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What's New? The Role of Asymmetry and Breaks in Oil Price - Output Growth Volatility Nexus

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Abstract
This study examines the role of asymmetry and breaks in oil price-output growth volatility nexus. A representative of 10 countries, each, was selected from net oil-exporting and importing countries for the period 1986-2017. It is hypothesized that countries respond differently to changes in oil price. To prove this point, we use the recent Nonlinear ARDL of Shin et al. (2014), based on the framework of the dynamic common correlated effect of the heterogeneous panel of Chudik and Pesaran (2015), to decompose oil price into positive and negative partial sums. Our results show that without accounting for breaks, asymmetry only matters for net oil exporters in both short- and long- run. However, accounting for breaks expanded the importance of asymmetry to net oil importers (in the short-run). These results are robust to changes in the measures of oil price and growth volatility.

Keywords: Oil price, Output growth volatility, Asymmetry, Breaks and Heterogeneous panels

1. Introduction

Among the macroeconomic (monetary) policy objectives of economies around the world is to attain stable and predictable trend of economic growth. There has been a paradigm shift in the frontier of knowledge of developmental economics. Early studies have based their argument on economic growth, while later set of studies have argued for the importance of accounting for business cycle. What's more, Ramey and Ramey (1995) estimated a negative relationship between economic growth and its volatility. Based on this identified importance of business cycle, several studies have made enormous attempt to understating the causes, nature and solution of this cycle. Essentially, studies have based scientific enquiries to identifying variables that have either dampening or magnifying influence on output growth volatility (business cycle)[1].

In a different approach, though common in the literature, we have identified oil price shock as having an important effect on economic activities and macroeconomic fundamentals. In this line of reasoning, the major argument is due to the epoch-making paper of Hamilton (1983) who argues that oil price shocks have "predictive content" on economic activities and macroeconomic policies of developed countries. Hamilton (1983) and succeeding studies[2], posit that huge and sudden increase in oil prices precede recession and also increases inflation rate in the United States (US). It can be summarily stated that the Hamilton and his followers assume a symmetry relationship between oil price shocks and economic activities.

The dominance of these symmetry studies was short lived. The following are the flaws and criticisms offered in the literature. The major criticism dwells on their (symmetry based studies) inability to account for asymmetry. For instance, all but one of the five major recessions in the US, between the end of World War II and 1973, were preceded by oil price rise. Barsky and Kilian (2002) argue that the major oil price changes in the 1970s were not the main cause of stagflation but due to monetary factors. Mork (1989) pin-pointed that for the mere fact that oil price increase has negative effects on growth does not necessarily mean oil price reduction would lead to economic growth, at least for the US. Of specific importance is the failure of oil price collapse, in 1986, to translate into economic growth, hence serves as a pointer to the asymmetry effect. Mork, Olsen and Mysen (1994) concluded that asymmetry effect is present in most OECD countries. In fact, Lee, Ni and Ralti (1994) expressed that the increasing oil price volatility contributed to the asymmetric effect especially when economic activities are being deflated by oil price volatility. Hooker (1996) concluded that the linear relationship between oil price and the economy appears to be much weaker after 1973. As such, the symmetry relationship appears to be a mere illusion. Interestingly, another source of flaw for the symmetry and by extension

[1] See Chami et al., 2009; Ebeke and Chami, 2013; Ajide et al. 2015 a, b and 2016; and Raheem, 2016 and the references therein.

[2] Among the earlier supporters of Hamilton include Gisser and Goodwin (1986), and Burbidge and Harrison (1984) to mention a few.

advantage of asymmetry is based on ignoring the effect of 1986 Tax Reform Act (in the United States) on fixed investment and the aggregation of energy and non-energy related investment (see Edelstein and Kilian, 2007 and 2009).

Based on the foregoing, it has become imperative for studies to test for the existence of asymmetry when modeling oil price. Thus, the crux of this present study is in two-fold. The first objective is to check if oil price shock serves as a plausible candidate to have a significant effect (dampening or magnifying) on business cycle, an important macroeconomic policy objective. If the above is confirmed, we proceed to the second objective, which is to examine the asymmetric effect (if any) of oil price shocks on output growth volatility. Thus, we examine both the short- and long-run effects of oil price shock on economic growth using the partial sum decompositions of the Shin et al. (2013) NARDL framework. The NARDL is further complemented with the dynamic common correlated effect estimator of Chudik and Pesaran (2015).

This study presents two novelties to the literature. First and in contrast to the routine of earlier studies to focus on the US, we expanded our scope to account for not only net oil exporting countries but also for net oil importing countries. The aim of this exercise is to shed more light on how countries, with different characteristics, respond to shocks. This intuition is coming from the fact that the responses of oil exporting countries are quite different from those of importing countries[3]. Hence, in order to have a holistic perspective, we consider these two sets of countries. The second innovation lies on the test of possible existence of asymmetries. While we acknowledge that quite a huge amount of studies have dwelled in this line of research, our innovation lies on the use of the recently developed test, nonlinear autoregressive distributed lags (NARDL) by Shin et al (2014).

Purveying our results, we found that oil price magnifies the business cycle of both oil- importing and exporting countries. On the asymmetry between oil price and economic growth volatility, results show that without accounting for breaks, asymmetry only matters for net oil exporters in both short- and long- run. However, accounting for breaks expanded the importance of asymmetry to net oil importers, in the short-run. These results stand the test of changes in the measure of volatility and oil prices.

We structure the rest of the paper in this order: the next section deals with literature review. Data and methodology are discussed in the section three. Section four houses result interpretation, discussion and robustness tests. In section five, we highlight the conclusion as well as policy implication of our rest.

[3] For the transmission mechanism of oil price shock and differentiating the response of oil exporting countries to their importing counterpart, see Kilian et al. (2009), Rafiq et al. (2016) and Raheem (2017).

2 Literature Review

The literature on oil price changes/shocks can be categorized into three groups. They are: pro Hamilton; anti Hamilton and Asymmetric based studies.

We begin with pro Hamilton. In the epoch-making paper of Hamilton (1983)[4], the results of the estimated model show that increase in the price of crude oil granger causes economic recession in the US. Decades succeeding this paper have shown that Hamilton's idea has become a conventional wisdom and has remained unchallenged[5]. Among studies that appear to be in the same spirit with Hamilton include Gisser and Goodwin (1986), who focused on St. Louis-type equations of selected macroeconomic indicators. Sadorsky (1999) provided evidence supporting the conclusion of Hamilton. He established that increase in oil price have a greater impact on economic activities and attributed this scenario to the forecast error variance of real stock returns and interest rate. Based on the criticism received from Hooker (1996), Hamilton in 1996 proposed better measure of oil price change dabbed "net oil price increase" (NOPI)[6]. With this new measure and the adoption of VAR framework for the United States data, the results of his earlier study in 1983 were revalidated.

Studies that seem not to be in agreement with Hamilton have based their decision on the fact that the restrictive monetary policies of central banks of developed countries are the major cause of macroeconomic instability. The first major rejoinder was Bohi (1991) who stated that the restraining policies of central banks of Germany, Japan, US and the United Kingdom accounts for a greater chunk of the decline in the economic output in the succeeding years of an oil price increase. Also, Bernanke et al. (1997) argued that Hamilton's result seems to antagonize historical data on oil price and economic recession in the United States. They adopted a VAR model to document that recessions in the post-world war II era were preceded by increase in oil price and tightening of monetary policy. They concluded that the increase in interest rate after the oil price shock was the major reason for the economic turmoil. Hooker (1999) was able to establish the fact that the two widely used measures of oil price (Brent and WTI) do not "granger cause" many US macroeconomic variables after 1973. This is just as Hooker (2002) pinpointed to the existence of break in the US inflation such that oil price's contribution to the inflation rate prior to 1981 was significant, though years after this period has showed that the pass-through is

[4] Caution must be exercise here in that there are prior studies to Hamilton, who have examined the oil price change and macroeconomic nexus. For instance, Darby (1982) modeled the relationship between increase in oil price and real income growth of developed economies, inclusive of the US. Based on simulation experiment, he was unable to find a direct and significant relationship between oil price changes and income growth. However, through an indirect effect of export, exchange rate and money supply, there seems to be a significant relationship between the two key variables of interest.

[5] On the theoretical front, several attempts have been made to link macroeconomic fundamentals with oil price dynamics. Some of the more recent contributions include Kim and Loungani (1992), Rotemberg and Woodford (1996), Finn (2000), Leduc and Sill (2004) and Carlstrom and Fuerst (2005).

[6] NOPI is defined as the positive difference between the current oil price level and the maximum oil price relative to the previous four quarters.

very minute[7]. To further compound to the foes of Hamilton's conclusion, Barsky and Kilian (2002) opined that the increase in oil price around 1970s were not the major cause of staginflation-an indication of macroeconomic fluctuations-rather the latter is caused by some selected monetary policy tools that were adopted by the Federal Reserve Bank. Kilian (2008) reached a similar conclusion. Jimenez-Rodriguez and Sanchez (2005) were able to estimate negative coefficient in the association between oil price and GDP. It is also interesting to infer that the conclusion of these "anti-Hamilton" studies has also been criticized. In fact, results of Hamilton and Herrera (2004), Brown and Yucel (1999) and Balke, Brown and Yucel (2002) show that counter-inflationary monetary policy is just "partially" responsible for the real effect of oil price shocks that have hit the US during the last thirty years.

In another interesting twist, studies have shown that the linear relationship between oil price and macroeconomic fluctuations break down due to high volatility of oil price movement. This is in addition to estimating the effect of oil price change on the economy using two-regime model[8]. For instance, Lee, Ni and Ratti (1994) while using GARCH argued that oil price shock is likely to have a greater impact in environments where there is relative stability in oil price as compared to regions that is susceptible to frequent changes. Raymond and Rich (1997) develop a generalized Markov switching model of output to examine the capabilities of oil price change to generate shifts in the mean of GDP growth and to predict transitions between dichotomous growth phases. The results indicate that while the behavior of oil prices has been a contributing factor to the mean of low-growth phases of output, movements in oil prices generally have not been a principal determinant in the historical incidence of these phases. Other studies that have used Markov-Switching model include Engemann, et al. (2011), Abiyev et al. (2015).

As stated above, studies have indicated that increase in oil price have a negative effect on macroeconomic indicators, it would not be out of place to hypothesis that oil price collapse should lead to macroeconomic boom. The failure of the 1986 oil price collapse to produce an economic prosperity is a classic example. Thus, this has emanated academics and policymakers to conclude hypothesize the existence of an asymmetric relationship between oil price change and the economy. Studies supporting this stance include Mork (1989) who argued that if the scope of Hamilton was extended to capture oil price collapse of 1986, the positive relationship cease to exist. Thus, he was the first to test the asymmetry hypothesis using the United States data by having diverging effects of increase and decrease in oil price. Based on his results, it was found that increase in oil price have a negative and significant coefficient, while the inverse effect was found for the decline in oil price, though it was insignificant. Mork et al. (1994) replicated this analysis with an expanded dataset. Specifically, they verified that there was a negative and significant relationship between an oil price increase

[7] This break date roughly coincides with (but precedes) the beginning of a period of remarkable macroeconomic stability of key macroeconomic in some selected developed countries. (Nakov and Pescatori, 2010).

[8] In this line of reasoning, Markov–Switching regime autoregressive (MSRA) models are commonly used.

and national output, while no statistical significance could be attributed to when the oil price falls. Sadorsky (1999) estimated the asymmetric relationship between economic activities and oil price changes using a two-regime model. Clements and Krolzig (2002) concluded that three-state Markov-Switching model is the appropriate for investigating the explanatory power of the asymmetric effect of oil on business cycle; oil prices do not appear to be the sole explanation of regime-switching behavior; and the asymmetries detected in the business cycle do not appear to be explainable by oil prices. Cologni and Manera (2009) studied the effect of oil price change on business cycle of G-7 countries by comparing alternative regime switching models of MSRA. They were able to identify three-regime Markov-Switch model in describing the business cycle features of each country.

There are also studies that have confirmed the existence of asymmetric effect using diverse methodology apart from MSRA. For instance, Huang et al. (2005) applied multivariate threshold model for three industrialized economies (Canada, Japan and the US). Some of the result that was estimated include: (i) an oil price change or its volatility has a limited impact on the economies if the change is below the threshold levels; (ii) if the change is above threshold levels, it appears that the change in oil price better explains macroeconomic variables than the volatility of the oil price; and (iii) if the change is above threshold levels, a change in oil price or its volatility explains the model better than the real interest rate. An et al. (2014) using simulation methods of Factor-Augmented Vector Autoregressive model to trace the effects of positive and negative oil price shocks on the macroeconomic variables through the Impulse Response Function (IRF). It was found that the negative impacts of higher oil prices are larger than the positive effects of lower oil prices. Also, the asymmetric effects are more evident when the oil price shocks are larger. Menoda and Vera (2010) using Venezuelan data confirm that oil price shocks have asymmetric effect on output growth.

Mehrara's (2008) results were based on nonlinear dynamic panel framework for selected oil exporting countries. Essentially, he found that economic growth is negatively correlated with negative oil price shock. However, positive oil price shock has limited effect on economic growth. Rahman and Serletis (2011) are of the view that monetary policy and oil price volatility are the major causes of asymmetry between oil price and economic performance of the USA. Moshiri and Banijashem (2012) concluded that decrease in oil price fuels drop in oil revenue and thus leads to stagnation of the economy, while higher oil price does not lead to improved economic performance. The current norm in the literature is to examine asymmetry through partial sum decomposition of oil prices into positive and negative changes. This methodology was inspired by Shin et al. (2014) and coined Non-linear Autoregressive Distributed Lag (NARDL). Nusair (2016) used this methodology and conclude that rising oil price increase real GDP and falling price lower real GDP. It was further stated that increasing oil prices have a considerably larger impact than falling prices. Other related studies include

A number of studies have extended the asymmetric effect of oil price shock beyond economic growth. Some of these studies found significant and robust effect of oil price shock on some macroeconomic variables. For instance, Allegret et al. (2014) focused on current account position. Awartani and Maghyereh (2013), Jouini and Harrathi (2014) and Salisu and Isah (2016) analyses were centered on stock price- oil price shock. Raheem (2017) limited his analysis to oil price and trade nexus. On inflation, Sek (2017) show that oil price nonlinearly affect domestic prices across the selected sectors.

The prowess of asymmetry has not gone unchallenged. For instance, Serletis and Istiak (2013) used slope-based tests and tests of the null hypothesis of symmetric impulse response. Mixed results were estimated, in that some countries data reveal the existence of asymmetry, while others do not. Similarly, Moshiri (2015) found that the asymmetry between oil price and economic growth is heterogeneous to income group of countries. He show that lower, for developing countries, oil prices lead to major revenue cuts and ensuing stagnation in the economy, but higher oil prices and accompanying higher revenues do not translate into sustained economic growth. However, asymmetry does not have significant effect on oil-exporting developed countries.

3 Data and Methodology

In analyzing the asymmetric effect of oil price change and output growth volatility, two groups of countries are selected. The first group contains countries considered to be net exported of oil, while the second group contains the list of net oil importers[9]. The variables used for analysis are oil price, measure of output growth volatility and inflation. Oil price is measure using WTI and Brent (measured in $USD). Output growth is measured as the current GDP growth (in $USD). Inflation is measured at the logarithm of consumer price index. The two measures of volatility adopted in this study are standard deviation and Hodrik-Prescott Filter Trend. Economic growth and inflation are sourced from the World Development Indicators, while oil prices are collected from the US Energy Information Administration website. We employed annual data series for the period, 1986-2017, for the selected variables in the model. We used annual data series. The reason for the use of large T panel data is attributed to the underlining methodology, which would be adequately discussed in the succeeding sub-section.

Two innovations were made in the methodological aspect of the study. The first, which is quite burgeoning, is the adoption of the asymmetric relationship between the variables of interest. Enunciating on this, Shin et al. (2014) proposed the use of nonlinear autoregressive distributed lags (NARDL) approach in testing for nonlinear/asymmetric relationship between a pair variable. The advantage of this model over other models lies on is ability to simultaneously

[9] The net oil exporters are Angola, Canada, Iran, Kuwait, Mexico, Nigeria, Norway, Russia, Saudi Arabia, and United Arab Emirate. The net oil importers are Belgium, France, Germany, Italy, Japan, South Korea, Netherlands, Spain, United Kingdom and United States. The yardstick for selecting these countries is based on the intuition that that are the top 10 countries in their respective group (various issues of World Fact Book) and Salisu et al. (2017).

capture the short- and long-run asymmetries through positive and negative partial sum decompositions of changes in the independent variable(s), which is oil price in this case (van Hoang et al., 2016). The fact that the approach has less computational technicalities as compared to other models (such as Bayesian VECM or various other specifications of the error-correction models and smooth transition autoregressive models), particularly in terms of dealing with time series of different orders of integration, is another beauty of this study. It should also be noted that we conducted the symmetric version of Shin et al. (2014) developed by Pesaran et al (2001) in order to justify whether asymmetry matters for oil price shock-growth volatility nexus.

The second innovation is to extend the NARDL framework in a panel data structure. What's more, a further innovation is made on the above. Unlike Pasaran (2006) that estimated the short- and long-run coefficients based on common correlated effect (CCE) estimator, we espouse the recent framework of Chudik and Pesaran (2015) whose major novelty is the transformation of the Pesaran's (2006) CCE to dynamic model. It is acknowledged that CCE belongs to the family of Mean Group (MG) Estimator. The superiority of CCE over other variants of MG [10] is based on the inability to incorporate information on common factors, which might be present, about the panels in the estimated model. The common factors are time specific effects that are common across countries and might include fluctuations in global energy prices, technological change, and global business cycle conditions. As such, CCE improved on the MG by including cross-sectional dependence and heterogeneous slope coefficients in the model. In a related fashion, Dynamic-CCE improved on CCE based on the notion that adding the lag of the cross sectional averages and ensuring that the number of cross section averages must be at least as large as the number of unobserved common factorsimprove the consistency of the model (Chudik and Pesaran, 2015).

The linear/symmetric version of the panel type ARDL is specified below:

$$\Delta y_{it} = \alpha_{1i} y_{i,t-1} + \alpha_2 inf_{i,t-1} + \alpha_{3i} oil_{i,t-1} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{N2} \gamma_{ij} \Delta oil_{i,t-j} + \sum_{j=1}^{N3} \gamma_{ij} \Delta inf_{i,t-j} + \varepsilon_{it}, \quad \text{and} \quad \varepsilon_{it} = \propto_{0i} + \varepsilon \lambda_{i'} f_t + \mu_{it} \quad (1)$$

where y is the measure of output growth volatility, Oil is proxy for oil price, inf is the log of CPI, which measures inflation. The equation is designed in such a way it also includes country specific intercepts $\propto_{0i}$, unobserved common factors and country specific factor loadings[11]. The long run slope coefficient for each cross-section is given as $-\frac{\propto_2}{\propto_1}$ and $\frac{\propto_3}{\propto_1}$ because there is an implicit assumption

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[10] Examples include Pooled Mean Group (PMG), Augmented Mean Group (AMG), and Cross-Sectional Dependence Fixed Effect (CDFE).

[11] Chudik et al. (2011) listed the common "strong" factors to include the recent financial crisis, 1970 oil price crisis, or the emergence of China as a major economic power. The "weak" factors include variables such as culture heritage, geographic proximity, economic or social interaction (Chudik et al., 2011). These variables should be considered to be latent variable rather than treating them with levity like we would for omitted variables (Eberhardt and Presbitero, 2015).

that $\Delta y_{i,t-j} = 0$; $\Delta inf_{i,t-j} = 0; and\ \Delta oil_{i,t-j} = 0$. Equation (1) above needs to be transformed to get the short run estimates. Thus, the re-specified equation (1) is expressed as:

$$\Delta y_{it} = \rho_i \varphi_{i,t-1} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{N2} \beta_{ij} \Delta oil_{i,t-j} + \sum_{j=1}^{N3} \theta_{ij} \Delta inf_{i,t-j} + \varepsilon_{it} \quad (2)$$

where $\varphi_{i,t-1} = y_{i,t-1} - \theta_{ij} inf_{i,t-1} - \beta_{ij} oil_{i,t-1}$

We also employ error correction model (ECM) of equation 1 due to the importance of the time series properties and the dynamics of macro panel analysis. The ECM offers the following advantages: (i) it facilitates easy distinction between short- and long-run dynamics; and (ii) it can serve as guidance as to the time required for the economy to adjust back to the long-run equilibrium. The ECM is presented below:

$$\Delta y_{it} = \propto_i + \rho_i \left(y_{i,t-1} - \beta_0 - \beta_i oil_{i,t-1} - \beta_i inf_{i,t-1} - \beta_{i'} f_{t-1} \right) + \sum_{j=1}^{N1} \theta_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{N2} \theta_{ij} \Delta inf_{i,t-j} + \sum_{j=0}^{N3} \theta_{ij} \Delta oil_{i,t-j} + \varepsilon_{it} \quad (3)$$

The parameters β_i and θ_i represents the long- and short- run, respectively, and ρ_i captures the speed of adjustment. The values in the bracket are the cointegrating relationship.

In line with Pesaran (2006), we took the cross-section averages of all the series in the model to capture the unobservable common factors. Chudik and Pesaran (2015) have demonstrated that this approach is has very small sample bias in a dynamic panel framework, particularly for moderate time series dimensions. Also, they relaxed the assumption of strict exogenity and replaced with it the inclusion of the (i) lags of the cross-section averages and (ii) cross-section averages of all the variables in the model.

The asymmetric version of equation 3 draws inspirations from Shin et al. (2014) that decompose oil price into positive and negative changes and it thus specified below:

$$\Delta y_{it} = \alpha_{1i} y_{i,t-1} + \alpha_2 inf_{i,t-1} + \alpha_{3i} oil^{+}_{i,t-1} + \alpha_{4i} oil^{-}_{i,t-1} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{N2} \gamma_{ij} \Delta inf_{i,t-j} + \sum_{j=1}^{N3} \left(\gamma^{+}_{ij} \Delta oil^{+}_{i,t-j} + \gamma^{-}_{ij} \Delta oil^{-}_{i,t-j} \right) + \varepsilon_{it}, \quad \text{and } \varepsilon_{it} = \propto_{0i} + \varepsilon \lambda_{i'} f_t + \mu_{it} \quad (4)$$

Equation 4 shows that oil has been decomposed into $oil^{+}_{i,t}$ and $oil^{-}_{i,t}$, where are defined theoretically as:

$$oil^{+}_{it} = \sum_{j=1}^{t} \Delta oil^{+}_{it} = \sum_{j=1}^{t} max(\Delta oil_{it}, 0) \quad (5)$$

$$oil^{-}_{it} = \sum_{j=1}^{t} \Delta oil^{-}_{it} = \sum_{j=1}^{t} min(\Delta oil_{it}, 0) \quad (6)$$

The ECM asymmetric version is specified as:

$$\Delta y_{it} = \tau_i \xi_{i,t-1} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{N2} \gamma_{ij} \Delta inf_{i,t-j} + \sum_{j=1}^{N3} (\gamma_{ij}^{+} \Delta oil_{i,t-j}^{+} + \gamma_{ij}^{-} \Delta oil_{i,t-j}^{-}) + \varepsilon_{it}, \text{ and } \varepsilon_{it} = \propto_{0i} + \varepsilon \lambda_{i'} f_t + \mu_{it} \quad (7)$$

The error correction term in the panel ARDL is captured by $\xi_{i,t-1}$ and its speed of adjustment is τ_i showing how long it would take the economy to converge to its long-run equilibrium state.

Another extension of the model dwells on accounting for structural break. Theoretical and empirical studies have confirmed oil price is susceptible to structural breaks (see Salisu and Fasanya, 2013; Narayan and Liu, 2015 and Salisu and Oloko, 2015). This is due to evidence of significant shift in the trend of the series employed. If breaks actually exist and are not accounted for, it might bias our results. We use Bai-Perron test (2003) structural break test.

The symmetric version of panel ARDL with structural break is given as:

$$\Delta y_{it} = \propto_i + \rho_i (y_{i,t-1} - \beta_i oil_{i,t-1} - \beta_i inf_{i,t-1} - \beta_{i'} f_{t-1}) + \theta_i \Delta inf_{i,t-j} + \theta_i \Delta y_{i,t-j} + \theta_i \Delta oil_{i,t-j} + \sum_r^k D_r B_{rt} + \varepsilon_{it} \quad (8)$$

Once break(s) are determined, we endogenously include break dummies into the model, which is defined as $B_{rt} = 1$ for $t > T_B$, otherwise $B_{rt} = 0$. The time period is represented by t; T_B is the structural break dates where r =1, 2, 3,……., k and D_r is the coefficient of the break dummy.

The asymmetry with structural break is expressed as:

$$\Delta y_{it} = \alpha_{1i} y_{i,t-1} + \alpha_2 inf_{i,t-1} + \alpha_{3i} oil_{i,t-1}^{+} + \alpha_{4i} oil_{i,t-1}^{-} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{N2} \gamma_{ij} \Delta inf_{i,t-j} + \sum_{j=1}^{N3} (\gamma_{ij}^{+} \Delta oil_{i,t-j}^{+} + \gamma_{ij}^{-} \Delta oil_{i,t-j}^{-}) + \sum_r^k D_r B_{rt} + \varepsilon_{it}, \quad (9)$$

4 Empirical Results and Discussions

The results of the descriptive statistics are presented in Table 1. It is depicted that the net oil exporting countries have higher growth rate as compared to their oil importing counterpart. The same argument extends to inflation. However, it terms of growth stability, the net importing countries are better off. Brent has a higher pricing mechanism, while WTI has less price fluctuations.

Table 1: Descriptive Statistics

	Net Oil Exporting					**Net Oil Importing**			
	Mean	Min	Max	Std D		Mean	Min	Max	Std D
GDP	3.465	-24.70	33.99	5.936		2.361	-5.715	12.27	2.531
INF	3.684	-1.025	5.568	1.86		1.914	1.564	2.051	0.134
	WTI					**Brent**			
	Mean	Min	Max	Std D		Mean	Min	Max	Std D
	42.90	14.42	99.67	29.68		45.74	12.764	111.63	33.364

Source: Author's computation

A fundamental prerequisite of an ARDL framework is to examine the order of integration of the series of interest. To this end, we employ three variants of unit root test. They are Levin, Lin and Chu [LLC] (2002); Im, Pesaran and Shin [IPS] (1997); and Hadri (2002) tests. LLC and Hadri tests assumes common autoregressive structure and unit root, while the inverse is the case for IPS. It should be noted that these tests does not account for structural break(s) in the series. These results are presented in Table 2.

Table 2: Unit Root Tests without Structural Break

Panel A						
	Oil Importing			Oil Exporting		
	LLC	IPS	Hadri	LLC	IPS	Hadri
GDP Growth	-2.036[a]	-15.035[a]	0.544[a]	-17.025[a]	-16.145[a]	0.804[a]
Inflation	-15.035[b]	-3.032[b]	0.320[a]	-2.024[a]	-4.035[b]	0.302[a]

Panel B

	LLC	IPS	Hadri
Brent	-3.024[a]	-2.024[b]	0.241[a]
WTI	-4.025[a]	-11.024[a]	0.461[b]

Source: Author's computation

Note: a and b represents stationarity at level and first difference, respectively. LLC, is Levin, Lin and Chu tests whilst IPS is Im Pesaran and Shin, respectively

Unit root test that incorporate structural break was also explored. Being explicit, Culver and Papel (1997) and Breitung and Candelon (2005) tests were used and its results are presented in Table 3. An over view of both tables shows that the order of integration of the series hovers between level I(0) and first difference I(1). Since none of the series is stationary at secondary different, the coast is not clear for a formal ARDL estimation.

Table 3: Unit Root Test with Break(s)

Panel A				
	Net Oil Exporting		Net Oil Importing	
	CP	BC	CP	BC
GDP	-0.384**	-1.684**	-0.593*	-1.203
Inflation	-0.485**	-1.948**	-0.638**	-1.983**
Panel B				
		CP	BC	
Brent		-0.445*	-2.039**	
WTI		-0.439**	-1.495*	

Source: Authors' computation

Note: * and ** represents stationarity at 10 and 5%, respectively. CP and BC imply Culver and Papel (1997) and Breitung and Candelon (2005) unit root with structural break tests, respectively.

The result of the asymmetric relationship between oil price change and output growth volatility would be presented in three main focal points. The first is to examine the role of asymmetry in the oil price change - output growth volatility nexus using the full sample size. The second would improve on the first by accounting for the role of structural break in the model, while the last form of presentation will with robustness check.

4.1 Oil Price and Output growth volatility (no structural break test)

The study determined the long and short-run dynamics of the relationship between oil price and growth volatility. These estimates are presented in Table 4. Prior to testing for the role of asymmetry, we conducted the symmetric version of the model. Estimated coefficients pinpoint that oil price has similar effect for both net exporters and importers of oil in the long run. In essence, oil price change tends to have magnifying effect on the volatility of economic growth. In terms of magnitude and statistical significance, the net importers edge out the net oil exporters (short run). However, in the long run run, oil prices have no meaningful effect on the both oil- importing and exporting countries. These results seem quite intuitive because the exogenous shock, stemming from oil prices, only affects economies in the short-run. With the passage of time, countries would adjust to sync with the changes in the oil prices.

We next accounted for the decomposition of oil price changes. Starting with the long-run results, we show that the decompositions of oil prices do not have any meaning effect on the growth volatility of the countries in sample. This result seems to follow logic and economic predictions. Raheem (2017) shows that the oil price change has three effects (revenue, demand and supply), thus the net effect (long run) of oil price shock would depend on the magnitude of the coefficient among the interplay of these three effects[12]. Another plausible reason might not be unconnected to the fact that the time required for the complete production of oil is somehow lengthy. As such, changes in oil price do not immediately affect the exporting economy. This is to say that the gain of oil price increase on exporting country is not as eye-catchy as the first glimpse.

Table 4: Empirical Results without Structural Break

	Variables	Net Exporting		Net Importing	
		No Asymmetry	Asymmetry	No Asymmetry	Asymmetry
Short run	CPI	0.215* [0.098]	0.68* [0.028]	0.005* [0.003]	0.009 [0.009]
	WTI	0.058** [0.021]		0.311*** [0.078]	
	WTI^{+}		0.654** [0.254]		0.211 [0.147]
	WTI^{-}		0.425** [0.146]		-0.122* [0.055]
	ECT	-0.159*** [0.000]	-0.236*** [0.000]	-0.216** [0.076]	-0.423** [0.184]
	CONS	0.744** [0.298]	0.301** [0.074]	0.099 [0.070]	1.174 [0.854]

[12] It is thus expected that the three effects will have a spillover effect on economic growth and its volatility.

Long Run	CPI	-0.147*** [0.012]	-0.325** [0.140]	-0.054*** [0.000]	1.021 [0.731]
	WTI	0.025 [0.045]		-0.079 [0.081]	
	WTI^+		-0.411 [0.236]		-0.100 [0.095]
	WTI^-		-0.257 [0.130]		0.022 [0.067]
Statistics	No of CS	10	10	10	10
	CD Test P Value	0.954	0.900	0.158	0.351
	RMSE	0.074	0.035	0.022	0.033
	R-Sq	0.425	0.183	0.412	0.302

Source: Author's computation. Note: "*", "**", and "***" signifies level of statistical significance at 10, 5 and 1 percent respectively. The values in braces are the standard error coefficients

However, the short run produces some interesting results. For instance, either positive or negative changes in oil prices matter for the dependent variable for the oil exporting countries. This result can be justified based on the understanding that majority of the exporting countries in our sample over rely on oil earning as a major source of income. Hence, changes in oil prices would definitely affect the growth trajectories in the short run. For the oil importing countries and in the short run, it is only negative oil price shock that is relevant to the economy. In essence, decline in oil price reduces the volatility of economic growth. Once prices of oil fall, costs of production fall, hence consumers are confronted with lower costs of final goods. This being the case, it is expected that there would be a surge in the growth trajectories in the economy. Another reason for this might be due to the fact that decline in oil prices ensures more stability as compared to a positive oil price shock. In sum, asymmetry matters more for the net oil exporters since both positive and negative oil price change affects the dependent variable, while only negative oil price shock matters for the oil net importers.

4.2 Oil Price and Output growth volatility (with structural break test)

The aim of this sub-section is to inquire if the results obtained above are sensitive to structural break(s) in the data. The study employs the use of Bai and Perron (2003) structural break tests. The obtained break dates are endogenously included in the model using break dummy with the value of 1, years succeeding the break dates and 0 otherwise. The obtained break dates coincide with a number of events[13]. The results of this exercise are presented in Table 5 below. The main points to note here are as follow: (i) negative oil price change reduces the growth volatility for both categories of countries in the short-run and the reverse is the case for long-run; (ii) irrespective of the type of

[13] Russian currency crises in 1998, European Single Market in 2002, 9/11 terrorist attack (in US) in 2001, Asian financial crises in 1993, the Iraqi war in 2003, global financial crises in 2007 and the recovery era in 2010.

oil price shock, asymmetry is important in the long run for net oil exporters and the exact opposite is the case for the net oil importers.

Furtherance to the above, we divided our sample size into before and after break dates by assigning the value of 1 for years succeeding the break dates and 0 if otherwise[14], whose results are presented in Table 6 below. A comparative analysis of the results of the before and after global financial crisis produces some mixed findings. First, negative oil price shock has a dampening effect on growth volatility for both classifications of countries in the short run. Second, in the long run, positive and negative changes in oil prices have different effect on growth volatility of the exporting countries before the crisis. Third, negative oil prices change only matters for net importing countries in the long run. In sum, asymmetry matter more for the net exporting countries than the net importing countries due to the higher number of statistical significant coefficients in the case of the former.

Table 5: Empirical Results with Structural Break

	Variables	Net Exporting		Net Importing	
		No Asymmetry	Asymmetry	No Asymmetry	Asymmetry
Short Run	CPI	0.302** [0.133]	0.130** [0.068]	0.144 [0.164]	0.301*** [0.025]
	WTI	0.254*** (0.021)		0.331*** [0.004]	
	WTI^+		0.057*** [0.001]		0.254** [0.095]
	WTI^-		-0.236** [0.100]		-0.184*** (0.002)
	CONS	0.148** [0.041]	0.454*** [0.125]	0.658** [0.202]	0.365 [0.412]
	ECT	-0.422** [0.185]	-0.153** [0.046]	-0.366* [0.142]	-0.142** [0.056]
Long Run	CPI	0.126 [0.085]	0.236 [0.198]	0.042*** [0.000]	0.321* [0.156]
	WTI	0.200** [0.086]		0.698** [0.315]	
	WTI^+		0.135** [0.077]		0.111 [0.320]
	WTI^-		0.306** [0.085]		-0.177 [0.161]
Statistics	No of CS	10	10	10	10

[14] This attempt is extended to all the break dates. However, we only present the results of 2007, for the want of space. The choice of 2007 is premised on the recent and importance of the global financial crisis. However, the results of other break dates can be made available upon request. It is instructive to state here that there are no major differences in the results of the different break dates.

	CD Test P Value	0.458	0.302	0.448	0.502
	RMSE	0.031	0.009	0.043	0.035
	R-Sq	0.554	0.436	0.447	0.298

Source: Authors' computation. Note: "*", "**", and "***" signifies level of statistical significance at 10, 5 and 1 percent respectively. The values in braces are the standard error coefficients

The error correction coefficients of the entire estimated models are theoretically and empirically validated. The coefficients are statistical significant, less than unity (in absolute value) and negative. This implies that, on the average, output growth volatility in the short run adjust to equilibrium in the long run for both net oil importing and exporting countries irrespective of whether asymmetry and breaks are considered or not. This stance is also valid for the decomposition of timeframe to pre- and post- global financial crisis.

4.3 Robustness Check

An attempt is made to determine whether our results stand the test of changes in the measures of oil prices and volatility. In essence, two checks are explored. The first is the use of Brent prices. Results of this exercise were presented in table 7. It can be deduced that this table is almost a perfect replica of Table 4. This might be due to high correlation between WTI and Brent prices[15]. The second test dwells on the use of alternative measure of volatility. Essentially, we employed the use of Hodrik-Prescott Filter Trend. Table 8 below highlights the results of this check. Results show that our analyses are robust to these two checks. It is worthy to note that there are few noticeable differences in terms of magnitude, significance and direction of influence.

5.0 Conclusion

In examining the relationship between oil price and output growth volatility, this study analyzed the role of asymmetries and breaks. A representative of 10 countries each was selected from net oil- exporting and importing countries. The timeframe is for the period 1980 – 2015. To test for asymmetry, we decomposed oil price into positive and negative changes as depicted by Shin et al. (2014). This asymmetry is estimated using the dynamic common correlated effect of heterogeneous panel of Chudik and Pesaran (2015). The structural break test was based on the method of Bai and Perron (2003).

The symmetric version of our results show that oil price only affects, by magnifying output growth volatility, the net oil importing countries in the short run. Turning to asymmetric models and without accounting for structural breaks, it was estimated that asymmetry only matter for net oil exporters in both short- and long- run. For the net oil importing country, only negative oil price shock matters. The importance of asymmetry is missing in the long-run for both representative countries. Accounting for breaks, negative oil price change is important, in the short-run for both categories of countries. As for long run, positive and negative oil price shocks are important for the net oil exporters. In

[15] The correlation coefficient between WTI and Brent is about 0.78.

sum, asymmetry matters most for the net oil exporting country. These results are robust to changes in the measures of oil price and growth volatility.

Future studies could consider replicating this exercise for firm level or sectoral data. This is due to the fact that the energy intensity of firms/sectors are different. Thus, asymmetry could exist beyond the aggregate level. Such analysis promises to expand the knowledge space and have serious policy implications.

Table 6: Empirical Results Pre and Post Global Financial Crisis

		Pre-Crisis				Post Crisis			
		Net Exporting		Net Importing		Net Exporting		Net Importing	
		No Asymmetry	Asymmetry	No Asymmetry	Asymmetry	No Asymmetry	Asymmetry	No Asymmetry	Asymmetry
Short Run	CPI	0.066** [0.012]	0.032* [0.011]	-0.015*** [0.000]	-0.049** [0.000]	-0.111* [0.051]	-0.295** [0.069]	-0.214* [0.087]	-0.308 [0.253]
	WTI	0.258 [0.194]		0.136 [0.122]		0.666 [0.421]		0.225 [0.235]	
	WTI^+		0.136*** [0.027]		0.174** [0.068]		1.126** [0.326]		1.222** [0.369]
	WTI^-		-0.095** [0.032]		-0.366** [0.085]		-0.143* [0.058]		-0.226 [0.115]
	Cons	1.214** [0.476]	0.715** (0.276)	0.304** [0.076]	0.420* [0.215]	1.952 [0.862]	1.035 [0.798]	1.159* [0.526]	1.126*** [0.211]
	ECT	-0.495*** [0.106]	-0.305** [0.073]	-0.209** [0.056]	-0.192** [0.047]	-0.321* [0.121]	-0.158** [0.042]	-0.426*** [0.035]	-0.197** [0.051]
Long Run	CPI	0.189 [0.199]	-0.606 [0.546]	0.177* [0.073]	0.056*** [0.000]	-0.200** [0.085]	-0.326 (0.215)	0.077 [0.096]	-0.259* [0.115]
	WTI	0.109* [0.048]		-0.198* (0.047)		1.024* [0.492]		-0.222* [0.042]	
	WTI^+		-0.236 [0.361]		-0.164 [0.179]		0.951** [0.328]		-0.355* (0.136)
	WTI^-		0.219* [0.109]		0.326** [0.084]		-0.201* [0.069]		0.343* [0.147]
Statistics	No of CS	10	10	10	10	10	10	10	10
	CD Test P Value	0.346	0.489	0.652	0.654	0.739	0.756	0.819	0.165
	RMSE	0.047	0.032	0.015	0.035	0.025	0.036	0.018	0.054
	R-Sq	0.458	0.395	0.279	0.286	0.342	0.365	0.154	0.305
	No obs	159	159	70	70	159	159	70	70

Source: Authors' computation. Note: "*", "**", and "***" signifies level of statistical significance at 10, 5 and 1 percent respectively. The values in braces are the standard error coefficients

Table 7: Robustness Test I

	Variables	Net Exporting		Net Importing	
		No Asymmetry	Asymmetry	No Asymmetry	Asymmetry
Short Run	CPI	0.202 [0.175]	0.302 [0.197]	0.022 [0.015]	0.132 [0.075]
	WTI	0.175** [0.052]		0.302** [0.122]	
	WTI^+		0.125** [0.047]		-0.451 [0.289]
	WTI^-		0.147*** [0.069]		-0.143** [0.036]
	CONS	0.866*** [0.124]	0.365* [0.144]	0.099 [0.107]	2.125*** [0.332]
	ECT	-0.256*** [0.000]	-0.125*** [0.002]	-0.362** [0.084]	-0.114* [0.054]
Long Run	CPI	0.031 [0.054]	-0.542* [0.192]	-0.142* [0.054]	0.125** [0.043]
	WTI	-0.221 [0.328]		-0.150 [0.134]	
	WTI^+		0.276** [0.106]		-0.154 [0.216]
	WTI^-		0.205* [0.076]		0.133 [0.104]
Statistics	No of CS	10	10	10	10
	CD Test P Value	0.154	0.320	0.341	0.326
	RMSE	0.014	0.022	0.025	0.036
	R-Sq	0.318	0.269	0.202	0.201

Source: Authors' computation. Note: "*", "**", and "***" signifies level of statistical significance at 10, 5 and 1 percent respectively. The values in braces are the standard error coefficients

Table 8: Robustness Test II

	Variables	Net Exporting		Net Importing	
		No Asymmetry	Asymmetry	No Asymmetry	Asymmetry
Short run	CPI	0.112* [0.059]	0.044** [0.021]	0.174* [0.089]	0.365* [0.134]
	WTI	0.025 [0.163]		0.362 [0.196]	
	WTI^+		0.129** [0.054]		0.364** [0.079]
	WTI^-		-0.321** [0.122]		0.265 [0.166]
	CONS	1.028*** [0.000]	1.369*** [0.002]	1.201** [0.426]	2.364** [1.024]
	ECT	-0.201*** [0.032]	-0.125*** [0.035]	-0.249** [0.078]	-0.302** [0.100]
Long Run	CPI	0.015 [0.102]	0.245** [0.061]	0.154** [0.032]	0.142** [0.047]
	WTI	0.158 [0.176]		0.111 [0.193]	
	WTI^+		0.102 [0.174]		-0.115 [0.201]
	WTI^-		0.162*** [0.036]		0.305** [0.125]
	No of CS	10	10	10	10
Statistics	CD Test P Value	0.424	0.303	0.102	0.302
	RMSE	0.015	0.033	0.019	0.035
	R-Sq	0.218	0.253	0.325	0.375

Source: Authors' computation. Note: "*", "**", and "***" signifies level of statistical significance at 10, 5 and 1 percent respectively. The values in braces are the standard error coefficients

References

Abiyev, V., Ceylan, R. and Özgür, M. (2015) "The Effects of Oil Price Shocks on Turkish Business Cycle: A Markov Switching Approach", International Journal of Business and Economic Sciences Applied Research, 8(2), 7-18

Ajide, Kazeem Bello; O.Adeniyi and I.Raheem (2015). Output Growth Volatility, Remittances and Institutions, International Journal of Development Issues Vol. 14 (3).pp 190-203.

Ajide, Kazeem Bello; O.Adeniyi and I.Raheem (2016)."The Role of Institutions in Output Growth Volatility-Financial Development Nexus: A Worldwide Study" Forthcoming in Journal of Economic Studies.

Allegret, J.-P., Couharde, C., Coulibaly, D., (2014) "Current accounts and oil price fluctuations in oil-exporting countries: the role financial development", Journal of International Money and Finance, 47(1), 185–201.

An, L., Jin, X and Ren, X. (2014) "Are the macroeconomic effects of oil price shock symmetric? A Factor-Augmented Vector Autoregressive approach" Energy Economics, 45, 217-228

Awartani, B., Maghyereh, A., (2013) "Dynamic spillovers between oil and stock markets in the Gulf Cooperation Council countries". Energy Economics 36, 28–42

Bai, J. and Perron, P. (2003). Computation and analysis of multiple structural change models. Journal of applied econometrics, 18(1), 1-22.

Balke N. S., Brown S. P. A., and Yucel M. K. (2002). "Oil Price Shocks and the U.S. Economy: Where Does the Asymmetry Originate?" *Energy Journal*, 23(1), 27–52.

Barsky, R.B. and Kilian, L. (2002). "Do We Really Know that Oil Caused the Great Stagflation? A Monetary Alternative," in Ben S. Bernanke and Ken Rogoff, eds. NBER Macroeconomics Annual 2001, MIT Press: Cambridge, MA, pp. 137-183

Bernanke, B.S., M. Gertler and M. Watson, 1997, "Systematic Monetary Policy and the Effects of Oil Price Shocks," Brookings Papers on Economic Activity, 1,.91-142.

Bohi, Douglas R. (1991), "On the Macroeconomic Effects of Energy Price Shocks," *Resources and Energy*, 13, pp. 145-162

Breitung, J and Candelon, B. (2005) "Purchasing Power Parity during Currency Crises: A Panel Unit Root Test under Structural Breaks", *Review of World Economics,* 141(1), 124-140.

Brown, S. and Yücel, M. (1999) "Oil prices and US aggregate economic activity" Federal Reserve Bank of Dallas Economic Review (Second Quarter) 16-23

Burbidge, J. and A. Harrison 1984, "Testing for the effects of oil-price rises using Vector Autoregressions", *International Economic Review*, 25(2), 459-484.

Carlstrom C.T. and Fuerst T.S. (2006) "Oil Prices, Monetary Policy, and Counterfactual Experiments" *Journal of Money, Credit and Banking*, 38, 1945-1958

Chami, R., D. Hakura, and P.Montiel. (2009) Remittances: An Automatic Output Stabilizer? *IMF Working Paper* 09/91.

Chudik, A. and M. H. Pesaran (2015) "Common correlated effects estimation of heterogeneous dynamic panel data models with weakly exogenous regressors," *Journal of Econometrics*, 188, 393-420.

Chudik, A., M. H. Pesaran, and E. Tosetti (2011). Weak and Strong Cross-Section Dependence and Estimation of Large Panels. *The Econometrics Journal,* 14, C45-C90.

Clements, M. P. and Krolzig, H. M., (2002), "Can Oil Shocks Explain Asymmetries in the U.S. Business Cycle?", *Empirical Economics*, 27,(2) 185–204.

Cologni, A. and Manera, M., (2009), "The Asymmetric Effects of Oil Shocks on Output Growth: A Markov-Switching Analysis for the G-7 Countries", *Economic Modelling*, 26, pp. 1-29.

Culver, S. E and David H. Papell, D.H. (1997) "Is There a Unit Root in the Inflation Rate? Evidence from Sequential Break and Panel Data Models", Journal of Applied Econometrics, 12(4), 435-444

Darby, M.R. (1982), "The Price of Oil and World Inflation and Recession", *American Economic Review*, 72 (4), 738-751

Ebeke, C. and Combes, J.-L. (2013). Do remittances dampen the effect of natural disasters on output growth volatility in developing countries? *Applied Economics*, 45, 2241–2254.

Eberhardt, M and Presbitero, A (2015): "Public debt and growth: heterogeneity and non-linearity", Journal of International Economics, 97(1), 45–58

Edelstein, P., and Kilian, L. (2007), "The Response of Business Fixed Investment to Energy Price Changes: A Test of Some Hypotheses about the Transmission of Energy Price Shocks," *B.E. Journal of Macroeconomics* 7 (November), 1–39

Edelstein, P., and Kilian, L. (2009) "How Sensitive Are Consumer Expenditures to Retail Energy Prices?" *Journal of Monetary Economics* 56: 766-779

Engemann, K.M., Kliesen, K. L., and Owyang, M. T. (2011). „Do oil shocks drive business cycles? Some U.S. and international evidence", *Macroeconomic Dynamics*, 15, 498-517

Finn, Mary G. (2000), "Perfect Competition and the Effects of Energy Price Increases on Economic Activity," *Journal of Money, Credit, and Banking*, 32, 400-416

Gisser, M. and Goodwin, T.H (1986), "Crude Oil and the Macroeconomy: Tests of Some Popular Notions," *Journal of Money, Credit, and Banking*, 18, 95-103

Hadri K. (2002) "Testing for stationarity in heterogeneous panel data" Econometrics Journal, 3(2):148-161

Hamilton, J.D. (1996), "This is What Happened to the Oil Price-Macroeconomy Relationship" Journal of Monetary Economics, 38, 215-220.

Hamilton, J.D. and and Ana Maria Herrera (2004), "Oil Shocks and Aggregate Macroeconomic Behavior: The Role of Monetary Policy," *Journal of Money, Credit, and Banking*, 36, 265-286.

Hamilton, James D. (1983), "Oil and the Macroeconomy Since World War II," *Journal of Political Economy*, 91, pp. 228-248.

Herrera, A.M, Lagalo, L.G., and T. Wada (2015), "Asymmetries in the Response of Economic Activity to Oil Price Increases and Decreases?" *Journal of International Money and Finance*, 50(1), 108-133.

Holmes, M. J. and Wang, P., (2003), "Oil and the Asymmetric Adjustment of U.K. Output: A Markov–Switching Approach", *International Review of Applied Economics*, 17(3). 181–192.

Hooker, M.A., 2002. Are Oil Shocks Inflationary? Asymmetric and Nonlinear Specifications versus Changes in Regime, Journal of Money Credit and Banking 34 (2), 540–561.

Hooker, Mark A. (1996), "What Happened to the Oil Price-Macroeconomy Relationship?" *Journal of Monetary Economics*, 38, pp. 195-213

Huang, B.N., M.J. Hwang, and 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, 455-476.

Im K.S, Pesaran M.H, and Shin Y (1997) "Testing for unit roots in heterogeneous panels" mimeo: Department of Applied Economics, University of Cambridge.

Jimenez-Rodriguez, R., and Sanchez, M. (2005), "Oil Price Shocks and Real GDP Growth: Empirical Evidence for Some OECD Countries," *Applied Economics*, 37 (2), pp. 201-22

Jouini, J., Harrathi, N., (2014) "Revisiting the shock and volatility transmissions among GCC stock and oil markets: a further investigation" Economic Modelling 38, 486–494.

Kilian L. (2008) "Exogenous Oil Supply Shocks: How Big Are They and How Much Do They Matter for the U.S. Economy?" *Review of Economics and Statistics* 90: 216-240

Kilian, L., Rebucci, A., & Spatafora, N. (2009). Oil shocks and external balances. Journal of International Economics, 77(2), 181–194.

Kim, I., and Loungani, P. (1992) "The role of energy in real Business cycle models." *Journal of Monetary Economics*, 29, 173-189.

Leduc, S. and Sill, K. (2004), "A Quantitative Analysis of Oil-Price Shocks, Systematic Monetary Policy, and Economic Downturns," *Journal of Monetary Economics*, 51, pp. 781-808

Lee, K., Ni, S. and Ratti, R. A., (1994) 'Oil Shocks and the Macroeconomy: The Role of Price Variability', The Energy Journal, 16(4), 39-56.

Levin A, Lin, C.F, and Chu, C.S.J. (2002) "Unit root tests in panel data: asymptotic and finite sample properties" Journal of Econometrics, 108(1):1-24.

Mehrara, M., 2008. The asymmetric relationship between oil revenues and economic activities: the case of oil-exporting countries. Energy Policy 36, 1164–1168.

Mendoza, O. & Vera, D. (2010). "The asymmetric effects of oil shocks on an oil-exporting economy" Cuadernos De Economía, 47(135), 3-13.

Mork, K. A., (1989), 'Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton's Results', *Journal of Political Economy*, 97, 3, pp. 740–744.

Mork, K.A. Olsen, O., and Mysen, H.T (1994), "Macroeconomic Responses to Oil Price Increases and Decreases in Seven OECD Countries," *Energy Journal*, 15, 4, pp. 19-35

Moshiri, S. (2015) "Asymmetric effect of oil price shocks in oil-exporting countries, the role of institutions", OPEC Energy Review 39(2), 222-245

Moshiri, S., Banijashem, A., 2012. Asymmetric effects of oil price shocks on economic growth of oil-exporting countries. Social Science Research Network (SSRN). ⟨⟨http://papers.ssrn.com/sol3/papers.cfm?abstract_id¼2006763⟩

Nakov, A., & Pescatori, A., 2010. "Oil and the great moderation," *Economic Journal*, Royal Economic Society, 120(543), 131-156
Narayan, P. K., & Liu, R. (2015). A unit root model for trending time-series energy variables. Energy Economics, 50, 391–402
Nusair, S. A. (2016). The effects of oil price shock s on the economies of the Gulf Co-operation Council countries: Nonlinear analysis. Energy Policy, 91, 256–267.
Nusair, S.A. (2016), "The effects of oil price shocks on the economies of the Gulf Co-operation Council countries: Nonlinear analysis", Energy Policy 91, 256–267
Pesaran, M., Shin, Y., & Smith, R. (2001). Bound testing approaches to the analysis of level relationship. Journal of Applied Econometrics, 16, 289–326
Pesaran, M.H (2006) Estimation and inference in large heterogeneous panels with a multifactor error structure. Econometrica 74(4), 967–1012.
Rafiq, S., Sgro, P., & Apergis, N. (2016). Asymmetric oil shocks and external balances of major oil exporting and importing countries. Energy Economics, 56(1), 42–50.
Raheem, I. D. (2016) "'More Finance' or 'Better Finance' in Output Growth Volatility Literature: Evidence from a Global Perspective" *Journal of International Economic Studies*, 30(1), 61-68
Raheem, I.D (2017) "Asymmetry and Break Effects of Oil Price –Macroeconomic Fundamentals Dynamics: The Trade Effect Channel" *The Journal of Economic Asymmetries*, forthcoming
Rahman, S. and Serletis, A. (2011), "The Asymmetric Effects of Oil Price Shocks", *Macroeconomic Dynamics* 15(3), 437-471.
Ramey, G. and Ramey, V (1995) "Cross-Country Evidence on the Link between Volatility and Growth," *American Economic Review,* 85(5), 1138–1151.
Raymond, Jennie E., and Robert W. Rich (1997), "Oil and the Macroeconomy: A Markov State-Switching Approach," Journal of Money, Credit and Banking, 29 (May), pp. 193-213. Erratum 29 (November, Part 1), p. 555
Rotemberg, J. J., and Woodford, M. (1996), "Imperfect Competition and the Effects of Energy Price Increases," *Journal of Money, Credit, and Banking*, 28 (part 1), pp.549-577
Sadorsky, P. (1999) "Oil price shocks and stock market activity", *Energy Economics*, 21, 449-469
Salisu, A. A., & Fasanya, I. O. (2013). Modelling oil price volatility with structural breaks. Energy Policy, 52, 554–562.
Salisu, A. A., & Oloko, T. F. (2015). Modeling oil price–US stock nexus: A VARMA–BEKK–AGARCH approach. Energy Economics, 50, 1–12.
Salisu, A.A. and Isah, K. (2016) "Revisiting the oil price and stock market nexus: A nonlinear Panel ARDL approach" Economic Modelling, 66, 258-271
Salisu, A.A., Isah, K.O., Oyewole, O.J. and Akanni, L.O. (2017), "Modelling oil price-inflation nexus: The role of asymmetries", Energy, 125(1), 97-106
Sek, (2017), "Impact of oil price changes on domestic price inflation at disaggregated levels: Evidence from linear and nonlinear ARDL modeling", Energy 130, 204-217
Serletis, A., & Istiak, K. (2013). "Is the oil price–output relation asymmetric?" *Journal of Economic Asymmetries*, 10(1), 10–20.

Shin, Y., Yu, B. and Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in an ARDL framework. In: W.C., Horrace.

Van Hoang, T. H., Lahiani, A., & Heller, D. (2016). Is gold a hedge against inflation? New evidence from a nonlinear ARDL approach. Economic Modelling, 54, 54–66