 43% of the energy mix used in the Indian industry, followed by oil. In the year 2018, coal's share remained 115 Mtoe[14], registering the highest usage among all energy mixes.

A lot of literature has also considered coal as one of the major causes of macroeconomic uncertainty in advanced countries like the United States, Japan, etc. For example, Guo et al. (2016) found that coal price changes lead to stronger and longer impacts on PPI (Producer Price Index). Similarly, Yang and Li (2006) analyzed China's risk from uncertainty in the energy market and argued a long-term relationship between various energy prices, economic growth, and inflation. Lin and Wang (2009) analyzed the effects of energy price fluctuations on general price and found that uncertainty in energy price has a long-term impact on PPI.

The impact of the electricity price increase has also drawn significant attention recently. Nguyen (2008) analyzed the effects of increase in the electricity price on the marginal cost of production of complementary products. Similarly, applying the input-output model, He et al. (2006) investigated the impact of electricity price rise on the related sectors in China. There are two channels through which electricity price can affect the economy: cost-push inflation and output shrinkage. For example, while analyzing the impact of electricity price increase on the Mexican economy, Alvarez and Valencia (2015) found that output responded more to a change in electricity prices than inflation.

By and large, almost all studies mentioned above are related to oil price or overall energy price. Therefore, examining the role of other energy resources gains greater significance in the absence of any such study earlier. The present study assesses whether there is any substitution effect between energy resources. Heterogeneity in

[14] Source: IEA, world energy outlook, 2019, https://www.iea.org/reports/world-energy-outlook-2019/coal

demand for energy consumption may give rise to its sensitivity to the price of energy resources and hence provides a lot of scope for substitution effect between energy resources. Very little attention is given to studying whether different energy prices, such as coal and electricity, can substitute oil. Hence, this study tries to investigate the substitution effect of various energy resources. Inclusively, the substitution effect between energy resources largely depends on whether energy demand is sensitive to other related energy resources' prices. If there is a substitution effect between energy resources, what is the substitution effect's sign and magnitude? Investigating the substitution effect from oil to coal and electricity consumption can provide valuable insight into several facts: first, it allows one to test the substitution between oil, coal, and electricity consumption demand and gives way to adapt a national energy plan, which conserves carbon-intensive energy resources. Its motivation is to find the substitution effect between energy resources and conserve fossil fuel. The specific reason to perform this study is to establish a relationship between energy demand and price of its own and related products in the long-run. In the long-run, relations might change under the influence of technological change, environmental, and other public policies.

This study contributes to the existing literature by re-examining the substitution effect between oil, coal, and electricity demand in the long-run. The study uses Autoregressive distributed lag ARDL and ECM for short and long-run estimation. The finding suggests that oil consumption is most sensitive to its price change and price of coal. Whereas in the long-run, all energy resources are positively driven by the economic situation of the country.

6.2 DATA DESCRIPTION

The Indiastat and Reserve Bank of India database provide data on consumption and prices of energy products, namely oil, coal, and electricity. To investigate interfuel substitution between energy products, the study considers energy products, namely oil, coal, and electricity. The study period covers from 1995 to 2020. There are five subcategories under electricity: domestic, agriculture, industry, commercial, and railways. The present study considers electricity for industrial use as electricity consumption for industrial use is much more than in other sectors. The oil, coal, and electricity consumption are measured in a million metric tonnes, metric tonnes, and

Gigawatt Hour per year. The present study uses the WPI number for oil, electricity and coal as a proxy for real oil price coal, and electricity price[15]. For income, GDP at market prices is considered as a proxy. The WPI number for energy prices and GDP at market prices are extracted from the Handbook of Statistics of Reserve Bank of India. Before proceeding to any pre-tests, the data series are brought under one constant price of 2004-05 prices, using splicing method.

6.3 METHODOLOGY

To fulfil the objective, present study uses ARDL and ECM on energy related variables. Energy consumption is determined by its own price and other factors such as prices of related products, income, and wealth. To measure the magnitude of the impact of a price change and income on demand, price and income elasticity of demand in ARDL setup are estimated. Like all other consumer products, the study also assumes that demand for fuel is influenced by its price and prices of related products and changes in income. The study focuses on three main factors: the real price of energy resources, prices of related energy resources, and income. Hence the equations can be specified as:

$$FD_{it} = cP_{it}^{\alpha} Y^{\beta_1} P1_{it}^{\beta_2} P2_{it}^{\beta_2} e^{\mu_{it}} \qquad ...(6.1)$$

Where FD_{it} is fuel demand of the energy resources i at time t, P_{it} is the real price of the energy resources i at time t, Y_t is income (GDP), $P1_{it}$ and $P2_{it}$ are prices of related energy resources, μ_{it} is the error term. While taking log on both sides, the equation can also be written as:

$$FD_{it} = \alpha_0 + \beta_1 P_{it} + \beta_2 Y_t + \beta_3 P1_{it} + \beta_4 P2_{it} + \mu_{it} \qquad ...(6.2)$$

First, the study estimates price elasticity in the model, keeping other prices of related products as constant. Second, income elasticity is estimated keeping prices of energy price resources constant. Third, while estimating cross-price elasticity for oil, study considers the price of coal and electricity as related products. Before estimating ARDL model, some pre-tests are done, so that the data series becomes suitable for further estimation. To analyse the stationary of the variables, the Augmented Dickey Fuller (ADF) Test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) is estimated. In general,

[15] WPI is a broad-based measure of inflation in India. More details about WPI are available at http://www.eaindustry.nic.in/WPI_ manual.pdf

the null hypotheses for ADF reads that time-series data has unit root against the alternative hypothesis of no unit root. Whereas KPSS test hypothesize that variables are stationary against the alternative hypothesis of non-stationarity. The principle behind the applying cointegration technique is that all the variables: energy prices and consumption are non-stationary at level and becomes stationary at first differencing. Therefore, if the linear combination of I (1) results in I (0) residual in variables, then there is a long-run relationship between variables under consideration. Hence, the study employs ARDL in the study to estimate the long-run relationship in microeconomic theory set up. The advantage of using ARDL technique is that it is less of endogeneity present in variables. The issue of finding appropriate lag length for each underlying Variables is significant. The present study considers Schwarz Bayesian Criterion (SBC) to determine lag length. Variables are specified in ARDL model in the following equation:

$$FD_{it}=\delta_0+\sum_{i=1}^{k}\delta_1 FD_{it-1}+\sum_{l=0}^{L}\delta_2 P_{it-l}+\sum_{p=0}^{p}\delta_3 Y_{t-p}+\sum_{r=0}^{R}\delta_4 P1_{it-r}+\sum_{u=0}^{U}\delta_5 P2_{it-u}+\nu_{1t} \qquad ...(6.3)$$

However, ARDL estimation only gives us the short-run relationship between the variables. It does not provide any information about the long-run behaviour of the parameters in the model.

$$\Delta FD_{it}=\delta_0+(FD_{t-1}-\sum_{i=1}^{M}\theta_p P_{t-1})+\sum_{i=1}^{k}\delta_1\Delta FD_{it-1}+\sum_{l=0}^{L}\delta_2\Delta P_{it-l}+\sum_{p=0}^{p}\delta_3\Delta Y_{t-p}+\sum_{r=0}^{R}\delta_4\Delta P1_{it-r}+\sum_{u=0}^{U}\delta_5\Delta P2_{it-u}+\nu_{1t} \qquad (6.4)$$

Where error correction term is the speed of adjustment parameter.

6.4 RESULTS

Table 6.1 elucidates the summary statistics, which includes mean and standard deviation of price and consumption of energy resources. The mean of WPI number for coal is higher than oil and electricity. Whereas, the standard deviation of oil price is higher than other energy resources. This is due to the reason that oil price is subjected to volatility than other energy resource prices. The mean and standard deviation of consumption of coal is significantly different to oil and electricity.

Table 6.2 reports the results of preliminary unit root tests on time series data to confirm whether the variables used in the study are integrated with the order I (0) or I (1). It is evident from ADF test results that all the variables are non-stationary at level as the

ADF does not reject the null hypothesis of non-stationarity. KPSS test rejects the null hypothesis of stationarity, confirming that variables are non-stationary at level, whereas at first difference, all the variables become stationary as asymptotic critical values for KPSS test are significant at 1%, 5%, and 10% level. Therefore, ADF and KPSS unit root tests confirm that variables viz., energy prices, and consumption are integrated of order I (1). These findings draw an inference that at first, difference variables become stationary, and hence they are said to be integrated in the order I (1). As a linear combination of I(1) of variables results in I(0) residuals, there is a possibility of a long-run relationship among energy consumption, energy prices, and cross prices as the variables.

The present study implements the microeconomic theory of price elasticity of demand on ARDL model. The results of own and cross-price elasticity estimate along with income elasticities estimates are presented in table 6.3. The panel estimation is categorized into short and long-run estimates. Starting from oil consumption, the own price elasticity of demand for oil in short-run is negative, and less than one implying oil demand is inelastic. The negative-ness of own-price elasticity validates the price elasticity of demand. However, in the long-run, the oil demand is elastic, which means that oil demand is responsive to oil price changes. The majority of crude oil is used in the mining and metallurgy industry; hence, an increase in oil price soars production costs and cuts the firm's cash flow. These developments make firms adopt new technologies that use alternative energy resources such as natural gas, coal, and electricity. The conservation of oil leads to a reduction in demand for oil. Even though oil price declines, firms do not switch to oil use to reduce sunk cost, hence oil price decrease may not bring positive consequences in the economy, witnessing the asymmetric effect of oil price (Ahmed & Wadud, 2011).

Own price elasticity of electricity and coal in short-run (-0.356 and -0.256) is inelastic and statistically significant. This means that coal and electricity for industrial output purposes are not affected by its prices. Similarly, in the long-run, own-price elasticity of coal is inelastic and statistically strong. The sign of the coefficient is contrary to the relationship between price and quantity demanded. That means a change in coal price has no effect on the quantity demanded. The sign of own-price elasticity of electricity also is negative in the long-run and remains inelastic. Among all fuel types, oil $(\eta_{oil-oil})$ has the biggest absolute value, which indicates that oil demand is the most sensitive to its price changes, followed by coal and then electricity. There are some studies that, on the contrary, found electricity demand most sensitive to its price change than oil (Lin & Tian, 2017).

On the contrary, the income elasticity of demand in the short-run is positive for oil and electricity and statistically significant. Whereas the coefficient associated with income elasticity of demand for coal is negative and statistically significant. This shows that coal has costlier substitutes, indicating that coal is a Giffen good in short-run. However, in the long-run, all energy resources are positively influenced by income.

Cross-price elasticity between oil, coal, and electricity in the short-run and long-run are presented in table 6.3. Here, the study`s focus lies particularly on the substitutability of oil with coal and electricity. Coefficients attached to cross-price elasticity between different fuels are both positive and negative; hence, there is a mix of substitutability and complementarity among oil coal and electricity. For example, the use of oil can be substituted by coal as the coefficient of cross-price elasticity of oil to that of coal is positive. Table 6.3 suggests that substitution between oil and coal is 0.996, which means that coal is a potential substitute resource. On the other hand, the cross-price elasticity coefficient between oil and electricity $(\eta_{oil-elec})$ is -0.789, which implies that oil and electricity demand serves as compliments. Similarly, cross-price elasticity between coal and oil $(\eta_{coal-oil})$ suggests being substitutes (0.874) but statistically insignificant. On the other hand, the sign of coefficient of cross-price elasticity between coal and electricity $(\eta_{coal-elec})$ is negative, indicating that coal and electricity are complimentary. As far as electricity demand is concerned, it is evident from the coefficient of cross-price elasticity that there is substitutability from electricity to oil and coal, and it is statistically significant.

In the long-run, all cross-price elasticities except cross-price elasticity from coal to electricity are positive; therefore, interfuel potential substitutability is estimated. The coefficient of cross-price elasticity of oil to coal $(\eta_{oil-coal})$ and electricity to oil $(\eta_{elec-oil})$ is very near to 1; in fact, the coefficient of cross-price elasticity of electricity to coal is above 1, which is very large. These findings suggest that consumption of oil and electricity is primarily influenced by coal and oil, respectively. These results are consistent with the study done by (Serletis et al. 2010), where findings suggested substitutability among different fuels. Similarly, Serletis et al. (2010) found substitutability among energy fuels, especially between coal and natural gas in the United Kingdom`s residential sector.

6.5 SUMMARY

This study investigates the substitution between crude oil, coal, and electricity, taking price elasticity of demand, and using ARDL and ECM as micro-econometrics. Particularly, the study has considered cross-price elasticity for inter fuel substitution between oil, coal, and electricity to determine whether in long-run oil can be substituted by coal and electricity. The findings of the study indicate that oil consumption is much more sensitive to its price change with the own-price elasticity, followed by coal and electricity. The findings of income elasticity suggest the country's economic performance positively influences just oil, coal, and electricity consumption. In the case of cross-price elasticity, the study finds that there is a possibility of inter-fuel substitution in the long-run. Notably, oil demand is largely influenced by coal price. This means oil consumption can be substituted by coal consumption. Hence, firms that are highly dependent on oil for the production process can switch to coal. The reason is coal price is less volatile as it is domestically controlled. The government has control over coal and electricity prices; it is the government's duty to monitor demand and supply dynamics of coal and electricity prices. Even though neoclassical growth labels suggest that there are no exclusive contributions of energy to the firm's productivity since it accounts for a tiny fraction in factor costs, the production process becomes quite costly when there is a substantial energy price increase. There is also growing encouragement for the use of renewable energy in production process as a solution for climate change and anticipated increase in price of fossil fuels. But policymakers should also be aware that the transition from fossil fuels to renewable energy sources may not be smooth. It requires restructuring the production process.

Table 6.1: Summary Statistics of the Variables Used in the Study

Variables	Statistics	WPI	Consumption
Oil	Mean	256	130222.80
	Std. Deviation	95.26	66116.14
Coal	Mean	312.25	234000000.00
	Std. Deviation	45.25	127000000.00
Electricity	Mean	198.36	254901.70
	Std. Deviation	36.25	148339.80
	Mean	**Std. Deviation**	
GDP Series	7426078	5250330	

Table 6. 2: Panel Unit Root Tests of the Variables Used in the Study

Method:	**Unit root**					
	ADF Test				KPSS Test	
	Level		**First Difference**		**Level**	**First Difference**
Variable Name	**t- Statistics**	**Prob.**	**t- Statistics**	**Prob.**	**t- Statistics**	**t- Statistics**
Oil Price	0.009	0.66	-2.296	0.024	0.611	0.246
Coal Price	0.571	0.832	-6.904	0.000	0.395	0.212
Electricity Price	1.534	0.965	-4.291	0.000	0.683	0.081
Oil consumption	0.508	0.818	-1.347	0.015	0.691	0.301
Coal consumption	0.622	0.437	-5.108	0.000	0.511	0.326
Electricity-Industry consumption	4.083	0.999	-2.122	0.035	0.679	0.349

Table 6.3: ARDL Estimates and ECM Estimates

Own price/ Cross elasticity price	Short-run estimates		Own price/ cross elasticity price	Lon-run estimates	
	Coefficient	**Prob.**		**Coefficient**	**Prob.**
$\eta_{oil-oil}$	-0.325	0.07	$\eta_{oil-oil}$	0.789	0.054
$\eta_{coal-coal}$	-0.256	0.08	$\eta_{coal-coal}$	-0.652	0.00
$\eta_{elec-elec}$	-0.356	0.06	$\eta_{elec-elec}$	-0.563	0.02
$\eta_{oil-coal}$	0.996	0.02	$\eta_{oil-coal}$	0.925	0.00
$\eta_{oil-elec}$	-0.789	0.04	$\eta_{oil-elec}$	0.633	0.00
$\eta_{coal-oil}$	0.874	0.12	$\eta_{coal-oil}$	0.984	0.00
$\eta_{coal-elec}$	-0.587	0.02	$\eta_{coal-elec}$	-0.632	0.00
$\eta_{elec-oil}$	0.567	0.54	$\eta_{elec-oil}$	0.258	0.00
$\eta_{elec-coal}$	0.962	0.05	$\eta_{elec-coal}$	1.528	0.00
Income Elasticity	**Short-run estimates**		**Income Elasticity**	**Lon-run estimates**	
	Coefficient	**Prob.**		**Coefficient**	**Prob.**
η_{oil}	0.254	0.01	η_{oil}	0.882	0.000
η_{coal}	-0.269	0.09	η_{coal}	1.000	0.000
η_{elec}	0.357	0.00	η_{elec}	0.632	0.00

Asymptotic critical values for KPSS Test at 1%, 5% and 10% level are 0.739, 0.463 and 0.347 respectively.

CHAPTER 7

SUMMARY AND CONCLUSION

7.1 INTRODUCTION

Since the episode of 1986 oil price fall and realization of asymmetric impact it holds on the macroeconomic variable in general and stock returns in specific, various studies examined whether an increase or decrease in oil price has any asymmetric impact on stock returns. Researchers started exploring theoretical justification for the asymmetric impact of oil price shock on stock returns. First, according to the irreversible investment theory by Henry (1974) and Bernanke (1983), an increase in energy prices may force firms to postpone irreversible investment. As uncertainty in future returns, firms may not be willing to commit resources on those investments which are irreversible. Hence the skepticism among consumers and investors prevails over the short-run, so a decrease in oil price need not bring about a boom in the economy. Second, Wan (2005) puts forward theoretical justification for the asymmetric impact of oil prices on stock returns. So, during a higher oil price, firms decide not to pay dividends, and hence, stock prices decrease. On the contrary, during a decline in oil price, there is an expectation that firms pay a higher dividend, and so, stock prices increase. But the stock prices are more sensitive to an oil price increase than to an oil price decrease. Third, observing asymmetries in oil price increase and their effect on Indian stock returns may be economically counter-intuitive to expectation. But asymmetries in oil price shock occur due to the adaptation of new technologies by firms so that during high oil price regime, firms can conserve oil by switching to alternative energy such as coal, natural gas, or solar power. So, when oil prices decline, firms do not straightway cut the sunk costs and decline their investments. Hence, a reduction in oil price does not fetch the desired boom in the economy.

The literature review provides a comprehensive view of the impact of the oil price shock and its sources on stock returns at the firm level. These studies are largely done at the global level, however, in Indian context, these studies are limited at the aggregate level. The present study analyzes the impact of oil price shock on stock returns of energy-intensive firms. The subject matter of the study is classified into four objectives, first objective estimates the asymmetric impact of oil price shocks on stock returns. The objective is to examine whether various oil price shocks viz. oil price-change, oil price shock, shock due to oil price increase (oil price shock-positive), shock due to oil price decrease (oil price shock-negative), net oil price increase and oil price decrease has any asymmetric impact on stock returns of energy-intensive companies. The second objective deals with examining the impact of various sources of oil price shocks on stock returns at the firm level. In order to examine the impact, the study considers oil price shock, oil supply shock, aggregate demand shock, and speculative demand shock. The third objective analyses the asymmetric impact of oil price shocks on stock returns at the firm level, the impact is examined at various structural breaks in the presence of cross-section dependence and heterogeneity. Further, this objective analyses the long-run relationship between various oil price shocks and stock returns. Finally, the fourth objective assesses whether energy resources such as oil, coal, and electricity can be substituted for each other. The present study focuses on whether oil resources can be substituted with other resources or it is complimentary.

7.2 FINDINGS OF THE STUDY

7.2.1 Asymmetric Impact of Oil Price Shocks on The Indian Stock Returns at Firm-Level

The first objective analyzes whether response of stock returns are asymmetric towards oil price shock in the presence of inflation, hence recording how stock returns at the firm level react to oil price shock keeping inflation as the catalyst. This objective considers the impact of various linear and non-linear measures of oil price shocks on firm-level stock returns using PSVAR. GMM estimation indicates that the relationship between oil price shocks, inflation, and stock returns is never constant. Results confirm that net oil price increase has a positive relationship with stock returns, confirming the asymmetric relationship between the two. On other hand, the relation between net oil price decrease and stock returns is positive. This indicates that there is symmetric relation between the same.

In the case of the relation of inflation with stock returns in the presence of oil price specifications, it changes with each specification. For example, the response of a firm`s stock returns to inflation in the presence of oil price shock and shock due to oil price increase is positive and with shock due to an oil price decrease, the relation is negative. Regarding asymmetries, the empirical findings from the PSVAR-X model show the asymmetric impact of shocks emerging from the net oil price decrease for most of the sectors. The impulse response function from the PSVAR-X model reveals that the various dimensions of oil price shock led to volatility in the response variables. It can also be observed that negative oil price shock has a radical impact on the stock market. These results shed some light on whether the Indian stock market is immune to oil price shocks, given that India is a net oil importing country. Observing asymmetries in net oil price increase and their effect on Indian stock returns may be economically counter-intuitive, but asymmetries in oil price shock occur due to adaptation of new technologies by firms so that during a high oil price regime, firms can conserve oil by switching to alternative energy sources such as coal, natural gas or solar power. So, when the oil price declines, firms do not straightway cut the sunk costs and decline their investments. Hence, a reduction in oil price does not fetch the desired boom in the economy. This could be the main source of asymmetry in oil price shock. Also, as stated by Wan (2005), a negative impact of oil price increase is higher than the positive impact of oil price decrease. Salisu et al. (2017) suggested that depending on how monetary policy reacts to an oil price change, the discount rate may indirectly affect the stock prices.

7.2.2 Do Different Types of Oil Price Shocks Affect the Stock Returns Differently

The second objective assesses whether various oil price shocks such as oil supply shock, aggregate demand shock, speculative demand shock, and oil price shock has a significant impact on Indian stock returns. Based on the PSVAR-X estimator, results reveal that there is a negative relationship between oil supply shock and stock returns, so any disruption in the supply of oil makes oil price uncertain, which, in turn, has a negative impact on stock returns. Also, an expected higher aggregate demand shock has a positive impact on stock returns. The present study results are in line with certain literature which suggests that there is a positive relationship between aggregate demand and stock returns (Abhyankar et al. 2013 and Koh, 2017). From impulse response function, the effect is again cyclical as one could witness ups and downs in stock returns. This is because the domestic oil price is partially dependent upon the status of subsidiaries and taxes. Also, inflation does not depend just upon oil price shocks and their sources, but it depends on other shocks such as inflation shock as well.

7.2.3 Time-Varying Effect of Oil Price Shocks on Stock Returns at Firm-Level

The third objective intends to examine the time-varying asymmetric effect of the oil price shock on a firm`s stock returns. Using panel unit root tests, the study was conducted by identifying six structural breaks to the data set. Estimation results from the panel unit root test by Lluis Carrion-i-Silvestre et al. (2005) and Pesaran (2007) reveal that structural break occurring in the data set is linked with local events and global events. For example, structural break associated in the year 2020 is linked with the COVID-19 outbreak. It led to a public health emergency, also disrupting the stock market. Industries that were affected by COVID-19 lockdowns include traditional industries such as mining, crude oil & natural gas and machine tools, etc. Westerlund and Edgerton's (2008) cointegration estimator reveals that in presence of no breaks, mean shift, and regime shift null hypothesis of no cointegration is rejected. Hence, there is the presence of a cointegrating relationship between stock returns, inflation, Fama-French variables, oil price-C, oil price shock, oil price shock-positive, oil price shock-negative, net oil price increase, and decrease. The estimated coefficients obtained from the cross-sectionally augmented autoregressive distributed lags CS-ARDL test confirmed the asymmetric impact of a net oil price increase and decrease on stock returns. Whereas other measures of oil price shock exhibit a symmetric impact on stock returns.

7.2.4 Substitution of Oil with Coal and Electricity

The fourth objective assesses the substitution between crude oil, coal, and electricity, taking price elasticity of demand. The main focus of this objective is to find whether in the long-run oil can be substituted by coal and electricity, to fulfill the objective the study uses cross-price elasticity for inter-fuel substitution between oil, coal, and electricity. The findings of the study indicate that oil consumption is much more sensitive to its price change with the own-price elasticity, followed by coal and electricity. The findings of income elasticity suggest the country's economic performance positively influences just oil, coal, and electricity consumption. In the case of cross-price elasticity, the study finds that there is a possibility of inter-fuel substitution in the long-run. Notably, oil demand is largely influenced by coal price.

This means oil consumption can be substituted by coal consumption. Hence, firms that are highly dependent on oil for the production process can switch to coal. The reason is coal price is less volatile as it is domestically controlled.

The study considers the following four hypotheses:

The first objective null hypothesis states that ‘there is no asymmetric impact of various oil price shocks on stock returns at firm level', while the alternative hypothesis states that 'there is the asymmetric impact of various oil price shocks on stock returns.' Findings of the study suggest that net oil price has a direct asymmetric impact on stock returns. Therefore, the null hypothesis of the first objective is rejected.

The null hypothesis of the second objective states that 'different sources of oil price shock do not have a significant impact on stock returns, while alternative hypothesis states that ‘different sources of oil price shock have significant impact on stock returns.’ The study considers various sources which include shock due to oil price increase/decrease, shock in oil supply, shock in aggregate demand, and finally, shock due to disruption in oil inventory. The findings suggest that different sources of oil price shocks showed a significant impact on stock returns. For example, oil price shock has a positive impact on stock returns. On the other hand, there is negative relationship between oil supply shock and stock returns. Hence, the null hypothesis of the second objective is rejected.

The third objective uses various estimators to examine the time-varying relationship between oil price shock and stock returns in the presence of cross-section dependence, heterogeneity, and structural break. The null hypothesis of cross-section dependence states that ‘there is no cross-section dependence for all the variables', whereas alternative hypothesis states that 'there is cross-section dependence among mentioned variables.’ Estimation results indicate the presence of cross-section dependence. Hence, the null hypothesis of no cross-section dependence is rejected at 1% significance level. The null hypothesis of panel unit root test with structural breaks assumes ‘no unit root issue whereas, alternative hypothesis supports unit root’. Empirical results derived from the model indicate that all variables are stationary at level. In this case, the null hypothesis is not rejected. This object also makes use of Westerlund and Edgerton's (2008) cointegration technique, the null hypothesis states that 'there is no cointegration exist among the variables against alternative hypothesis which assumes 'there is cointegration among variables.' The empirical results indicate that in the presence of no breaks, the mean shift and regime shift null hypothesis of no cointegration is rejected. Hence, there is the presence of a cointegrating relationship between stock returns, inflation, Fama-French variables, oil price-C, oil price shock, oil price shock-positive, oil price shock-negative, net oil price increase, and decrease.

The last objective null hypothesis states that 'electricity price and coal price cannot be substituted for oil', while the alternative hypothesis states that 'electricity and coal price can be substituted for oil price'. Estimation results of cross-price elasticity indicate that there is a possibility of inter-fuel substitution in the long-run. Notably, oil demand is largely influenced by coal price. This means oil consumption can be substituted by coal consumption. Therefore, null hypothesis is rejected in this objective.

7.3 CONTRIBUTION TO THE BODY OF KNOWLEDGE

The present study contributes in several ways to the body of knowledge. First, from the realization of the asymmetric relationship between oil price and macroeconomic variables in the mid-1980s, when oil price in mid-1986, there has been numerous researches to examine the significance of the asymmetric impact on macroeconomic variables across countries. But in Indian context, very few studies explored asymmetric impact of oil price shock on stock returns at the firm level. Here, for the study, each industry is taken into consideration and asymmetric impact of oil price shock is examined on stock returns. Therefore, evaluation on asymmetric impact can help firms to be mindful about whether to go ahead or postpone irreversible investment in some crucial sectors. Also assessing the impact of various sources of oil price shock on stock returns can also highlight the possibility of asymmetric impact arising due to some global events such as oil supply and aggregate demand shock. Further, while examining the oil price shock impact on stock returns, this study applies structural breaks to data sets ranging from January 1995 to December 2020. Results derived from the estimation help government with policy formulation when there are global or local disturbances. For example, structural break in 2020, is associated with some important local and global events. For example, COVID-19 followed by stringent lockdowns had a drastic impact on oil price and the Indian financial sector. These and many more events may give scope for implementing appropriate fiscal and monetary policy. Finally, examining the cross-price substitutability between oil, coal and electricity may help firms switching to low-cost resources.

7.4 LIMITATIONS OF THE STUDY

The present study is based only on the Indian stock market context using monthly frequency data. As proved by earlier studies that oil price is highly volatile, considering daily oil price data could shed some more light on the relationship between oil price and a firm`s stock returns. However, due to the unavailability of daily domestic retail oil price data, this study has a limitation of not using daily oil price data.

7.5 FUTURE SCOPE OF THE STUDY

The limitation of the study could become the future scope of the study. The current study focuses on the impact of oil price shock on Indian stock returns at the firm level using secondary data. However, in the future similar kind of work can be done by decomposing the oil price shock into oil supply shock, aggregate demand shock, and speculative demand and examining and understanding the asymmetric impact of decomposed oil price shock on stock returns. Further, other energy resource substitutes such as coal electricity can be considered for understanding the cause and direction of asymmetry.

7.6 CONCLUSION

From the first episode of 1986 oil price fall, numerous studies tried to find the exact cause of the asymmetric puzzle. Although early literature embodied cause for asymmetry as reallocation and uncertain effect, the real cause of asymmetric response of macroeconomic variables and stock returns is still unknown. The theoretical justification given for the asymmetric impact of oil price shocks on stock returns is that if monetary authority, while managing interest rate, reacts differently towards oil price increase decrease, then it may result in asymmetric relation between oil price shock and stock returns. Further, some studies found no evidence of the asymmetric impact of oil price shock on stock returns before GFC but found the asymmetric effects post-GFC.

The present study empirically examines the relationship between oil price shock and stock returns across the firms with and without structural breaks. The study introduces other energy resources and examines whether oil resources can be substituted with coal and electricity resources. It further examines the relationship between various sources of oil price shock and stock returns across firms. The time frame of the dataset considered in the study covers starting from January 1995 to December 2020.

The study begins by examining whether various oil price shocks exhibit any asymmetric impact on stock returns at the firm level. It introduces various oil price shocks as explanatory variables and Fama-French factors as control variables. The results show the asymmetric impact of shocks emerging from the net oil price decrease for most of the sectors. The impulse response function from the PSVAR-X model reveals that the various dimensions of oil price shock led to volatility in the response variables. Further, change in oil price due to oil supply and aggregate demand shock can also have different effects on stock returns. The present study also introduces different sources of oil price shocks and examines their impact on stock returns at the firm level. Results reveal that there is a negative relationship between oil supply shock and stock returns. Also, an expected higher aggregate demand shock has a positive impact on stock returns. To analyze the oil price shock impact on stock returns at different periods, the study considered Westerlund and Edgerton (2008) cointegration technique and CS-ARDL test. Results convey that net oil price increase has an asymmetric impact on stock returns across most of the sectors. The present study also introduces other energy resources and examines whether oil resources can be substituted with coal and electricity resources. By employing ARDL and ECM on energy-related variables, the study finds the presence of substitutability from oil to coal and electricity to oil. In other words, consumption of oil and electricity is primarily influenced by coal and oil, respectively.

Overall results shed some light on whether the Indian stock market is immune to oil price shocks, given that India is a net oil importing country. There are some policy implications emerging from the findings: first, given the presence of asymmetry in responses of stock returns towards shock emerging from the net oil price increase, Indian investors could postpone those. Investors and energy-intensive firms should keep a close watch on oil price volatility so that during uncertain oil price increase, they can delay their investment, and during low oil price, they can invest and increase their production at maximum scale so that asymmetric impact of oil price shock is reduced. Second, since while using inflation as a catalyst to measure the asymmetric impact of oil price shock, it is found that high inflation can retard stock prices, affect consumer demand, and can dampen overall growth. There is a need for monetary policy to keep a check on inflation; it can be stabilized by employing some of the effective instrument policies. Finally, fiscal policy, combined with monetary policy, should regulate the information flow which determines the business decision of firms, especially when there is scepticism raised owing to external shocks. Policy formulators should closely observe the underlying cause for oil price shock, whether it is arising from disturbances in oil supply or demand. Any disruption in oil supply/production may adversely impact oil market. Cartels such as OPEC can be instrumental to oil price increase or decrease. Further, firms can conserve oil by switching to substitutes such as electricity, coal, natural gas, or solar power. Given these implications, formulating the policies of an economy accordingly is essential these days, when the international oil price is very volatile.

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Seeking a challenging position where I can further develop my skills and use them to their fullest potential to achieve Company's Objectives.

Summary

- 2 year and 6 month of Experience as core researcher in **Institute for Social and Economic Change**, Bangalore.
- Trained to handle econometric packages such as E-views, and to learn any new packages which will be required to estimate econometric models.
- Used econometric tools to analyze the data, especially to make forecast for Post graduation dissertation.
- Trained on for modelling time series and cross section data using advanced econometric tools which are widely used for forecast.

Professional Synopsis

- Analysis of data with strong background in writing with excellent editing and proofreading skills.
- Exceptional written communication skills and can work independently or in a team environment.
- Worked on Input-Output Table and Social Accounting Matrix, worked on paper entitled "Fiscal Restructuring and Green growth: SAM(Social Accounting Matrix) based analysis for India."
- Ability to effectively communicate technical specifications/instructions to a wide range of audiences.
- Knowledge of E-views, STATA, SPSS and R-Software.
- Work with Development in planning the documentation requirements for changes/new reports.

Software Knowledge

- Advance user of MS Word, PowerPoint and Excel,
- Experienced in using tools like E-views, SPSS, STATA, R-Software.

Experience

Institution for Social and Economic Change, Bangalore **from September 2013 to March 2016.**

Job Roles:

- Field Work, collecting data, analyzing the data using software and report writing.
- Worked on project entitled **"Impact of Education and Employment on the Economy of Scheduled Tribes in North East India" –** Handled secondary and primary data from households in North eastern states and worked on NSSO unit level data for consumption expenditure.

- Worked on project entitled "**Urban Governance and Planning in Karnataka and Andhra Pradesh" –** Did field work in urban cities of Andhra Pradesh and Karnataka and to find out how city is governed.
- Worked on project entitled "**Non Tariff Barriers between India and Sri Lanka"-** did quantification of non tariff barriers in supply chain between India and Sri Lanka. Collected information from exporters, Importers, various shipping line, Logistics regarding the problems faced by them.
- Working on Paper entitled "**Fiscal Restructuring and Green growth: Social Accounting Matrix based analysis for India**."
- Working on Project "**Climate smart agriculture in Madhya Pradesh**"- Base line survey was conducted to track the technologies adopted in 4 districts of Madhya Pradesh. Also I estimated cost-benefit analysis on technologies adopted by farmers in Madhya Pradesh to analyze profit-oriented technologies.
- Working on a project "Sources of Funding for Social Science Research in India: Flows, Adequacies and Priorities" under Dr. Gayithri

Qualification

Course (Stream)/Examination	Institution/University	Board	Year of Passing	%/CGPA
10th	A.E.C.S	C.B.S.E	May 2006	62
12th	Demonstration School	C.B.S.E	May 2008	77
Bachelors of Arts (Economics, History and English Literature)	J.S.S College For Women (Mysore University)	State Board	June 2011	73.74
M.A(Applied Economics)	Pondicherry University	Central	June 2013	73.3
Ph.D. in Economics	National Institute for Technology, Surathkal	Central	June 2016 to Present	-

Cerification

- Project Topic : Training in Software skills- E-Views and SPSS
- Organization : Pondicherry University
- Duration : From May to June 2012.

Workshops Attended

No.	Name of the Course	Dates/ Duration	Host Organization
1.	A Four- Day Short term course on TIME Series Modelling and Forecasting using E-views Package	May to June 2012	Department of Humanities and Social Science, NIT, Rourkela
2.	Financial Time-Series Modelling in R (Fin MODE-2017)	September 5th to 9th 2017	Indian Institute of Technology, Kanpur
3.	Faculty Development program titled "Structural Equation Modelling using R-studio"	16th and 17th December 2016	T. A. PAI Management Institute, Manipal.

Conferences/ Seminars Attended
The Indian Econometrics society (TIES). Presented a paper on Non-Tariff Barriers in Supply chain between India and Sri Lanka at ISEC, Bangalore. Presented a paper on Non-Tariff Barriers in Supply chain between India and Sri Lanka at Colombo, Sri Lanka. Bhagavatula Aruna & Rajesh Acharya H. (2019), Is the Effect of Oil Price Shock Asymmetric on the Indian Stock Market? Firm-Level Evidence from Energy-Intensive Companies. 2019 meeting of World Finance & Banking Symposium - New Delhi - India, December, 19th to 21th. Bhagavatula Aruna & Rajesh Acharya H. (2018), "Is the Effect of Oil Price Shock on Stock Market Asymmetric? Empirical Evidence from Oil related Industries in India." in the 6th International Conference

on Applied Econometrics" by ICFAI Business School (IBS), Hyderabad, in Collaboration with The Indian Econometrics Society during 5-6 July, 2018.

PUBLICATIONS

Papers Accepted

Aruna, B. and Acharya, R. H. (2019), "Do Different Types of oil price shocks Affect the Indian Stock Returns differently at Firm-level? A Panel Structural VAR approach." International Journal of Energy Economics and Policy. 8891 – Scopus 10(2):238-249. DOI: 10.32479/ijeep.8891.

Bhagavatula Aruna and Rajesh H. Acharya (2020) "Is the Effect of other Energy Price Shocks Different from Oil Price Shock on the Stock Market at the Firm Level? A Panel SVAR Approach." *Economics and Policy of Energy and the Environment,* Scopus DOI: 10.3280/EFE2020-001009.

Aruna, B. and Acharya, R. H. (2021), "Is the Effect of Oil Price Shock Asymmetric on the Indian Stock Market? Firm-Level Evidence from Energy-Intensive Companies." *International Journal of Energy Sector Management,* IJESM-05-2021-0004. Scopus & Emerging Sources of Citation Index. (Accepted).

Papers under Review

1. Aruna, B. and Acharya, R. H. (2021), "Time-Varying Effect of Oil Price shocks on Stock returns: Evidence from India." *Energy Economics,* ENEECO-D-21-00591.

Papers Reviewed

Negative market prices on power exchanges: Evidence and policy implications from Germany, *Applied Economics,* APE-2019-0797.

I hereby certify that the information I have furnished is true to the best of my knowledge.

Place:Mangalore

Date: 13th June 2022 (Bhagavatula Aruna)