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Abstract

The study hypothesizes if asymmetric relationship exists between oil price and inflation nexus. Essentially, this study uses a multiple threshold nonlinear autoregressive distributed lag model in a dynamic common correlated effect within the environment of heterogeneous panel framework. Results reveal the importance of asymmetry in the model for both oil- import and exporting countries, with countries responding more to positive shocks. Quantile decompositions show that the asymmetry effect of oil price change fizzles out only for the oil importing country. For the oil exporting countries, asymmetry is important at higher quantiles. Accounting for breaks do not significantly alter earlier results. In line with empirical outcomes, policy implications are discussed.

Keywords	Oil price; inflation; Asymmetry; Breaks; Heterogeneous panels

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Dear Reviewer

We thank you for your interest in our manuscript. The comments passed on the same as further enhanced the quality of the manuscript. We also appreciate you for spotting some of our hitherto oversights. We have responded, to the comments raised, to the best of our ability. It is our hope that these corrections would be acceptable to you. Below are our responses.

Comment One
The literature cited is older, please update the latest literature. In addition, it is lack of comments on existing literature.

Response
We have update our literature to accounts for more recent studies.

Comment Two
The authors select ten countries from the group of net oil exporting and importing countries. As far as I know, China is the world 's largest oil importer, why do not select China?

Response
We completely agree with you that China is the largest importer of oil. Our decision to drop the country was not an easy one. The major reason for the dropping of China is to account for any potential outlier effects, which might bias our results. This is because the difference in the volume of China's oil import hugely exceeds other members of the group. This might be the reason why related studies have also excluded China from their analysis (e.g. Salisu et al., 2017; Chkir et al., 2020 and Nafar et al., 2020).

Comment Three
For economic growth and CPI variables, or economic growth and CPI variables, why not consider the base period?

Response
We are largely guided by existing related studies in formulating the model setup and data measurement (see Salisu et al., 2017; Pal Mitra, 2016; and Lacheheba and Sirag, 2019). A fundamental problem with selecting a base year is the need to justify it. We have collected data for countries with diverse socio-economic path. It might be difficult to identify a date that is common to the countries in our dataset.

Comment Four
In the table 1, do the authors take the average of 10 countries? Why not take the natural logarithm? How to eliminate heteroscedasticity? Yes, we used the average of the 10 countries. GDP is measured in growth. There are countries that recorded negative growth at some period. Hence, there is no way we that logarithmic a negative number. Inflation already is in log.

Response

Yes, we used the average of the 10 countries. GDP is measured in growth. There are countries that recorded negative growth at some period. Hence, there is no way we can logarithmic a negative number. Inflation already is in log. We thank you for this piece of advise.

Comment 5:

In the parts of Empirical Results, why not adopt the adjusted R2.

Response

Thank you for this feedback. We have followed your suggestion. Please see tables 4-10 to track these changes.

Comment 6

It is necessary to cite some previous literatures to enhance the rationality of the empirical results.

Response.

We acknowledge the need to sync empirical results with earlier literature, just have you have mentioned. What is common in the literature is to examine the asymmetric effect of oil price. These studies have shied away from further decomposition of the partial sums changes. However, there are handful number of related studies, which we have not incorporated in the discussion of our results. Please see the highlighted portions of the empirical result section.

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Naifar, N., Shahzad S.J.H., Hammoudeh, S. (2020) "Dynamic nonlinear impacts of oil price returns and financial uncertainties on credit risks of oil-exporting countries" Energy Economics https://doi.org/10.1016/j.eneco.2020.104747

- The study examines the asymmetric relationship between oil price and inflation
- Results confirm the existence of asymmetry for both oil-importing and export countries
- Countries responds more to positive shock
- Asymmetry is weak for exporting countries
- This asymmetry fizzles out at higher quantiles for exporting countries
- These results are robust to accounting for multiple breaks.

A New Insight into Oil Price-Inflation Nexus

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Abstract
The study hypothesizes if asymmetric relationship exists between oil price and inflation nexus. Essentially, this study uses a multiple threshold nonlinear autoregressive distributed lag model in a dynamic common correlated effect within the environment of heterogeneous panel framework. Results reveal the importance of asymmetry in the model for both oil- import and exporting countries, with countries responding more to positive shocks. Quantile decompositions show that the asymmetry effect of oil price change fizzles out only for the oil importing country. For the oil exporting countries, asymmetry is important at higher quantiles. Accounting for breaks do not significantly alter earlier results. In line with empirical outcomes, policy implications are discussed.

Keywords: Oil price, inflation, Asymmetry, Breaks and Heterogeneous panels
JEL Classifications: C21, C22, E31 and Q41

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1. Introduction

The usage of a non-renewable source of energy remains prevalently dominant in the global economy[1]. This, arguably, can be attributed to at least two reasons: (i) an important input in virtually all economic activities e.g like production, consumption and transportation of goods and services; (ii) relatively cheaper source of energy as substantial costs are often associated to procuring and/or installing renewable-based energy technology. In view of the foregoing, oil pricing requires a closer empirical scrutiny. This explains why widespread attentions are continuing to be drawn to its implicative impacts on a wide-range of socio-economic phenomena from theory, academic and policy circles alike. From the theoretical front, scientific investigations have hypothesized and validated that changes in the price of oil will have a spillover effect on some macroeconomic fundamentals such as inflation, interest rate, financial sector development and economic growth. From the policy perspective, achieving relative price stability has remained a cardinal monetary policy mandate of most monetary authorities. This might plausibly explain why utmost importance has been accorded to changes in oil price as it could trigger instability in the general price levels in an economy.

In view of the foregoing, a large number of studies have examined a causal relationship between oil price and inflation, thus leading to lack of consensus and inconclusive debate[2]. This occurrence has been attributed to a number of factors. First, Cartwright and Riabko (2015) have alleged that different methodologies, scopes and measurements of the variables of interest as probable culprits. Second, existing studies have equally been faulted for failing to account for the roles of asymmetry (see Çatik and Önder, 2011, Chou and Lin, 2013; and Atil et al. 2014), and structural breaks (see Salisu and Fasanya, 2013; Salisu and Oloko, 2015 and Raheem, 2017). Third, the assumption of homogeneity in "oil price change" across the global economy has been alleged as fundamentally wrong (Salisu et al. 2017). Fourth, oil prices have been subjected to high volatility over the past four decades and thus have resulted to both demand and supply shocks (see Kilian, 2009; Noguera, 2013; Narayan and Liu, 2015).

This present study's contribution to the literature stems from the last three points in the immediate preceding paragraph. Beginning with the second and fourth points, we argue that the roles of asymmetry and demand and supply shocks are quite interwoven. This is because demand and supply shocks take precedence over asymmetry[3]. As regards the fourth point, Raheem (2017) expressed the view that net oil importing and exporting countries react differently to oil price changes. Among the notable shocks that have occurred include the: 1973 Yom Kippur War, 1979 Iran-Iraq war, 1990 Iraq-Kuwait war,

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[1]Of the variant types of non-renewable energy, oil is considered to be the most important, which is partly due to the fact that it is a globally traded commodity.

[2]See, *inter alia,* Barsky and Kilian (2004), Atkins and Jazayeri (2004), Al-Qahtani et al. (2008) and Ederington et al. (2011) for literature survey.

[3]Demand shock is mainly caused by political instability in the oil producing economies, while economic down turn and excessive changes (in most cases, increase) in oil price cause demand shock (Chou and Lin, 2013 and Atil et al., 2014).

Iraq invasion by the United States in 2003 and recent global financial crisis of late 2008*, inter alia* (Kilian, 2009). As such, these shocks are expected to impact on oil pricing, and by extension on inflation. Theoretical underpinnings posit that there should be a symmetric relationship between oil price and macroeconomic fundamentals. However, this claim has been refuted using historical data and more recently, in asymmetric-based studies. For instance, Mork (1989) expressed the view that while oil price increase has significant effect on inflation's dynamics, the same cannot be said when there is decrease in the oil price. Hooker (1996) also concluded that the linear relationship between oil price and the economy appear to be much weaker after 1973. Hamilton (2003) orated that oil price changes would have an effect on inflation on the condition that the change is large enough. Barsky and Kilian (2002) equally argued that the major oil price changes in the 1970s were not the major cause of stagflation but monetary factors. Mork, Olsen and Mysen (1994) concluded that only the Organization for Economic Co-operation and Development (OECD) countries react asymmetrically to changes in oil price. Lee, Ni and Ralti (1994) also averred that the increasing oil price volatility contribute to the asymmetry effect especially when economic activities are being deflated by oil price volatility.

Turning to the homogenous effect of oil price changes. The norm of asymmetry based studies lies in (i) the use of time series analysis; (ii) assuming a role for asymmetry. For the fact that countries react differently to changes in oil prices do not mean that countries with similar experience, would behave in the same manner. This implies that further decomposition of the asymmetric effect would reveal dissimilar reactions among countries sharing identical tendencies. Hence, there is the need to account for heterogeneity. Essentially, we use the recent dynamic common correlated effect (CCE) within the heterogeneous panel framework of Chudik and Pesaran (2015). The rationale behind this lies on its advantage in incorporating information on common factors, which might be present, in the panels of the estimated models. CCE works well in models that suffer from observable common factors. CCE improves on mean group estimator based on the inability of the latter to incorporate information on common factors, which might be present. The common factors are time specific effects that are common across countries and might include fluctuations in global energy prices, technological changes, and global business cycle conditions[4].

The closest study to this present inquiry is that of Salisu et al. (2017). They examined the asymmetric relationship between inflation and oil price for both oil exporting and importing countries. Our study charts a different path in the following ways: (i) using an extended dataset; (ii) accounting for heterogeneity in the series; (iii) improve on the extant literature by decomposing oil price changes into both positive and negative partial sum series, thus allowing for multiple partial sum decomposition. Thus, oil price changes are partially

[4]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 and economic or social interaction (Chudik et al., 2011). These variables should be considered to be latent variables rather than treating them with levity like we would for omitted variables (Eberhardt and Presbitero, 2015).

decomposed into quintiles and deciles to capture the asymmetric price pass-through from oil price to inflation. Giving insights into the results, we show the importance of asymmetry in the model for both oil- import and exporting countries, with countries responding more to positive shocks. Quantile decompositions show that the asymmetry effect of oil price change fizzles out only for the oil importing country. For the oil exporting countries, asymmetry is important at higher quantiles. Accounting for breaks do not significantly alter earlier results.

After this introductory section, the remaining sections of the paper are structured as follows. Section two dwells on literature review on the oil price and inflation nexus. In section three, methodological and data related issues are discussed. We present and discuss the results of the estimated coefficients in section four, while we wrap up the study by way of concluding with some policy implications in section five.

2. Literature Review

Studies on the effect of oil price change on inflation are huge. The review of existing studies is dissected into three sections. The first section is based on studies that establish positive relationship between macroeconomic variables and oil price dynamics, thus supporting Hamilton's (1983) hypothesis. The second strand of review consists of studies that refute the conclusion of Hamilton. While the first and second strands were on a symmetric approach on the one hand, the last segment delves into studies that had considered the asymmetric relationship in the oil price-inflation dynamics.

The first stream of studies basically focused on the effect of oil price changes on the general macroeconomic variables[5]. The seminal paper by Hamilton (1983), using United States (US) dataset, found that changes in oil prices affect the macroeconomic indicators. Gisser and Goodwin (1986) adopted the St. Louis-type equations of selected macroeconomic indicators to validate the results of Hamilton. Sadorsky (1999) and Papapetrou (2001) provided evidences supporting the conclusion of Hamilton. In a later paper, Hamilton (1996) proposed another measure of oil price change which he tagged as "net oil price increase" and tested this data in a Vector Autoregression (VAR) framework. He showed that his previous conclusion, about oil price-macro economy, remains robust to this new measure of oil price. Succeeding studies have narrowed their investigations to examining inflation- oil price nexus. For instance, Gao et al. (2014), using the US monthly data for the period 1974M01 to 2014M07, found positive effect of the oil price shock on energy consumer price index (CPI). Using Taiwanese data, Lu et al. (2010) concluded that the volatility of oil price granger causes inflation. Chou and Lin (2013) extended the argument to disaggregated price indices based on the framework of nonlinear Error Correction Model (ECM). They found that oil price has both long- and short- term pass through

[5]Among the proxies for macroeconomic dynamics include inflation, exchange rate, interest rate, economic growth and its volatility, stock market returns, industrial production among others. But inflation and stock returns appear to be the most studied.

effects on inflation. Also, Cartwright and Riabica (2015) limited their analysis to two countries (France and the US) and proxied inflation by spot and future wheat prices. Using Fully Generalized Least Squares, they showed that, *inter alia,* there is a positive correlation between future wheat prices and spot oil price. Valcarcel and Wohar (2013) provided an innovation in the literature to show that there is a paradigm shift in the oil price pass-through inflation from a supply side to a demand side occurrence.

Among the anti-Hamilton papers include Bohi (1991) whose main critique was based on the restrictive monetary policies of central banks of developed countries as the major cause of macroeconomic instability. He showed that the restraining policies of developed countries' central banks such as those of Germany, Japan, US and the United Kingdom account for a large cause of the decline in economic growth in the years after increase in the prices of oil related commodities. Bernanke et al. (1997) posit that the results of Hamilton (1986), defy the logic of historical data of oil price and recessions in the US. Using VAR, they showed that recessions in the US were preceded by oil price increase and tight monetary policies. Hooker (1996) showed that oil price does not granger cause many US macroeconomic variables after 1973. Also, Hooker (2002) pinpointed to the existence of breaks 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 very minute[6]. Barsky and Kilian (2004) opined that the increase in oil price around 1970s were not the major cause of stagflation, rather the latter is caused by some selected monetary policy tools that were adopted by the Federal Reserve Bank. Chen (2009) also expressed the weak effect of oil price change in driving inflation. Specifically, they show that oil price pass through inflation were important in the 1970s but became weak in the succeeding decades. The lowest ebb of this insignificant effect of oil price occurs in the 2000s. Kilian (2008) reached a similar conclusion. Jimenez-Rodriguez and Sanchez (2005) were able to estimate a negative coefficient in the association between oil price and GDP.

Studies to be reviewed forthwith have argued that the relationship between inflation and oil price is non-linear. They expressed the view that decomposition of oil price into positive and negative changes matter for the nexus. On the one hand, studies have shown that increase in oil price have a negative effect on the macro economy. For instance, Lee et al. (1994) presented results that infer that countries with relative stability in the prices of oil commodities tend to have mild effect of oil price shock. Raymond and Rich (1997) developed a generalized Markov switching model of output to examine the capabilities of oil price change to generate shifts in the mean of Gross Domestic Product (GDP) growth and to predict transitions between dichotomous growth phases. Other studies that have used the Markov-Switching model to reach a similar conclusion include Engemann, et al. (2011) and Abiyev et al. (2015).

[6]This break date "roughly coincides" with the beginning of a period of remarkable macroeconomic stability of key macroeconomic in some selected developed countries. (Nakov and Pescatori, 2009).

On the other hand, it has also been confirmed that oil price collapse has failed to lead to economic boom. The inability to record economic growth during the 1986 oil price collapse is a testimony to this claim. Among the earlier callers of this assertion is Mork (1989) who argued that if the scope of Hamilton was extended to capture oil price collapse of 1986, the positive relationship ceases to exist. Thus, he was the first to test the asymmetry hypothesis using the US data by having diverging effects of increase and decrease in oil price. He showed that an increase in oil price has a negative and significant coefficient and vice-versa. In an expanded dataset, Mork et al. (1994) showed that there was a negative and significant relationship between oil price increase and national output, while no statistical significance could be attributed to when the oil price falls.

Ibrahim and Chanchaoroenchai (2014) used symmetric and asymmetric cointegration and ECM on Taiwanese data to find that oil prices have inflationary pressures on both the aggregated economy and the decomposition of the economy into several sectors. Atil et al. (2014) adopted a nonlinear Autoregressive Distributed Lag (ARDL) framework of Shin et al. (2014) to show that the decomposition of oil price into positive and negative shocks matters for inflation. Çatik and Önder (2011) concluded that there is a regime switching effect in the inflation-oil price shocks nexus. Essentially, they validated the presence of asymmetry in Turkey. In a more recent study, Salisu et al. (2017) confirmed the existence of asymmetry using representative countries from net exporting and importing countries. Lacheheba and Sirag (2018) show that while asymmetry is exists, the Algerian economy responds more to positive oil price shock as compared to negative shock. Using batteries of economic tools, Nusair (2019) show that the important of asymmetry is felt more in the long-run for Gulf Cooperation Council (GCC) countries. López-Villavicencio and Pourroy (2019) used state-space model to estimate the pass-through of oil price changes to inflation. The authors' results our results suggest that there is asymmetric pass-through, which is higher for inflation targeting countries. Another strand of the literature has examined the influence of asymmetric oil price on output (see Raheem and Olabisi, 2018 and Awartani et al., 2020).

3. Data and Methodology

3.1 Data

The scope of this study would be limited to 20 oil-trading economies. Essentially, 10 countries are selected each from the group of net oil exporting and importing countries[7]. This categorization becomes important because the responses of the oil-exporting countries are different to their oil-importing counterparts[8]. We used annual data series for the period 1986-2017. The reason for the use of large

[7]The net oil exporters are Angola, Canada, Iran, Kuwait, Mexico, Nigeria, Norway, Russia, Saudi Arabia, and United Arab Emirates. 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 there are the top 10 countries in their respective group (various issues of World Fact Book).

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

T panel data is attributed to the underlining methodology, which would be adequately discussed in the succeeding sub-section. The two main variables of interest in this study are inflation that is proxied by logarithm of consumer price index (CPI) and measures of oil price (WTI and Brent). The model also allows for the inclusion of a control variable (economic growth). Data on oil prices are collected from United States Energy Information Administration's website (www.eia.gov), data on CPI and economic growth are obtained from world development indicators database.

3.2 Methodology

The large T dimension of the data serves as a pointer for us to use a Mean Group Estimator. The nonlinear ARDL (NARDL) is attributed to Shin et al. (2014). The NARDL serves as an extension to the general ARDL bound testing framework of Pesaran et al. (2001) by allowing for some level of asymmetries in both the long and short run coefficients. The main innovation in the NARDL is that it allows for the partial sum decomposition of the variable(s) of interest. By this, oil price could be decomposed into positive and negative shocks.

The general ARDL is typically represented in the form below:

$$\Delta inf_{it} = \alpha_{1i} y_{i,t-1} + \alpha_2 inf_{i,t-1} + \alpha_{3i} oil_{i,t-1} + \sum_{j=0}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{N2} \gamma_{ij} \Delta oil_{i,t-j} + \sum_{j=0}^{N3} \gamma_{ij} \Delta inf_{i,t-j} + \varepsilon_{it}$$

$$, \quad \text{and} \quad \varepsilon_{it} = \propto_{0i} + \varepsilon \lambda_i' f_t + \mu_{it} \qquad (1)$$

Where inf is the log of CPI, y is the measure of output growth, and Oil is used as a proxy for oil price. The equation is designed in such a way that it also includes country-specific intercepts $\propto_{0i}$, unobserved common factors and country-specific factor loadings[9].

We also employ the 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:

[9]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 interactions (Chudik et al., 2011). These variables should be considered to be latent variables rather than treating them with levity like we would for omitted variables (Eberhardt and Presbitero, 2015).

$$\Delta inf_{it} = \propto_i + \rho_i(y_{i,t-1} - \beta_0 - \beta_1 oil_{i,t-1} - \beta_2 inf_{i,t-1} - \beta_3 f_{t-1}) + \sum_{j=1}^{N1} \theta_{ij} \Delta inf_{i,t-j} + \sum_{j=0}^{N2} \theta_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{N3} \theta_{ij} \Delta oil_{i,t-j} + \varepsilon_{it} \quad (2)$$

The parameters β_i and θ_i represent the long- and short- run, respectively, and Ï□$_i$ captures the speed of adjustment. The values in the bracket represent 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 has very small sample bias in a dynamic panel framework, particularly for moderate time series dimensions. Also, they relaxed the assumption of strict exogeneity and replaced it with the inclusion of the lags and current values of the cross-section averages of all the variables in the model.

3.2.1 The Single Threshold NARDL

The original methodology of Shin et al. (2014) split the hypothesized asymmetric variable into positive and negative partial sum series. The positive(negative) partial sum series, capture an increase(decrease) in the dependent variable.

This is mathematically presented below:

$$\Delta inf_{it} = \alpha_{1i} inf_{i,t-1} + \alpha_2 y_{i,t-1} + \alpha_{3i} oil^{+}_{i,t-1} + \alpha_{4i} oil^{-}_{i,t-1} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{N2} \gamma_{ij} \Delta inf_{i,t-j} + \sum_{j=1}^{N3} \left(\gamma^{+}_{ij} \Delta oil^{+}_{i,t-j} + \gamma^{-}_{ij} \Delta oil^{-}_{i,t-j}\right) + \varepsilon_{it},$$

and $\varepsilon_{it} = \propto_{0i} + \varepsilon \lambda_i' f_t + \mu_{it}$ (3)

Equation 3 shows that oil has been decomposed into $oil^{+}_{i,t}$ and $oil^{-}_{i,t}$, where are defined theoretically as:

$$oil^{+}_{it} = \sum_{j=1}^{t} \Delta oil^{+}_{it} = \sum_{j=1}^{t} max(\Delta oil_{it}, 0) \quad (4)$$

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

The ECM asymmetric version is specified as:

$$\Delta inf_{it} = \tau_i \xi_{i,t-1} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{N2} \gamma_{ij} \Delta inf_{i,t-j} + \sum_{j=1}^{N3} \left(\gamma_{ij}^{+} \Delta oil_{i,t-j}^{+} + \gamma_{ij}^{-} \Delta oil_{i,t-j}^{-} \right) + \varepsilon_{it},$$

and

$$\varepsilon_{it} = \propto_{0i} + \varepsilon \lambda_i' f_t + \mu_{it} \quad (6)$$

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.

We extended equation 6 to account for the important role of structural break. Essentially, we use Kao et al. (2005) structural break test.

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

$$\Delta inf_{it} = \propto_i + \rho_i \left(y_{i,t-1} - \beta_i oil_{i,t-1} - \beta_i inf_{i,t-1} - \beta_i' f_{t-1} \right) + \theta_i \Delta inf_{i,t-j} + \theta_i \Delta y_{i,t-j} + \theta_i \Delta oil_{i,t-j} + \sum_{r}^{k} D_r B_{rt} + \varepsilon_{it} \quad (7)$$

Once break(s) is (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:

$$\Delta inf_{it} = \alpha_{1i} y_{i,t-1} + \alpha_2 inf_{i,t-1} + \alpha_{3i} oil_{i,t-1}^{+} + \alpha_{4i} oil_{i,t-1}^{-} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=0}^{N2} \gamma_{ij} \Delta inf_{i,t-j} + \sum_{j=0}^{N3} \left(\gamma_{ij}^{+} \Delta oil_{i,t-j}^{+} + \gamma_{ij}^{-} \Delta oil_{i,t-j}^{-} \right) + \sum_{r}^{k} D_r B_{rt} + \varepsilon_{it}$$

(8)

3.2.2 Multiple Thresholds NARDL

This study also extends the framework of Shin et al. (2014) to account for the presence of multiple decompositions[10]. Thus, we moved beyond the concept of

[10] Two factors necessitated the adoption of a multiple decompositions. First, Hamilton (2003) argued that the oil price change must be large enough to have effect on macroeconomic fundamentals, inflation inclusive. Thus, the reliance on the positive or negative partial decomposition says nothing about the "size effect" rather focused exclusively on "direction effect". Second, Pal and Mitra (2016) also argue that multiple decomposition improves precision in estimating the asymmetric effect of the oil price change over that of the conventional positive and negative decompositions.

positive and negative changes to examine whether the potential asymmetric effect of oil price change varies from minor to major changes in the variable of interest. In this line of reasoning, we disaggregated oil price changes into quintiles of five partial sum series:

$$oil_{it} = oil_0 + oil_{it}(\varphi_1) + oil_{it}(\varphi_2) + oil_{it}(\varphi_3) + oil_{it}(\varphi_4) \quad (9)$$

The above equation shows the four partial sums for the 20th, 40th, 60th, and 80th quintiles of oil price for the four thresholds represented by $\pi_{20}, \pi_{40,} \pi_{60,}$ $and\ \pi_{80,}$ respectively. They are derived in the forms below:

$$oil_{it}(\varphi_1) = \sum_{i=1}^{t} \Delta oil_{it}(\varphi_1) = \sum_{i=1}^{t} \Delta oil_{it}\, I(\Delta oil_{it} > \pi_{80,}) \quad (10a)$$

$$oil_{it}(\varphi_2) = \sum_{i=1}^{t} \Delta oil_{it}(\varphi_2) = \sum_{i=1}^{t} \Delta oil_{it}\, I(\pi_{80} \geq \Delta oil_{it} > \pi_{60}) \quad (10b)$$

$$oil_{it}(\varphi_3) = \sum_{i=1}^{t} \Delta oil_{it}(\varphi_3) = \sum_{i=1}^{t} \Delta oil_{it}\, I(\pi_{60} \geq \Delta oil_{it} > \pi_{40}) \quad (10c)$$

$$oil_{it}(\varphi_4) = \sum_{i=1}^{t} \Delta oil_{it}(\varphi_4) = \sum_{i=1}^{t} \Delta oil_{it}\, I(\pi_{40} \geq \Delta oil_{it} > \pi_{20}) \quad (10d)$$

$$oil_{it}(\varphi_5) = \sum_{i=1}^{t} \Delta oil_{it}(\varphi_5) = \sum_{i=1}^{t} \Delta oil_{it}\, I(\Delta oil_{it} \leq \pi_{20}) \quad (10e)$$

Where I(.) is a dummy variable that takes the value of 1 if the conditions stated within (.) in equations 10a – 10e are satisfied, otherwise the function takes the value of 0. Thus, the decomposition of oil price into these quintiles is expressed in the form:

$$\Delta inf_{it} = \alpha_{1i} inf_{i,t-1} + \alpha_2 y_{i,t-1} + \alpha_{3i} oil_{i,t-1} + \sum_{j=1}^{N1} \gamma_{ij} \Delta y_{i,t-j} + \sum_{j=1}^{N2} \gamma_{ij} \Delta inf_{i,t-j} + \sum_{j=1}^{N3} \sum_{i=0}^{n} \propto_{ki} oil_{i,t-1}(\varphi_j) + \sum_{j=1}^{5} \pi_k oil_{i,t-1}(\varphi_j) + \varepsilon_{it} \quad (11)$$

Where k= j+1, N represents the number of partial sums.

We also tried to examine whether the impact of large change in oil prices differ significantly from the effect of smaller change in oil prices. Thus, we experimented these using deciles and setting 10 thresholds. Mathematically, the same logic as per equations 9, 10a-10e and 11 can be applied to the decile decomposition.

4. Empirical Results

Table 1 presents the results of the descriptive statistics. The net oil exporting countries exhibit high economic growth and inflationary pressures. In terms of oil pricing, Brent has higher pricing mechanisms as compared to West Texas Intermediate (WTI). Oil-exporting countries have better economic growth trajectories in comparison with the importing countries.

Table 1: Descriptive Statistics

	Net Oil Exporting					**Net Oil Importing**			
	Mean	Min	Max	Std D		Mean	Min	Max	Std D
GDP	3.465	-5.780	8.599	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: Authors' computation. GDP: Gross Domestic Product growth. Min: Minimum. Max: Maximum. Std D: Standard Deviation.

The order of integration of the series in the model is examined using Levin, Lin and Chu [LLC] (2002); Im, Pesaran and Shin [IPS] (1997); and Hadri (2002) tests. LLC and Hadri tests assume common autoregressive structure and unit root, while the inverse is the case for IPS test. It should be noted that these tests do not account for structural break(s). Our results could be biased if the existence of break(s) is/are not being accounted for in the model. Thus, we also used Culver and Papel (1997) and Breitung and Candelon (2005) that accounts for structural break.

Table 2: Unit Root Test without Break(s)

Panel A						
	Oil Importing			Oil Exporting		
	LLC	IPS	Hadri	LLC	IPS	Hadri
GDP Growth	-3.643[a]	-16.337[a]	0.573[a]	-16.495[a]	-14.394[a]	0.794[a]
Inflation	-12.283[b]	-2.974[b]	0.421[a]	-3.747[a]	-3.489[b]	0.392[a]

Panel B

	LLC	IPS	Hadri
Brent	-3.384[a]	-2.244[b]	0.310[a]
WTI	-5.305[a]	-12.143[a]	0.234[b]

Source: Authors' 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

Results of unit root test without breaks are presented in Table 2, while test that incorporates the role of breaks are presented in Table 3. A snapshot of both tables show that the order of integration of the series hovers between level and first difference. The advantage of an ARDL framework over other estimators is the ability of the former to estimate series with different orders of integration. Also, since none of the series is integrated of order 2 (i.e I[2]), we can then forge ahead to estimate an (N)ARDL model. Also, table 2 shows the result of the cross-sectional dependence test of Pesaran (2004). It could be deduced that the series are cross-sectionally independent of each other.

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.

Table 4 shows the result of NARDL as per equation 3. It should be recalled that the equation dealt with the decomposition of oil prices into two partial sums (positive and negative changes). Oil price change has the same effect on both the oil exporting and importing countries. Essentially the estimated coefficients reveal an inflationary pressure on the economies irrespective of the direction of oil price change. This effect is more pronounced: (i) in the short run; and (ii) for oil-exporting countries. Hence, there is evidence of an asymmetric effect of oil price changes. In most cases, the positive changes in oil price have higher coefficients. This implies that changes in inflation in response to fluctuations in oil prices are much higher (lower) when the price of crude oil increases (falls). These results are in tandem with the earlier literature such as Atil et al. (2014), Çatik and Önder (2011), Salisu et al. (2017), Lacheheb and Sirag (2018), and Nusair (2019). Raheem (2017), among other reasons, justified these results based on the belief that an increase in oil price usually fuels inflation. However, storyline for the inflationary effect of a fall in oil price goes thus: fall in oil prices will lead to lower cost of production, increase in disposable income and thus consumption. In the end, this might have an inflationary effect on the economy.

Table 4: NARDL Results (+ve and -ve decompositions without breaks)

Variable		Export	Import
WTI +	Short Run	0.057* [0.006]	0.045* [0.016]
WTI -		0.031* [0.005]	0.026** [0.009]
GDP		-0.031** [.0.015]	-0.059 [0.033]

ECT		-0.201** [0.065]	-0.354* [0.000]
Constant		1.105* [0.000]	2.032* [0.014]
WTI +	Long Run	0.432** [0.047]	0.156** [0.054]
WTI -		0.320** [0.101]	0.284* [0.068]
GDP		0.039** [0.005]	0.058* [0.001]
Diagnostics			
Adj. R^2		0.247	0.438
CD Test (P-value)		0.254	0.389
RMSE		0.052	0.084

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

In an attempt to ensure that these results are valid to multiple decompositions of the partial sums of oil price change, we consider quintile decomposition. Also, these decompositions would: (i) give hint on whether the strength of its impact varies for different levels of oil price change; and (ii) help to differentiate the effect of small from large changes in oil price. As such, estimated coefficients of Table 5 are based on equations 10a – 10e. The estimated coefficients show mixed results. For instance, the coefficients are accompanied by higher quintile values for (i) oil-exporting countries in the short and long run; and (ii) for oil-exporting countries, the direction of asymmetry were negative at lower quintiles. This result supports the conclusion of Hamilton (2003) that the change in oil prices must be large enough to affect inflation. The noticeable feature of the results of the oil-importing countries is that the importance of asymmetry is less pronounced as compared to earlier results in Table 4[11]. The exact reverse is the case for the oil- importing countries in the long run, while there is no clear-cut pattern in the short run analysis for oil-importing countries. To some extent, our results share semblance with Pal and Mitra (2016) who found that large oil price change affects the pricing dynamics of crude products, however, the advantage of the sharp fall of crude prices is not fully transmitted to the oil products. In another paper, Pal and Mitra (2015) concluded that the reduction in the prices of oil does not, in general, transferred to other crude oil products. Thus, their results imply that reduction in oil price does not fuel inflation, at least for crude products.

Table 5: NARDL Results (quintile decompositions without Breaks)

Variable		Export	Import
WTI (ω_1)		-0.014 [0.042]	0.167* [0.004]
WTI (ω_2)		-0.254* [0.014]	0.541** [0.172]
WTI (ω_3)		1.155* [0.295]	0.546 [0.042]

[11]This argument is based on the significance level of the coefficients.

WTI (ω_4)	Short Run	0.091* [0.001]	0.054 [0.052]
WTI (ω_5)		0.079* [0.011]	0.201 [0.098]
GDP		0.223* [.0.002]	0.091 [0.032]
ECT		-0.147* [0.025]	-0.222* [0.007]
Constant		2.021** [0.751]	2.489* [0.000]
WTI (ω_1)	Long Run	-0.759* [0.000]	-0.105* [0.000]
WTI (ω_2)		-0.036* [0.07]	0.112 [0.81]
WTI (ω_3)		0.342* [0.023]	-0.154 [0.065]
WTI (ω_4)		-0.408* [0.100]	0.20 [0.186]
WTI (ω_5)		0.223** [0.079]	0.598* [0.000]
GDP		0.145*** [0.048]	-0.201** [0.055]
Diagnostics			
Adj-R^2		0.185	0.325
CD Test (P-value)		0.371	0.200
RMSE		0.044	0.032

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

In addition to the above, the study extends the decomposition of the partial sums to deciles, and the results are presented in Table 6. There is no significant difference between the quintile and decile decompositions. In order words, there is an overwhelming evidence to suggest that there is an asymmetric relationship between oil price and inflation for oil-exporting countries. In essence, for exporting countries, the coefficients reveal that inflation increases at higher magnitude in response to increase in oil price, but falls at a slower pace for oil price decrease. Asymmetry was found to be weak for oil importing countries. It is also difficult to compare (between minor and major changes) the magnitude of the level of the oil price change[12].

Table 6: NARDL Results (decile decompositions without Breaks)

Variable		Export	Import
WTI (ω_1)	Short Run	0.325^a	0.201
WTI (ω_2)		0.005^a	0.069^b
WTI (ω_3)		-0.315	0.169
WTI (ω_4)		2.012^a	0.201^a
WTI (ω_5)		-0.214^a	0.514

[12]This is premised on the intuition that there is no major difference between ω_1 *and* ω_{10} in both the short and long run.

WTI (ω_6)		0.083	0.0544
WTI (ω_7)		-0.415	-0.140
WTI (ω_8)		-0.511	0.214^c
WTI (ω_9)		0.199^b	0.143^b
WTI (ω_{10})		0.608	0.328
GDP		0.325^b	0.011
ECT		-0.325^a	-0.100^a
Constant		1.068^a	2.548^a
WTI (ω_1)	Long Run	0.254^a	-0.125
WTI (ω_2)		-0.514^b	0.201^a
WTI (ω_3)		0.417^a	-1.189
WTI (ω_4)		0.438	0.903^a
WTI (ω_5)		0.258^b	0.386^c
WTI (ω_6)		-0.202^a	-0.250^b
WTI (ω_7)		-0.511^a	0.102
WTI (ω_8)		0.845^b	0.211^a
WTI (ω_9)		0.114^c	0.102
WTI (ω_{10})		0.432	0.301^a
GDP		0.417^a	-0.137^c
Diagnostics			
Adj-R^2		0.188	0.168
CD Test (P-value)		0.447	0.518
RMSE		0.014	0.027

Source: Authors' computation.
Note: "*","**", and "***" implies level of statistical significance at 1%, 5% and 10% respectively. For the want of space, the standard error statistics are not presented but can be made available upon request.

A fundamental characteristic of a high frequency series is their susceptibility to the problem of structural break. This problem could lead to wrong/bias results and by extension, fundamentally wrong policy prescriptions based on the obtained results. To circumvent this problem, we first conduct structural break on the variable of interest, which in this case is oil price change. Next, we create a dummy variable by assigning 1 to years succeeding the break dates and zero if otherwise. The structural break test is based on Kao et al. (2005). The advantage of this test is based on its ability to account the presence of cross-sectional dependence and exploit it to obtain powerful statistics. The obtained break dates coincide with a number of events[13]. Subsequent to the above, we included the dummy breaks into the NARDL framework.

Table 7: NARDL Results (quintile decompositions with Breaks)

Variable		Export	Import
	Short Run		
WTI (ω_1)		0.114	-0.155***

[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.

		[0.032]	[0.057]
WTI (ω_2)		0.109 [0.177]	0.155 [0.129]
WTI (ω_3)		0.129* [0.000]	0.157* [0.000]
WTI (ω_4)		0.192** [0.053]	0.215*** [0.079]
WTI (ω_5)		0.291* [0.036]	0.222** [0.085]
GDP		0.168** [.0.055]	0.005 [0.021]
ECT		-0.521* [0.099]	-0.201** [0.059]
Constant		1.254* [0.321]	2.955* [0.305]
WTI (ω_1)	Long Run	0.325** [0.057]	0.091* [0.000]
WTI (ω_2)		0.305** [0.107]	-0.098 [0.127]
WTI (ω_3)		-0.201** [0.072]	-0.151 [0.325]
WTI (ω_4)		0.408** [0.167]	0.275 [0.203]
WTI (ω_5)		0.451* [0.000]	-0.337 [0.487]
GDP		0.224* [0.008]	0.395 [0.197]
Diagnostics			
Adj-R^2		0.193	0.315
CD Test (P-value)		0.236	0.195
RMSE		0.043	0.065

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

We present the results of NARDL with structural break dummies in Table 7. Only the break date that coincides with the global financial crisis was presented[14]. Also, the results of the both quintile and decile are quite similar. However, we prefer to showcase the result of the quintile because it is more informative and interesting. The major differences between these results and those presented in Table 5 include: (i) the importance of asymmetry in the short-run became noticeable for oil-importing economies; and (ii) for the oil-exporting countries, the estimated coefficients are associated with higher values of quintiles. Essentially, accounting for structural breaks extend the effect of asymmetry in the short-run for the oil-importing countries. Studies such as Rafailidis and Katrakilidis (2014) and de Jesus et al. (2020) show that accounting for structural break is important to fully understand the asymmetric effect of oil price change.

[14] For want of space we refrained from presenting results of other break dates, but the results can be made available upon request. The reason for choosing 2007 as a representative date is strictly attributed to the importance of the recent crisis.

As a robustness check, we proxy oil price using Brent prices. The main aim of this exercise is to inquire the sensitivity of asymmetry between oil price-inflation dynamics to changes in data measurement. For this act, we estimated a NARDL with structural breaks[15]. For the sake of equity and fairness, (because the last result presentation was based on quintile decompositions) results of the decile decomposition are presented in Table 8. Summarizing the table, the only significant difference between Tables 8 and 6 is the significance of the coefficients in the short run for importing countries (Table 8). This further reinforces the importance and existence of asymmetric effects of oil price change on inflation.

Table 8: NARDL Results (decile decompositions with Breaks) Brent Prices

Variable		Export	Import
WTI (ω_1)	Short Run	0.199[b]	-0.178[c]
WTI (ω_2)		-0.035[a]	0.026[a]
WTI (ω_3)		0.257	-0.302[c]
WTI (ω_4)		1.362[b]	-0.105[b]
WTI (ω_5)		0.017[c]	0.233
WTI (ω_6)		0.157[b]	-0.048[c]
WTI (ω_7)		0.293[a]	-0.098[b]
WTI (ω_8)		-0.202[c]	0.084[c]

[15]We used varieties of decompositions: positive and negative (single threshold), quintile and decile (multiple thresholds). Results of those decompositions that not presented in this study, for want of space, but can be provided available upon request.

WTI (ω_9)		0.201[b]	-0.055
WTI (ω_{10})		0.469[a]	0.054
GDP		0.192c	0.024[a]
ECT		-0.147[a]	-0.198[c]
Constant		3.521[a]	1.333[c]
WTI (ω_1)	Long Run	0.158[a]	0.130[c]
WTI (ω_2)		-0.187[b]	0.154[a]
WTI (ω_3)		-0.101	0.199[c]
WTI (ω_4)		1.224	0.219[b]
WTI (ω_5)		-0.307[b]	-0.227
WTI (ω_6)		0.105	0.186
WTI (ω_7)		-0.221[a]	0.025
WTI (ω_8)		0.362	0.192[c]
WTI (ω_9)		0.420[b]	0.204[a]
WTI (ω_{10})		0.224	-0.233
GDP		0.298[a]	-0.462[b]
Diagnostics			
Ajd-R^2		0.221	0.145
CD Test (P-value)		0.334	0.276
RMSE		0.057	0.144

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

Table 9: Comparison of coefficients corresponding to the partial sum series at the highest threshold with that of the lowest threshold

		Export		Import	
		SR	LR	SR	LR
Single Threshold (Extract from Table 4)	Partial sum series at the lowest threshold (WTI -)	0.031	0.320	0.026	0.284
	Partial sum series at the highest threshold (WTI +)	0.057	0.432	0.045	0.156
	Ratio (highest/lowest)	1.838	1.350	1.740	0.549
5 thresholds with no	Partial sum series at the	-0.014	-0.759	0.167	-0.105

break (Extract from Table 5)	lowest threshold (ω_1)				
	Partial sum series at the highest threshold (ω_5)	0.079	0.223	0.201	0.598
	Ratio (highest/lowest)	-5.642	-0.289	1.203	-5.695
10 thresholds with no break (Extract from Table 6)	Partial sum series at the lowest threshold (ω_1)	0.325	0.254	0.201	-0.125
	Partial sum series at the highest threshold (ω_{10})	0.608	0.417	0.328	0.301
	Ratio (highest/lowest)	1.870	1.642	1.631	-2.408
5 thresholds with break (Extract from Table 7)	Partial sum series at the lowest threshold (ω_1)	0.114	0.325	-0.155	0.091
	Partial sum series at the highest threshold (ω_5)	0.291	0.451	0.222	-0.337
	Ratio (highest/lowest)	2.552	1.387	-1.432	-3.703
10 thresholds with break (Extract from Table 8)	Partial sum series at the lowest threshold (ω_1)	0.199	0.158	-0.178	0.130
	Partial sum series at the highest threshold (ω_{10})	0.469	0.224	0.054	-0.233
	Ratio (highest/lowest)	2.356	1.417	-0.303	-1.792

Source: authors' computation. SR and LR imply short- and long-run respectively.

In Table 9, we conduct a comparative analysis between the coefficients associated with the partial sum series at the highest threshold with that of the lowest threshold. The aim is to summarize and quantify the magnitude of the change in inflation that is attributable to changes in oil price. It is thus hypothesized that should the ratio of these coefficients be greater than unity, oil price increase in higher quantiles is associated with a higher inflationary pressure compared to when oil price changes is within the region of lower quantile. Hence, the results of the table can be summarized as follows: (i) for oil-exporting countries, the ratios of these coefficients are higher than 1 in most cases; (ii) the exact opposite is the case for oil-importing countries, as the number of negative coefficients exceeds the number of positive coefficients. Thus, the study argues that importance of asymmetry is weak for oil-importing countries whose effect is more felt in the short run. A possible candidate of explanation for this scenario could be that the importing countries coincide to be the developed economies. Ensuing from the above, they have better economic structures that could absorb "mild" shocks due to oil price change[16]. Thus, we confirm higher degree of asymmetry between higher and lower quantiles for oil-exporting countries.

Table 10: Comparison of Adjusted-R² and cross-sectional dependence test across models

Model	Adj-R^2	CD-Test

[16]We are cautious of the use of "mild" because it has been established that decomposition if oil price change to positive and negative have significant effect. However, this level of significance disappears or weakens with further decomposition.

	Export	Import	Export	Import
Single Threshold (Extract from Table 4)	0.247	0.438	0.254	0.389
5 thresholds with no break (Extract from Table 5)	0.185	0.325	0.371	0.200
10 thresholds with no break (Extract from Table 6)	0.188	0.168	0.447	0.518
5 thresholds with break (Extract from Table 7)	0.193	0.315	0.236	0.195
10 thresholds with break (Extract from Table 8)	0.221	0.145	0.334	0.276

Source: Authors' computation CD means cross-sectional dependence test.

There is the need to examine the superiority between single and multiple decomposition of oil price change. For the fact that our results support the use of multiple thresholds/decompositions do not in any way imply its superiority to the commonly used single decomposition. To this end, two indicators were used as yardsticks. The first is the value of the Adjusted -R^2 (i.e. the explanatory power of the model). The second indicator is related the cross sectional dependence test. An overview of Table 10 shows that, for oil-exporting countries, the migration from single to multiple decompositions improves the predictive power of the model. Again, there are no clear-cut results for the importing countries. Also, the models for the exporting countries better account for the problems of cross-sectional dependence.

5.0 Conclusion

In this study, we propose a multiple threshold nonlinear autoregressive distributed lag (NARDL) to capture the asymmetric relationship between oil price change and inflation. Also, we expand the decomposition of oil price beyond the conventional positive and negative partial sum to quintile and decile partial sums. This gives more detailed and minute analysis that would yield precise estimates. A representative sample of 10 countries were selected from both net oil-exporting and -importing countries.

Using the conventional positive and negative changes, we found an asymmetric effect of oil price on inflation in both long and short runs for the countries under investigation, with countries responding more to positive partial sum. When we explored the quintile decomposition, some interesting results are worthy to report. First, for exporting-countries, it was observed in most cases, the coefficients reveal that inflation increases at higher magnitude in response to increase in oil price, however, falls at a slower pace for oil price decrease. This thus suggests that asymmetry is more important at higher quintiles. Second, for importing-countries, decomposition of oil price beyond the positive and negative change is very weak, as the asymmetry effect fizzles out. It was also found that the lower quintile values yield negative asymmetric effect. Similar results were estimated for decile partial sums decomposition. Accounting for breaks do not significantly alter the earlier results but extend the prowess of asymmetry to the short run for the oil-importing countries. Again, this extension was found to be weak.

Based on the results obtained, two critical policy issues emanate. The first policy implication is directed towards the oil-exporting countries. This study has provided evidence that suggests that fluctuations in oil prices would transmit to inflation. Achieving price stability is one of the core objectives of countries around the globe. This objective can easily be derailed by fluctuations in oil prices. Thus, the need for government intervention(s) in the domestic oil pricing is unquestionable. In this line of reasoning, complete deregulation of oil products' prices should be discouraged. The oil-exporting economies are not yet developed to the level of shielding themselves from the attendant effects of oil prices. In order to achieve price stability, through oil prices, subsidies and/ or taxes should be part of policy tools that should be considered. In essence, a positive shock to oil prices should be counteracted with subsidy(ies) from the government. In a situation where there is a negative shock, governments should formulate policies that seek to increase taxes on oil products. This might account for why most, if not all, the oil-exporting countries have subsidy programs for oil products.

It is erroneous to assume that changes in oil prices have significant effects on countries in the world. The effect of heterogeneity, among countries, should be considered. This reason for the preceding assertion is because countries have varying levels of income, financial development, and energy legislation, thus oil price changes would affect these economies in a dissimilar way. Our results buttress this point. We find that asymmetry is more exhibited for the exporting-countries, while the effect of asymmetry vanishes for the oil-importing countries. Oil-importing countries should place less emphasis on the pricing mechanism, as the effect of oil price change is not only weak but has a short run effect. Hence, in the long run, the economy could possibly maintain its balance.

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