The Impact of Oil Price Shocks on the Macroeconomy of Ghana

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Abstract
The impact of oil price shocks on macroeconomic activities has attracted a great deal of attention since the 1970s first oil price shock. Initially, many studies argue that there exist a significant negative impact of oil price shocks on GDP, but recent empirical studies suggest a diminishing relationship between oil shocks and the macroeconomy. A key feature characterizing existing literature is that it applies predominantly to advanced oil-importing economies. For developing oil importing countries, different conclusions may be expected but this can be empirically ascertained. Despite the key role energy plays in industrial production and the socio-economic development of countries, many studies only focused on the causal link between oil price shocks and output. This study therefore, employs a restricted VAR model and Johansen Cointegration test to investigate the impact of oil price shocks on the macroeconomy of Ghana- a developing oil importing economy. The findings reveal that oil price shocks have significant negative impact on output and economic activities in Ghana. We further employ a nonlinear oil price shocks specification to account for asymmetric effects and we find that negative oil price shocks adversely affect economic growth whiles positive oil price shocks stimulate growth and increase output. Our results indicate a nonlinear oil-price macroeconomy relationship but no evidence of asymmetric effects exist between oil price shocks and macroeconomic variables in Ghana. This study recognizes that the magnitude of the percentage impact is small, however, this does not mean that the oil shock effects on the Ghanaian economy is negligible.
Keywords: Oil price shocks; Macroeconomy; Nonlinear models; Ghana; VECM.

1 INTRODUCTION

The debate in the energy economics literature and among policy makers in recent times is the effects of oil price shocks on macroeconomy performance (Al-Khouri and Dhade, 2014). In fact, the discussion on oil price-macroeconomy relationship has received a great deal of attention and has generated colossal volumes of studies among researchers and economists since the first oil price shock in the early seventies.

The phenomenon has given policy makers and the global economy food for thought regarding the mechanism through which oil shocks impact economic activity and the policy implications oil shocks pose to socio-economic development. Energy remains a major bedrock for most industrial productivity and socio-economic development in almost every country. Scarcity or decline in the supply of energy resources, particularly oil, often leads to a crashing halt in almost all sectors of the economy. Crude oil prices are generally credited with the ability to directly influence the spending decisions of households, industries and the overall economy. Over the past few decades, the crude oil market has witnessed dramatic fluctuations in prices with the July, 2008 record high price of $147 per barrel been the most recent.

Following the Arab oil embargo of 1973-1974 which led to the first oil shock, a number of studies have attempted to establish the causal link between oil price shocks and macroeconomic activity (Barsky and Kilian, 2004). One of the pioneers in this line was Hamilton (1983), who studied on oil and macroeconomy since World War II. His findings reveal that out of the eight post World War II recessions in the US, seven have been preceded by major shocks in oil prices and a negative correlation exist between oil price shocks and economic activity. Hamilton's work in particular stimulated great interest among many early researchers. A plethora of their work which mainly investigated the causal link between oil price shocks and global recession supported this claim that an unexpected increase in oil prices has negative impact on output (see Rasche and Tatom, 1981; Hamilton, 1985, 1996).

These historical evidences and findings by early researchers although unable to prove causation, were held to be true until recent studies began to question the importance attached to the study of oil price shocks in affecting economic activities (see Hooker 1996; Hamilton, 1996). Their concerns re-open another chapter and interest into the oil price-macroeconomy relationship debate. The consensus in recent literature is that the negative relationship between oil price increase and output has broken down. According to these studies, the negative relationship existed predominantly only during the 1970s -1980s era and has become less important after the end of the eighties (see Hooker, 1996a, 2002; Nakov and Pescatori, 2010). The reasons suggested for this breakdown in the relationship include the following: First, there is a change in the monetary policy workings of most economies with strong commitment towards stable inflation rate. Second, there is a decline in real wage rigidities which smoothens the trade-off between prices and output. Third is the reduction of oil intensity in the share of output and efficiency in energy use across most economies. Fourth, the mechanics of oil impacts through the exchange rate has declined. Last but not the least, there is an increase in energy control policies, the development of alternative energy sources as well as technological innovations among major oil importing economies.

Despite the key role energy plays in industrial production and the socio-economic development of countries, many studies only focused on the causal link between oil price shocks and output. This study however, will contribute to existing knowledge by examining the impact of oil price shocks on macroeconomic variables. The study will also include other macro-economic variables which might as well be affected by the oil price shocks to provide a better explanation to describe the oil price-macroeconomy relationship. Additionally, this study is important because it is the first of its kind on Ghana in terms of up to date dataset and a more robust estimation techniques. It would be interesting to discover if the conclusions concerning asymmetric effects and declining impact of oil prices shocks on output in advanced-oil importing economies also apply to a country like Ghana.

The aim of our research is to investigate the oil price-macroeconomy relationship by examining the impact of oil price shocks on some selected macroeconomic indicators in Ghana using the restricted vector autoregression (VAR) model and Johansen cointegration test for a yearly time series data over the period 1972 to 2012.

1.1 Brief Historical Overview

1.1.1 The oil sector in Ghana

Ghana is one of the fastest developing economies in Africa with an average GDP growth rate of 7.9% in 2012 and a per capita income of about 1,563 USD in 2012 (Ghana Statistical Service). Like most countries in the sub-region, Ghana is blessed with diverse natural resources from minerals, timber, to oil finds among others. Concerning the oil sector, Ghana is still an oil-importing economy despite her discovery of oil in commercial quantities. The country's major source of oil importation is Nigeria, reasons being the proximity to Ghana and because Nigeria has sweet crude and light oil which are the preferred oil for Ghana's refinery, known as the Tema Oil Refinery (TOR). The nation's only refinery hub is one of the largest in the Sub-Saharan Africa and is located in Tema, about 24 kilometers away from the country's capital Accra.

The Tema Oil Refinery (TOR) has a total crude oil storage capacity of about 285,000 cubic meters, which is about 2 million barrels and covers a total area of 440,000 meters. In 2007, Ghana discovered oil in commercial quantities in the Deep Water Tano (DWT) and West Cape Three Points (WCTP) blocks. Coinciding with Ghana's jubilee anniversary upon turning 50 years of independence in 2007, the oil field is named the Jubilee field (JF). The first production and lifting of oil in commercial quantities is made in November 2010 and the operators of the field, called the Jubilee partners, comprise Tullow oil, Kosmos oil, Anardako oil, Sabre oil and Ghana National Petroleum Company (GNPC)[1]. The total production from the jubilee field in 2012 was 27.4 million barrels compared to 23.8 million barrels in 2011, an increase of about 15% over the previous year. Average daily oil production from the field has increased from 73,000 barrels in 2011, to 81,000 barrels in 2012.Operators of the jubilee field however estimated that the field could record a daily average production of around 120,000 bpd, at full operational efficiency[2].

To this end, it is noteworthy that Ghana's annual petroleum requirement has far exceeded the capacity of her sole refinery (TOR) by about 50 percent[3]. This is because the nation lacks adequate storage capacity and the necessary logistics to take advantage of commercial oil production at home. As a result, the country is still a net-importer of oil with very high import of finished oil products[4] and is yet to source her oil demands from the jubilee fields. Although the country has other local oil fields such as the Saltpond field, they are not commercialize due to high sulphur content.

1.1.2 Consumption of oil in Ghana

As already indicated, Ghana is an oil-importing country with petroleum products accounting for about 24 percent of the country's energy demand (see Energy commission, Ghana, 2013 report). This is mainly because of an increase in consumption and lack of adequate storage facility to engage in commercial production at home. In 2012 for instance, total petroleum products consumed in Ghana amount to about 3.2 million tons compared to 2.8 million tons in 2011, an increase of about 14 percent over 2011 (see table 1). Total supply of oil products in Ghana has shown continued upward trend from about 2.3 million tons in 2011 to about 2.4 million tons in 2012 due to increase in consumption (see Energy commission, Ghana, 2013 report). Fig.2 indicates that even with the

[1] See Quagraine (2012)
[2] See Jubilee field operators update: Tullow, January 2012.
[3] See Energy commission, Ghana: 2013 report.
[4] See Bank of Ghana: 2012 annual report.

2.4 million tons increase in 2012, the total supply of petroleum product in Ghana continues to lag behind demand and consumption from mid-2008 to 2012. Thus, the gap in supply will be bridged by an extra importation of finished product to meet the consumption. The transport sector accounts for the greatest consumption of petroleum products in Ghana with about 50 percent of total oil supply, followed by the other sectors accounting for the remaining 50 percent (see Nnadikwe, 2011).

1.1.3 Importance of oil to the Ghanaian economy.

In spite of the discovery of oil in 2007 and the consequential lifting of oil in commercial quantities in 2010, Ghana's oil importation is still significantly high. In fact, ample studies have demonstrated that for an emerging economy like Ghana, there is a direct and very strong interaction between economic growth and injection of adequate energy, of which oil forms a significant part (see Table 2). A World Bank (2005) work on "The impact of higher oil prices on Low Income Countries and the poor", reveals that Ghana's oil dependence ratio has reached 53.6 percent as of 2001. Similar work by Nnadikwe (2011) shows a further increase of about 64 percent in 2006, a percentage increase of 19 percent between 2001 and 2006. Scientific studies have revealed that petroleum consumption as a percentage of total energy consumption in Ghana has reached the neighborhood of 70 percent in 2010 (see Lin et al., 2014). Fig. 2 demonstrates that petroleum products and for that matter oil consumption forms a vital part of Ghana's energy mix and will continue to be strong in the coming years.

Interestingly, Ghana is not only a highly oil-dependent economy with increasing consumption for her socio-economic growth, but also highly vulnerable to oil price shocks. According to the ESMAP (2005) paper on "Vulnerability of African Countries to Oil price shocks" from 1990-2003, Ghana's oil vulnerability indicator, which shows the amount of GDP spent as a result of increase in oil price reveals that, 4.4 percent of the country's GDP was spent in 2003 due to increase in oil price; a 50 percent increase between 1990 and 2003. Furthermore, it is reported that the vulnerability indicator of Ghana has increased from 4.4 percent in 2003 to about 8.49 percent in 2006; a percentage increase of about 93 percent over the 2003 figure (see Nnakidwe 2011).

Clearly, one cannot underestimate the importance of oil to the economy of Ghana, given its vital role in economic growth. To this point, it is important to also mention that until 2005, the government of Ghana has highly subsidized petroleum products to an estimated average of about 2.3 percent of GDP (see Anokye and Tweneboah, 2008). However, the government of Ghana has recently remove the costly petroleum products subsidies with the aim of bringing domestic petroleum prices closer to world prices and to restore fiscal stability. The scrapping of fuel subsidies by the government has become a matter of hot debate among policy think tanks in Ghana as majority holds the view that the removal only dampens citizen's welfare.

Table 1 Displays Petroleum Consumption Statistics in Ghana from 2010-2012

PETROLEUM PRODUCT	2010 (1000 tonnes)	2011 (1000 tonnes)	2012 (1000 tonnes)
LPG	178.4	214.4	268.5
Gasoline	737.8	807	992.7
Premix	32.4	45.5	58.9
Kerosene	49.3	62.4	45.6
ATK	108.4	135.3	141.3
Gas oil/Diesel	1,271.9	1,511.5	1,665
RFO	30.9	37.5	21.4
Total	**2,409.1**	**2,813.7**	**3,205.5**

Source: National Petroleum Authority, 2012.

The table shows that from 2010 to 2012 petroleum products consumption in Ghana have been increasing and this phenomena persist till date.

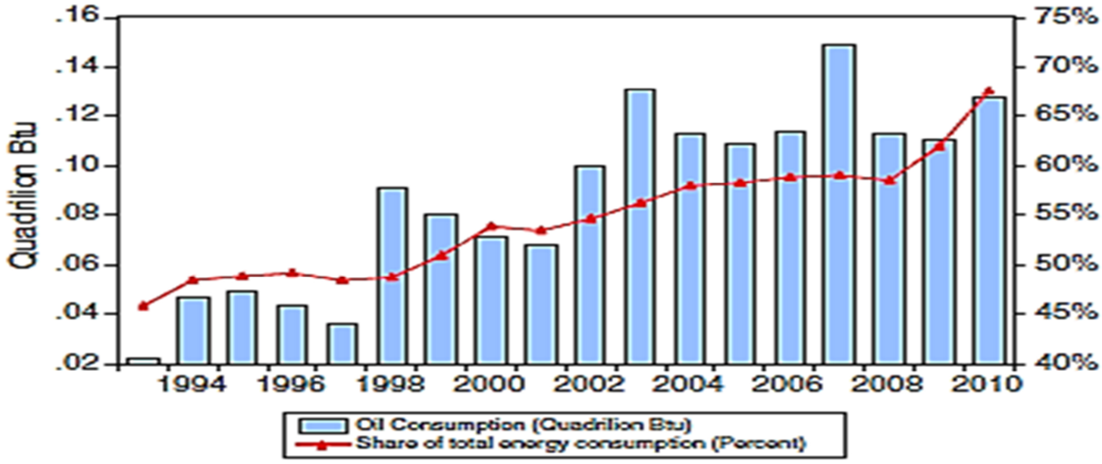
Table 2 Displays Ghana's Oil imports and GDP growth rate from 2006-2012

Year	Crude oil imported (million tonnes)	Products imported (1000 tonnes)	Average Crude oil price (USD)	Real GDP at 2006 constant prices (Millions of GH cedis)		Real GDP growth Rate (%)
2006	1.71	906		66	18,705	6.4
2007	2.05	1,200		73	19,913	5.7
2008	1.98	1,096		98	21,592	7.3
2009	0.98	1,890		62	22,598	6.3
2010	1.66	1,450		80	25,129	8
2011	1.53	2,075		111	29,100	15
2012	1.21	2,478		113	31,500	7.9

Source: Energy Commission, Ghana; 2013 report (adapted)

This table shows a strong relation between injection of imported oil product and real GDP growth in Ghana from 2006 to 2012 and persisting till now.

Figure 1 Displays Ghana's oil consumption as a share of her total energy consumption



Source: B. Lin et al., 2014, adapted

This figure shows that oil consumption in Ghana (bars) has risen above 60 percent of her total energy consumption since 2002 and has reached the neighborhood of around 70 percent in 2010. The implication is Ghana's high oil consumption will continue to surge into the near future as the economy relies heavily on oil for productive activities.

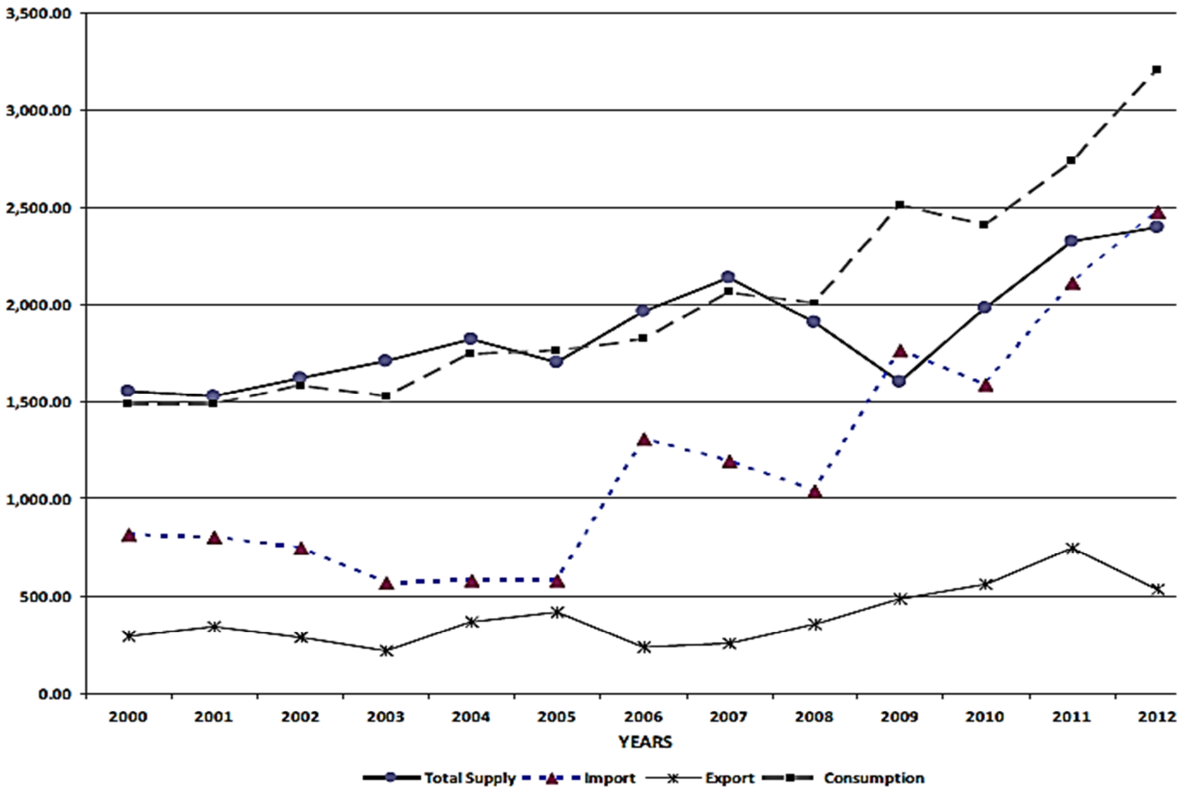


Figure 2 Displays Ghana's total oil consumption above her total oil supply

Source: Energy Commission, Ghana; 2013 report.

This figure shows that from mid-2008-2012, oil demand and consumption has risen above the supply, an indication that Ghana actively engages in huge import of highly priced finished petroleum products to meet her energy needs. The conclusion is that this phenomenon is still persistent till date, driving up government expenditure on oil products import to about US$ 3.3million in 2012.

2 LITERATURE REVIEW

The studies on oil price-macroeconomy relationship have over the periods attracted colossal volumes of literature with a lot of contradictory results. Hamilton (1983) landmark work, which establishes oil price shocks as a contributing factor to recession in the United States, stimulates the interest in many researchers to study the connection between oil price shocks and the macroeconomic indicators, including GDP per capita. Preponderance of the studies from various developed and developing countries (Rasche and Tatom, 1981; Darby, 1982; Hamilton, 1983, 1996, 2003, 2008; Burbidge and Harrison, 1984; Loungani, 1986; Gisser and Goodwin, 1986; Bohi, 1989, 1991; Mork, 1989; Lee et al., 1995; Hooker, 1996; Uri, 1996; Raymond and Rich, 1997; Bernanke et al., 1997; Amamo and Van Norden, 1998; Chaudhuri and Daniel, 1998; Davis and Haltiwanger, 2001; Lee and Ni, 2002; Barsky and Kilian, 2002, 2004; Chang and Wong, 2003; Cunado and Gracia, 2005; Ayadi, 2005; Rodriguez and Sanchez, 2005; Omolola and Adejumo, 2006; Jumah and Pastuszyn, 2007; Kilian, 2008; Blanchard and Gali, 2008; Cologni and Manera, 2008; Limin Du et al., 2008; Lorde et al., 2009; Rafiq et al., 2009; Gomez-Loscos et al., 2010; Dogrul and Soytas, 2010; Trung and Vinh, 2011, Rasmussen and Roitman, 2011; Sanchez, 2011; Cavalcanti and Jalles, 2012) have argued that oil price shocks significantly affect economic activities (mainly economic growth).

As may be observed, there are several strands of literature on the oil-price macroeconomy relationship with many of the studies and results from the perspective of developed economies (Gisser and Goodwin, 1986; Hanson et al., 1993; Uri, 1996; Amamo and Van Norden, 1998; Papapetrou, 2001; Berument and Tasci, 2002; Rautava, 2004; Jimenez-Rodriguez and Sanchez, 2005; Huang et al., 2005; Lardic and Mignon, 2006; Zhang, 2008; Aydin and Acar, 2011). It is however important to point out two fundamental questions that arise in the literature for net oil importing countries following Hamilton's (1983) work. First is whether the relationship between oil prices and economic output is stable over time. Second is whether there is asymmetric response between oil price fluctuations and economic activity[1]. Some recent studies attempt to answer the first question by the considering the oil price changes and macroeconomic activities again.

Among such studies are Hooker (1996a, 2002), Doroodian and Boyd (2003), De Gregorio et al. (2007), Herrera and Pesavento (2007), Kilian et al. (2007), and Kapetanois and Tzavalis (2010). The general consensus from these studies is that the negative effects of oil price spikes on most important economies have become relatively less important after 1980. Jbir and Zouari-Ghorbel (2008) opines the control of energy policy, exploration of alternative energy, and technological advancement in the oil-importing industrialized economies as the primary reasons for this observation. In considering the second question, several researchers have evidenced that economic activity exhibits asymmetric responds to oil price shocks (see Mork, 1989, 1994; Mory, 1993; Mork, Olsen and Mysen, 1994; Ferderer, 1996; Brown and Yucel, 2002; Cunado and Gracia, 2005). Thus, increase in oil prices appear to depress aggregate economic activity by more than decrease in oil price stimulate it. Studies that were instrumental in the line of asymmetrical response of macroeconomic variables to oil price shocks include Mork (1989). He suggests an asymmetric response specification with claims that only oil price increases matter and not the decreases and therefore categorize the oil price variable into upward and downward movements. To add to the argumentation, Hamilton (1996) proposes to consider the net oil price increase (NOPI) measurement. He argues that oil price increases will only matter if they are significantly larger in comparison to past experiences since most of the individual price increases are simply corrections to the earlier declines. Lee et al., (1995) also worked on the same non-linear measurement dilemma and they opine that variability in oil prices are likely to have greater impact on GDP in an environment of stable oil price movements than in an environment of frequent and erratic oil prices. They further propose to consider the generalized autoregressive conditional heteroskedasticity (GARCH) model. Despite the main focus of research directed towards developed oil-importing economies there are some studies nonetheless, which directly shed light into the impact oil price shocks on the macroeconomic activities of developing oil-importing economies. The following paragraphs summarize the results of main studies on oil price-macroeconomy relationship from the perspective of developing oil-importing countries which is the focus of this study. Chang and Wong (2003) examine the long term relationship between oil price volatilities and the Singapore macroeconomy using the Johansen Cointegration methodology for the sample period running from 1978-2000. The result reveals that oil price shocks have negative impact on macroeconomic activities in Singapore. Nevertheless, this impact is only marginal. They further investigate Singapore's experiences of past oil price shocks and argue that oil intensity and expenditure on oil consumption as a percentage of GDP have declined overtime in Singapore accounting for the less significant adverse effect of oil price shocks on macroeconomic activities in Singapore. The findings confirm similar conclusion by Hooker (1996) that there exists a diminishing oil price-macroeconomy relationship. In contrast, Jbir and Zouari-Ghorbel (2009) model the recent oil price shock and the Tunisian economy by analyzing the role of subsidy policy. The vector autoregressive (VAR) model was employed by the authors to analyze the data over the period 1993-2007, and their findings reveal that oil price shocks do not have

[1] Farzanegan and Markwardt (2009)

any direct impact on economic activities. They argue that the impact of oil price shocks on economic activities is indirect and can be transmitted largely through government spending in a form of subsidy. Furthermore, no evidence of asymmetric relationship was found between oil price shocks and economic activity as reported in other studies. Sanchez (2011) analyze the welfare effects of rising oil prices in oil-importing countries using dynamic Computable General Equilibrium (CGE) model on six oil-importing counties (Bangladesh, El Salvador, Kenya, Nicaragua, Tanzania, and Thailand) for the period 1990-2008. He argues that oil price rise has significant adverse impact on GDP with an average annual GDP loss varying from 0.1% for Tanzania to 20% for Kenya. According to Sanchez, the decline in GDP consequently results in unemployment and higher consumer prices, thereby reducing welfare.

While we acknowledge diverse results and conclusions from the above studies, there is also clear and convincing evidence that oil price shocks pose detrimental effect to the economic activities of most oil-importing developing economies like Ghana. From the literature review, it can be observed that relatively very little work is done when it comes to the contribution from oil-importing developing countries in Africa on this topic despite the continent's high dependency on oil. In light of the literature presented above, there is a clear absence of non-linear oil price specification to consider the possibility of asymmetrical response in most of the studies especially, the few on Africa. According to Zhang (2008) accurate estimation of asymmetric and nonlinear oil price shock measure enables a better forecast of the future dynamics of macroeconomic performance. Therefore, our study will step in to provide an asymmetric response transformation and employ a nonlinear estimation in the data series to give further robustness and accuracy to the results. It is an effort to fill the research gap by contributing to the scarce literature on developing oil-importing countries in general and principally on Africa.

3 DATA AND METHODOLOGY

3.1 Data Description

This study aims to investigate the impacts of oil price shocks on the economic activity of Ghana using yearly data which spans from 1972-2012, a total of 40 observations. The sample period from 1972-2012 is chosen because the first major oil shock occurred between 1973-1974, which was followed by the 1979 second major oil price shock and these dates are presumed to be very important factors that accounted for the global economy slowdown at a time of rising inflation by most literature. A total of four data series which include oil prices and three Ghana macroeconomic variables namely; real Gross domestic product per capita (GPC), consumer price index (CPI) and exchange rates (ER) are used in the study to examine the relationship between oil price shocks and the macroeconomy of Ghana.

Selection of these variables to proxy the macroeconomic activity is based on the availability of macroeconomic data series that are sufficiently long. Economic activity is measured by log difference of real GDP per capita, inflation, by the log variation of consumer price index (CPI), difference of nominal exchange rate of the US dollar to Ghana cedis (US$/GHS), and the Europe Brent spot oil prices difference (FOB) expressed in Dollars per Barrel is used to proxy real oil price variable. The choice of the Brent crude oil price over the Dubai crude oil price is because Ghana imports most of her petroleum products from Europe and its crude oil demands from Nigeria which uses the Brent spot prices.

Moreover, Brent is a major benchmark in the world of international trading today and also the reference crude oil for the North Sea. GDP per capita is chosen as the most appropriate macroeconomic variable to proxy economic activity instead of the GNP, because the GDP measures the level of total output produced by domestic factors of production and also, an economy's total energy consumption depends on the goods and services produced within the economy and not outside the economy. CPI is chosen as a desirable proxy to capture inflation level in the economy because the CPI tells us variation in the prices of a market basket of goods over time. Even though it might be more reliable to use the GDP deflator to measure the level of inflation since this statistics covers a broader population and accounts for substitution and quality improvements, such time series data are currently unavailable for Ghana.

In order to capture the economy's competitiveness, the nominal exchange rate of the US dollar to Ghana cedi ($/GHS) is chosen as a desirable proxy of the exchange rate, because it is the most largely traded currency in Ghana forex market. The oil price variable is obtained from the US Energy Information Administration (EIA) database. Nominal exchange rate of dollar to the Ghana cedi is extracted from the yearly Bulletin of the Bank of Ghana publications. The rest of the macroeconomic variables, GDP per capita and CPI are obtained from the World Development Indicators (WDI) available online at: http://www.worldbank.org.

3.2 Variables Abbreviations

GPC…. Gross Domestic Product Per Capita
ER…. Exchange Rate
CPI…. Consumer Price Index
O…. Crude Oil Price
LGPC…Log of GDP Per Capita
LCPI… Log of CPI
DER… First difference of ER
DO…. First difference of Oil Price shocks
DLGPC… Log difference of GDP per capita
DLCPI…Log difference of CPI
DOP….Negative oil price shocks (positive values)
DON…Positive oil price shocks (negative values)

3.3 Definition of Oil Price Shock Measures

From the literature, the measurement of oil price shock has proven a contentious issue as different researchers has come up with diverse oil price shock specifications. Indeed, the functional form of the oil price-macroeconomy relationship broadly depends on the particular measure of oil price shocks chosen and as generally suggested by Hamilton (2003), an incorrect specification of the functional form has often accounted for the unstable empirical relationship observed between oil price shocks and macroeconomic variables.

According to Mork (1989), Lee et al. (1995), and Hamilton (1996), there is a nonlinear oil-price macroeconomy relationship and these authors have proposed different nonlinear specifications of oil price shocks. In this study, we follow the convention by most literature to include both benchmark (linear) and nonlinear specifications of oil price shocks in our analysis.

By linear oil price shock specification, we mean both negative oil price shocks (price increase) and positive oil price shocks (price decrease) are considered together in one analysis. Thus, we did not account for oil shocks separately (see Hamilton, 1996); rather, we only take into consideration the yearly changes in real crude oil price.

In order to account for the existence of asymmetrical response where the effects of negative shocks may not be the same as positive shocks, we further specify the nonlinear approach in the analysis (see Mork 1989). Thus, with the non-linear specification we categorize oil price shocks into oil price increase and oil price decrease using the Mork (1989) transformation and investigate their impact separately on economic activity in Ghana. For the purpose of simplicity and want of space, our analysis makes use of these two different oil price shock measurements to ensure robustness of results as possible and also to offer a better explanation into the oil-price macroeconomy discussion in Ghana.

We first specify the linear oil shock measure as follows:

$$\Delta Oil_t = \ln Oil_t - \ln Oil_{t-1} \qquad (1)$$

In the above expression, ΔOil_t measures yearly changes (difference) in the real price of crude oil. Establishing a significant relationship between this variable and GDP would be interpreted as having a linear oil to GDP relationship. The next measure demonstrates a nonlinear specifications of oil shocks in which oil prices are divided into positive and negative changes to capture the nonlinear oil-macroeconomy relationship. Mork (1989) distinguished between rises and falls of oil price, allowing for asymmetries in the oil price and derived positive and negative oil price shocks. According to Mork, the variable which defines the oil price change can be expressed as follows:

$$ROILP_t^+ = \max(0, (\mathrm{roilp_t} - roilp_{t-1}))$$
$$ROILP_t^- = \min(0, (\mathrm{roilp_t} - roilp_{t-1})) \qquad (2)$$

Where $\mathrm{roil_{pt}}$ is the log of real price of oil at time t, $ROILP_t^+$ is the real oil price increase and $ROILP_t^-$ being the real oil price decrease.

3.4 Stationarity Properties

In this section, we check the stationarity properties of the time series data since determination of the orders of integration in the all series is an important stage of the analysis. Previous studies have evidenced that majority of time series data are non-stationary at levels but turn become integrated (stationary) of order 1 (Engle and Granger, 1987). A stationary time series process therefore is one which has a constant first and second moments and whose probability distribution is stable over time. Stationarity in the data series needs to be ascertained because our estimation technique for the analysis is the restricted Vector Autoregressive (VAR) model, which assumes that all the variables in the system are stationary. Therefore, to avoid spurious results and to ensure that the variables fit into the estimation techniques, the study will conduct unit root test generally used in the VAR model to examine stationary properties in time series data.

We carried out the stationarity test using Augmented Dickey–Fuller (ADF) unit root test on the null hypothesis that all series have unit root (non-stationary) against the alternative that series have no unit root.

Testing at levels, we found the variables to be non-stationary (see table 3, section 4.1). Since stationarity property is required in the variables, we proceed to further test for unit root at first difference and the results showed stationarity among variables. Thus, the series tends to become stationary after first differencing, what is commonly referred to as, I(1) order. This notwithstanding, it has been established that the results of the ADF test depend on the number of lag parameter chosen. According to Agiakoglu and Newbold (1992) the test tends to under-reject the null hypothesis and points to non-stationarity quite often. Hence, as a confirmation of the results of the ADF test, the Phillips–Perron (PP) test is also applied in the study. The test is conducted by means of a nonparametric technique which controls for serial correlation in the unit root process. Like the ADF test, the null hypothesis also represents non-stationarity and again the results confirm that series are integrated of order 1, I(1). Base on the evidence that original series are stationary of the same order, I(1), which is a precondition for a cointegrating relationship testing, we proceed to check for the existence of any long-run interaction among the variables under consideration. Johansen and Julius (1990) cointegration test is applied as per convention to make a decision on the long-run relationship.

3.5 Criteria for Lag Length Selection

Due to the possibility of losing potentially valuable information with too low lag order and increasing estimation errors in a forecast with too high order (*p)*, it is generally required in an autoregression to choose lag order that neutralizes the trade-off. The study employs five different information criteria namely; Likelihood Ratio (LR), Final Predict Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan-Quinn information criterion (HQIC) to select the optimal length. To decide on the optimal lag length from the five criteria, we make an arbitrary choice of a maximum lag intervals of 5 and based on the majority decision that the lag suggested by most of the criterion might probably be the best, we chose lag 5, which is suggested by three out of the five information criteria. Consequently, a uniform lag structure of 5 is applied in our analysis.

3.6 Cointegration Test

Cointegration is a specification of models that include the belief about the movement of variables relative to each other in the long-run. Thus, to investigate the long-run relationship between the variables, the Johansen method of Cointegration is carried out (Johansen, 1988, 1991; Johansen and Julius, 1990). What we seek to find is whether there exist a common stochastic trend in the oil price variable and the macroeconomic variables and use the maximum likelihood procedure by Johansen to confirm the presence of cointegrating vectors. This method is considered because compared to other cointegrating test methods, the Johansen tests provides more robust estimations. Two tests are proposed under the Johansen method namely, the Trace statistics and the Maximum Eigenvalue statistics. The null hypothesis for the trace statistics is cointegrating vectors are less than or equal rank ($\leq r$) against the alternative that cointegrating vectors exactly equals to rank ($=r$). The maximum Eigenvalue statistics test the null hypothesis that the number of cointegrating vectors equals rank ($= r$) against the alternative that cointegrating vectors equals rank+1 ($= r + 1$). We compare the test statistics against critical values specified by the Johansen method and reject the null when the critical value is less than the test-statistics for both tests.

3.7 Estimation Techniques

Vector Error Correction (VEC) model

Although the convention in most of the above literature is the use of unrestricted vector autoregression (VAR) model for the oil price-macroeconomy relationship, we decide to go on the line of the restricted VAR or vector error correction model (VECM) for this study. The essence of the VECM lies in the implication that the series being studied is cointegrated, thus implies the existence of long-run relationships between the integrated time series. In statistics, the presence of cointegration among relevant variables indicates that a linear combination of nonstationary time series exhibits a stationary series, thus avoiding the problem of spurious regression. An error correction mechanism is incorporated in the model to capture the variations associated with adjustment to a long-term relationship. The choice of VECM above the VAR model is necessary because it helps to distinguish between short-run and long-run dynamics and also includes a correction aspect called error correction term (ECT) or coefficient.

The ECT helps to determine how much of the past deviation to the equilibrium state is restored in current period. The estimated coefficients of the ECT can be either positive or negative in sign. In fact, the sign of the error term coefficient in a VECM estimation is fundamental to the understanding of the mechanics because it explains the rate at which disequilibrium in the long-run relationship among cointegrating variables is corrected. The general rule is that the coefficient of the error correction term must be negative and statistically significant at any of the conventional significance level; 1%, 5% or 10% to guarantee convergence back to the long-run path. Since the VAR model does not account for the existence of long-run (Cointegration) relationship, the VECM remains the better and most appropriate choice (see Granger 1969). In case there is no long-run interaction among variables the VAR model will have sufficed. Thus, the VECM simply is that restricted part of the VAR which helps us to work with series that are non-stationary at levels and only become stationary after first differencing and also have exhibited a long-run relationship. Furthermore, the VEC model treats all series endogenously thereby allowing the predicted variable to explain itself using its own lags, lags of independent variables, the error correction term as well as residual.

The VECM can be expressed as;

$$\Delta GPC_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} GPC_{t-1} + \sum_{i=1}^{p} \beta_{2i} CPI_{t-1} + \sum_{i=1}^{p} \beta_{3i} ER_{t-1} + \sum_{i=1}^{p} \beta_{4i} O_{t-1} + \lambda_1 ECT_{t-1} + \mu_{t1} \text{............(3)}$$

$$\Delta CPI_t = \alpha_o + \sum_{i=1}^{p} \alpha_{1i} GPC_{t-1} + \sum_{i=1}^{p} \alpha_{2i} CPI_{t-1} + \sum_{i=1}^{p} \alpha_{3i} ER_{t-1} + \sum_{i=1}^{p} \alpha_{4i} O_{t-1} + \lambda_2 ECT_{t-1} + \mu_{t2} \text{...........(4)}$$

$$\Delta ER_t = \gamma_o + \sum_{i=1}^{p} \gamma_{1i} GPC_{t-1} + \sum_{i=1}^{p} \gamma_{2i} CPI_{t-1} + \sum_{i=1}^{p} \gamma_{3i} ER_{t-1} + \sum_{i=1}^{p} \gamma_{4i} O_{t-1} + \lambda_3 ECT_{t-1} + \mu_{t3} \text{.............(5)}$$

$$\Delta O_t = \chi_o + \sum_{i=1}^{p} \chi_{1i} GPC_{t-1} + \sum_{i=1}^{p} \chi_{2i} CPI_{t-1} + \sum_{i=1}^{p} \chi_{3i} ER_{t-1} + \sum_{i=1}^{p} \chi_{4i} O_{t-1} + \lambda_4 ECT_{t-1} + \mu_{t4} \text{..............(6)}$$

Where β_o, α_o, γ_o and χ_o are the constant terms, Δ is the first lag difference and ECT_{t-1} is the error correction term lagged one period which also indicates the speed of adjustment towards long-run equilibrium state. GPC, CPI, ER and O are the variables investigated, GDP per capita, inflation rate, exchange rate and crude oil price, $\beta_1 \ldots \beta_4$, $\alpha_1 \ldots \alpha_4$, $\gamma_1 \ldots \gamma_4$ and $\chi_1 \ldots \chi_4$ represents the coefficients of the variables, $\lambda_1 \ldots \lambda_4$ are the short-run coefficients and $\mu_{t1} \ldots \mu_{t4}$ represents white noise. For want of space, the VECM estimation above have been applied to the three oil price specification used in the analysis (see subsection 3.2).

4 EMPIRICAL RESULTS AND ANALYSES

In this chapter, we provide empirical results for the study on macroeconomy impacts of oil price shocks in Ghana, which forms the premise for our analysis, conclusion and recommendation. We employ the restricted VAR model with an error correction term (VECM) and the results are presented as below:

4.1 Unit Root Tests

In order to avoid spurious results and since the study involves time series data, we carried out a formal test to check for the stationarity (unit root) which is also a requirement for the VECM model. Series which tend to be stationary at level are said to be integrated of order zero, I (0) and those stationary after taking the first difference are said to be integrated of order one, I (1). Table 1 reports both the ADF and Philips-Perron tests results for all the variables under consideration. Testing the null hypothesis that variables have unit root (non-stationary) against the alternative of no unit root (stationarity), the level series for both tests fail to reject the null at the 5% or even at 1% and 10% levels.

For the most of the variables the stationarity property indicate conflicting results at levels with intercept and even with intercept and trend. As a result, we took the first difference for all variables and each series rejects the null hypothesis at 5% level. Thus, evidence from the ADF and Philips-Perron tests suggests that all variables are integrated of order one, I(1). Following that all variables have unit root (nonstationary) at levels and integrated (stationary) of the same order, we infer a possibility of the presence of long-run relationship (cointegration) between oil prices and the macroeconomic variables in Ghana. On that premise, the next subsection explores a cointegration analysis.

Table 3 Displays Unit Root Test with T-statistics, P-Values and Critical value at the 5% level

Variable	Levels		First diff.		Critical value @ 5% level
ADF test.	T-statistics	P-Value	T-statistics	P-Value	
Assumptions: intercept					
DLGPC	0.4794	0.9839	-3.8792	0.0049**	-2.9389
DLCPI	-4.0741	0.0029	-2.3054	0.1755	-2.9389
DER	-3.1079	0.0442	-6.6200	0.000**	-2.9389
DO	-6.9326	0.0000	-9.7221	0.0000**	-2.9389
Assumption: intercept & trend					
DLGPC	-1.1574	0.9054	-5.3569	0.0005**	-3.5289
DLCPI	-0.2574	0.9893	-5.4667	0.0003**	-3.5298
DER	-4.6278	0.0034	-6.5599	0.0000**	-3.5298
DO	-5.7478	0.0002	-9.6851	0.0000**	-3.5298

PP Test	**Levels**		**First Difference**		**Critical Value**
Intercept	***T-test***	***P-Value***	***T-test***	***P-Value***	***5% S.L***
DLGPC	-0.9458	0.9952	-3.8232	0.0057**	-2.9389
DLCPI	-4.0741	0.0029	-3.8702	0.0051**	-2.9389
DER	-2.9524	0.0485	-11.6102	0.0000**	-2.9389
DO	-6.9984	0.0000	-19.9268	0.0001**	-2.9389
Intercept &Trend					
DLGPC	-0.0951	0.9932	-5.8349	0.0001**	-3.5298
DLCPI	-0.3364	0.9867	-5.4877	0.0003**	-3.5298
DER	-4.4481	0.0055	-16.9648	0.0000**	-3.5298
DO	-7.2168	0.0000	-21.2332	0.0000**	-3.5298

** asterisk mean *p*- value less than 5% significant level

4.2 Johansen Cointegration Two-test Analysis

To test for cointegrating relationships between oil price and the three macroeconomic variables, the Johansen Cointegration test is conducted (see Johansen and Julius, 1990). However, before estimating the Johansen method, we need to select an optimal lag order (length) using the VAR model with variables at level. To contain this problem, five different information criteria are applied to make a final decision.

4.3 Lag Selection for the Model

Following the argumentation from section 4.2 above, I employ five different information criterion namely; Likelihood Ratio (LR), Final Predict Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan-Quinn information criterion (HQ) to determine the optimal length. The appropriate lag length selected by three (3) out of the five selection criterion in the VAR specification is 5. Consequently, the cointegration test is set to a lag length of 5, (p=5).

Table 4 Displays VAR Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	-353.7903	NA	8899.153	20.44516	20.62291	20.50652
1	-304.2047	85.00386	1315.989	18.52598	19.41475*	18.83278
2	-284.3479	29.50153*	1098.075	18.30559	19.90538	18.85784
3	-263.9137	25.68862	943.7973	18.05221	20.36302	18.84990
4	-242.2664	22.26583	841.9954	17.72951	20.75133	18.77264
5	-212.1108	24.12450	552.4072*	16.92062*	20.65345	18.20919*

* indicates lag order selected by the criterion LR: sequential modified LR test statistic (each test at 5% level)

4.4 Cointegration Test

We conducted the cointegration test base on the two test statistics proposed by Johansen (1991); the trace statistics and the maximum Eigenvalue statistics. From the results below, the two tests suggest a cointegrating long-run relationship among our variables. The Trace test indicates 3 cointegrating relationships whereas the Maximum-Eigenvalue shows 2 cointegrating relationships among the variables (see table 3). The variables that have the long-run relationship (cointegrated) are DLGPC, DLCPI, and DO; GDP per capita, inflation and crude oil price respectively. Thus, based on the results we fail to reject the alternative hypothesis that variables are cointegrated with at least 3 cointegrating vectors at the 5% significance level.

Table 5 Displays Johansen Cointegration Two-Tests

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized NO. of CE(s)	**Eigenvalue**	**Trace Statistics**	**0.05 Critical Value**	**Probability****
None*	0.863411	129.1550	47.85613	0.0000
At most 1*	0.739550	61.46857	29.79707	0.0000
At most 2*	0.340855	15.72681	15.49471	0.0461
At most 3	0.044711	1.555218	3.841466	0.0038

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
None*	0.863411	67.68642	27.58434	0.0000
At most 1*	0.739550	45.74175	21.131	0.0000
At most 2	0.340855	14.17159	14.26460	0.0517
At most 3	0.044711	1.555218	3.841466	0.2124

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

4.5. Vector Error Correction Model (VECM)

Premised on the results of the Johansen cointegration test which suggests the existence of a long run association among variables (cointegration) and coupled with the I(1) order condition in the series, we further employed VECM estimation with the 5 lag structure to analyze the long- run dynamics in the variables. Consequently, we applied the VEC estimation for both the linear oil price shocks measure for oil price shocks and an explanatory non-linear oil price shocks specification.

Table 6 below provides the results of the long-run dynamics of the VEC model using the linear oil price shock specification.

-Linear specification

Table 6 Displays Results of Long Run Dynamics of VEC Model

Cointegrating Eq:	CointEq1
DLGPC(-1)	1.0000
DLCPI(-1)	-0.0516* (0.0077) [-6.6983]
DER	0.2729 (0.2589) [1.0541]
DO	-0.02719* (0.0017) [-15.8495]
C	-5.8876

VECM: Standard errors in the ( ) and the t-statistics in the [ ] *, **, and *** asterisks indicate the coefficients are significant at 1%, 5% and 10% significant level respectively.

The results in table 6 above indicates that only the coefficients of DLCPI and DO are statistically significant at the 1% level. This is consistent with the cointegration test (section 4.4) which confirms at least 3 cointegrating vectors. From the result above, the GDP per capita (DLGPC) series is set as the dependent variable whiles the exchange rate (DER), inflation (DLCPI) and crude oil price (DO) are the independent variables with the intercept (C). Reporting on the cointegrating variables which are statistically significant, the DLCPI which represent inflation has a coefficient of -0.0516. This implies that 1 percent increase in inflation will lead to a 5.16% decrease in the dependent variable, DLGPC, at a 1% significance level. Premise on the coefficient which is statistically significant at 1% significance level, we argue that increase in inflation poses negative impact on economic growth in Ghana holding other variables constant.

Focusing on the oil price variable (DO) which is the main interest of this study, we found that the coefficient is statistically significant at the 1% significance level. The economic interpretation of this result is that, given a 1 unit change in the crude oil price, the dependent variable, DLGPC will fall by 2.72%. This result confirms the negative impact of oil price shocks on most oil-importing developing economies as already reported in previous studies and it is not surprising at all that the same situation holds for Ghana- a developing oil importer. From the result, we argue that holding all other variables constant, a unit change in world crude oil price will adversely affect macroeconomic performance in Ghana.

Table 7 Displays Short-run Dynamics of the VEC Model

Variable	Coefficient	Standard Error	t-statistics
DlnGPC	-0.0462	0.1597	-0.2892

*means the coefficient is statistically significant at 1% significance level.

The next part of the VECM estimation is to analyze the short run dynamics which primarily captures how disequilibrium among the cointegrated variables is corrected through the ECT. From the results in table 7 above, the estimated error term coefficient (-0.0462) is negative in sign but statistically insignificant. Since our focus is on economic activity, the study provides the short-run dynamics result on DLGPC only which is the proxy for economic activity. The economic interpretation of the negative coefficient is that, any short-run fluctuations or shocks among the cointegrated variables (DLCPI and DO) that cause output (DLGPC) to divert from the long run equilibrium state is corrected by 4.62% in the current year. However, the speed of adjustment of 4.6% is not statistically significant which means, a stable long-run relationship is not restored among the cointegrated variables. Thus, from table 7, we argue that despite the reduction in disequilibrium by 4.6%, it is not statistically significant enough to restore variables to stable long-run relationship. The remaining cointegrated variables, DLCPI and DO indicates positive and statistically insignificant coefficients which implies that disequilibrium is not restored and stable long-run relationship does not exist. The implication is that the effects of oil price shocks on economic activities may not hold perfectly forever due to break in cointegration relationship.

-Asymmetric or Nonlinear Impact

Following the increasing consensus in most literature that oil price shocks has a non-linear relationship with macroeconomic variables, many studies have accounted for asymmetric response possibilities of oil prices on economic activities. By asymmetric response or impact, we mean the macroeconomic effects of increase in oil price are not the mirror image of the decrease in oil price.

With the benchmark (linear) specification, it is unclear whether oil price shock occurs from decrease or increase in crude oil prices. Consequently, this study followed the convention according to Mork (1989) non-linear oil price shocks transformation by categorizing the oil price shocks into negative oil price shocks (when oil price increase or are positive) and positive oil price shocks (when oil price decrease or are negative). Interestingly however, we estimated the negative shocks (oil price increase) as DOP and the positive shocks (oil price decrease) as DON because of the positive values for negative shocks and the negative values for positive shocks. Additionally, the non-linear specification is included to help give further robustness to the results from the benchmark estimation and to provide better explanation to the oil-macroeconomy discussion in Ghana. Table 8 provides the results using the same VECM estimation on the non-linear specification with the negative oil price shocks or oil price increase shocks.

Table 8 Displays Results of Long Run Dynamics of VEC Model

Cointegrating Eq:	CointEq1
DLGPC(-1)	1.0000
DLCPI(-1)	-0.3501* (0.0890) [-3.9317]
DER	18.5168* (3.1779) [5.8366]
DOP	-0.0352*** (0.0203) [-1.7336]
C	-5.9840

VECM: Standard errors in the ( ) and the t-statistics in the [ ] *, **, and *** asterisks indicate the coefficients are significant at 1%, 5% and 10% significant level respectively.

Given the non-linear specification and the results from the negative oil price shocks estimation in the table above, it can be observe at a glance that the slope of the negative oil price shocks (DOP) and output (DLGPC) are negatively related. Which implies that while oil price (DOP) is increasing, output (DLGPC) will be decreasing. This is quite fascinating as the result is consistent with previous studies which shed economic credence to our analysis. Following the same logic as the benchmark estimation, the GDP per capita (DLGPI) represents the dependent variable and inflation (DLCPI), exchange rate (DER) and the negative oil shocks (DOP) are the independent variables.

From the long-run dynamics, the negative oil price shocks indicates that there exist a negative relationship between output, inflation and crude oil prices while a positive relation exist between output and exchange rate. In this estimation all variables are cointegrated with coefficients that are statistically significant at the 1% and 10% significance levels. This result confirms the cointegration test results which indicate that at least 3 cointegrating vectors exist in the model. The coefficient of the inflation proxy, DLCPI, is -0.35 which implies that a 1% increase in general price levels, will lead to a 35% decrease in the output (DLGPC) in Ghana. Exploring the implication of the statistical significance reveals that holding all other variables constant, increase in inflation rate can depress macroeconomy performance in Ghana. For the negative oil price shocks (DOP), which still remains the variable of interest, the coefficient is -0.0352 and is also statistically significant at the 10% significance level. The result implies that for any 1 unit increase in world crude oil price, output (DLGPC), will fall by 3.52% in Ghana.

Juxtaposing this result with the benchmark (linear) estimations, we observe that the impact at the non-linear level is relatively larger in terms of percentage. This gives an inherent indication that the oil price-macroeconomy relationship is more of non-linear than linear in Ghana. Furthermore, the statistically significant coefficient indicates that an increase in crude prices (negative oil price shocks) can dampen economic growth in Ghana and consequently reduce output.

Table 9 Displays Results of Short-run Dynamics of the VECM Model

Variable	Coefficient	Standard Error	t-statistics
DlnGPC	-0.0462	0.1597	-0.2892

*means the coefficient is statistically significant at 1% significance level.

Following the same argumentation from the benchmark estimation, the short-run dynamics primarily provides the coefficients for the error correction aspect in the model. From table 9, we observe that despite the correction of disequilibrium in the cointegrated variables to the magnitude of 4.62% given by the coefficient (-0.0462), a stable long-run relationship is not restored. The implication is that oil price shocks impacts on economic activity do not hold perfectly for a long-term. This is consistent with the benchmark estimation which indicate that any fluctuations in the cointegrated variables (DLCPI, AND DOP) that causes DLGPC to deviate from equilibrium is corrected in current year but is statistically insignificant to restore stable long-run relationship among cointegrated variables.

On the final part of the nonlinear specification, we explore the case of positive oil price shocks (decrease in oil prices) using the Mork (1989) transformation and the results are as follows:

Table 10 Displays Results of Long Run Dynamics of the VEC Model

Cointegrating Eq:	CointEq1
DLGPC(-1)	1.0000
DLCPI(-1)	-0.2566* (0.0708) [-3.6249]
DER	0.9484 (1.9475) [0.4869]
DON⁻	0.2036* (0.0467) [-4.3625]
C	-5.07836

VECM: Standard errors in the ( ) and the t-statistics in the [ ] *, **, and *** asterisks indicate the coefficients are significant at 1%, 5% and 10% significant level respectively.

The results confirm DLCPI and DON as the cointegrated variables with the dependent variable, DLGPC and a statistically significant coefficients at the 1% significance level. Thus, output, inflation and negative oil price have long-run relationship. From the long-run dynamics of the VECM in table 10 above, positive oil price shocks (oil price decrease) stimulates economic activity. From the result, the coefficient (0.2036) of the positive oil price shock (DON) is positive while the coefficient (0.2566) of the inflation (DLCPI) is negative. The statistical inference is that a 1 unit decrease in crude oil price will translate into a 20.36% increase in output. This is a bit high but not surprising because Ghana is largely an oil dependent economy with imports of finished petroleum products accounting for the largest share of her total crude oil demand. The coefficient for the oil price variable is statistically significant at the 1% significance level which therefore stands to reason that, all things being equal, decrease in crude oil price can be a catalyst for economic boom in Ghana, causing a strong growth in output.

The rather large negative coefficient of the DLCPI, only implies that high inflation will decrease output (DLGPC) by 25.7% which has been the case in all three estimations so far. A more interesting results to note is the coefficient of the exchange rate proxy (DER) which indicates a positive correlation with positive oil shocks (DON). The inference is that, both exchange rate and negative oil shocks moves in the same direction. Thus, as crude oil price decrease, the exchange rate also decreases in Ghana. This support economic theory partly in the sense that, as the US Dollar denominated crude oil price decreases, fewer US dollars will be demanded in the forex market to make oil import payments and all things being equal, the exchange rate will appreciates.

Table 11 Displays Short-run Dynamics of the VECM Model

Variable	Coefficient	Standard Error	t-statistics
DlnGPC	-0.0398*	0.0082	-4.8837

*means the coefficient is statistically significant at 1% significance level.

From the short-run dynamics of the VECM above, the coefficient is negative in sign and statistically significant at the 1% significance level which indicates that any deviation to the equilibrium state among the cointegrated variables is restored. In a more simplistic form, the negative and significance coefficient suggest that, any short-run fluctuations among the cointegrated variables (DLCPI and DON) that cause output (DLGPC) to diverge from equilibrium state is corrected by the error term to maintain stable long-run relationship among the variables.

The main conclusion from the foregoing analysis is that both linear and negative oil price shocks adversely impact economic activity whiles a positive oil shock stimulates growth. No evidence of asymmetric relationship exist between oil price shocks and macroeconomy variables in Ghana. Furthermore, there is nonlinear oil price-macroeconomy relationship from the Ghanaian perspective. Thus, from the results above oil price increase decreases output while oil price decrease stimulate output growth.

5 CONCLUSION AND RECOMMENDATION

As Ghana continues to grow into a high middle income status with her recent discovery of crude oil which is under exploration, the stakes are quite high that in the near future the country can wean herself off the high crude and finished oil products importation. Nonetheless, Ghana is still a developing net-oil importing economy with heavy dependence on energy for that matter, crude oil imports for most industrial and socio-economic activities. Subsequently, the verification of the relationship between oil price shocks and macroeconomic variables seems very essential for most policy implications and investment decisions.

There is a large amount of literature on the effects of oil shocks on developed economies which have largely driven theoretical suggestions about the oil price-macroeconomy relationship. Formal study on the impact of oil price fluctuations on Ghana as well as most developing oil importing economies seems to be lacking especially from Africa. This study departs from other papers in focusing on the impacts of oil shocks on the macroeconomy of a developing net oil importer in the case of Ghana, thereby providing a fresh perspective into the oil-macroeconomy relationship. Applying the Johansen cointegration methodology as an empirical modeling, we examine the long-term relationship between the oil price shocks and macroeconomy of Ghana. Following the results from the Johansen cointegration testing, we applied the VEC model as estimation technique for the oil price-macroeconomy relationship.

As per a common notion among many researchers in the literature, the nonlinear relationship is more appropriate for capturing the oil-macroeconomy relationship hence, we specify the benchmark (linear) oil price shocks and a nonlinear oil price shocks. The empirical findings of this study suggest that both the linear and negative nonlinear oil price shocks have adverse impact on the macroeconomic variables in Ghana. This confirms what economic theory suggest and also given that Ghana is highly an oil dependent economy. However, the magnitude of impact ranges around 3% to 4% decline in GDP, and although this is statistically significant at the 1% significance level, we argue that it is relatively marginal. This view is in line with what recent studies in most literature claim that a diminishing oil-macroeconomy relationship exist (Hooker, 1996; Chang and Wong, 2003). In addition, with Ghana's oil export accounting for around 22% (Bank of Ghana, 2012) of her total merchandise export, it is probably realistic to experience such a minute decline in output during oil price shocks.

On the contrary to most popular views in literature however, the results from the positive non-linear oil price shocks reveal an output growth of about 21% given a 1 unit decrease in crude oil prices. This result is relatively acceptable on economic grounds because with a trade balance deficit of about US$4,220.4 million in 2012 compared to a 2011 figure of US$3,052.3 million, which according the Bank of Ghana (2012) report was mainly due to significant increase in oil imports, we expect that a decrease in oil prices will free oil budget which can be injected into other growth projects. To this end, it is noteworthy that no evidence of asymmetric relationship exist between oil price shocks and macroeconomy variables in Ghana but there is nonlinear oil price-macroeconomy relationship from the Ghanaian perspective.

Despite the small magnitude of the percentage decline in output during oil price shocks, this study argues that smaller in number does not necessarily mean smaller in impact since the literature has already evidenced how significant oil is to the socio-economic development of Ghana. Our proposition is that the impact of an oil shocks on the macroeconomy of Ghana should not be treated with triviality or considered negligible. Government should pursue the policy of fuel diversification by making investment into other fuel substitutes and other sources of energy like biofuel which can help reduce the high oil dependency ratio. With the world calling for clean energy and with some big economies making huge investment in that line, Ghana should also pursue aggressively some of these policies to help reduce the pressure on oil. To this end, we wish to also point out that, there is a room for refining our empirical findings since the VECM methodology used in the study might be overly simplified. To ensure a natural progression in this direction, the structural vector autoregression (VAR) methodology could be pursued.

REFERENCE

Amano, R.A. & Van Norden, S. (1998), "Oil prices and the rise and fall of the US real exchange rate", Journal of International Money and Finance 17, 299–316.

Anokye, M.A. & Tweneboah, G. (2008), "Implication of oil price shocks for Monetary Policy in Ghana: Vector Error correction Model", MPRA Resources, University of Leicester, NO. (11968).

Agiakoglu, C. & Newbold, P. (1992), "Empirical evidence on Dickey–Fuller type tests", Journal of Time Series Analysis13, 471–483.

Al-Khouri, R. & Dhade, A. (2014), "The Role of Savings in Reducing the Effect of Oil Price Volatility for Sustainable Economic Growth in Oil Based Economies: The Case of GCC Countries", International Journal of Economics and Finance; Vol. 6, No. 4; 2014

Ayadi O.F. (2005), "Oil price fluctuations and the Nigerian economy", OPEC Review: Energy Economics & Related Issues 29 (3), 199-217.

Bank of Ghana Data Base- *www.bog.gov.gh* . (Accessed on February 20, 2013)

Bank of Ghana Annual Report 2012- *www.bog.gov.gh* (Accessed on February 20, 2013)

Barsky, R.B. & Kilian, L. (2002), "Do we really know that oil caused the great stagflation? A monetary alternative", In: Bernanke, B.S., Rogoff, K. (Eds.), NBER Macroeconomics

Barsky, R.B. & Kilian, L. (2004), "Oil and the macroeconomy since the 1970s", Journal of Economic Perspectives 18 (4), 115–134.

Bernanke, B.S., Gertler, M. & Watson, M.W. (1997), "Systematic monetary policy and the effects of oil price shocks", Brookings Papers on Economic Activity 1, 91–157.
Berument, H. & Tasci, H. (2002), "Inflationary effect of crude oil prices in Turkey" Physica A: Statistical Mechanics and Its Applications 316, 568 – 80.
Blanchard, O.J. & Galí, J. (2008), "The macroeconomic effects of oil price shocks: why are the 2000s so different from the 1970s"? In: Galí, J., Gertler, M. (Eds.), International
Bohi, D. (1989). "Energy Price Shocks and Macroeconomic Performance", Resources for the Future, Washington, DC.
Bohi, D.R. (1991), "On the macroeconomic effects of energy price shocks", Resources and Energy 13, 145–162.
Brown, S.P. & Yucel, M.K. (2002), "Energy prices and aggregate economic activity: an interpretative survey", The Quarterly Review of Economics and Finance 42.
Bruno, M. & Sachs, J. (1982), "Input price shocks and the slowdown in economic growth: the case of UK manufacturing", Review of Economic Studies XLIX, 679–705.
Burbidge, J. & Harrison, A. (1984), "Testing for the effects of oil-price rises using vector autoregressions", International Economic Review 25 (2), 459.
Cavalcanti, T. & Jalles, J.T. (2013), "Macroeconomic effects of oil price shocks in Brazil and in the United States" Applied Energy 104, 475–486.
Chang, Y. & Wong, J.F. (2003), "Oil price fluctuations and Singapore economy", Energy Policy 31, 1151–1165.
Chaudhuri, K. & Daniel, B.C. (1998), "Long-run equilibrium real exchange rates and oil prices", Economics Letters 58, 231–238.
Cologni, A. & Manera, M. (2008), "Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries", Energy Economics 38, 856–888.
Cunado, J. & Gracia, P. (2005), "Oil prices, economic activity and inflation: evidence for some Asian countries", Quarterly Review of Economics and Finance 45.
Darby, M. (1982), "The price of oil and world inflation and recession", The American Economic Review 72 (4).
Davis, S.J. & Haltiwanger, J. (2001), "Sectoral job creation and destruction responses to oil price changes" Journal of Monetary Economics 48, 465–512.
De Gregorio, J., Landerretche, O. & Neilson, C. (2007), "Another pass-through bites the dust? Oil prices and inflation", Economia 7 (2), 155–196.
Dimensions of Monetary Policy. University of Chicago Press, Chicago, IL.
Dogrul, H.G. & Soytas, U. (2010), "Relationship between oil prices, interest rate, and unemployment: evidence from an emerging market", Energy Economics 32, 1523– 8.
Doroodian, K. & Boyd, R. (2002), "The linkage between oil price shocks and economic growth with inflation in the presence of technological advances: a CGE model", Energy Policy (31), 989–1006 DPAE/10/01. Universidad de Oviedo.
Du, L., He, Y. & Wei, C. (2010), "The relationship between oil price shocks and China's macro-economy: An empirical analysis", Energy Policy 38, 4142–4151.
Elmi, Z. & Jahadi, M. (2011), "Oil price shocks and economic growth: evidence from OPEC and OECD", Australian Journal of Basic and Applied Sciences 5 (6), 627–635.
Engle, R.F. & Granger, C.W.J. (1987), "Cointegration and error correction: representation, estimation, and testing", Econometrica55, 251–276.
ESMAP (Energy Sector Management Assistance Program), 2005$_b$. "The vulnerability of African countries to oil price shocks: major factors and policy options: the case of oil importing countries", Details available at *www.esmap.org* Assessed on June 1, 2013
Farzanegan. M.R. & Markwardt, G. (2009), "The effects of oil price shocks on the Iranian economy", Energy Economics 31, 134–151
Ghana Government http://www.ghana.gov.gh Assessed on June 8, 2013
Ghana National petroleum Corporation http://www.gnpcghana.com (Accessed on May 20, 2013).
Ghana Statistical Service, 2012 report: http://www/statsghana.gov.gh (Accessed on January 4, 2014).
Gisser, M. & Goodwin, T.H. (1986), "Crude oil and the macroeconomy: tests of some popular nations), Money, Credit and Banking 18 (1).
Gómez-Loscos, A., Gadea, M.D. & Montañés, A. (2010a), "Economic growth, inflation and oil shocks. Are the 1970s coming back"? Discussion Paper on Applied Economics
Granger, C. W. J. (1969), "Investigating Causal Relations by Econometric Models and Cross- Spectral Methods", Econometrica, 37: 424–438.
Granger, C.W.J., Huang, B. & Yang, C. (2000), "A Bivariate Causality between stock prices and Exchange rate: evidence from recent Asian flu", The Quarterly Review of Economics and Finance 40, 337-354.
Hamilton, J. (2001), "A parametric approach to flexible nonlinear inference", Econometrica 69, 537–573.
Hamilton, J.D. (1983), "Oil and the macroeconomy since World War II", Journal of political economy 91, 228–

248.
Hamilton, J.D. (1985), “Historical causes of postwar oil shocks and recessions”, Energy Journal 6, 97–116.
Hamilton, J.D. (1988), “Are the macroeconomic effects of oil-price change symmetric? A Comment, Carnegie Rochester Conference Series on Public Policy, 28, pp. 369–378.
Hamilton, J.D. (1996), “This is what happened to the oil price-macroeconomy relationship”, Journal of Monetary Economics 38.
Hamilton, J.D. (2003), “What is an oil shock”? Journal of Econometrics 113.
Hamilton, J.D. (2008), “Oil and the macroeconomy, In: Durlauf, S.N., Blume, L.E. (Eds.), The New Palgrave Dictionary of Economics, Second Ed. Palgrave Macmillan, Houndmills,
Hanson, K., Robinson, S. & Schluter, G. (1993), “Sectoral effects of a world oil price shock: economy wide linkages to the agricultural sector”, Journal of Agricultural and Resource Economics 18 (1), 96–116.
Herrera, A.M. & Pesavento, E. (2007), “Oil price shocks, systematic monetary policy and the ‘great moderation’. Macroecon. Dyn. 13 (1), 107–137.
Hooker, M.A. (1996), “What happened to the oil price-macroeconomy relationship”? Journal of Monetary Economics 38 (2).
Huang, B.-N., Hwang, M.J. & Peng, H.-P. (2005), “The asymmetry of the impact of oil price shocks on economic activities: an application of the multivariate threshold model”, Energy Economics 27, 445–476.
IMF January, 2012 update. http://www.imf.org (Assessed on June 8, 2013)
Iwayemi, A. & Fowowe, B. (2011), “Impact of oil price shocks on some selected macroeconomic variable in Nigeria”, Energy Policy 39, 603-612.
Jbir, R. & Zouari-Ghorbel. (2009), “Recent oil price shock and Tunisian economy”, Energy Policy 37, 1041–1051.
Jiménez-Rodríguez, R. & Sánchez, M. (2005), “Oil price shocks and real GDP growth: empirical evidence for some OECD countries”, Applied Economics 37, 201–228.
Johansen, S. (1988), “Statistical analysis of cointegration vectors”, J. Econ. Dyn. Control 12, 231–234.
Johansen S. & Juselius K. (1990), “Maximum Likelihood Estimation and Inference on Cointegration – with Applications to the Demand for Money”, Oxford Bulletin of Economics and Statistics 52.
Johansen, S. (1991), “Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models), Econometrica, 59: 1551–1580.
Kapetanios, G. & Tzavalis, E. (2010), “Modeling structural breaks in economic relationships using large shocks”, Journal of Economic Dynamics and Control 34 (3), 417–436.
Kilian, L. (2008b), “The economic effects of energy price shocks”, Journal of Economic Literature 46 (4), 871–909.
Kilian, L., Rebucci, A. & Spatafora, N., 2007, “Oil shocks and external balances”, IMF Working Paper 07/110.
Lardic, S. & Mignon, V. (2006), “The impact of oil prices on GDP in European countries: An empirical investigation based on asymmetric Cointegration”, Energy Policy 34, 3910–3915.
Lee, K., Ni, S. (2002), “On the dynamic effects of oil price shocks: a study using industry level data”, Journal of Monetary Economics 49 (4), 823–852.
Lee, K., Ni, S. & Ratti, R.A. (1995), “Oil price shocks and the macroeconomy: the role of price variability”, Energy Journal 16, 39.
Lin, B., Presley Jr, W. K. & Micheal, A.O. (2014), “Oil price fluctuation, volatility spillover and the Ghanaian equity market: Implication for portfolio management and hedging effectiveness”, Energy Economics 42 (2014) 172–182.
Lorde, T., Jackman, M. & Thomas, C. (2009), “The macroeconomic effects of oil price fluctuations on a small open oil-producing country: the case of Trinidad and Tobago”, Energy Policy; 2708e16.
Market Report, February, 2012. IEA: http://www.iea.org. Accessed on June 8, 2013.
Ministry of Energy, Ghana 2012, 2013 report: http://www.energymin.gov.gh. Accessed December 30, 2013.
Mork, K.A. (1989), “Oil and the macro-economy, when prices go up and down: an extension of Hamilton’s results”, Journal of Political Economy 97 (3), 740–744.
Mork, P., Oslen, O. & Mysen, H. (1994), “Macroeconomic responses to oil price increases and decreases in seven OECD countries”, Energy Journal 15, 15–38.
Mory, J.F. (1993), “Oil prices and economic activity: is the relationship symmetric”? The Energy Journal 14, 151–161.
Nakov, A. & Pescatori, A. (2010), “Oil and the great moderation”, Economic Journal 120 (543), 131–156.
Nnadikwe, K., 2011, “High Oil Dependence in Ghana: To What Extent is Ghana Vulnerable to Oil Price Shock”? Library Resource for CEPMLP, University of Dundee.
Olomola, P.A. & Adejumo, A.V. (2006) “Oil price shock and macroeconomic activities in Nigeria”, International Research Journal of Finance and Economics 3, 28–34.
Papapetrou, E. (2001), “Oil price shocks, stock market, economic activity and employment in Greece”, Energy

Econ. 23, 511–532.
Quagraine, F. (2012), "Is Ghana's value capture from petroleum sector fair? Case study of the Jubilee Fields-Ghana", CEPMLP Annual Review-CAR Volume 16 (2013).
Rafiq, S., Salim, R. & Bloch, H. (2009), "Impact of crude oil price volatility on economic activities: an empirical investigation in the Thai economy", Resources Policy; 121– 32.
Rasche, R.H & Tatom, J.A. (1981), "Energy price shocks, aggregate supply, and monetary policy: the theory and international evidence", In: Brunner, K., Meltzer, A.H. (Eds.), Supply shocks, Incentives, and National Wealyh, Carnegie-Rochester conference Series on Public Policy, vol. 14. North-Holland, Amsterdam.
Rasmussen, T.N. & Roitman, A. (2011), "Oil Shocks in a Global Perspective: Are they really that Bad? IMF Working Paper No: WP/11/194.
Rautava, J., (2004), "The role of oil prices and the real exchange rate in Russia's economy—cointegration approach", Journal of Comparative Economics 32 (2), 315–327.
Raymond, J.E. & Rich, R.W. (1997), "Oil and the macroeconomy: a Markov state-switching approach", Journal of Money, Credit and Banking 29, 193–213.
Rodriguez, R.J. & Sanchez, M. (2005), "Oil price shocks and real GDP growth: empirical evidence for some OCDE countries", Applied Economics 37, 201–228.
Romer, C.D. & Romer, D.H. (1989), "Does monetary policy matter? A new test in the spirit of Friedman and Schwartz", NBER Macroeconomics Annual.
Sanchez, M., 2011 "Welfare effects of rising oil prices in oil-importing developing Economies", The Developing Economies 49 (3), 321–346.
Tatom, J.A. (1993), "Are there useful lessons from the 1990–1991 oil price shock"? The Energy Journal 14 (4), 129–150.
Trung, L.V. & Vinh, N.T.T. (2011), "The Impact of 0il Prices, real effective exchange rate and inflation on economic activity. Novel Evidence foe Vietnam", Research Institute for Economic and Business Administration, Knobe University. Online available at: http://www.rieb.kobe-u.ac.jp/academic/ra/dp/English/DP2011-09.pdf. (Accessed on January 8, 2013.
Tullow Oil 2012 Report: http://www.tullowoil.com/ghana (Accessed on December 12, 2013)
UNDP/ESMAP (United Nations development programme/world Bank Energy Sector Management Assistance Program), 2005. The Impact of Higher Oil Prices on Low Income Countries and on the Poor: http://www.worldbank.org (Accessed on June 4, 2013)
Uri, N.D., 1996. "Crude oil price volatility and unemployment in the United States", Fuel Energy Abstracts 37, 91.
Zhang, D., 2008. "Oil shock and economic growth in Japan: A nonlinear approach", Energy Economics 30, 2374–2390.
Zivot, E. & Andrews, D.W.K. (1992). "Further evidence on the great crash, the oil price shock and the unit root hypothesis", Journal of Business and Economic Statistics 10, 251–270.