Do Stock Market disruptions induced by oil price shocks affect firm-level investment in South Africa?

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DECLARATION

I, Priscah Kyalo declare that the research work reported in this dissertation is my own, except where otherwise indicated and acknowledged. It is submitted for the degree of Master of Management in Finance and Investments, at the University of the Witwatersrand, Johannesburg. This thesis has not, either in whole or in part, been submitted for a degree or diploma to any other universities.

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Signature of candidate   Date

ABSTRACT

Various studies have been carried out to establish the effects of oil price shocks on various macroeconomic variables in South Africa. These have mostly focused on effects related to the cost of production. However, such studies fail to establish the particular oil shock responsible for the effects as well as the secondary effects of oil price shocks. This study examines the effects of decomposed oil price shocks on firm-level investment in South Africa when the shocks are transmitted through the stock market. The oil price shocks were disentangled into oil demand shock, supply shock and risk shock using Ready (2018) model. The generalised method of moments estimation technique was applied to South Africa firms data over the period 2000 to 2019. The investment model was estimated using Tobin's Q theory, and augmented with alternate variables including the stock market volatility induced by the disentangled oil shocks.

The findings indicate that indeed there exists an oil shock pass-through mechanism with the stock market acting as the channel of transmission. The supply shocks are negatively correlated with stock market returns, but their induced volatility is too small to significantly affect firm-level investment. The demand shocks have a positive effect on stock market returns and consequently positive and statistically significant effect on firm-level investment. Risk shocks are negatively correlated with stock market returns and have a negative and significant effect on firm-level investment. The volatility induced by the three oil shocks jointly has a positive and statistically significant effect on firm-level investment. The study revealed that the demand shocks were dominant over the sample period, hence the positive influence on firm-level investment. The results will be useful to market participants to know what to anticipate in the stock market when they are aware of the prevalent oil shock. They will also be useful to firm managers in deciding on proper timing of investment as well as to policy makers.

DEDICATION

I dedicate this thesis and my Masters degree to my family without whose assistance and support I would not have made such a great achievement:

- My parents, Penninah Kimanthi and Peter Kimanthi, for your prayers, unconditional love, encouragement, sacrifice and a strong belief in me.
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Table of Contents

List of Acronyms

JASI- JSE All Share Index

JSE – Johannesburg Stock Exchange

DDM – Dividend Discount Model

GCF – Gross Capital Formation

CBOE -Chicago Board Options Exchange

VIX – Volatility Index

"DISR" – Short form for a stock market disruption caused by oil price shocks

List of Figures

List of Tables

CHAPTER ONE

1.0 INTRODUCTION

1.1.0 Background of the Study

One of the most fundamental decisions that a firm has to make is with regards to investment; it is a complicated matter with countless variables to be considered. The firm management tries to identify investment opportunities that will give the firm more returns than the cost of acquiring them (Ross, Westerfield, Jordan, & Firer, 2012). The investment decision challenge is compounded by the fact that most investment decisions are irreversible, hence the need for proper analysis before any investment project is undertaken to ensure that the investments lead to acceptable returns and the timing is right (Bulan, 2005). In making such investment decisions, a firm encounters enormous constraints that range from financial, capacity, or even political limitations and uncertainties about future situations which may influence their cost of operation, demand for their goods, and firm earnings (Alaali, 2020).

Various studies have been conducted to establish what determines investments, and what firm managers need to consider when making investment decisions for optimal returns. Some authors (Bo (2002); Leahy and Whited (1996); Hartman (1972); Cukierman (1980)), have established that one common factor that affects investments is uncertainty about the future. The uncertainty can be internal (idiosyncratic), that is, arising from within the firm, or external, arising from sources other than the firm, such as market conditions, industry developments, and/or macroeconomic uncertainty. The issue of uncertainty has long interested economists, and the effects of uncertainty on investments has been investigated extensively, as noted by Bo (2002).

Crude oil price volatility is one of the market uncertainties which can adversely affect firm investment decisions. The adverse effects of oil price changes are felt more when they rise as opposed to when they fall, furthermore the impact is larger if the price increase occurs after a long period of steady prices than when it is a correction of previous price decreases (Hamilton, 2003). Oil price shock can be decomposed into three components as identified by Kilian (2009): ‘Oil supply shock’, which is associated with disruptions in physical availability or oil production leading to a fall in global oil supply with a subsequent rise in oil prices, ‘Oil demand shock’, which emanates from an increase in world economic activity, resulting to a rise in the price of oil, and 'Oil market-specific demand shocks', which results from precautionary demand for crude oil due to uncertainty about the sustainable supply of oil in the future, which also leads to high oil prices.

Oil price shocks can be transmitted to firms directly, where oil forms part of the input, or indirectly through other mechanisms. The direct transmission impacts firms in two ways. Firstly, an increase in oil price often leads to an increase in the cost of production since oil is a factor of production in combination with capital and labour, resulting in an adverse effect on the firm's output, consequently hurting any future investment plans (Hamilton, 2003). Secondly, a rise in imported crude oil prices lowers the domestic household purchasing power, since much of the income is transferred abroad (Kilian, 2014). Reduced consumption leads to a reduction in output, which translates to idle capacity, with no incentive for the firm to invest.

Extensive research has been conducted on upward causality effects (i.e. effects arising from direct transmission of price oil shocks to firms); (Sadath and Acharya (2015); Yoon and Ratti (2011); Pinno and Serletis (2013); Henriques and Sadorsky (2011)) amongst others, who focus on production function approach with relation to input (capital, labour, and energy) and output (Hamilton, 2003). However, some results cannot be explained by this approach since crude oil is not a direct input in some of these industries. A case in point is presented by Alaali (2020) where he examined the effect of oil price volatility on UK firms and observed a negative relationship between crude oil volatility and firm-level investment in financial firms, an indication that there are other transmission mechanisms (secondary effects) of crude oil shocks to firms.

One of the other transmission mechanisms is the stock market, whereby the oil shock is first transmitted to the stock market followed by a second-moment volatility transmission to the firms-; a focus of this study. Oil price shocks can be transmitted to the stock market either through the reduced/increased profitability of the firm as a result of the impact of the shocks to the cost of inputs, which will then reflect on the share price of such firms at the stock market. However, as noted earlier, this is only attributable to firms that use oil as a direct input. The other channel through which oil shocks can be transmitted to the stock market is through the discount rates at which future dividends are discounted in determining the price of a stock or the expected cash flows in form of dividends. There are various theoretical models of valuing a stock and the common one is the dividend discount model (DDM), where the price of the stock is determined by discounting the future expected cash-flows.

The DDM model maintains that the value of a stock is ultimately determined by the cash flow accruing to stockholders, the dividends (Bodie, Kane, & Marcus, 2014). This implies that changes in expectations of future dividends, and the discount rate used to discount them to the present value will determine the movement of the stock price (Campbell & Shiller, 1988). Oil price shocks tend to put inflationary pressure on economies, especially net oil-importing emerging economies (Misati, Nyamongo, & Mwangi, 2013). The central banks respond to such inflationary pressures by adjusting the interest rates accordingly. Ben S Bernanke, Gertler, Watson, Sims, and Friedman (1997) observed that "the majority of the impact of an oil price shock on the real economy is attributable to the central bank's response to the inflationary pressures engendered by the shock", (p.33). The adjusted interest rates will then determine the discount rates used in discounting the expected future dividends, hence impacting on the value of the stock. Therefore, oil price shocks will impact the price of stock first through a change in expectations of the future cash flow and secondly through the discount rates used to discount such cash flows (Chortareas & Noikokyris, 2014).

The state of the stock market is crucial for firms in decision making, and it performs three key functions as noted by Wang, Wu, and Yang (2009); firstly, the stock market acts as a source of investment financing. The stock market helps the firms raise capital either through the initial public offering or seasoned public offering. When firm managers believe that their company shares are overvalued, they may decide to raise capital by issuing more equity. Secondly, in many corporates, the remuneration for firm managers is pegged on the firm's stock performance, consequently, the stock market may influence the firm managers' investment decisions, leading to decisions that are leaned towards more benefits and avoiding those which involve risk-taking. Thirdly, firm managers use the information obtained from the stock market to gauge the quality of their investment decisions. This is due to the fact that the stock market movements are determined by the market perception of the firm's investment valuation, which informs them (firm managers) of how their investment decisions are viewed by the potential investors.

The connection between stock market instability and firm investment decisions has been explored extensively, but with mixed findings. Raunig and Scharler (2011) employed post-war U.S data to investigate the effect of stock market volatility on consumption and private investment growth, and observed that stock market volatility has statistically and economically significant adverse effects on both consumption and private investment growth, with a bigger magnitude of effect noted on investments due to its high degree of irreversibility. Rashid (2011) examining data for UK Manufacturing firms found a significant reduction in investment as financial markets uncertainty increases.

In contrast, Shaoping (2008) examining data for various Chinese firms employed the volatility of daily stock market returns to measure the effect of uncertainty on firm-level investment and observed a positive and statistically significant effect of uncertainty on firm investments, meaning higher levels of uncertainty arising from stock market volatility were linked to higher levels of investment. The variations in the above results can potentially be explained by examining the inducers of the stock market volatility or the market being studied (developed or emerging). As noted by a comparison of the sources referred to above, developed markets (U.S and U.K) reveal a negative relationship between stock market volatility and investment, while China which is an emerging market, presents a positive relationship between stock market volatility and investment. This calls for more empirical research focusing on emerging economies in conjunction with a specific origin (causes) of stock market volatility to explain the variations.

Carrière-Swallow and Céspedes (2013) observe that emerging markets tend to suffer more acute falls in investments, with an approximation of four times more compared to established economies when exposed to external uncertainty shocks. He further adds that the magnitude of the drop in investments is highly correlated with the business institution's quality, the growth of the financial sector, and the extent of financial dollarization, with the conclusion that financial linkages may play a large role in the transmission mechanism of uncertainty shocks across countries. This brings us to the connectedness between oil price shocks, where oil is priced in dollars, and the financial market volatility, and their causal effect on firm-level investments.

South Africa as an emerging economy is not immune to such uncertainty shocks. Since its independence, South Africa's economic performance has been strong but not outstanding (Clarke et al., 2005), especially when compared with other emerging economies of its category, namely Brazil, Poland, and the comparable Asian economies, adding that the key driver of the economic growth has been fixed investment. Clarke et al. (2005) further note that investment in South Africa remained low compared to the other emerging markets, with the investment to GDP rate ranging between 15% to 16%, with the private sector accounting for 12%, which was also noted to be below expectations. From their survey and analysis, the capital formation was projected to be the key component of GDP which was expected to contribute more to economic growth, hence the need to pay more attention to investment.

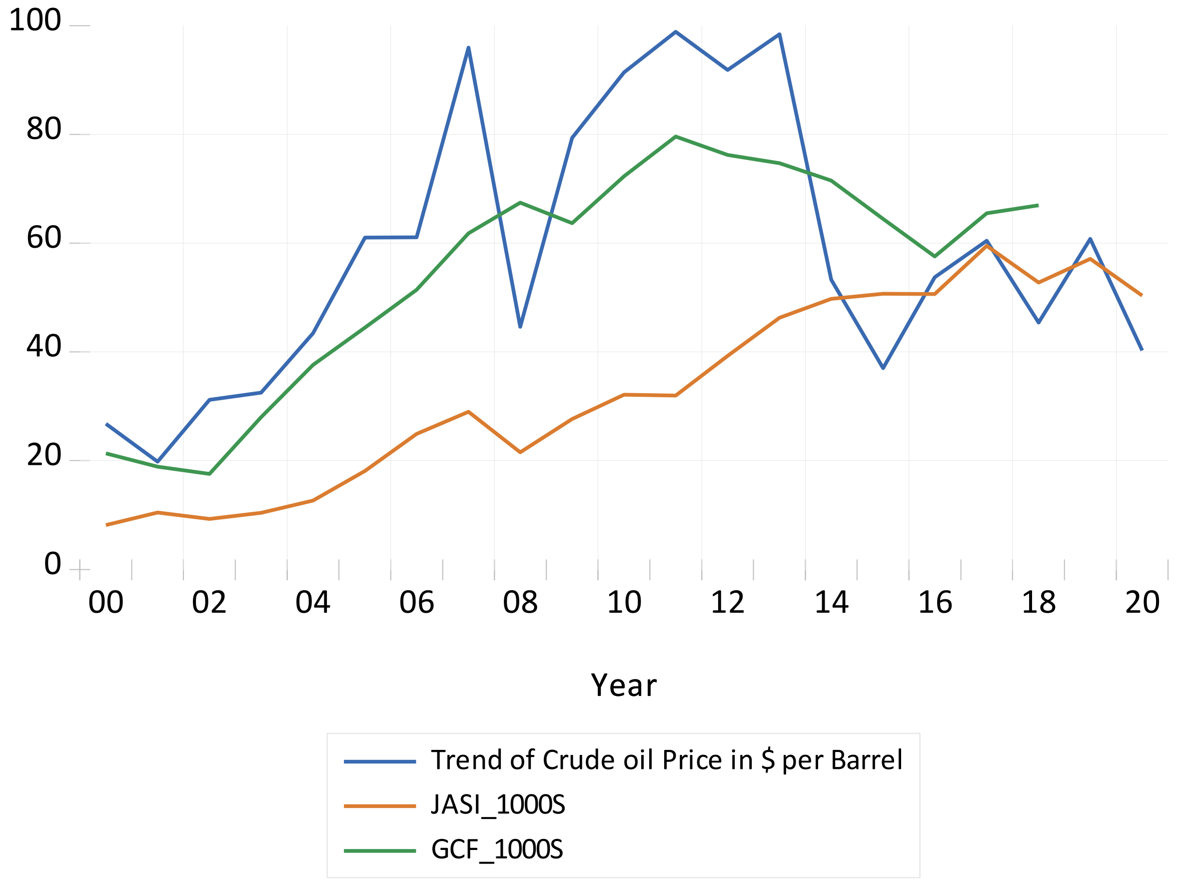
Nicolai and Vincent (2018) in their research on investment in South Africa observed that South Africa's economy had stalled for over ten years, as evidenced by a drop in private sector investment. They further noted that the private sector investment as at the year 2018, was around 20% lower than the levels it was prior to the global financial crisis, terming the whole situation as a private sector "investment strike", believed to have been occasioned by the political and economic uncertainty. SARB (2020) in their Quarterly Bulletin also observed a reduction in real capital formation in South Africa over the last two years, which they attributed to the persistent low business confidence, lethargic real economic activity, and further deterioration in the fiscal position, which consequently resulted to a decline in the ratio of nominal fixed capital formation to nominal GDP further to 17.9%, the lowest since 2005 (whose figures were around 15% to 16% as per Clarke et al. (2005) observation noted above).

Various studies have been conducted to establish some of the factors which have contributed to the stagnation of investment in South Africa. Vengesai and Muzindutsi (2019) noted that risk rating shocks hurt firm-level investment in South Africa. Maepa (2015) observed that the exchange rate plays an immense role in investment decisions in South Africa, more so the free-floating rate which exposes the Rand to external shocks. Other Scholars (Wakeford (2006); Fofana, Chitiga, and Mabugu (2009); Wakeford (2013)) explore the effects of oil price shocks on the South African economy and make a similar observation that oil price shocks have adverse effects on the economy. Their studies focus on the economy as a whole and not a specific component of the economy, they also do not specify which particular oil shocks are responsible for adverse effects on the South African economy.

Notably, there is limited study on the impact of stock price volatility on investment in South Africa, despite the key role played by the stock market in relation to firm investment decision making. Much of the research focuses on an upward causality effect in the argument of how the economic development impacts stock prices. Odhiambo (2010) argues in support of investment-financial development nexus, while Diebold and Yilmaz (2008) examining data for 49 countries, including South Africa, argue that fundamental volatilities lead to stock market volatility. However, some studies are noted to support the volatility spill-over effect from the stock market to other sectors of the economy.

Chinzara (2011) investigates the relationship between macroeconomic uncertainty and its impact on the stock markets of emerging economies; with South Africa serving as a case study. He observes a bidirectional effect on the transmission of volatility between the stock market and other macroeconomic variables. Paetz and Gupta (2016) examine the relationship between stock price dynamics and business cycle in South Africa and note that financial shocks have a negative effect on firm output, consequently, this is likely to affect firm investment decision, as we know, low output translates to underutilization of capacity, which may not incentivize the firm to invest further. However, what Paetz and Gupta (2016) are not clear on is the origin of the stock market volatility in this case. According to Corradi, Distaso, and Mele (2012) understanding the origin of stock market volatility is central to policymakers' decisions for appropriate policy interventions as well as market participants to make informed decisions.

***Figure* 1: Annual Trend of Gross Capital formation (in $1000), JASI (in ZAR1000) and -Crude oil (in $ per barrel)**



Source: EquityRT Database, UNCTAD - plotted by the researcher.

Figure 1 above shows a combined plot of the Annual Gross Capital Formation (GCF, representing total investments) in thousands of dollars, the annual closing price of the JSE All Shares Index (JASI, representing stock price movement) in thousands of ZAR, and the annual price of crude oil in dollars per barrel. From the line graph, we notice that the three graphs are trending in the same direction. We notice that before the year 2007, all three graphs were uptrending. Between the years 2007 and 2008, there is a sharp change of direction on the oil price graph to a downward direction, and the JASI graph follows suit immediately. However, it is not until after the year 2008 that the gross capital formation graph changes direction to a downtrend. Between the years 2008 to 2009, the oil price graph changed to an upward trend, and the JASI graph follows. Not until after 2009, does the gross capital formation graph change from downtrend to an uptrend.

However, in the year 2011, we notice a different relationship. The oil price graph starts downtrending, but the JASI does not respond, it tends to stagnate temporarily then continues to uptrend. On the other hand, the gross capital formation changes direction and starts downtrending. This new relationship goes on until the year 2015 when the oil price graph starts rising, and the gross capital formation follows suit in the year 2016, the GFC upturn seems to respond to the sharp gradient rise by JASI. The unidirectional relationship is resumed in the year 2017. The graph, therefore, appears to suggest the existence of a strong relationship between oil price shocks and stock market prices. However, although a strong effect appears not to exist between oil price shocks and aggregate investment, a secondary relationship can possibly be established with stock price changes (proxying for the cost of capital) acting as a potential link between the two. This study will be examining the existence of this secondary relationship.

The oil price movement can be explained by various factors. The sharp rise in oil prices from below $30 per barrel to $145 per barrel between 2004 and 2008 represents an oil price shock, which was quite unprecedented. It is argued that this price change did not originate from oil supply disturbances, but was as a result of an isolated small increase in demand associated with an unforeseeable growth of the global economy and driven by strong additional demand for oil from emerging economies, Asia in particular (Baumeister & Kilian, 2016). Similar observations were also made by Lee, Kang, and Ratti (2010) who noted that demand for oil associated with increased global business activity was responsible for the persistent oil price increases between 2003 - 2008. Since the oil producers could not satisfy the demand, the effect was a subsequent rise in the price of oil (Baumeister & Kilian, 2016), signifying an oil demand shock. Thereafter we notice a sharp drop in oil prices from mid-2007 due to the global financial crisis. The demand for crude oil dropped in anticipation of the global recession, causing the oil prices to plunge from $134 per barrel to $39 per barrel as observed by Baumeister and Kilian (2016). This is again followed by a period of some 'calmness', with smaller shocks between the year 2010 to the year 2013/2014, with an upward trend in general.

The decline in prices in 2014 can be attributed to several factors. According to Baffes, Kose, Ohnsorge, and Stocker (2015) some of those factors include; several years of an unexpected increase in the production of unconventional oil: weakening global demand, a significant shift in OPEC policy, the unwinding of some geopolitical risks; and an appreciation of the U.S. dollar, out of which, OPEC's action of renouncing price support and the surge of oil supply from the unexpected sources played the bigger role in price drop from 2014, with emphasis that supply (much more than demand) factors contributed more to the drop in oil prices, signifying an oil supply shock. No significant oil price shocks have been experienced between the year 2016 to end of 2019/early 2020, until the outbreak of the Covid-19 pandemic which led to uncertainty in the market. The release of the coronavirus reports by the World Health Organization on March 29th, 2020, sent more panic, consequently, Saudi Arabia, the world-leading oil exporter reacted by oversupplying oil, this combined with increased volatility in the financial markets resulted to the plunging of oil prices (Albulescu, 2020).

The movements of the JSE All-Share Index (JASI) from the year 2000 to 2020 can be attributed to various factors. It is noticeable that the index had a steady upward trajectory from the year 2003 to 2007. This can partly be attributed to the JSE revision of their rules in the year 2003 which required all the listed firms to adhere to the recommendations of King II report issued in 2002, whose objective was to promote high standards of corporate governance practices for the benefit of the stakeholders (Abdo & Fisher, 2007). Abdo and Fisher (2007) further note that investors place a premium (investor confidence) on companies with good governance; this was evidenced by a positive correlation between good corporate governance and stock returns. The continued rise in 2007 can also be supported by the JSE adoption of the Trade Elect equity system (April 2nd, 2007), which led to an improvement in market performance as evidenced by increased liquidity and reduction in trading costs (South African Institute of Financial Markets, 2008), as cited by Kgosietsile (2015).

The drastic drop of the index in 2008 is attributable to the global financial crisis, which resulted in a reduction in private capital inflows, exports, as well as reduced commodity prices impacting the stock market negatively (Balchin, 2009). However, the capital flows recovered relatively swiftly as per Moreno, Mihaljek, Villar, and Takáts (2010) observation that the net and gross capital flows to emerging markets rebounded starting in the second quarter of 2009- an indication of an early recovery in foreign investor interest in emerging economies- this is further evident in the upturn of the index from the year 2009, which continued to rise steadily until it peaked in the year 2017/2018. We notice a drop between 2018 to 2019 which can partly be attributed to the political climate at the time, before the country went into elections in May 2019, after which the index started to rise again, then a sudden fall in the year 2020 due to covid-19 pandemic as well as South Africa's credit downgrading to junk status, leading to low investor confidence.

1.2.0 Problem Statement.

According to the International Monetary Fund, 2018 report (Vengesai & Muzindutsi, 2019), South Africa is ranked among the top emerging economies with high potential for growth due to its exclusive mix of industrialized economic infrastructure and energetic emerging market economy. Adjasi and Yartey (2007) note that JSE plays an important role as a source of finance for investments by listed corporations. They observed that between the years 1996 to 2000, new equity issues accounted for over 19% of corporate financing, the highest percentage in Africa, and the same range with the patterns in other emerging markets outside of Africa.

Due to its development status and sophistication, there is evidence of volatility contagion effects by other global stock markets, especially during the times of international financial crisis as observed by Heymans and Da Camara (2013), an indication of JSE exposure to global shocks. It is because of these combined factors that the research focuses on South Africa. The level of JSE exposure to the global financial markets is an indication of the possibility of exposure to global commodity markets like the oil market, and JSE being the most active in Africa signifies the value firms place on it, meaning its operations have the potential to influence firm decision making. This can also partly be confirmed by the oil price, JASI, and GCF relationship observed in the introduction section.

As pointed out earlier in the study, various studies have been carried out with a common observation of adverse effects of oil price shocks on macroeconomic variables in South Africa, although it was also noted that their focus has been more on shock transmission through the production function approach, yet we have seen there is a possibility of an oil-shock pass-through mechanism through the stock market to other sectors of the economy. Further, the studies fail to explain the shock (demand or supply shock) responsible for the adverse effects. We also noted that most of them focused on the macroeconomic aggregate (that is economy as a whole). For any viable measures to be put in place to cushion the economy against such adverse effects, it is important to carry out a focused study of their effects on the specific components of the economy. Chien (2015) points out three key factors that drive the economy; namely accumulation of capital stock (investments), increase in labour inputs (workers or hours worked), and technological development.

The difference between this research and previously published studies is that it narrows down on the effects of the said uncertainties on one of the factors (components) that drive the economy, that is investments, specifically firm-level investment. The focus on investment as a component of the economy is further strengthened by Ben S. Bernanke (1983) argument that micro-level investment decisions of the firm have a contribution to the aggregate investment cyclical fluctuations. This is more so if the aggregate economy is not sufficiently diversified to the extent of being immune to shocks to certain large industries such as the automobile industry. This is to mean, for an emerging economy like South Africa, which is a net oil importer, and not highly diversified to withstand oil shocks to certain industries or sectors of the economy, understanding the effects of such shocks to firm-level decision making will be key in cushioning the entire economy against such shocks by addressing them at the firm level, with the understanding that what happens at the firm level will reflect on the aggregate economy. This study, therefore, seeks to investigate whether stock market disruptions induced by oil price shocks (supply and demand shock) have any effect on firm-level investment in South Africa.

1.3.0 Research Objectives

The research seeks to achieve the following objectives.

1. To establish the nature of the relationship between the different oil price shocks and stock returns in South Africa; and
2. To ascertain the effects of stock price volatility induced by oil price shocks on firm-level investment in South Africa.

1.4.0 Significance of the Study

This study will contribute to the literature on oil price shocks secondary effects and the different transmission mechanisms. Most of the previous studies have focused more on the direct transmission, leaving out gaps on other channels of oil price shock transmission. Secondly, by decomposing the oil shocks to supply and demand shocks, and identifying the effect of each on the stock market will make it possible for the firm managers to do proper investment timing when they know the likely effect of the prevailing oil shock, as well as put in place other contingency measures. Further, for other participants in the stock market, knowing the origin of the stock market volatility and its effects on the stock market will guide them in making informed investment decisions, like engaging in cross-market hedging, across the stock market, and the oil- market.

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter will focus on literature review around the relationships between the oil price shocks, the stock market, and firm-level investment. Will also review any past studies on oil price shock secondary effects, with the stock market as the main channel of shock transmission. The review will focus on the following areas;

- Oil price shocks and the stock market
- Oil Price shocks decomposition
- Stock Market and firm-level investment
- Role of change of expectations on the price of stocks through DDM
- Oil price shock secondary effects.

2.1.0 Oil price shocks and the Stock Market.

Information regarding the relationship between oil price shocks and the stock market is crucial for investors, especially for portfolio diversification, and has attracted a lot of interest, with extensive research and varied findings. Nandha and Faff (2008) argue that there are key reasons why oil price shocks affect the stock market; firstly, due to its fundamental role as a driver of the economic activity and secondly due to the general market view that the stock markets will tend to respond to oil price fluctuations. Some studies have established a negative correlation between the oil price shocks and the stock market, others indicate a positive link, while a few argue non-existence of any link between the oil price shocks and the stock market.

Most of the studies have viewed oil price fluctuations to affect the stock market by firstly adversely affecting firm output, then the firm’s profitability as oil raises the cost of inputs (Nandha & Faff, 2008). Hamilton (1983) observes that increases in oil prices between 1948 to 1972 were followed by a drop in GNP growth which would have been unexpected based on the previous behaviours of output, prices, or money supply, had the oil prices not risen. To imply that an increase in oil prices was responsible for the drop in GNP. Narayan and Sharma (2011) argue that if an increase in oil price will lead to a drop in GDP, it then follows that the earnings for firms with oil as a direct or indirect input will drop, leading to a fall in the price of stocks of such firms, and for inefficient stock markets, such adverse effects on firm returns will be lagged. Nandha and Faff (2008) examine the impact of oil price shocks on 35 global industry indices and observe a negative effect on equity returns across all industries, except for mining, and oil and gas industries. They further note that the impact spreads to industries like banks, health, and insurance, adding that the rise in oil prices affect interest rates and also a drop in consumer confidence, an indication of other indirect channels through which oil prices increases can spread to the stock market. Sadorsky (1999) notes that positive shocks to oil prices led to an adverse effect on US stocks, through the negative impact the oil prices have on the economic activity.

Other studies have found a positive relationship between oil price shocks and the stock market. Sadorsky (2001) examines the relationship between the oil price shocks and the Canadian Oil and Gas industry returns and observe a positive relationship, where an increase in oil prices led to an increase in the returns for the oil and gas stock prices.

Interestingly, some studies have found that oil price shocks do not affect the stock market. Cong, Wei, Jiao, and Fan (2008) examine the relationship between oil price shocks and Chinese stock markets and observe that oil price shocks have no statistically significant effect on the stock returns of most of the Chinese stock market indices, except for manufacturing index and oil companies.

These results imply that stock markets react differently to oil price volatility. Such reactions depend on various factors, one of them being the type of the oil shock (Supply, Demand, or Oil-specific demand shock) responsible for the oil price movement, which most of the studies have not given attention to, hence the mixed findings. Naser and Rashid (2018) examine the reaction of real stock returns to oil price volatility in four emerging economies and observe that Brazil and India’s stock returns react negatively to oil price shocks, whereas China responds positively. Russia stock returns react positively the first four months, but thereafter the response is negative. China displayed a smaller impact than the other three.

However, when the oil shocks are decomposed, the results tend to vary. Fang and You (2014) examine the effect of oil shocks on the stock markets of the largest emerging markets (China, India, Russia) and find mixed reactions to different oil shocks. They observe that for India, an increase in oil prices negatively affected its economy when the rise was due to other factors other than an increase in India’s oil demand. For Russia, they observe a positive impact on stock returns when the rise in oil price results from Russian oil-specific supply shocks, otherwise had a negative impact. China had interesting results where oil price increase resulting from global oil demand shocks had an insignificant impact, China's oil-specific demand shocks had an adverse effect. These results indicate the need to disintegrate the oil price shocks when determining their effect on different stock markets since different stock markets will react differently to different oil shocks.

2.2.0 Oil Price Shocks Decomposition

As observed in the preceding section, oil price shocks affect the stock market, and the economy as a whole differently. Many studies have focused on the effects of oil price shocks on macroeconomic variables treating the oil as an exogenous variable, holding all other factors constant (Kilian, 2009). Kilian (2009) notes two limitations with this approach, firstly, it ignores the reverse causality effect of the macroeconomic variables on the price of oil, and secondly, the fact that just like any other commodity, the price of oil is determined by forces of demand and Supply, negates the holding of other factors constant assumption.

With the motivation to address the above limitations, Kilian (2009) takes the path of decomposing the oil shocks to various components arguing that understanding the underlying demand and supply shocks in the global oil market will not only explain the real oil price fluctuations, but also in explaining the response of the economy to a particular oil shock. He proposes a methodology for structural disintegration of the oil shocks into three mutually orthogonal components using the structural VAR Model. These components include oil supply shocks which he defines as unexpected changes in crude oil production, aggregate demand shocks defined as oil demand resulting from increased economic activity and is independent of oil production, and oil specific demand shocks associated with the oil market, also referred to as precautionary demand shock resulting from uncertainty surrounding future availability of crude oil.

Kilian and Park (2009) adopting the decomposition methodology designed by (Kilian, 2009) investigates the effect of oil price shocks in their decomposed form on the U.S stock market and observe that indeed the U.S stock returns' response to oil shock varies depending on the force behind the oil price change, that is whether it is an aggregate demand shock, supply shock or oil specific demand shock. Further noting that oil-market specific demand shocks led to negative response of US stocks to oil shocks, expected global economic growth resulted to a positive response of U.S stocks, while the supply shocks had no significant effect on the U.S stock returns, with the crude oil demand shocks accounting to more than 2/3 of the total effect of oil shocks on stock returns.

The decomposition theory is further supported by Ready (2018) where he uses asset prices to develop an oil shock decomposition model that defines oil shocks as either demand-driven or supply-driven. In support of the use of the asset prices, Ready (2018) argues that when the oil prices are demand-driven, the oil producers will sell more and at a higher price, pushing the producer stock returns higher. Whereas when the oil prices rise due to supply disruptions, the oil producers tend to sell less, but at a higher price, resulting in no effect on the oil-producing firms stock returns. It is in line with this argument that Ready (2018) chooses to use different proxies for demand shocks and supply shocks, with the oil producer firms global returns index proxying for demand shocks while oil supply shocks are proxied by one-month returns on the second nearest maturity NYMEX Crude-Light Sweet Oil contract, to capture the unexpected variations in oil prices. Ready (2018) introduces another variable, VIX Index, to proxy collective variations in market discount rate resulting from changes in attitude towards risk. Similar to Kilian and Park (2009), Ready (2018) observes a positive correlation between oil demand shocks and stock returns. However, in contrast to Kilian and Park (2009) who observed that oil supply shocks have no significant effect on stock returns, Ready (2018) observes that supply shocks have a strong and significant negative correlation with stock returns, accounting for 78% of the total oil price shock effects on the stock returns.

Gupta and Modise (2013) adopt the decomposition model developed by Kilian (2009) and Kilian and Park (2009) to investigate the effect of different oil shocks on the South African stock returns, a net oil importing country. Similar to Kilian and Park (2009), they observe that oil demand shocks resulting from increased global economic activity lead to a positive response in the stock returns and the oil-market specific demand shocks result in a negative reaction of the stock returns. However, in contrast to Kilian and Park (2009), Gupta and Modise (2013) observe that oil supply shocks have a negative effect on the South African stock returns.

2.3.0 Stock Market and Firm-Level Investment

According to Tobin's Q theory, investment depends on ratio *q*, which is the ratio of the stock market valuation of existing capital to the cost of its replacement (Summers, Bosworth, Tobin, & White, 1981). It, therefore, follows that investment growth depends on variations in Q, and since the stock prices are the most contributors of such changes (forms the numerator of ratio *q*), then the stock market is expected to have strong effects on fixed capital formation (Hu, 1995). Additionally, as noted earlier in the study, the stock market plays three key roles at the firm level; source of financing, source of information about the quality of investment decision taken by firm managers in form of customer perception, and thirdly as a motivator for corporate governance since firm managers' compensation is based on the firm's stock performance (Wang et al., 2009). It, therefore, follows that the performance of the stock market can influence firm managers' investment decisions.

Hu (1995) identifies various channels through which stock market volatility can affect firm-level investment decisions. He argues that, firstly, in a case where the stock price is highly volatile with substantial deviations from fundamentals, it demotivates investors to hold equities since they are not adequately compensated for the risk premium of holding such stocks, hence raises the firm's cost of capital through equity financing, and inhibits new investment. Secondly, if the firm capital is undervalued by the stock market, then the firm is likely to resort to selling existing fixed assets instead of investing in new ones, which results in mergers and acquisitions with no or little new investment taking place. Thirdly, in times of high stock market volatility, it becomes difficult for firms to use the stock market for forecasting purposes, as a result, the firms often ignore the volatile short-run variations in stock prices when making long-term investment plans, consequently affecting investment timing, since the investment is irreversible.

Bolbol and Omran (2005) argue that the significance of the stock market valuations to firm-level investment in developing countries has an added significance in that, firstly, the developing countries equity finance surpasses their debts or internal funds financing, unlike the pecking order pattern of corporate finance observed in the developed world. Second, equity finance introduces risk-sharing through reduction of moral hazard which would be experienced in the case of individual (sole) ownership and also achieves efficient resource allocation through share price signalling, hence minimizing the destabilizing effect occasioned by capital inflows to developing countries. Finally, developing countries going through relaxation of trade and interest rates rules are likely to experience high costs of funds (bankruptcy risk) as well as higher but uncertain returns. Consequently, a high perception of returns variance will tend to reduce debt funding in support of equity financing for new investment projects.

Various studies have been carried out to establish the relationship between the stock market and firm investment with varied findings, some have observed a positive relationship, others a negative relationship, while others argue there is no link between the two. Hu (1995) employs U.S firms' data to examine the effects of stock market volatility on real investment and observe a strong negative correlation between stock market volatility and real investment, highlighting the desirability of reducing stock market volatility. Raunig and Scharler (2011)using post-war U.S data examine the effect of stock market volatility on the growth rate of investment and note that high levels of stock market volatility have an adverse effect on investment growth rates. Rashid (2011) engages data for UK firms to investigate private firm's responses to uncertainty and observe that, in times of increased financial market uncertainty, firms significantly reduced their investments. Raza, Shahzad, Tiwari, and Shahbaz (2016) examine the impact of oil prices and their associated volatilities on the stock markets of the top ten emerging economies (South Africa included) and observe a negative relationship between oil prices and stock markets of all the ten emerging economies, an indication that indeed oil price shocks can be passed to stock markets, even those in emerging economies. The question which remains unanswered is how the said oil shocks once passed on to the stock market can affect firm-level investment, and this study is aimed at offering the answer to the question.

Alaali (2020) examines the effect of stock market volatility on both financial and non-financial firms in the UK, where he employs firm-level data for U.K firms and daily returns and observes a highly significant and positive correlation between stock market volatility and firm investment in both cases. He attributes the positive relation to the act of incorporating new information received from the stock market in their investment decisions. Baum, Caglayan, and Talavera (2008) using U.S firms' data and daily stock returns examine the relationship between uncertainty and firm investment, and note a negative correlation between idiosyncratic uncertainty and firm investment but a positive correlation between market uncertainty and firm investment.

In summary, it is notable that stock market movements do influence firm-level investment. It is also notable that the effect stock market volatility has on firm-level investment is varied, some results revealing a negative relationship while others indicate a positive relationship. There are various factors that can explain the variations in findings, and one of those factors is the origin of the stock market volatility. The studies have not gone further to establish the inducers of the stock market volatility, which can probably account for the differences in findings, and as per Corradi et al. (2012), understanding the origin of the stock market volatility is important. The difference between this study and previous research is that it will investigate the impact of stock market volatility induced by oil price shocks on firm-level investment.

2.4.0 Role of change of expectations on the price of stocks through the Dividend Discount Model.

Fundamental analysts, in their quest for arbitrage opportunities, engage in a search for mispriced securities where they use any available information regarding the current and prospective profitability of a company to establish its fair market value (Bodie et al., 2014). Bodie et al. (2014) further add that one of the quantitative tools commonly used by these analysts to estimate the value of the firm as a going concern is the Dividend Discount Model (DDM). Using DDM, the value of the company stock is computed by discounting all the expected cash flows to their present values, meaning that the price at which one can sell a share today depends on the dividend forecasts at the time of the sale. DDM model for the expected constant growth of dividends can be expressed as; $V_0 = \frac{D_0\,(1+g)}{k-g} = \frac{D_1}{k-g}$, where V_0 is the present-day intrinsic value of the firm, D_1 is the expected dividend, k is the stock discount rate and g is the dividend growth rate (constant). From this equation, we can infer that the stock price movement is a function of the firm's future expected cash flows and the discount rate adopted in discounting them.

Castrén, Fitzpatrick, and Sydow (2006) investigate the key drivers of EU banks' stock returns using the DDM model and observe that, in an efficient market hypothesis, the price of bank securities appeared to be forward-looking and they take into consideration expectations of future earnings (cash flows), whether positive or negative. The dividend-discount model of equity states that "a firm's stock returns can be high either if its future earnings growth (the fundamental often measured by dividends) is high, its expected returns are low or in case of any combinations of these two" (Castrén et al., 2006)(pp.11).

Jones and Kaul (1996) examining the reaction of the stock markets (U.S, Canada, Japan, and the UK) to current and future variations in cash flows as well as changes in expected returns as a result of oil shocks establish that, for all the four countries, the stock market returns are correlated with the current and future changes in expected cash flow. To mean when there is a change of expectations concerning future cash flows (dividends), the stock price will vary to factor in investor expectations. This ties in with the Campbell and Shiller (1988) observation that corporate stock price movements are related to expectations of future dividend changes and the expected discount rates applied to bring them to the present value. Expectations of future changes in the discount rate, triggered by inflationary pressure will affect the price of stocks since the discount rate is a key factor in determining the intrinsic value of a stock.

Chortareas and Noikokyris (2014) investigate the effects of different oil price shocks using the DDM model and note the key role expectations play through the stock market. They observe that higher oil prices caused by oil supply shocks led to a positive change in the U.S dividend yield by raising expectations regarding higher future risk premium and interest rates. On the other hand, higher oil prices induced by demand shocks lower the U.S dividend yield in the initial 9 months by lowering subjective equity premium, excess dividend growth, as well as mispricing. However, they noted that in the long-run (18 months) the oil demand shocks are observed to activate positive U.S dividend yield by raising expectations of future dividend growth, mispricing, and real interest rates.

2.5.0 Evidence of oil shock pass-through mechanism through the stock market to other sectors of the economy.

As observed earlier in this research, various studies have been conducted to establish the relationship between the oil price shocks and the stock market, with observations that indeed oil price shocks have an effect on the stock market, which can be negative or positive. But there are limited studies on how the impact occurs, with more focusing on the effect as arising from the increased cost of inputs lowering the firm output, hence lower stock prices. Further, not many studies have explored the oil price shock secondary effects through the stock market or second-moment transmission of shocks to other sectors of the economy, despite the evidence of the existence of the stock market volatility spill over effects. In this study, the stock market is viewed as a transmission channel through which oil price shocks are passed on to firms, influencing firm-level investments.

Malik and Hammoudeh (2007) examine the shock and volatility transmission among the Gulf equity markets, the global oil market, and the U.S equity market. They find the existence of significant transmission of volatility from the global oil market to the Gulf equity markets and a second-moment volatility transmission from the oil market and Gulf equity markets to the US Equity market which is as a result of their interconnectedness through cross-market hedging as well as changes in the expectations of market participants in reaction to changes in shared information. They also notice evidence of volatility spill over from Saudi Arabia stock market to the oil market which can be attributed to its role as the leading oil exporter.

Chortareas and Noikokyris (2014) examine effects of oil supply and demand shocks on the components of U.S dividend yield (dividend growth, real interest rate, subjective equity premium, and mispricing) by exploring the relationship between the U.S stock market prices and oil price changes and find a positive correlation between a rise in oil price and dividend yield, confirming that oil shocks are indeed transmitted through the stock market to other sectors of the economy. According to Chortareas and Noikokyris (2014), the connection between the oil price shocks and the U.S dividend yield's constituents is true evidence of oil price pass-through mechanism, which proves that oil shocks penetrate the stock market price by affecting inflation rates, productivity levels, real interest rates, uncertainty levels as well as central bank’s monetary policy decisions.

CHAPTER THREE

3.0 METHODOLOGY

This study sought to establish if the stock market disruptions /volatility induced by oil price shocks have any effect on firm-level investment in South Africa. This was achieved by first decomposing the oil price shocks into demand shock and supply shock, then determining the effects of these shocks on the stock return. The component of the stock returns explained by these shocks was then extracted and plugged into the investment model to establish their effect on South African firms' investment decisions. Two-stage System Generalised Method of moments technique was employed to panel data for 311 Local firms listed in JSE as at 31.12.2019, for 20 years (from 2000 to 2019). The research adopted Tobin's Q theory to estimate the investment model, which expresses investment using ratio Q.

3.1.0 Data

The study employed three data sets, all for the period Jan 2000 to Dec. 2019. Firstly, to disintegrate oil price shocks into the three components; oil demand shock, oil supply shock, and the risk shock, the study adopted Ready (2018) decomposition model. The data employed in the decomposition was daily close price data for (i) World Integrated Oil and Gas Producer Index (from Datastream database), (ii) The changes in crude oil prices (from EquityRT database), (iii) the CBOE volatility index (VIX) (from Datastream database). The World Integrated Oil and Gas producer Index was used to proxy demand shocks and the changes in crude oil prices to proxy supply shocks. According to Ready (2018), risk shock is proxied by innovations in VIX, obtained as the residuals from an autoregressive moving average (1,1), that is ARMA (1,1) process.

The second set of data was the daily close price for JSE all share Index (JASI) obtained from EquityRT database to proxy stock market returns. In order to control for other external effects, the MSCI Emerging Markets stock index (From Datastream) to proxy for Emerging markets stock returns, MSCI SA stock index (from Datastream) to proxy domestic returns and SA Nominal effective exchange rate, NEER (from Bloomberg) were also adopted in the estimation equation. The third data set which was used in the estimation of the investment model was an unbalanced panel of annual data set of 311 local SA firms listed in JSE securities exchange drawn from EquityRT database. The firm-level data constitutes total assets, capital expenditure, the book value of common stock, market value of equity (market capitalization), debt, and cash from operations. Following Yoon and Ratti (2011) firm-level data was discarded in a case where the firm was observed to have three or fewer years of data reported continuously, or missing investment, capital stock, and cash flow values, and if there were observed negative values for assets or capital stock. The outlier rule according to Gilchrist and Himmelberg (1998) was also applied, whereby the observations in the top and bottom 1% were removed.

3.2.0 Oil price shocks decomposition

Kilian and Park (2009), extends Kilian (2009) methodology by examining the effect of the different shocks to the U.S stock market, where he adopted the global crude oil production to proxy for supply shock, bulk dry cargo ocean shipping freight rates as an index of real economic activity to proxy for aggregate demand and the crude oil prices to measure changes in crude oil price. They observed that the demand and supply shock responsible for driving crude oil prices only accounted for 22% of the changes in the U.S stock exchange, with more than two-thirds of the contribution attributable to demand shocks.

However, Ready (2018) noted some limitations in both the Kilian and Park (2009) and Kilian (2009) models. Firstly, he was dissatisfied with their finding on the diminutive contemporaneous explanatory power for the stock returns (< 2% jointly), which again is wholly attributable to the residual variations in the price of oil, unrelated to supply nor demand shocks. To overcome this limitation, Ready (2018) proposes the need for correlation between the data included in the model and the contemporaneous or future oil price variations to successfully point out shocks. Secondly, Ready (2018) notes that oil-specific demand shocks were given too much weight at the expense of supply and demand shocks, specifically in Kilian (2009) observation that 77% of the contemporaneous variation in oil prices is attributable to the precautionary demand shocks. Ready (2018) criticises this finding arguing that there is no way to verify if these oil price changes linked with oil-specific demand shocks could have been occasioned by worries regarding supply or expectations of demand changes, the weakness he links to the type of variables used. For example, oil increase induced by increased global activity which does not reflect on the shipping rates may pass for an oil-specific demand shock, whereas in reality it's driven by demand shocks. Thirdly, their model is limited to monthly data, limiting application on high-frequency data (Demirer, Ferrer, & Shahzad, 2020).

To address these limitations, Ready (2018) proposes an oil shock decomposition model whereby the oil price demand shock is defined by the portion of the contemporaneous return of a global index of oil-producing firms that are statistically independent of unexpected variations in the VIX index, supply shocks to be defined as the component of the contemporaneous oil price changes that are orthogonal to demand shocks as well as to changes in VIX index. He also included changes to VIX as a proxy to variations in the discount rate, which he calculated using the ARMA (1,1) model, and extracts the residuals to proxy for innovations in VIX, or risk shocks. The variable used to proxy demand is an index of oil-producing firms, specifically World Integrated Oil and Gas Producer Index, so as to have a global representation of the oil industry. The Index includes big publicly traded oil-producing firms, such as Exxon, Chevron, BP, Petrobras, etc, excluding nationalized oil producers. To proxy supply, he uses the second nearest maturity NYMEX crude – light sweet oil contracts, to focus on unforeseeable variations to oil prices. He argues that oil-producing firms have a likelihood of benefiting from a rise in oil demand, but are naturally hedged against oil supply shocks. When high demand causes oil prices to increase, producers' sales will go up, both in volume and value, which result in positive returns. On the other hand, when production is affected leading to increased oil prices, oil producers sell less, but at a higher price, and the two effects offset each other, with no effect on the producer's equity values. Therefore, the producer stock return becomes the right control variable for the identification of price changes originating from the two distinct shocks. He then uses innovations to the VIX Index to proxy for discount rate changes, and to eliminate any unforeseeable variations in the VIX, he estimates an ARMA (1,1) and uses the residuals from the process as innovations.

This study adopts Ready (2018) identification strategy in disentangling the oil shocks into demand and supply shocks. The variables used in the study include; the index of oil-producing firms (World Integrated Oil and Gas Producer Index) to proxy demand shock, the changes in the price of crude oil to proxy supply shocks (Thorbecke, 2019), innovations in the CBOE volatility index (VIX), obtained as the residual for an ARMA (1,1) process, was used to proxy risk shocks (discount rate), and the JSE all share Index (JASI) was used to proxy the aggregate market returns.

Disintegrating the shocks using Ready (2018), the supply shocks, demand shocks, and risk shocks are expressed in the following matrix form;

$$X_t \equiv \begin{bmatrix} \Delta p_t \\ R_t^{Prod} \\ \xi VIX,_t \end{bmatrix}, \; Z_t \equiv \begin{bmatrix} s_t \\ d_t \\ v_t \end{bmatrix}, \; A \equiv \begin{bmatrix} 1 & 1 & 1 \\ 0 & a_{22} & a_{23} \\ 0 & 0 & a_{33} \end{bmatrix}.$$

3x1 3x1 3x3

Where; Δp_t represents the change in crude oil price, R_t^{Prod} denotes the return on global stock index of oil-producing firms, $\xi VIX,_t$ stands for innovations in VIX, based on ARMA (1,1), s_t represents the supply shock, d_t represents demand shock and v_t denotes the risk shocks.

The three matrices can be expressed in the following form to map the disentangled shocks into the observable variables;

$$X_t = AZ_t,$$

Further, to guarantee orthogonality amongst the various shocks, Ready (2018) imposes a condition in the form:

$$A^{-1}\textstyle\sum_x (A^{-1})^T = \begin{bmatrix} \sigma_s^2 & 0 & 0 \\ 0 & \sigma_d^2 & 0 \\ 0 & 0 & \sigma_v^2 \end{bmatrix},$$

Where $\sum_x$ is the covariance matrix of the observable variable in X_t and σ_s^2, σ_d^2 and σ_v^2 are the variances of the decomposed shocks. It is important to note that the above process (condition) is merely a readjustment of the standard orthogonalization adopted in defining the structural shocks in a Structural Vector Autoregressive setting. In this setting, the shocks are restricted, to add up to the variation in oil prices, as opposed to normalizing the volatilities of the oil price shocks to one, Ready (2018).

3.2.1 The effects of oil shocks on stock returns

After identifying the shocks, the next step was to establish their effects on the stock returns. This was done by applying a multifactor linear regression of the stock market return on the disintegrated shocks following Demirer et al. (2020), plus the three control variables alternately in the form:

$$R_t = \alpha_0 + \alpha_d d_t + \alpha_s s_t + \alpha_{VIX} \xi VIX,_t + \alpha_{em} r_{em,t} + \alpha_{dom} r_{dom,t} + \alpha_{neer} NEER_{SA,t} \quad (1)$$

Where; R_t is the stock return, d_t is the demand shock, s_t is the supply shock, $\xi VIX,_t$ is the innovation in VIX or the risk shock, $r_{em,t}$ is the emerging markets stock return, $r_{dom,t}$ is the domestic return, and $NEER_{SA,t}$ is the South Africa nominal effective exchange rate. In the regression equation, $\xi VIX,_t$ is used to denote risk shock instead of v_t, (ideally v_t are non-varying multiples of $\xi VIX,_t$) to provide a clear indication of the size of the coefficients. Once the regression is run, we then extracted the explained component of the stock returns, labelled "DISR", to be added as an explanatory variable in the investment model.

To forecast the stock market volatility induced by the combined oil shocks, GARCH (1,1) model was employed to "DISR" term, and the conditional standard deviation extracted from the GARCH (1,1) process of "DISR". The conditional standard deviation was estimated from the conditional variance following Chris (2014) as follows:

$$\sigma^2 = \alpha_0 + \alpha_1 \mu_{t-1}^2 + ß\sigma_{t-1}^2 \quad (2)$$

$$(\sigma^{DISR}) = \sqrt{\alpha_0 + \alpha_1 \mu_{t-1}^2 + ß\sigma_{t-1}^2} \quad (3)$$

The conditional standard deviation, (σ^{DISR}) was then annualised and fitted in the investment model to examine the effect of stock market volatility induced by the combined oil shocks on firm-level investment.

Further, to establish the relationship between the stock market disruption caused by each individual shock and the firm-level investment, a regression of the stock market return on each individual shock together with control variables was run alternately and the explained component of the stock return extracted and added as an additional regressor on the Investment model. The second regression was of the form:

$$R_{td} = \alpha_0 + \alpha_d d_t + \varepsilon_t + \alpha_{em} r_{em,t} + \alpha_{dom} r_{dom,t} + \alpha_{neer} NEER_{SA,t} \quad (4)$$

Where R_{td} is the stock return attributable to demand shock alone, d_t is the demand shock, and ε_t is the disturbance term, $r_{em,t}$ is the emerging markets stock return, $r_{dom,t}$ is the SA domestic return, and $NEER_{SA,t}$ is the South Africa nominal effective exchange rate. The above equation (4) was then repeated with the supply and risk shocks alternately, as well as with the shocks only, excluding the control variables. The explained component of stock returns was then extracted and labelled "OIL_SHOCK STOCK_RET" for each respective oil shock, which was then used to forecast stock market volatility.

To measure the stock market volatility induced by the individual oil shocks, GARCH (1,1) model was again employed to "OIL_SHOCK STOCK_RET" term, that is the explained component of the stock returns by the individual shock, and the conditional standard deviation, (σ^{RET}) extracted from the GARCH (1,1) process of "OIL_SHOCK STOCK_RET". The estimated conditional standard deviation, (σ^{RET}), for each individual shock was then annualised and fitted in the investment model equation alternately to establish the effect of stock market volatility induced by each individual shock on firm-level investment.

3.3.0 Investment Estimation Model

To estimate the investment, the research adopted Tobin's Q model, which is derived from Tobin's Q theory. The theory states that, if the value of ratio Q (the ratio of the value of the firm's existing share capital to the cost of replacing the firm's tangible assets) is bigger than one, it would be sensible for the firm to add more investments since the earnings generated will be in excess of the cost of the firm's assets. If the value of Q is smaller than one, it would be more appropriate if the firm sold off its assets as opposed to attempting to put them in to use, and when Q is equal to one, the firm is indifferent (equilibrium).

However, the average Q- investment model assumes a perfectly competitive market where the firm maximizes returns in an environment of convex adjustment costs in changing its capital stock (Summers et al., 1981). Bond and Van Reenen (2007) argue that such assumptions may not be adequate and render the average Q investment model insufficient statistic to influence expectations, and therefore formulates a linear Q model of investment which incorporates marginal adjustment costs in the form;

$$\frac{I_{it}}{K_{it}} = a + \frac{1}{b} Q_{it} + \varepsilon_{it} , \qquad (5)$$

Where; I_{it} is the firm gross investment for the firm *i* at time *t*, K_{it} denotes firm-fixed capital for firm *i* at the beginning of period *t*, Q_{it} is the ratio of the market value of a firm as measured by existing share capital to the cost of replacement of the firm's assets for the firm *i* at time *t*, *b* is the adjustment cost function parameter and ε_{it} is the error term. This research adopted this Q model which was then expanded to incorporate the firm and time fixed effects as well as other regressors under review.

This research focuses on the relationship between stock market disruptions induced by oil price shocks and firm-level investment. Hence equation (5) was expanded with the component of stock return explained by supply and demand shock extracted from equation (1) as “DISR”, the stock market volatility induced by combined oil price shocks, (σ^{DISR}), the stock market volatility induced the three shocks individually, (σ^{RET}), alternately. From previous studies, cash flow and leverage have been proved to explain the investment behaviour of a firm (Baum, Caglayan, & Talavera, 2010), and therefore, other supplementary regressors added were cash flow and leverage, as well as firm and time fixed effects. The measurement of some of the variables adopted in the Investment estimation equation used in this research follows the work of Alaali (2020). Investment (*I*) is measured by capital expenditure while capital stock (*K*) is measured using total assets. Tobin’s Q is computed as;

$$Q = \frac{book\ value\ of\ assets - book\ value\ of\ equity + market\ value\ of\ equity}{book\ value\ of\ assets}$$

Similar to Alaali (2020), cash flow was measured by funds from operations while leverage was estimated using the ratio of debt to total assets. Since the firms are of different sizes, there is a possibility of heteroscedasticity and this was eliminated by dividing cash flow and investment values by the total assets generating new variables in the form; CF/K and I/K (Alaali, 2020).

Therefore, equation (5) was augmented with the stock return component explained by the oil shocks (“DISR”), cash flow (CF_{it}), leverage (Lev_{it}), firm (μ_i) and year (η_t) effects to take the form:

$$\frac{I_{it}}{K_{it}} = \alpha + \frac{1}{b} Q_{it} + \lambda_1 CF_{it} + \lambda_2 Lev_{it} + \lambda_3 \text{"DISR"} + \mu_i + \eta_t + \varepsilon_{it} \qquad (6)$$

However, with firm-level panel data of over 20 years, there is a likelihood that the time-varying error component (ε_{it}) is serially correlated (Mohn & Misund, 2009). According to Mohn and Misund (2009), it is assumed that the error term, ε_{it}, follows an AR (1) process of the form:

$$\varepsilon_{it} = \rho \varepsilon_{i,t-1} + \upsilon_{it}, \qquad (7).$$

Where υ_{it} represents white noise.

Taking to account these properties of the error term, and substituting equation (7) to equation (6), we obtain the following dynamic firm investment equation:

$$\frac{I_{it}}{K_{it}}=\alpha(1-\rho)+\rho(\frac{I_{i,1-t}}{K_{i,1-t}})+\frac{1}{b}Q_{it}-\frac{\rho}{b}Q_{i,1-t}+\lambda_1 CF_{it}-\rho\lambda_1 CF_{i,1-t}+\lambda_2 Lev_{it}-\rho\lambda_2 Lev_{i,1-t}+\lambda_3"DISR"_t-\rho\lambda_3"DISR"_{t-1}+(1-\rho)\,\mu_i+\eta_t-\rho\eta_{t-1}+\upsilon_{it} \quad (8)$$

For econometric estimation purposes, (Mohn and Misund (2009); Henriques and Sadorsky (2011); Alaali (2020)), equation (8) can conveniently be written as:

$$\frac{I_{it}}{K_{it}}=\pi_0+\pi_1(\frac{I_{i,t-1)}}{K_{i,t-1}})+\pi_2 Q_{it}+\pi_3 Q_{i,t-1}+\pi_4 cf_{it}+\pi_5 cf_{i,t-1}+\pi_6 Lev_{it}+\pi_7 Lev_{i,t-1}+\pi_8"DISR"_t+\pi_9"DISR"_{t-1} \quad (9)$$

Equation (9) was further augmented with stock market volatility induced by the combined oil price shocks (σ^{DISR}), stock market volatility induced by each individual oil shocks, (σ^{RET}), and their lags alternately to establish their respective effects on firm-level investment.

The time-invariant firm fixed effects (μ_i) can be expunged using various methods, one of them being differencing. Differencing is done by transforming the level equation to a change in the dependent variable through the application of first differencing, and as a result the variables which do not change over time, in this case, μ_i, cancels out (Chris, 2014). However, the challenge with differencing is that it magnifies gaps, especially in the unbalanced panel because some observations across the cross-section are lost (Roodman, 2009) hence worsening the measurement error bias. Since this study involves unbalanced panel data, then the first-differencing (difference GMM) was not applicable.

Roodman (2009) further notes that if the dependent variable exhibits a random walk characteristic, then first differencing will perform poorly because past levels are not predictive of future changes, and this takes us to the second transformation option considered which is "orthogonal deviations" as discussed by Arellano and Bover (1995), whereby instead of subtracting the previous observation from the current one, the mean of all future available observations are subtracted from the contemporaneous one, hence minimizing the data loss problem since it will compute variables for all observations except the last observation, and the resultant instruments are exogenous to fixed effects. In summary Arellano and Bover (1995) propose a GMM estimator that utilizes instruments in the first difference for equations in level in addition to using instruments in level for first differenced equations. This is in line with Roodman (2009) view that, if a variable has a random walk like characteristics, past variations may be more predictive of the current levels than past levels are predictive of the current changes, to justify the relevance of the new instruments. Therefore, this study employed the system Generalised Methods of Moments (GMM) estimator as derived by Arellano and Bover (1995) which Blundell and Bond (1998) also demonstrate to be an efficient and informative estimator, especially where the first difference GMM results to weaker instruments.

CHAPTER FOUR

4.0 RESULTS ANALYSIS AND DISCUSSION

This chapter focuses on the analysis and discussion of the results achieved after application of the methodology outlined in Chapter three. The study analyzed data for 127 local firms listed in JSE, divided into financial and non-financial firms. The financial firms included banks and insurance companies, while the non-financial firms included every other firm not in the category of financial institutions as defined by the researcher. Although the initial data were for a total of 311 firms, after screening and eliminating data as outlined in chapter three, the final data were composed of a total of 127 firms, out of which 15 were financial institutions with 229 firm-years and 112 non-financial institutions with 1338 firm-years, this was also after eliminating firm years with negative Tobin's Q or with Q values in excess of 10 following Almeida and Campello (2007).

4.1.0 Results

The data were analysed in two steps. The first step was to establish the effects of oil price shocks on stock returns, and the second step was to establish the consequential effect of the stock market volatility induced by the oil shocks on firm-level investments.

4.2.0 The effects of oil price shocks on stock returns

Table 1 shows the results of the ARMA(1,1) process for the log of VIX, whose residuals were extracted and adopted to proxy risk shocks. From the results, the intercept coefficient, the AR(1) and MA(1) coefficients are highly significant at 1% significance level. The inverted roots in both AR and MA parts are less than a unit, implying that the process is stationary. From the table, the adjusted R^2 is very high, meaning that 96.62% of variations in VIX can be explained by the model.

Table 1. Estimation results of ARMA(1,1) model

Variable	Coef.	Std. Error
C(Constant)	2.896263	0.064245***
AR(1)	0.985521	0.002278***
MA(1)	-0.080521	0.009658***
Adj. R^2	0.966243	
Log-likelihood	6671.402	
Inverted AR Roots	.985	
Inverted MA Roots	.080	

This table reports the ARMA(1,1) process of the log of VIX whose residuals were extracted to proxy risk shocks. Estimated using Eviews 11.

Table 2 reports summary statistics for the JSE stock returns, the oil producer index returns, oil price changes, innovations in VIX, emerging markets stock returns, domestic returns and the South Africa nominal effective exchange rate. The oil producer returns (d_t) exhibits higher volatility than the JSE stock return (R_t), which is in line with the observation made by Demirer et al. (2020), an indication of the unpredictability of the crude oil prices over the period under review. The supply shock (s_t) has the lowest level of volatility. The mean of the stock returns is positive, an indication of attractive and beneficial investment activity (Mokni, 2020). The return series (R_t, r_{em}, and r_{dom}) are all negatively skewed, implying that the markets have a greater likelihood of incurring losses than making profits. This observation ties in with Demirer et al. (2020) where upon considered data for 21 countries globally, observed that practically all returns were negatively skewed.

Table 2. Summary Statistics data for daily oil price shocks and the stock returns

	R_t	d_t	s_t	VIX_t	$r_{em,t}$	$r_{dom,t}$	$NEER_{SA,t}$
Mean	0.039	0.012	0.0001	-0.0003	0.023	0.023	-0.014
Std. Dev.	1.149	1.299	0.023	0.068	1.163	1.789	0.955
Skewness	-0.118	-0.433	-0.103	1.114	-0.484	-0.277	-0.327
Kurtosis	6.693	10.82	7.992	10.535	11.439	7.039	9.228
Jarque-Bera	2841.21***	12856.45***	5180.17***	12813.36***	14974.00***	3449.06***	8137.33***

This table reports the descriptive statistics of the disintegrated oil price shocks series and the JSE stock returns as well as the control variables. d_t denotes oil demand shocks proxied by oil producer returns, s_t denotes supply shocks proxied by changes in oil prices, VIXt is the innovation in VIX proxied by residuals extracted from ARMA(1,1) process in table 1, R_t is the JSE stock returns to proxy stock prices, $r_{em,t}$ is the emerging markets stock returns proxied by MSCI Emerging Markets stock index, $r_{dom,t}$ is the domestic stock returns proxied by MSCI SA stock Index and $NEER_{SA,t}$ is the South Africa Nominal Effective Exchange rate. Std. Dev which stands for standard deviation, skewness, Kurtosis and Jarque-Bera test for normality. *** indicates the results for normality is statistically significant from zero at 1 percent level, hence the null hypothesis of normality is rejected.

Table 3 reports the results of equation (1) regression with alternate variables. The value of R^2 in Model II to Model VI ranges from 0.76 to 0.77, meaning approximately 77% of the JSE stock movements can be explained by the included variables.

Table 3. Effect of disintegrated oil price shocks jointly on JSE stock returns

Panel A: Determinants of Stock Returns, dependent variable R_t

Regressors	Model I		Model II		Model III		Model IV		Model V		Model VI	
	Coef	Std. Error	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error
C(Constant)	0.031	0.013**	0.011	0.008	0.011	0.008	0.011	0.008	0.011	0.008	0.012	0.008
$r_{em,t}$			0.193	0.010***	0.131	0.011***	0.189	0.010***	0.171	0.010***	0.125	0.011***
$r_{dom,t}$			0.606	0.008***	0.585	0.008***	0.604	0.008***	0.604	0.008***	0.586	0.008***
$NEER_{SA,t}$			-0.68	0.011***	-0.68	0.010***	-0.68	0.011***	-0.68	0.011***	-0.68	0.010***
d_t	0.475	0.013***			0.118	0.008***					0.114	0.010***
s_t	-2.82	0.657***					1.122	0.360***			-1.033	0.386***
VIX_t	-0.95	0.229***							-1.14	0.126***	-0.564	0.133***

Panel B: Diagnostic tests

	Model I	Model II	Model III	Model IV	Model V	Model VI
Adj. R^2	0.290	0.762	0.772	0.762	0.766	0.773

Wald Chi-Square test

	Model I	Model II	Model III	Model IV	Model V	Model VI
Test 1	Null Hypothesis C(1)=0	Null Hypothesis C(1)=0	Null Hypothesis C(1)=0	Null Hypothesis C(1)=0	Null Hypothesis: C(1)=0	Null Hypothesis: C(1)=0
Chi-square	5.918310**	1.971305	2.183044	1.969561	2.030060	2.209236
Test 2	Null Hypothesis: C(2),C(3), C(4)=0	Null Hypothesis C(2),C(3), C(4)=0	Null Hypothesis C(2),C(3),C(4), C(5)=0	Null Hypothesis C(2),C(3),C(4), C(5)=0	Null Hypothesis: C(2),C(3),C(4), C(5)=0	Null Hypothesis: C(2),C(3),C(4),(5), C(6),C(7)=0
Chi-square	2299.848***	15938.21***	16807.16***	15975.89***	16281.24***	16917.33***

This table reports the coefficient estimates of equation (1), which includes the oil price demand shocks, d_t, oil price supply shocks, s_t, the innovation in VIX (risk shocks), VIX_t , the control variables Emerging markets stock index, $r_{em,t}$, domestic stock returns, $r_{dom,t}$ and SA nominal effective exchange rate, $NEER_{SA,t}$ and their p-values. *, **, *** statistically significant different from zero at 10%, 5%, and 1% levels respectively.

The coefficient for the constant in Model I is statistically significant, signifying a potential "omitted variables" problem. However, the coefficient of the constant is approximately the same in Models II to VI when control variables are included, and it is statistically insignificant. Model I records the coefficient of the three oil price shocks when regressed jointly but without the control variables. Notably, the value of R^2 is smaller compared to the value when the oil price shocks are regressed jointly with the control variables. The direction (sign) of the coefficients remain the same as when the three oil shocks are regressed jointly with the control variables in Model VI.

As indicated in Model I, the oil demand shocks are positively and significantly correlated with the stock returns. This finding is consistent with Kilian (2009), Kilian and Park (2009), Ready (2018) (for U.S stock returns) as well as Demirer et al. (2020) (for global financial returns), who all observed a positive relationship between oil price demand shock and the stock returns. This is an indication that oil prices, as driven by increased global economic activity have a positive effect on the JSE stock returns: a similar observation made by Gupta and Modise (2013). The results can be interpreted to mean that when the oil prices are driven upwards by increased global economic activity, the market interprets this as good news, resulting in high expectations for better dividends, consequently raising demand for stocks and hence driving their prices high.

The supply shocks have a negative and statistically significant effect on the stock returns as implied by the negative and significant supply shock coefficient in model I. This is in line with Gupta and Modise (2013), Ready (2018) and Demirer et.al (2020) findings who also observed the negative correlation between oil supply shocks and the stock market returns. This finding was not unexpected given that South Africa is a net oil importing country. Oil price increases due to supply disruptions are associated with high costs of production which is likely to affect firm profitability and hence lowering future cash flow expectations. This dampens the spirit of market participants, reducing demand for stocks which results in lower stock prices. This can also be interpreted in line with the Hamilton (2003) argument that oil price shocks effects are felt more through reduced consumer expenditure as opposed to an increase in the cost of production. When consumption is low, it follows that the firm sales will also go down, lowering profitability and eventually the expected cash flow. As noted in the DDM model, when the expected future cash flows (dividends) are low, then the share price will go down.

However, contrary to our finding of the negative effects of oil supply shocks on stock returns, Degiannakis, Filis, and Kizys (2014) examines European data to establish the effect of oil price shocks on stock market volatility and observe that oil supply shocks exert no significant effect on the stock market volatility. This is similar to the findings by Kilian and Park (2009) observation that oil supply shocks are insignificant in explaining changes in U.S stock prices in comparison to aggregate demand shocks or precautionary demand shocks.

Innovations in VIX, which is a proxy for risk shocks or discount rate (impacted through risk premium which needs to be rewarded), is negatively and significantly correlated with stock returns, which is in line with findings by Ready (2018), Thorbecke (2019) and Demirer et al.

(2020). When the oil prices go up, they tend to put inflationary pressure on the economy, which results in interest rate adjustments by governments. This interest rate adjustment leads to an increase in the discount rate, which is a key factor in determining the intrinsic value of a share. As per the DDM, when the discount rates go up, the value of the stock goes down, which explains the negative relationship between the risk shocks and the JSE stock returns. This view is also supported by Thorbecke (2019) argument that the stocks which benefit from high oil prices will "pay a discount to its *ex-ante* expected return" (p.12).

Model II reports coefficients of the control variables without any shock, which are all statistically significant. The domestic stock returns and the emerging market stock returns are positively correlated with the JSE stock returns. This is in line with Demirer et al. (2020) observation of a positive correlation between returns of 21 countries across the globe and the world market returns. This positive correlation between JSE stock returns and the emerging markets returns is a reflection of the shared economic fundamentals responsible for the movement of the cross-sections of equity returns in these markets or the herding behaviour in the stock markets as also observed by Sadorsky (2014).

The South Africa Nominal effective exchange rate is negatively correlated with the JSE stock returns, to mean a rise in the NEER, which translates to an appreciation of the South African Rand, leads to a drop in JSE stock prices, on the other hand a fall in NEER, which translates to a depreciation of the South African Rand, leads to a rise in JSE stock prices. This is in line with Hsing (2011) who also observed a negative relationship between the SA nominal effective exchange rate and the South African Stock market index. During the period under review, the NEER was falling, meaning the South African Rand was depreciating, and the South African Stock Market index was rising. Approximately, close to 50% of the JSE market value is constituted by mining and resource companies which tend to gain in value both in Rands and in U.S dollar when the Rand depreciates (Barr, Kantor, & Holdsworth, 2007). Barr et al. (2007) further argues that, this happens because the said companies, especially the mining companies, are labour intensive, which is priced in Rands, but much of their revenue is in U.S dollars earned from their offshore customers. This is to mean, when the Rand depreciates, their costs (which are mostly labour related), will fall, as their revenue goes up, hence improvement in their profit margins, consequently raising their returns.

When the oil price demand shock, d_t, is added to the control variables in Model III, there is negligible change in the coefficients of the control variables. The results in Model III also indicate that oil demand shock is positively and significantly correlated with the JSE stock returns, similar to the results observed when the demand shock is regressed with the other oil price shocks.

When the supply shocks are introduced in Model IV and regressed jointly with the control variables, there is still negligible change in the value of the coefficients of the control variables, likewise, the direction of the coefficients does not change. However, the coefficient of the supply shock is positive and significant, unlike when it is regressed with other oil shocks. Although increases in oil prices due to disruption in supply is associated with high costs of production which is likely to affect firm profitability, the positive response by the stock returns could be associated with increased hedging activity by the market participants, resulting in positive stock returns. According to Kilian and Park (2009), investors tend to shift their demand to precious metals such as gold and silver during times of political turmoil. It therefore, follows that, when the oil price increases results from oil supply disruptions occasioned by political turmoil, the share prices for companies producing such metals will go up, as the investors shift their investments to such metals or hedge their open positions using precious metals. The JSE stock market is dominated by mining companies and this could explain the positive correlation between oil price supply shocks and the stock returns. This observation is also supported by Thorbecke (2019) argument that companies in the mining industry tend to benefit during periods of higher oil prices. This is because high oil prices put inflationary pressure in the economy and gold mining stocks act as a good hedge against inflation.

However, these results contradict Ready (2018) finding whereby the univariate regression of the supply shocks against various industry returns yielded a negative correlation between supply shocks and the stock returns. Such variations could probably be explained by the choice of the variables proxying the supply shocks; Ready (2018) adopted the first nearest maturity NYMEX crude-light sweet oil futures contract to proxy supply shocks whereas this research adopted changes in the price of crude oil to proxy supply shocks.

Model V records the results of the risk shocks and the control variables, and again no much change on the coefficients of the control variables. The risk shocks are negatively and significantly correlated with the JSE stock returns, just as the case when they are regressed jointly with other oil shocks. Model VI reports the coefficients of all the regressors regressed jointly, that is all the oil shocks and the control variables. The direction of the coefficients of the control variables does not change, but the value for the emerging markets stock returns is at its lowest compared to other models when all the three oil shocks are introduced. All the three shocks have their coefficient signs similar to Model I, when regressed jointly without the control variables.

4.3.0 Investment Estimation Model

The second step of our analysis is to establish the effect of the stock market volatility induced by the disintegrated oil price shocks on the firm-level investment in South Africa. We begin by first computing the stock market volatility as defined in Chapter 3, which will be measured as the annualised conditional standard deviation of the component of the stock returns explained by the oil shocks, termed as the disruption ("DISR") variable. To compute the said volatility, we first compute the daily conditional variance, σ^2, from the GARCH (1,1) of the "DISR" variable, then compute its square root as per equation (3). The conditional standard deviation will then be plugged into equation (9) to establish its effect on firm-level investments.

Table 4. Estimation results for GARCH(1,1) model for the disruption terms

Variance equation for	DISR		DISRdt		DISRst		DISRvix	
	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error	Coef.	Std. Error
C (Constant)	0.004	0.001***	0.003	0.001***	0.0002	0.00008***	0.009	0.001***
RESID(-1)^2	0.077	0.007***	0.072	0.007***	0.044	0.005***	0.130	0.015***
GARCH(-1)	0.912	0.008***	0.919	0.008***	0.952	0.005***	0.804	0.020***
Log likelihood	-4039.691		-3958.583		970.7850		-1300.147	

This table reports the estimation results of equation (2) which estimates the variance of the "DISR" terms through the GARCH(1,1) process. "DISR" is the short word for "disruption", representing the component of stock returns explained by the three oil shocks jointly, coined to mean stock market disruptions induced by the oil shocks. "DISRdt, "DISRst" and "DISRvix" denote disruptions induced by the demand shock, supply shock and risk shock individually respectively. Statistically significant different from zero at: *10%, **5%, and ***1% levels respectively.

Table 4 shows the results of the GARCH (1,1) model for the "DISR" term as well as for the individual shocks disruptions terms derived from the univariate regression of the individual shocks on the stock returns without the control variables; "DISRdt" (demand shock), "DISRst" (Supply shock) and "DISRvix (Risk shocks) respectively. The coefficients of the lagged squared residual and the lagged conditional variance terms in the variance equation are both statistically significant in all the four variables. Secondly, as a typical characteristic of the GARCH model estimations for financial asset returns, the sum of the coefficients of the lagged squared residual and the lagged conditional variance is close to unity (-approximately 0.99, 0.99, 0.99 & 0.93 respectively), implying persistence of shocks to the conditional variance (Chris, 2014).

Table 5 reports the ARCH-LM test results for the disruption terms variance equations, whereby the null hypothesis of no ARCH is not rejected in all the four panels, meaning the residuals do not suffer from this particular form of heteroscedasticity.

Table 5. ARCH-LM test for heteroscedasticity for Disruption terms GARCH (1,1) process

ARCH-LM tests for	DISR	DISRdt	DISRst	DISRvix
Prob. Chi-Square(4)	0.1830	0.2185	0.4949	0.9597
Log likelihood	-10192.16	-10076.66	-11513.45	-12609.61
Durbin-Watson stat	2.000055	1.999975	1.999945	1.999763

The number on parenthesis (4) represents the number of lags used when running the ARCH-LM test.

Table 6 reports the results of Unit root tests for the conditional variance for the four GARCH (1,1) processes, confirming the absence of unit root in the four "DISR" variables.

Table 6. Unit root test for disruption terms GARCH (1,1) Variance

	ADF - Test	
Variable	Intercept	Constant & Trend
DISR	-4.660781***	-4.671030***
DISRdt	-7.726468***	-7.757900***
DISRst	-4.165832***	-4.203398***
DISRvix	-17.24665***	-17.70417***

ADF is the Augmented Dickey-Fuller test for stationarity applied at level with 12 lags, and the null of non-stationarity is rejected at 1% confidence level. *** statistically significant different from zero at 1% level.

Figures 2,*3*,*4*, and *5* show the annualised conditional standard deviation of disruption term of the joint oil shocks ($\boldsymbol{\sigma^{DISR}}$) as well as the individual shocks, predicted by subjecting the respective disruption terms to GARCH(1,1) process. The figures display different levels of volatility across the period under review. From the graph, it is clear that the highest volatility was experienced over the period 2007 to 2009, which coincides with the period of the global financial crisis. It is also observable that the volatility induced by the oil demand shocks is much higher than that induced by the oil supply shocks and the risk shocks for the sample period. This matches with the results in *Table* 2, where the standard deviation of the demand shock was noted to be higher than for the other two shocks. The demand shock-induced volatility (*Figure* 3) is equal in magnitude to the volatility noted in *Figure* 2, which is the stock market volatility induced by the three shocks when regressed on the stock returns jointly. This is an indication that much of the stock market volatility induced by the oil shocks over the period under review is predominantly attributable to demand shocks.

***Figure 2*. Conditional Standard Deviation (σ^{DISR}) attributable to the oil shocks jointly**

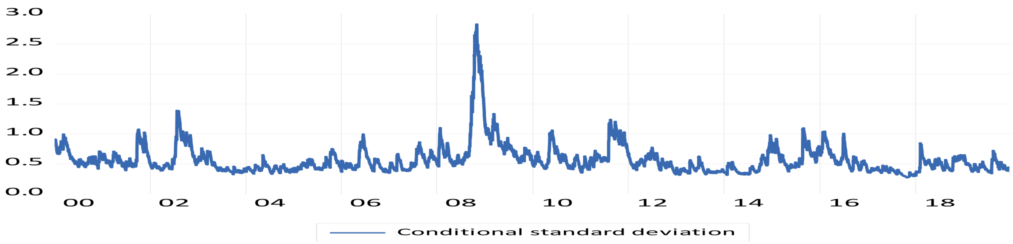


Figure 3. Conditional Standard Deviation (σ^{DISRdt}) attributable to demand shock

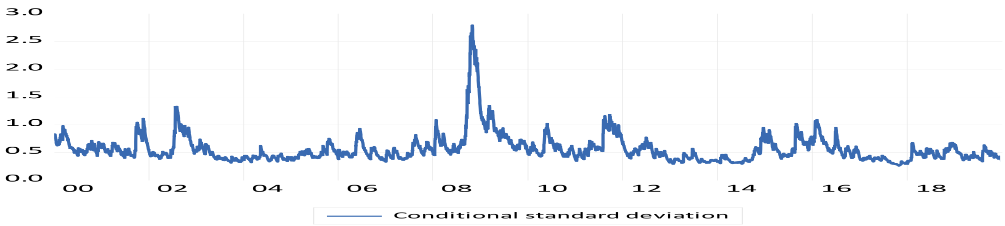


***Figure 4*. Conditional Standard Deviation (σ^{DISRst}) attributable to Supply Shock**

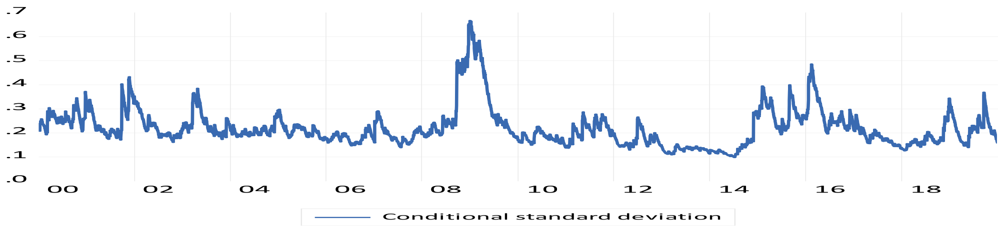
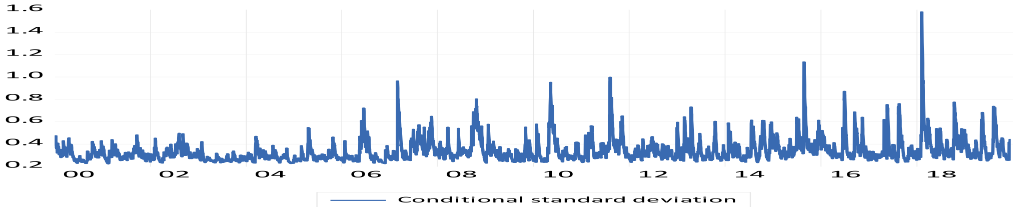


***Figure 5.* Conditional Standard Deviation ($\sigma^{DISRvix}$) attributable to risk Shocks**



The four figures plot the annualised conditional standard deviation of the disruption terms "DISR" (joint shocks), "DISRdt" (demand shocks), "DISRst" (supply shocks) and "DISRvix" (risk shocks) respectively, as estimated using equation (3).

This observation is supported by Kilian (2009) argument that historical oil price shocks have been caused mostly by demand due to increased economic activity as well as precautionary demand but not so much by oil supply shocks, as well as Baumeister and Kilian (2016) argument that pre-2008 oil price increases resulted from gradual increases in demand associated with the global economy mostly due to high demand for oil from emerging economies. In support of demand-driven oil prices post the financial crisis is the advent of the shale revolution which led to an increase in oil production, consequently more spending by oil producers, which triggered more capital spending by non-oil producers (Thorbecke, 2019).

Table 7. Unit Root Test for Investment estimation model variables (Panel data)

TEST	Levin, Lin & Chu t*		Breitung-t-stat		Im, Pesaran and Shin W-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
Individual Intercept and Trend										
	stats	**p-value**	stats	**p-value**	stats	**p-value**	stats	**p-value**	stats	**p-value**
(I/K)	-7.61	**0.000**	-5.04	**0.000**	-7.20	**0.000**	376.74	**0.000**	652.08	**0.000**
Tobin's Q	-4.55	0.000	-1.01	0.157	-4.33	0.000	302.30	0.000	441.61	0.000
(CF/K)	-2.24	0.000	-4.76	0.000	-7.61	0.000	411.04	0.000	698.49	0.000
(Lev)	-8.56	0.000	0.24	0.000	-2.32	0.000	259.39	0.000	415.04	0.000
"DISR"	-3.13	0.000	-28.76	0.000	-13.58	0.000	595.27	0.000	1022.47	0.000
(σ^{DISR})	-20.15	0.000	-24.94	0.000	-5.04	0.000	317.94	0.004	400.79	0.000

This table reports the unit root test results for the investment estimation model panel data variables. All the tests were carried out at level. "DISR" denotes stock market disruption induced by the oil shocks jointly, (σ^{DISR}) represents stock market volatility caused by the three oil price shocks jointly, predicted by subjecting "DISR" term to GARCH(1,1) process.

Kilian and Park (2009) argue that if a particular oil shock is more prevalent over the others over a given sample period, such a shock will have a higher influence on the average responses to oil price changes estimated over that period, which explains high levels of stock market volatility induced by the demand shocks compared to the volatility induced by the other two oil price shocks. The volatility induced by the supply shocks individually (*Figure* 4) is also lower in magnitude than the volatility induced by the risk shocks (*Figure* 5), which is also in line with the standard deviations of the two shocks in *Table* 2.

Table 7 reports the Unit root test for the investment model panel data variables under the individual intercept and trend. The Breitung test for Tobin's Q variable is not statistically significant, but the other four tests are statistically significant. Going by the majority rule, we reject the null hypothesis of the presence of unit root in all the variables under consideration.

Table 8. Descriptive statistics data for investment estimation model variables

Panel A: Financial Institutions

	(I/K)	Tobin's Q	(CF/K)	(Lev)	("DISR")	(σ^{DISR})
Mean	0.023804	1.551072	0.034889	0.085525	0.036323	0.564893
Median	0.008554	1.194418	0.018597	0.040270	0.045274	0.523178
Maximum	0.808597	4.324980	0.458624	0.689748	0.077812	1.034527
Minimum	-0.718969	0.372282	-0.484291	0.000000	-0.071414	0.364296
Std. Dev.	0.103490	0.682916	0.083785	0.141326	0.036614	0.159781
Total Observations	229	229	229	229	229	229

Panel B: Non-Financial Institutions

	(I/K)	Tobin's Q	(CF/K)	(Lev)	("DISR")	(σ^{DISR})
Mean	0.050670	1.875118	0.068600	0.158226	0.036017	0.559199
Median	0.038264	1.602409	0.061318	0.123719	0.045274	0.515412
Maximum	0.574167	9.301807	0.548044	0.988195	0.077812	1.034527
Minimum	-0.154000	0.012146	-0.641444	0.000000	-0.071414	0.364296
Std. Dev.	0.052721	1.046540	0.091475	0.140783	0.035413	0.156149
Total Observations	1338	1338	1338	1338	1338	1338

Panel C: Combined Financial and non-Financial Institutions

	(I/K)	Tobin's Q	(CF/K)	(Lev)	("DISR")	(σ^{DISR})
Mean	0.046744	1.827762	0.063674	0.147602	0.036061	0.560031
Median	0.033678	1.557293	0.054610	0.109356	0.045274	0.515412
Maximum	0.808597	9.301807	0.548044	0.988195	0.077812	1.034527
Minimum	-0.718969	0.012146	-0.641444	0.000000	-0.071414	0.364296
Std. Dev.	0.063423	1.008017	0.091148	0.143141	0.035580	0.156647
Total Observations	1567	1567	1567	1567	1567	1567

(I/K) = ratio of capital expenditure (Investment Proxy) to total assets, Tobin's Q= Market value of the firm to book value of assets ratio, (CF/K)= ratio of cash flow to total assets, (Lev)= ratio of total debt to total assets, "DISR"=Explained component of stock returns by oil price shocks, and (σ^{DISR}) =stock market volatility induced by the oil price shocks.

Table 8 presents a summary of descriptive statistics for the variables employed in the investment estimation model. From the data it is notable that, on average, the non-financial firms have an investment rate of 5.06%, which is significantly higher than the financial firms investment rate of 2.38%. This finding ties in with Alaali's (2020) observation on U.K firms where he noted that the non-financial firms' investment rate was on average 5.6%, which was higher than that of financial firms which was 3.4%.

Non-financial firms also exhibit high levels of internal liquidity, as indicated by cash flow mean of 6.86% compared to 3.49% for financial firms. In terms of leverage, in both types of institutions, we find firms with nil leverage, while others are highly levered, like the case for non-financial institutions where the highest has 98% leverage. On average, the non-financial institutions are noted to have higher values of Tobin's Q than the financial institutions. The combined descriptive statistics data in panel C records the descriptive statistics of combined financial and non-financial data. The means are the average of the two types of institutions.

4.4.0. Effects of stock price volatility induced by oil price shocks on firm-level investments

The firm data was divided into financial institutions and non-financial institutions for analysis purposes. However, the financial data did not meet one of the GMM specifications which require that the number of cross-sections/groups (*N*) should be greater than the time span (*T*). In our study, the financial data had 15 cross-sections (*N*) which is less than the time period of study (*T*) which is 20 years. Therefore, the study estimated the investment model for the non-financial institutions as well as combined data of both non-financial institutions and financial institutions, and no separate estimation was carried out for financial institutions.

4.4.1. Effects of stock price volatility induced by oil price shocks on non-financial firm-level investments

To estimate the investment model, different specifications were incorporated, which included the lagged value of the ratio of investment to total assets, the current and lagged value of Tobin's Q-ratio, the current and lagged value of the cash flow to total assets ratio as well as the current and the lagged values of debt to total assets ratio. Each model estimates the effect of stock price volatility induced by oil price shocks on firm level-investment with different specifications.

The diagnostic tests were also carried out to establish the validity of the model. In all the models, the p-values for j-statistics are greater than 0.05, hence validating the choice of instruments employed. Arellano and Bond autocorrelation test was also carried out, with the results showing the presence of first-order autocorrelation (AR(1)) in the differenced equation residuals, as the case should be, and absence of second-order autocorrelation (AR(2)). This validates the system-GMM results displayed by the various models. Test of specification to confirm non-existence of the instrument proliferation problem, which requires that the number of instruments should be less than or equal to the number of cross-sections as pointed by Roodman (2009), also indicated compliance. Wald Chi-Square test which indicates how close the estimates come to satisfying the restrictions on the null hypothesis was also carried out. In the first-differenced equation, the study employed a set of instruments with a lag length of up to 6 lags.

Table 9 reports the relationship between stock price volatility induced by oil price shocks on firm-level investment in non-financial firms. From the results, the lagged investment to total assets ratio (*I/Ki,t-1*) has a positive and statistically significant relationship with the contemporaneous investment across the three Models. This ties in with Lee et al. (2010) and Alaali (2020) observation of a positive relationship between the current investment ratio and its lagged values. The Q-ratio is also significant at 5% significance level in Model I & II and at 10% significance level in Model III, while the lag of Q-ratio is statistically significant in all the three Models. Although the Q values and their lags are significant, the coefficients are noted to be very small, almost negligible, an indication that the Q-ratio, though significant in explaining investment, does not have an appreciable economic influence on investments.

The coefficient of leverage in Model II & III is positive and significant, an indication of the positive contribution loans have on firm-level investment. But the coefficients of its lagged values are insignificant. The coefficient of the cash flow ratio and its lag are also positive and statistically significant in Model II & III, an indication of the positive contribution of firm liquidity to investments. This observation is in line with Baum et al. (2010) observation on the significance of cash flow and debt ratio in explaining the behaviour of firm investment. This implies that firm's with access to loans and those with sufficient cash flows are more likely to invest more than those which lack access to loans or with insufficient cash flow.

The coefficient of the contemporaneous stock price volatility induced by the oil price shocks, (σ^{DISR}), is positive and statistically significant in all the three Models, while the coefficient of its lagged value is negative and statistically significant in Model I, but positive after introducing cash flow and leverage in Model II & III. The coefficient of the contemporaneous stock price volatility is slightly lower when cash flow and leverage is introduced in Model II, but remains positive and statistically significant.

Table 9. The Impact of stock price volatility induced by the joint oil price shocks on non-financial firm-level Investments

Panel A: Determinants of investment, dependent variable $(I/K)_{it}$

Regressors	Model I			Model II			Model III		
	Coef.	t-Statistic	*p*-value	Coef.	t-Statistic	*p*-value	Coef.	t-Stats	*p*-alue
$(I/K)_{i,t-1}$	0.461	7121.98	0.000	0.354	134.47	0.0000	0.371	67.92	0.000
(Q)it	0.009	4691.44	0.000	0.001	3.96	0.000	0.001	1.88	0.060
$(Q)_{i,t-1}$	0.001	539.75	0.000	0.003	19.19	0.000	0.002	5.38	0.000
$(CF/K)_{it}$				0.111	28.39	0.000	0.114	19.20	0.000
$(CF/K)_{i,t-1}$				0.009	4.68	0.000	0.013	4.60	0.000
$(Lev)_{it}$				0.020	4.81	0.000	0.010	2.76	0.006
$(Lev)_{i,t-1}$				-0.001	-0.48	0.633	0.002	0.47	0.640
$(DISR)_{t}$							-0.011	-1.36	0.176
$(DISR)_{t-1}$							-0.035	-3.32	0.001
$(\sigma^{DISR})_{t}$	0.022	3927.94	0.0000	0.021	43.60	0.000	0.018	6.44	0.000
$(\sigma^{DISR})_{t-1}$	-0.0001	-21.88	0.000	0.017	63.92	0.000	0.014	19.07	0.000

Panel B: Diagnostic tests

	Model I		Model II		Model III	
J-Test	87.53	0.433	71.38	0.431	68.57	0.46
AR(2)	-0.041	0.2855	-0.071	0.407	-0.071	0.12
Root MSE	0.028		0.027		0.027	
Test of Specification						
Cross-sections	93		79		79	
Instrument Rank	91		79		79	

Wald Chi-Square test

	Model I		Model II		Model III	
Test 1	Null Hypothesis: C(1),C(2),C(3),C(4),C(5)=0		Null Hypothesis: C(1),C(2),C(3),C(4),C(5), C(6),C(8),C(9)=0		Null Hypothesis: C(1),C(2),C(3),C(4),C(5), C(6),C(9),C(10),C(11)=0	
Chi-square	2.46E+09	0.0000	181094.5	0.0000	76150.89	0.0000
Test 2	Null Hypothesis: C(4)=1		Null Hypothesis: C(7)=0		Null Hypothesis: C(7),C(8)=0	
Chi-square	3.12E+10	0.000	0.228336	0.6329	1.843353	0.3979

This table reports the coefficient estimates of equation (9) with alternate specifications. J-test is Hansen (1982) test of the suitability of the model, which is distributed as X^2 with degrees of freedom equal to the overidentifying restrictions (L-K), (Baum, Schaffer, & Stillman, 2003), failure to reject the null hypothesis supports the choice of instruments. AR (2) is the Arellano and Bond (1991) test for serial correlation of the error term, under the null differenced error term is first and second-order serially correlated. Root mean square error (RMSE) is a measure of the suitability of the model in predicting the data, the smaller the RMSE, the higher the accuracy of prediction. Test of specification is confirmation of non-existence of the instrument proliferation problem since the number of instruments should be less than or equal to the number of cross-sections as pointed by Roodman (2009). Wald Chi-Square Test how close the estimates come to satisfying the restrictions on the null hypothesis.

As noted earlier in *Figure 2* and *Figure 3*, the volatility induced by the oil demand shock, individually, for the period under review is equal in magnitude to the overall volatility induced by the component of stock returns explained by the three disintegrated shocks when regressed jointly, with a conclusion that the major contributor of oil price shocks for the period under review was the demand shocks, which was more responsible for the bigger portion of the stock price volatility component associated with oil price movements. As discussed earlier in the previous chapters, the demand shocks result from increased economic activity, which signifies positive economic growth. This in return raises expectations in the market, causing a rise in demand for stocks, consequently pushing the stock prices high. The high stock price raises the value of the firm, signalling the firm managers to raise funds from the stock market for investment purposes. This explains the positive correlation between the stock market volatility induced by oil shocks and firm-level investment over the sample period.

4.4.2 Effects of stock price volatility induced by combined oil price shocks on combined financial and non-financial firm-level investments.

Table 10 reports the relationship between stock price volatility induced by oil price shocks on both financial and non-financial firms' investments. It is notable that, the coefficient of the lagged value of investment drops when data is combined (financial and non-financial), compared to the coefficient for non-financial data only. The impact is also higher in Model I before cash flow and leverage are introduced in the Model, and the smallest in Model III after introducing the disruption term. This can be explained by the observation made on *Table 8* where the non-financial firms were noted to have a higher investment rate than the financial firms. Therefore, when the financial firms' data is added to the regression, the average coefficient of the lagged investment variable drops, as compared to the value for the non-financial firms only.

The coefficient of Q values is positive and statistically significant in Model I while in Model II and III are negative and equal in value. Similarly, the coefficients of lagged values of Q are positive and equal in Model II and III, and are also similar to the coefficient of the contemporaneous Q values in absolute values. The coefficient of cash flow remain positive and statistically significant in Model II and III, so is the leverage coefficient.

Table 10. The effect of stock price volatility induced by combined oil price shocks on combined financial and non-financial firm-level Investments

Panel A: Determinants of investment, dependent variable $(I/K)_{it}$

Regressors	Model I			Model II			Model III		
	Coef.	t-statistic	*p*-value	Coef.	t-statistic	*p*-value	Coef.	t-statistic	*p*-value
$(I/K)_{i,t-1}$	0.364	4188.42	0.000	0.235	15.43	0.000	0.205	7.58	0.00
$(Q)_{it}$	0.014	1353.93	0.000	-0.029	-14.43	0.000	-0.029	-7.24	0.00
$(Q)_{i,t-1}$	-0.008	-462.07	0.000	0.028	16.04	0.000	0.029	8.51	0.00
$(CF/K)_{it}$				0.877	28.69	0.000	0.851	20.99	0.00
$(CF/K)_{i,t-1}$				-0.391	-21.23	0.000	-0.355	-11.23	0.00
$(Lev)_{it}$				0.132	7.02	0.000	0.146	5.65	0.00
$(Lev)_{i,t-1}$				-0.114	-5.25	0.000	-0.125	-3.97	0.00
$(DISR)_{t}$							0.108	4.51	0.00
$(DISR)_{t-1}$							0.060	1.88	0.06
$(\sigma^{DISR})_{t}$	0.023	1385.78	**0.000**	0.005	2.55	0.011	0.019	3.16	**0.00**
$(\sigma^{DISR})_{t-1}$	0.006	290.88	0.000	0.023	6.02	0.000	0.008	1.71	0.09
Panel B: Diagnostic tests									
J-Test	102.5		0.44	67.72		**0.62**	64.17		0.73
AR(2)	-0.810		0.42	-0.147		0.70	-0.159		0.60
Root MSE		0.048			0.059			0.058	
Test of Specification									
Cross-sections		108			89			89	
Instruments Rank		106			81			83	
Wald Chi-Square test									
Test 1	Null Hypothesis: C(1),C(2),C(3),C(4),C(5)=0			Null Hypothesis: C(1),C(2),C(3),C(4),C(5), C(6),C(7),C(8),C(9)=0			Null Hypothesis: C(1),C(2),C(3),C(4)C(5) C(6),C(7),C(8),(9),(10), C(11)=0		
Chi-square	19318294		0.0000	3782.119		0.0000	1872.025		0.000

This table reports the coefficient estimates of equation (9) with alternate specifications, including variables for combined firms' panel data and the stock market volatility induced by the three oil price shocks jointly. J-test is Hansen (1982) test of the suitability of the model, which is distributed as X^2 with degrees of freedom equal to the overidentifying restrictions (L-K), (Baum et.al,2003), failure to reject the null hypothesis supports the choice of instruments. AR(2) is the Arellano and Bond(1991) test for serial correlation of the error term, under the null differenced error term is first and second-order serially correlated. Root mean square error (RMSE) is a measure of the suitability of the model in predicting the data, the smaller the RMSE, the higher the accuracy of prediction. Test of specification is confirmation of non-existence of instruments proliferation problem since the number of instruments should be less than or equal to the number of cross-sections as pointed by Roodman(2009). Wald Chi-Square test how close the estimates come to satisfying the restrictions on the null hypothesis.

The coefficients of stock price volatility and its lag values are positive and statistically significant across all the three Models, which can be interpreted to mean the existence of real option value for investment decisions for firm managers (Baum et al., 2008). This observation ties in with Alaali (2020) findings where he noted a positive correlation between contemporaneous stock price volatility and firm-level investments, although there is a contradiction on the relationship between the lagged value of stock price volatility and firm-level investment, in his case the coefficient was negative. This difference can be explained by the force behind the stock market volatility, whereby in his case the source of stock market volatility was not established.

The second-moment impact of the oil price shocks on firm-level investment through the stock market also ties in with the observation made by Lee et al. (2010) who examined effects of oil price shocks on firm-level investment through their interaction with the stock price volatility and noted that indeed oil price shocks affect firm-level investment through their influence on the firm's stock price volatility. However, their observation suggests a negative relationship between the stock price volatility induced by oil price shocks on firm-level investment. The difference in the direction of effect can be explained by the sample period under review, whereby Lee et al. (2010) study period covers 1962 – 2006, whereas this study covers 2000 – 2019, to imply the forces behind the oil price movements in each period could have been different, leading to different effects on firm-level investment.

This assertion is supported by Thorbecke (2019) observation that both demand-driven and supply-driven increases in oil prices pre- shale revolution period (study period 1990 – 2007) had a negative effect on aggregate stock returns, whereas the two shocks had a positive effect on aggregate stock returns post shale revolution (study period 2010-2018). Much of the study period for this research lies post shale revolution, which can further explain the positive relationship between stock market volatility induced by oil price shocks and firm-level investment.

4.4.3 Effects of stock price volatility induced by individual oil shocks on Combined financial and non-financial firms' investments.

Table 11 reports the impact of stock price volatility induced by individual oil shocks on firm-level investment as well as the impact of the volatility induced by the disintegrated oil shocks jointly. As per the previous results, the effect of lagged investment variable remains positive and significant across the five Models. Stock price volatility induced by oil demand shock in Model I has a positive and statistically significant effect on firm-level investment. It is also notable that the coefficients of the lagged investment variable, Q and its lagged value, cash flow and its lagged value as well as leverage and its lagged value in Model I, which reports the impact of stock price volatility induced by the oil demand shock, is similar to the results in Model V, which reports the impact of the stock price volatility induced by the three shocks jointly.

Table 11. The effect of stock price volatility induced by individual oil price shocks on firm-level Investments (Combined Financial and Non-Financial firms)

Panel A: Determinants of investment, dependent variable $(I/K)_{it}$

	Model I		Model II		Model III		Model IV		Model V	
Regressors	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
$(I/K)_{i,t-1}$	0.233	(0.015)***	0.232	(0.017)***	0.226	(0.019)***	0.209	(0.022)***	0.235	(0.015)***
(Q)it	-0.029	(0.002)***	-0.032	(0.002)***	-0.036	(0.002)***	-0.043	(0.005)***	-0.029	(0.002)***
$(Q)_{i,t-1}$	0.028	(0.002)***	0.031	(0.002)***	0.030	(0.002)***	0.032	(0.003)***	0.028	(0.002)***
$(CF/K)_{it}$	0.876	(0.029)***	0.897	(0.024)***	0.909	(0.030)***	0.862	(0.033)***	0.877	(0.0306)***
$(CF/K)_{i,t-1}$	-0.393	(0.018)***	-0.383	(0.027)***	-0.343	(0.024)***	-0.338	(0.033)***	-0.391	(0.018)***
$(Lev)_{it}$	0.132	(0.019)***	0.117	(0.017)***	0.130	(0.017)***	0.164	(0.019)***	0.132	(0.019)***
$(Lev)_{i,t-1}$	-0.116	(0.021)***	-0.136	(0.013)***	-0.118	(0.019)***	-0.122	(0.026)***	-0.114	(0.022)***
$(\sigma^{DISRdt})_t$	0.006	(0.002)***					0.070	(0.011)***		
$(\sigma^{DISR}dt)_{t-1}$	0.021	(0.004)***					-0.080	(0.019)***		
$(\sigma^{DISRst})_t$			0.003	(0.005)			-0.006	(0.020)		
$(\sigma^{DISR}st)_{t-1}$			0.031	(0.007)***			0.078	(0.024)***		
$(\sigma^{DISRvix})_t$					-0.068	(0.013)***	-0.374	(0.058)***		
$(\sigma^{DISR}vix)_{t-1}$					-0.048	(0.013)***	-0.107	(0.018)***		
$(\sigma^{DISR})_t$									0.005	(0.002)**
$(\sigma^{DISR})_{t-1}$									0.023	(0.004)***
Panel B: Diagnostic tests										
Tests	Stat	Prob.	Stat	Prob.	Stat	Prob.	Stat	Prob.	Stat	Prob.
J-Stat.	67.67	0.62	65.87	0.68	68.91	0.58	69.32	0.57	67.72	0.62
AR(2)	-0.147	0.69	-0.161	0.64	-0.194	0.60	-0.241	0.64	-0.147	0.69
Root MSE	0.059		0.059		0.059		0.059		0.059	
Test of Specification										
Cross-	89		89		89		89		89	
Instrument	81		81		81		85		81	
Wald Chi-Square test										
Test 1	Null Hypothesis: C(1),C(2),C(3), C(4),C(5),C(6), C(7),C(8), C(9)=0		Null Hypothesis: C(1),C(2), C(3), C(4),C(5), C(6), C(7),C(9),		Null Hypothesis: C(1),C(2), C(3),C(4) C(5),C(6), C(7),C(8), C(9)=0		Null Hypothesis: C(1),C(2),C(3) C(4),C(5),C(6) C(7),C(8),C(9), C(11),C(12), C(13)=0		Null Hypothesis: C(1),C(2),C(3), C(4),C(5),C(6), C(7),C(8) C(9)=0	
Chi-square	3918.69	0.000	3860.39	0.000	2681.71	0.000	4223.83	0.000	3782.12	0.000
Test 2	Null Hyp: C(8)=1		Null Hyp: C(8)=0		Null Hyp: C(8)=1		Null Hyp: C(10)=0		Null Hyp: C(8)=1	
Chi-square	319300.6	0.000	0.31	0.579	6502.178	0.000	0.085	0.7710	277746.1	0.000

This table reports the coefficient estimates of equation (9) with alternate specifications, including variables for all firms adopted in the study, the stock market volatility induced by the three oil price shocks jointly as well as volatility induced by individual shocks. *,**,*** statistically significant different from zero at 10%, 5%, and 1% levels respectively. J-test is Hansen (1982) test of the suitability of the model, which is distributed as X^2 with degrees of freedom equal to the overidentifying restrictions (L-K), (Baum et.al,2003), failure to reject the null hypothesis supports the choice of instruments. AR (2) is the Arellano and Bond (1991) test for serial correlation of the error term, under the null differenced error term is first and second-order serially correlated. Root mean square error (RMSE) is a measure of the suitability of the model in predicting the data, the smaller the RMSE, the higher the accuracy of prediction. Test of specification is confirmation of non-existence of instruments proliferation problem since the number of instruments should be less than or equal to the number of cross-sections as pointed by Roodman (2009). Wald Chi-Square test how close the estimates come to satisfying the restrictions on the null hypothesis. Coef is coefficient estimate; SE is standard error; Hyp stands for "Hypothesis".

The contemporaneous volatility induced by oil supply shock on its own is not statistically significant as reported in Model II. When the oil demand shock volatility and risk volatility are added, the supply shock volatility has a negative effect but still not significant. This tallies with the results in *Table 2* and *Figure 4*, where the supply shock volatility was noted to be the lowest when compared with the oil demand shock-induced volatility and risk shock-induced volatility. Hence its impact on the firm-level investment is not significant. The coefficient of the risk volatility is negative and significant when used individually and also when used jointly with the other oil shocks. This tallies with the results in *Table 3*, where the risk shock was noted to have a negative impact on the stock market, which explains the negative second-moment effect on firm-level investment.

CHAPTER FIVE

5.0 CONCLUSION

The study aimed to empirically establish the existence of a relationship between the different oil price shocks and the JSE stock returns as well as ascertaining the effects of the stock market volatility induced by such oil price shocks on firm-level investment in South Africa. We considered the stock market as the oil shock transmission channel to firm-level investment through the DDM model. This was done by first disintegrating the oil shocks into three components following Ready (2018) model; oil demand shocks (proxied by oil and gas producer returns), oil supply shocks (proxied by changes in crude oil prices) and the risk shocks (proxied by innovations in VIX, which was defined by the residuals to ARMA(1,1) process of log of VIX). The JSE stock market returns were regressed on the three oil shocks and the component of the returns explained by the shocks extracted and subjected to GARCH(1,1) process to compute the conditional standard deviation which was used as the measure of stock market volatility induced by the oil shocks. The standard deviation was fitted in the investment estimation model with other determinants of investment alternately to establish its effect on firm-level investment in South Africa.

The results show that the three oil shocks have an effect on the stock market returns, though in varying magnitude and direction, and the effects are further transmitted to firm-level investment. The supply shocks have a positive effect on stock market returns when regressed individually but a negative effect when regressed jointly with other oil shocks. It was surprising to get a positive effect of oil supply shocks, but this could probably be explained by the hedging practices by the market participants. The stock market volatility induced by the oil supply shocks was too small and had no significant effect on firm-level investment. The demand shocks have a positive and significant effect on stock market returns whether regressed singly or jointly with other oil shocks. Its induced volatility was the highest among the three oil price shocks and has a positive and significant effect on firm-level investment. The risk shocks have a negative effect on stock market returns in the two forms of regressions, that is singly or jointly with the other oil shocks, and has a significant negative effect on firm-level investment. The stock market volatility induced by the three oil shocks jointly has a positive impact on firm-level investment. This can be explained by the fact that demand shocks which affect the stock market returns positively were noted to have been more prevalent during the period under review.

Empirically, the results show that there exists a second-moment transmission of oil price shocks to firm-level investment through the stock market, since they influence demand (consumption), inflation, and interest rates through the monetary policy. The effect of the stock market volatility induced by the oil price shocks on firm-level investment depends on the dominant oil price shock and the magnitude of the induced market volatility. These results also explain the co-movement of the crude oil prices, JSE All Share Index and Gross Capital Formation observed in *Figure 1*. This is to mean, the oil price is a leading indicator of the stock market behaviour, which consequently affects the firm investment behaviour. When the oil prices go up due to increased economic activity, stock prices go up, and since firm managers use the stock market as a source of information, they incorporate it in their investment decision making.

The results from the study demonstrate the varying effects of different oil price shocks on the stock market and its consequential effect on firm-level investment. The oil price increase being a leading indicator of what to expect at the stock market, the firm managers should always indentify the shock behind the oil price increase for proper timing of investments as well as portfolio diversification. When the oil price increase is due to oil supply disruptions, the firm managers should diversify their portfolio to focus on investments which may not be affected by the reduced stock prices. On the other hand, when the oil price increase is as a result of increase in oil demand driven by increased economic activity, then the firm managers should take advantage and raise more funds for investment from the stock market, since the stock prices are expected to go up.

It has also been noted that, when the oil prices go up, the government tend to respond using the monetary policies, specifically interest rates, which affect the value of the firm as predicted by the Dividend Discount Model. To avoid such adverse effects on firms, the researcher recommends that the government come up with other policies to deal with oil price increases which are less harmful to firm-level investments and to the economy at large.

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