



Effect of Oil Price on Arms Import in OPEC Countries: A Panel Threshold Model

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Keywords:

Military spending
Oil price
Oil supplies
OPEC
threshold

JEL Classification:

E64, Q31, H53, C24

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Abstract

Oil-rich countries spend more of their oil revenue on arms import for protecting their oil supplies against wars and insurgences. This paper examines the relationship between arms imports and oil price using panel threshold model for eleven selected OPEC countries. Results indicate that multiple thresholds exist in arms import-oil price nexus. We find that a change in oil price either below or above the threshold exerts a negative effect on arms import. The result indicated that a change in oil price would reduce expenditure on arm import of the selected OPEC member countries as they may be interested in allocating more oil revenue for development and growth.

1. Introduction

Natural resources, especially oil and gas are often a driving engine for economic growth and development in resource-rich countries, and on which they mostly depend for social and political strength. Recently, allocation on military expenditures of oil-rich countries is determined by oil price changes as military expenditures are funded by oil revenues. Arm imports by these countries are noticed to substantially increase. This is traced to either their extreme security concerns, proneness to high social and political tensions, armed conflicts or wars (Erdogan *et al.*, 2020).

Digging back to history, Organization of Petroleum Exporting (OPEC) countries have in

one way or another participated in wars and frequently experienced internal tensions and fear of external threats. For example, Arab–Israeli War of 1948 involved two important oil-producing countries of OPEC, Saudi Arabia and Iraq. Israel-Egypt’s Six-Day war of 1957 involved oil producing countries of Algeria, Iraq, Kuwait and Saudi Arabia who contributed to the coalition. More recently, uprising of regional and interregional tensions and insurgencies spanning over a decade in many OPEC members, particularly in the Middle East and African countries, exposed oil infrastructure to risk (Hamilton, 2013; Ariweriokuma, 2009). This might have raised the concern of the

governments of OPEC countries and prompted the authorities to increase military expenditures. For instance, Saudi Arabia expenditures on military weapons increased from US\$2.8 billion in 1986 to US\$3.9 billion in 2017 and slightly dropped to US\$3.4 billion in 2019. The military expenditure of Algeria which stood at US\$146.0 million in 1986 rose to about US\$2.9 billion in 2016. Erdogan *et al.* (2020) pointed out that when oil prices are below speculative benchmark, military expenditures of many net oil exporting countries often increase but other public expenditures would reduce.

Oil resources are considered to be the most important energy and growth-led sources in the world despite being characterized as a curse or a disease in a few cases. However, its price is highly sensitive to market and non-market shocks, making it volatile, which may have a significant impact on the economy and expenditure policies of oil-reliant countries. Considering the supply side, the trend of oil price in the market is more important to net oil exporting countries as their economies heavily depend on oil and its price has a crucial influence on their budgetary policy. Thus, the responsiveness of oil price to a negative shock on the market, for instance, creates a considerable amount of economic uncertainty for net oil exporting countries. As Wang and Sun (2017) observed, such effect would be more echoed in oil exporters' economic policies and regulations at both micro and macro levels than for oil importers. Long before now, oil-rich countries were prone to disruptions especially when the effect is perceived not to trickle down, and it is observed that oil price has a close link with wars and tensions (Wang and Sun, 2017; Ross, 2012). Wang and Sun (2017), among others, claimed that an increase in oil price can induce a rise in expenditure of oil-rich governments. We further this argument on the basis that this may have more effect on military expenditure, and arms import, but not necessarily all their public expenditures. Oil-rich governments may increase

expenditure on arms purchase even when oil price falls. They may reduce arms purchase for development when oil price increases or increase arms import for protection of their oil fields and supplies against disruptions of wars and tensions when oil price falls. Historically, the experience has shown that an increase in oil price is usually short-lived (Zhang *et al.*, 2019). Oil price which stood at \$30 in November 1985, fell below \$10 in July 1986. It fell to US\$43 per barrel within a short period after it reached US\$64 in 2019 (OPEC, 2020; Erdogan *et al.*, 2020).

The impact of oil price volatility on macroeconomic developments and policies has attracted attention in the past. Recently, the impact of oil price on military expenditure has caught a deal of thought in the literature. Wang and Sun (2017) document that the Arab-Israeli war of 1973 that led to the OPEC oil embargo resulted in a substantial increase in the oil price and the aftermath was significant fluctuations of oil prices. Similarly, Noguera-Santaella (2017) reasons that the Iran-Iraq war of 1975 and Iraq's invasion of Kuwait of 1991, among others, increased arms purchase in the Gulf despite the fall in oil price. The expectations were that oil price would increase and increase revenue to finance the wars but the price fell owing to overproduction of oil. Noguera-Santaella (2017) points out that oil plentitude and lack of access has been a source of conflicts and sometimes has been the reason for political violence and interregional wars making reliance on oil even more crucial. This often increases volatility in oil prices and incentivizes the affected states to increase their military expenditures.

In Noguera-Santaella (2017), evidence shows that political turbulence has a significant positive effect on oil price volatility and concludes that world geopolitical unrests between 1990 and 2000 increased the demand for oil which led to a rise in price from US\$14 to US\$140 per barrel. On the contrary, Erdogan *et al.* (2020) used EGARCH and ARDL models to explore the link between oil price volatility and

military expenditure of Gulf Cooperation Council (GCC). Their ARDL long-run model found a positive and statistically significant relationship between oil price and defense expenditure. However, volatility in oil prices reduced defense expenditures in the short run. The EGARCH model showed that the dynamic parameter of oil price was statistically significant but negative. In a similar investigation, based on structural equation modeling, Wang and Sun (2017) find that wars and political tensions and oil price are related through oil supply, and affirm that the longer the tension involving oil-rich countries, the more severe the threat to oil supply disruptions, and hence the more volatile the oil price.

These findings, among others, support Jaffe's (2016) argument that following a swift fall in oil price in 2014, Middle East countries increased their military spending to more than ten percent of their GDPs, coupled with the support of the U.S and its allies, with utmost interest to protect their oil fields and oil infrastructure from armed conflicts and disruptions. Generally, the impact of oil price on oil economies and policies in oil-endowed countries owing to its volatility forms the basis of many arguments in oil-related studies but at what price could volatility be determined? what degree could crude oil price incentivize the interest of net oil suppliers for arms purchase? and what degree of oil price volatility increases or decreases arms purchase of oil-rich countries? These questions imply that the relationship between oil price and arms purchase may be non-linear and it may be an inverse relationship, where there will be a turning point of oil price in influencing the interest for purchase of arms. Thus, this paper examines the relationship between arms import and oil price in OPEC member countries, using panel threshold model. The evidence will shed light on the impact of change in crude oil price on arms imports of OPEC members. We acknowledge that some studies, for example Bakirtas and Akpolat

(2020), focused on similar issue. However, the questions raised above were not answered. Specifically, we explore whether there exists a threshold level in arms import-oil price relationship. Thus, we hypothesized that a change in oil price could influence arms purchase of OPEC countries when oil price reaches a certain turning point.

This study may signal important implications. Based on our knowledge, no similar study has been conducted for OPEC. This study contributes to the literature in some important aspects. First, we employ a panel threshold method that uses forward orthogonal transformation process to eliminate endogeneity, common in other nonlinear methods. This method does not violate distributional assumptions as it ensures error terms are not correlated. If the relationship between oil price and arms trade is nonlinear, then OPEC countries should focus on fiscal policy that will strengthen and stabilize oil market. This will regulate the market better than oil cut. In other words, the interest should be centered on market buffers that may make oil price resilient and less volatile to kinds of market and non-market shocks, with a shift in spending toward economic growth and development especially of low-income counterparts.

The remaining sections of the paper are structured as follows. Section 2 reviews theoretical and empirical literature. Section 3 presents the data and methodology. In Section 4, we present the empirical results and discuss their implications. Finally, section 5 concludes the paper.

2. Literature review

2.1 Theoretical review

In any theoretical model of decision making of resources, a key parameter is the value share of its revenue allocated to the goal(s) of the authority. This has been a known fact about resource-rich countries on social security concerns and geopolitical risks and their

commitments over increase of military expenditures and arms imports than any other sectors of their economies, which are mostly financed through oil revenue. Erdogan *et al.* (2019) argued that such commitments is often determined by oil price and emphasized that the spending on procurements for military is positively related to oil price. Even if oil price falls, they would either reduce their oil revenue reserves or cut allocations to other sectors, education and health for example, so as to meet their priority. Such decision has been explained in the literature using resource dependency theory. The theory states that when an economy is dependent on a single export sector that particularly contributes a large proportion to the national income, the economic and social decision makings of the state would strongly be determined by the revenue generated from the sector. However, the level of economic growth and development attainment in many resource-rich countries, especially middle- and low-income ones, is often abysmal in relation to their resource endowments. This is usually referred to as resource curse (Ross, 2012; Aunty et al., 2007; Hamilton, 2003; Sachs et al., 2001). The resource curse theory explains that resource-abundant countries often experience poor growth and development compared to resource-scarce countries. The natural resources especially oil resource generates huge revenue, determined by oil price, which is volatile. The volatility of oil price may cause instability in oil revenue of oil-dependent countries and the resources itself is linked to rent-seeking, inequality, which might aggravates conflict. The authorities import arms to counter threats and unrest that might distort oil infrastructure and oil supply. Jaffe (2016), thus, argued that oil price can be linked to arm import decisions in conflict affected oil-exporting countries, though the nature of the relationship remains unclear.

Erdogan et al. (2020) argued that the relationship between oil price and arms import could be linear or nonlinear. This is because if oil

price increases, spending on military arms may proportionally increase. This assertion is in line with income hypothesis that affirms that expenditure is a function of income as first suggested by Maynard Keynes. They equally argued that the variables may be inversely related, depending on the degree of fear of attacks. This supported the Hamilton's (2003) hypothesis that economic activity and oil prices are often inversely related. He asserted that increase oil price affects government expenditure in particular whereas decrease does not. Farzanegan, (2018) argued that oil rent and military expenditure are inversely related, as such the magnitude depends on level of corruption and other oil-related maladies. Under trade openness, recently, Bove *et al.* (2018) argued that arms-oil trade largely depends on the level of relationship between the oil-dependent and oil-rich countries. The author emphasized that the higher the amount of arms imported by an oil-rich country from arm merchant, the higher the amount of oil she has exported to the supplier. Meanwhile, Jaffe (2016) has earlier expressed that arms and oil trade is usually bilateral as arms suppliers in most cases have incentives to trade arms in exchange for oil for settling their oil imports deficits.

Chun (2010) and Hamilton (2013) argued that the relationship between military expenditures and oil price is nonlinear. They asserted that military expenditures may increase for protection against oil supply disruption even in periods of low oil prices. Jaffe (2016) noted that grievance among others usually prompts governments of major oil exporting countries, particularly OPEC members, to import more arms to protect oil infrastructure and against threats and militants' disruptions of production and supply of oil. Mowlaei and Golkhandan (2015) also stressed that arms-oil price can influence gross domestic product (GDP), citing for an example that the increase in military expenditure of oil-rich countries in the Middle East led to increased productivity and enhanced

economic growth. Wang and Sun (2017) established that GDP and oil price are related as boosts in global economic growth can lead to higher oil prices but tensions may put immense pressure on oil price through disruption of its supply.

Monge *et al.* (2017) argued that oil price volatility may not likely be related to arms imports as resource-rich countries may increase arm purchase as grievance is common in many of these countries, which supports the resource curse hypothesis, and that arm suppliers may offer incentives regardless of the price of oil. Khan and Haque (2019) observed that oil economies may shrink during low oil price as budgets in these economies are often benchmarked on oil price. Thus, oil price may influence expenditure in these economies. However, Bakirtas and Akpolat (2020) argued that arms and oil trade have *trivariate* relationship as oil exports, oil prices, and arms imports may exhibit bi-directional causal relationship. They argued further that the link between oil price and military spending, either current or capital spending, depends on the threat facing the arms importing country.

Based on aforementioned theories, the relationship between arms imports and oil price is yet certain, however, investigation on the inverse form may extend the literature on arms imports-oil price nexus. This study fills the gap and explores whether there exists threshold level in arms-oil trade relationship. Thus, we hypothesize that the relationship between oil prices and arms import may tend to be nonlinear as governments in oil-rich countries may increase military expenditure for fear of attack even when oil price is not favourable and reduce expenditure on arms for development and growth when oil price increases (Erdogan et al., 2020). This implies that a change in oil price could influence arms purchase of oil-rich countries when oil price reaches a certain turning point. This is modeled in Section 3 of the paper.

2.2 Empirical review

Empirical investigations of the behavior of oil price in relation to wars and tensions, rooted in conflict theory, is widespread in the literature. Recently, the link between oil price and military expenditure of major world oil exporters in the Middle East and North African (MENA) countries and GCC attracts the attention of many researchers. From a broad perspective, the argument of whether oil price volatility depends on tensions that disrupt oil supply was investigated by Monge *et al.*, (2017) and Noguera-Santaella (2016). The studies examined the world major tensions to analyze the relationship between armed conflicts and oil price, using monthly data. Noguera-Santaella (2016) found that intrastate armed conflicts positively affected oil prices before 2000, and that conflicts which occurred after that year had little impact on oil price volatility. Meanwhile, Monge *et al.*, (2017) did not find significant difference in volatility of oil price before and after the conflict.

On the oil supply and demand relationship with arms transfer, Bove *et al.* (2018) studied 149 countries covering the period from 1962 to 1999. They found that the higher the net oil demand of oil-dependent countries, the higher the net arms exports to oil supplier countries as an increase in oil demand of the former leads to an increase in the volume of arms transfers to the latter. The study concluded that net oil import would continue to exert a positive and significant effect on arms transfers. This supports Beker (1982) who argued that the Nixon's administration increased arms trade to oil-rich countries to balance its oil trade deficit. Wang and Sun (2017) sampled eight net oil exporting countries to study the relationship between price of oil and conflicts in the Middle East, applying the structural equation modeling method. The results could not confirm significant effect of wars in the region on oil price changes, however, they concluded that the effect largely depends on the degree to which the events disrupt oil supplies. Toft (2011)

analysed 39 intrastate wars in oil-producing countries between 1965 and 2007 found that intrastate wars have no significant impact on oil supply disruption. The study argued that this may occur if both sides face equal incentive simultaneously. Nonetheless, they concluded that supply disruption depends on the size of the oil production plant and its proximity to the battle area.

More recently, Erdogan *et al.* (2020) investigated the relationship between volatility in oil prices and military expenditures. They hypothesized that a negative shock on oil price may not reduce the military expenditures of the six GCC countries. An ARDL model was used to test the hypothesis. They found that oil price volatility positively affects military expenditures in the long-run, while in the short-run the relationship was inverse. The study concluded that despite oil price decline, military expenditures did not fall in the region. In a related study, Bakirtas and Akpolat (2020) examined the causality between oil price and military expenditures of seven of the OPEC countries, over the period 1980 - 2016. They found a significant causality running from oil price to military expenditures with weak feedback. They concluded that allocation of oil revenues to military expenditures in OPEC countries are economically inefficient.

Our review of the literature shows that some studies on the volatility of oil price in relation to various perspectives, but studies on arms-oil price nexus are scanty. The results of the available studies are inconclusive, making it important to investigate whether there exists a threshold effect in the relationship between oil price and military expenditure. This study intends to bridge the gap by investigating the

arms imports-oil price relationship, using a threshold model.

3. Data and Methodology

3.1 Data

The study utilized annual data spanning 1986 to 2021. The period encompasses the era Hamilton (2013) named “*the age of OPEC*”, as the demand for oil was high during the period, leading to increase in oil revenue, although the market witnessed different spikes in oil prices within the period. For instance, the first lowest oil price spike occurred in 1986 when oil price sharply dropped of which oil-dependence economies were affected (Erdogan *et al.* 2020), and also in 2020 when it reached negative resulting from the scourge of COVID-19 pandemic (Adedeji *et al.*, 2021). Moreover, within this period, a number of OPEC member countries experienced revolution or war (for example: Iran, Iraq, Libya, Kuwait) or armed conflict or fear of threat from proxy wars and insurgent attacks (for example: Nigeria and Saudi Arabia). These may be important factors for oil price volatility in international oil market, and perhaps a cause for increased import of arms in OPEC member countries. Eleven (11) countries of OPEC members are used out of the current 13. Venezuela and Equatorial Guinea are dropped for lack of data on arms import. The main reason for chosen OPEC countries is that they comprise of major net oil exporting countries (Nasir *et al.*, 2019). They host the largest of the world’s oil reserves and mostly affected by oil price fluctuations. Their budgets are highly benchmarked on oil price and financed by oil revenues.

The choice for the observed data is based on the belief that they may be weakly dependent or have low correlations.

Table 1. Series metadata

Variables	Acronyms	Description	Sources
Arm import	ARMS_M	Arms supplies through sales measured in constant (2020) US\$.	WDI, World Bank
Oil price	OILPRICE	Spot Prices for Crude Oil and Petroleum Products in dollars per barrel.	Energy information Administration
Gross Domestic Product	GDP	Sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Data are in constant 2015 U.S. dollars.	WDI, World Bank
Population	POP	The counts of residents (in each country) regardless of legal status or citizenship. The values are midyear estimates.	WDI, World Bank
Trade openness	TRADE_O	The value of exports converted to U.S. dollars and expressed as a percentage of the average for the base period (2000).	WDI, World Bank
Threat	THREAT	Military expenditure by country in US\$ at constant 2020 prices and exchange rates.	SIPRI

WDI = World Development Indicators (<https://databank.worldbank.org>). SIPRI = Stockholm International Peace Research Institute (<https://www.sipri.org/databases/milex>).

West Texas Intermediate (WTI) is used for oil price as it often plays a dominant role and often lead in the international oil market (Zhang *et al.*, 2019). Likewise, arms imports, according to Stockholm International Peace Research Institute (SIPRI), is expenditure on military weaponries designed for military use. The threat is measured as expenditure on local defense projects, such as peacekeeping forces and paramilitary forces, embarked by country for fear of disruption from proxy wars and insurgent attacks. Data were obtained from World Development Indicators, Energy Information Administration, and threat was obtained from SIPRI (Table 1). All the variables are transformed to natural logarithm.

3.2 Theoretical framework

Many macroeconomic variables are volatile in nature, they respond to exogenous and endogenous shocks. Threshold framework often

demonstrates the adjustment of variables to their multiple equilibria. Hansen (1999) developed a static threshold model that assumed a linear relationship between dependent and explanatory variables. However, Seo *et al.* (2019) pointed out that static threshold model does not allow asymmetric effect if it exists and it can be restrictive in real applications. Thus, threshold framework is built to detect turning point of a variable that is presumed to have inverse movement depending on whether the threshold variable is above or below the unknown parameter as proposed by Seo and Shin (2016). Seo *et al.*, (2019) introduced bootstrap algorithm that permits the test of threshold effect. Though the threshold framework relies on the Generalized Moments Method system (System-GMM), it provides little information about unknown threshold value. Recently, Asimakopoulous *et al.*, (2019) argued that

threshold value, if estimated, reflects the point at which the effect of threshold variable begins to change.

Equally, Matemilola *et al.*, (2013) evidenced that System-GMM in dynamic framework overcomes endogeneity as it uses lag dependent variable that accounts for possible endogeneity issue, and instrument proliferation. However, the system may weakly account for simultaneity bias that might be caused by dynamic relationship that may exist between dependent and independent variables. This makes System-GMM to be considered as inefficient in this scenario. Accordingly, threshold framework with instrumental variables proposed by Caner and Hansen (2004) deals with this issue. The asymptotic threshold framework is built on the assumptions that, according to Caner and Hansen (2004), the threshold variable must be exogenous, and does not require stationarity of the dependent variable as the framework uses the mean of the dependent variable as a function of the exogenous independent variable. The threshold parameter is unknown element and it performs dual functions. It splits sample into two subsamples and detects the threshold points when estimated. The slope parameters in the framework are estimated separately on each subsample and the assumption is that the estimated threshold parameters cannot be equal. For framework validation, Caner and Hansen (2004) established that asymptotic distribution of the threshold estimate should have a sharp V-shape with minimum point, the point at which confidence interval for $\hat{\gamma}$ approaches zero. The shape is likelihood ratio that validates sample

splitting and separates estimation for each subsample. Overall, as Hansen (1999) established, partitioning of sample for capturing if threshold effect exists is the strength of threshold model which makes the model nonlinear.

3.3 Model Specification

The hypothesis formulated for the study follows a linear model commonly used in examining the relationship between macroeconomic variables and stated as:

$$arms_{mit} = \beta oil_{pit} + \delta Z_{it} + \varepsilon_{it} \quad 1$$

where $arms_m$ represents arms import of country i over time t . It is measured as annual expenditure on military weaponries in US dollars; oil_p is oil price represented by West Texas Intermediate (WTI) crude oil price which is measured, according to EIA, in US dollars per barrel. The WTI oil price is among primary benchmarks in the world crude oil market and has commonly been used to represent oil prices in the literature (Adedeji, 2021; OPEC, 2020; Zhang, 2019). Z is a vector of control variables including real GDP, population, trade openness, and threat. ε_{it} is the error term, assumed to be serially uncorrelated. Following Kremer *et al.* (2013), we use implicit form of threshold model to explore possible nonlinear relationship between oil price and arms import. This was built on static threshold model developed by Hansen's (1999) and improved by Caner and Hansen's (2004) to deal with endogeneity. Our panel threshold model takes the following form:

$$arms_{mit} = \mu_i + \theta'_1 oil_{pit} I(oil_{pit} \leq \gamma_1) + \theta'_2 oil_{pit} I(\gamma_1 < oil_{pit} \leq \gamma_2) + \theta'_3 oil_{pit} I(oil_{pit} > \gamma_2) + \delta Z_{it} + \alpha_t + \varepsilon_{it} \quad 2$$

where μ_i and α_t are the country-specific and time fixed effects, respectively. Other variables remained as earlier defined. Oil_p is the threshold

variable, treated as exogenous and used to split the sample into regimes, and γ is the threshold parameter and it is determined empirically. $I(\cdot)$ is

indicator function which assign value of 1 if the threshold γ_i is observed, and 0 otherwise. Thus, the effect of oil_p is allowed to differ depending on whether it is below or above the threshold γ_i . z_i is vector of regressors (real Gross Domestic Product (GDP), trade openness, population, military expenditure, and threat) for which the slope coefficients are regime independent. The vector of explanatory variables is partitioned into a subset z_{1it} of exogenous variable uncorrelated with ε_{it} , and a subset of endogeneous variables z_{2it} , correlated with ε_{it} . Here, γ_1 and γ_2 are the threshold parameters that divide the model into three regimes. The oil price slope coefficients associated with each regime are θ_1 , θ_2 and θ_3 for regimes 1, 2 and 3, respectively and they capture the impact of oil_p on arms import. Due to contingency effects of oil price a multi-threshold model is specified. Thus, in the context of this model, there are either no thresholds, one threshold, or two thresholds of oil price. We also allow for differences in the regime intercepts.

3.4 Estimation procedure

A Panel threshold technique was employed. The basic idea is that estimating the specified model by classical tests, such as the Lagrange Multiplier (LM) test, may generate a biased result as threshold parameter γ is unknown and the classical methods do not have a standard distribution. More so, the individual country-specific effect μ_i may likely correlate with the error term if classical methods were applied, violating distributional assumptions underlying panel threshold model. Panel threshold method has some advantages over panel generalized method of moments and panel linear methods. It uses forward orthogonal transformation that deals with the country specific fixed effects and eliminates serial correlation in the transformed errors (Seo *et al.*, 2019; Zuhail, 2016; Kremer *et al.*, 2013). More so panel threshold keeps the error terms serially uncorrelated and avoids autocorrelation in the transformed error terms by

subtracting the average of all future observations from the data (Kremer *et al.*, 2013).

Procedurally, following Caner and Hansen (2004), we first estimate the reduced model for the endogenous variables, z_{2it} , as a function of the instruments, z_{1it} by the ordinary least squares (OLS) approach and obtain the fitted values of \hat{z}_{2it} . Next, we substitute the estimated value of the endogenous variable, \hat{z}_{2it} , into equation 2 and estimate the threshold γ_i using OLS method. Hanssen (2000) recommends that estimation of threshold value, γ , by OLS method minimizes sum of squared errors (SSE). Hence, the OLS estimators of γ_i is given by

$$\hat{\gamma} = \operatorname{argmin} S_i(\gamma) \quad 3$$

where the threshold parameter $\hat{\gamma}$ is the value that minimizes SSE $S_i(\gamma)$. We use bootstrap procedure, suggested by Hansen (1999), to determine asymptotic distribution of the likelihood ratio (LR). The null hypothesis takes on $H_0: \gamma = \gamma_0$. If homoskedasticity assumption holds, the distribution of $LR(\gamma_0)$ is free of nuisance parameters problem that may make the distribution of γ estimator to be nonstandard. Testing for threshold effects, a linear model under the assumption that the coefficients are the same in each regime ($H_0: \theta'_1 = \theta'_2 = \theta'_3$) is tested against the threshold model ($H_a: \theta'_1 \neq \theta'_2 \neq \theta'_3$). In taking the decision for significance of the threshold effects, F statistics are constructed:

$$F_i = \frac{(S_0(\gamma) - S_i(\hat{\gamma}_i))}{\hat{\delta}^2} \quad 4$$

where S_0 and S_1 are the residual sums of squared (RSS) obtained from the linear model and threshold model, respectively; and $\hat{\delta}^2$ is the residual variance of the panel threshold model. The hypothesis of single threshold is rejected in favor of double threshold or double is rejected in favor of triple threshold if the value of F_2 is greater than F_1 or F_3 . If there is(are) threshold effect(s) ($\theta'_1 \neq \theta'_2 \neq \theta'_3$), then linear relationship

between oil price and arms import would be inconsistent.

We consider that there may be multiple thresholds owing to the sensitivity of oil price (Erdogan *et al.*, 2020, Zhang *et al.*, 2019; Apergis & Payne, 2014), thus, we search for tripartite points with the assumption that multiple thresholds is more consistent and provide more important information about the threshold variable. Following Hansen's (1999) multiple thresholds estimation procedure, first, we estimate a single-threshold model. The threshold variable is trimmed off 0.05 at both sides to search for the threshold, and use grid (400) to reduce the computation. The bootstrap number is set at 5000 to attain the first-order asymptotic distribution, and p-values constructed from the bootstrap are asymptotically valid (Hansen, 1999). By repeating the resampling process in thousand times is reasonable for obtaining confidence limits for specific effects as it is suggested in the literature. This is to produce reliable estimate. In addition, if there is no single threshold, this will allow us to further test between one and two thresholds. Second, if single threshold does not exist, we estimate Eq. (2) for test on the statistical significance of $\hat{\gamma}_i$ as to either there are no thresholds, one threshold, or two thresholds. Then we use likelihood ratio to test between one and two thresholds. The hypothesis of single threshold will be rejected in favour of two thresholds if *F-statistics* constructed in Eq. (4) is large than critical value 3.70. The critical value is determined by the 95% percentile of the asymptotic distribution of the likelihood ratio statistic as given in Cancer and

Hansen (2004) monte carlo simulation provided for threshold effect estimation of at least 0.25. Once the threshold values are determined, the slope coefficients can be estimated. Finally, the estimator of the threshold value with a smallest sum of squared errors is selected for interpretation. Hansen (1999) reported that, when there is a threshold effect, $\hat{\gamma}_i$ will be consistent, and the value of $\hat{\gamma}_1$ or $\hat{\gamma}_2$ with smallest sum of squared errors will show a strong effect about the threshold variable oil_p .

4. Results and Discussions

The summary statistics and empirical results are presented in this section. Table 2 shows descriptive statistics and correlation matrix between the variables. Trade openness has the largest mean, 25.8%, with a range of 21.6% to 27.9%. The mean of threat variable is 21.5% while the mean of arm import and population are 18.8% and 16.6, respectively, with similar range of 13.8% to 22.6%. Oil price has the smallest mean, 3.6%, with a range of 2.7% to 4.6%, followed by mean of GDP, 8.7%, with range between 5.8% and 11.1%. The standard deviation of oil price is also the smallest (0.6%) while the value for arms import (2.0%) is the largest in the group. The trade potential of these countries in oil supply to the world is seen in trade openness (1.4%). The threats that face OPEC members may vary, but the trend between proneness to threat (1.7%) and arms import (2.0%) is closed based on these statistics. To some extent, this indicates that the data are not fundamentally different from the population from which they were drawn.

Table 2: Summary statistics and correlation matrix

	ARMS_M	OILPRICE	GDP	POP	TRADE_O	THREAT
Mean	18.811	3.617	8.672	16.557	25.753	21.526
Std. Dev.	2.001	0.633	1.303	1.429	1.421	1.726
Minimum	13.816	2.668	5.811	13.653	21.607	17.097
Maximum	22.092	4.601	11.097	19.169	27.981	25.191
Observations	396	396	396	396	396	396

Correlation matrix

ARMS_M	1.00					
OILPRICE	-0.08***	1.00				
GDP	0.35***	0.04	1.00			
POP	0.04	0.18	-0.66***	1.00		
TRADE_O	0.60***	0.17	0.47***	0.24***	1.00	
THREAT	0.64***	0.22***	0.55***	0.13***	0.85***	1.00

Note: *** denotes significance at 1% . 11 OPEC countries selected are: Algeria, Angola, Congo, Gabon, Iran, Iraq, Kuwait, UAE, Saudi Arabia, Libya, and Nigeria. T = 1986 -2021. Statistics for all variables are based on annual data and there are 396 number of observations s. All the variables are in natural logarithm.

The variables are weakly dependent as they do not show signs of high correlation (0.90) as suggested in literature. The highest correlation (0.85) was found between trade openness and threat. We also subject the variables to panel Levin-Lin-Chu and Im-Pesaran-Shin unit root tests. The former assumes common unit root

process while the latter assumes individual unit root process. From Table 3, except population that was stationary without trend, the Im-Pesaran-Shin test rejects the unit root null hypothesis for the other variables. Thus, all the variables are stationary, allowing for the study of a long-run co-movement.

Table 3: Panel unit root tests

	Levin-Lin-Chu		Im-Pesaran-Shin	
	without trend	trend	without trend	trend
ARMS_M	-8.193***	-7.748***	-6.666***	-7.636***
OILPRICE	-0.987	0.150	0.216	-2.755***
GDP	-2.021**	-1.773**	0.172	-1.669**
POP	-0.096	-26.366***	2.039**	-0.100
TRADE_O	-0.248	-0.938	1.098	-2.689***
THREAT	-1.345*	-2.144**	-1.101	-2.307**

Note: ***, **, & * denote significance at 1%, 5%, & 10% levels, respectively.

Table 4 presents the empirical results. The first panel presents results for the thresholds. The second panel presents regime-specific oil price effect on arms import. Finally, the third panel

presents the fixed-effect of the regime-independent variables.

Considering the threshold effect, the p-values for *F-stat* of the single, double and triple thresholds are less than their critical values,

evidence of no threshold, but the values are close to being statistically significant and all the three-point estimates of the thresholds are within the 95% confidence interval. The low F -values may result from heterogeneity problem, peculiar to panel data. However, the three F values exceed critical value 3.70 for a minimum of 250 observations in Cancer and Hansen (2004) monte carlo simulation provided for threshold effect estimation. Also, the cyclical patterns of graphs in Figure. 1, plotted from the threshold estimates, using the likelihood ratio function, these indicate the existence of thresholds in the regression. The plots provide better inference about the threshold values and the likelihood ratio (LR) tests. The point of the estimates are the values of $\hat{\gamma}_i$, at which the likelihood ratio reaches zero axis,

where γ and $\hat{\gamma}_i$ are identical for which the 95% confidence interval of the likelihood ratio clusters and lies beneath the red dotted line. The point estimate of the single threshold estimate is 41.5 with a corresponding 95% confidence interval of 39.2 to 43.3, while the point estimates of the second and third thresholds are 68.1 and 18.4 together with corresponding 95% confidence interval of 66.1 to 72.3 and 17.2 to 19.2, respectively. This shows that arms imports-oil price relationship is non-linear, thus, the estimates are important for predictions (Zuhail, 2016; Law and Singh, 2014). We conclude that there is evidence of multiple thresholds in the regression relationship, but the threshold effect of double threshold model is stronger; thus, we work with a double threshold model.

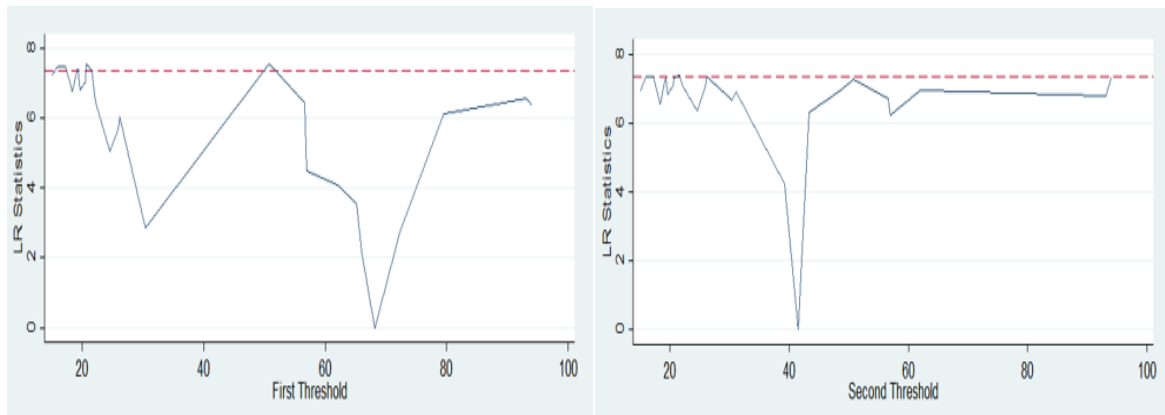


Fig.1 Confidence interval construction for first and second threshold

The threshold estimators falling within the confidence interval suggests that the estimated threshold level splits the observations into two regimes, thus, the coefficients below θ'_0 and above θ'_i threshold are of important interest. The first regime which contains observations below threshold has absolute value of 0.08 and above the threshold for single, double and triple thresholds have values of 0.05, 0.03, and 0.02, respectively, they are all negative and statistically significant at the 1% significant level. This shows that oil price has a negative

impact on arms demand of OPEC member countries whether the price is less or higher than the threshold level. The above and below threshold levels are slightly different but they signal two different regimes owing to swift responsiveness of oil price. This is not surprising as the negative effect of crude oil price, below the threshold, may be attributed to unprecedented shocks on international oil market, such as oil price war strategy and shale revolution, as well as non-market shocks, such as global financial 2008 crisis, conflict in Middle East, Iraq-Kuwait

war of 1997, and current shocks from COVID-19 pandemic, causes low petroleum demand globally and on-going Russia invasion of Ukraine that keeps oil price evenly low. Since natural resource revenues decreased due to the sharp decline in oil prices, OPEC countries might apply cuts in military expenditures. On the other hand, these countries might prefer improved development and stability in the wake of high price-regime and reduce military spending when oil price is above the threshold. This finding is consistent with Noguera-Santaella's (2016) and Wang and Sun's (2017) results. In particular, Wang and Sun found that wars have a significant

effect on oil supply of eight net oil exporters through disruptions which in turn negatively affect the oil price. Meanwhile, Noguera-Santaella established that even if disruption does not actually occur, this reflects volatility nature of oil price, if expectations react accordingly. The negative relationship between oil price and arms imports at even above threshold reflects resource curse of crude oil, consistent with the finding of Abdullahi, Shu and Khan (2019). The authors attest that if resource curse exists, focus would be on protection, peace, and investment, and allocation to arms expenditure will reduce substantially.

Table 4. Panel threshold results

	Coeff.		<i>F</i> -stat.	p-value	95% Conv. interval
<i>A. Threshold levels</i>					
$\hat{\gamma}_1$	41.510		5.04	0.558	39.160 - 43.290
$\hat{\gamma}_2$	68.130		6.44	0.348	66.050 - 72.340
$\hat{\gamma}_3$	18.430		4.45	0.604	17.200 - 19.200
	Coeff.	Std. Er	t-stat.	p-value	
<i>B. Impact of oil price – threshold variable</i>					
$\hat{\gamma} (oil_p \leq 41.51)$	-0.080	0.025	-3.22	0.001***	
$\theta'_1 (41.51 < oil_p \leq 68.13)$	-0.057	0.016	-3.52	0.000***	
$\theta'_2 (68.13 < oil_p < 18.43)$	-0.035	0.008	-4.07	0.000***	
$\theta'_3 (18.43 < oil_p)$	-0.022	0.005	-4.15	0.000***	
<i>C. Impact of regime-independent variables</i>					
GDP _{it}	-1.029	0.312	-3.30	0.001***	
POP _{it}	0.074	0.336	0.22	0.824	
TRADE _{0it}	0.450	0.147	3.06	0.002***	
THREAT _{it}	0.325	0.116	2.78	0.006***	

Note: * denotes significance at 1% levels, respectively. Conv. Interval. = confidence interval. All the variables are in natural logarithm.

The results of panel threshold regression for regime-independent variables are reported in the fourth output of Table 4, and are quite

informative. All the estimated coefficients are consistent with the theory except population which appears a statistically insignificant

determinant of arms imports, but positive. Unlike population, GDP has a negative significant effect on arms import at the 1% significant level. On average, a growth rate of GDP by 1% may correspond to US\$1.03 million fall in arms races of the organization, similar to Erdogan et al.'s (2020) result obtained for GCC in the short-run. With more revenue from oil, other things being equal, OPEC countries may be prompted to spend more on restive groups that may become accustomed to destruction, expand job creation, and involve in development and social reforms to their citizens that may quell conflict and offer foreign aids which may shield proxy wars than increase expenditure on arms imports. Trade openness has a positive significant impact on arms import.

The expenditure on arms purchase of OPEC countries may likely increase by US\$0.45 billion, if, on average, trade openness of these countries improved. Based on this, we can establish OPEC members and their arms merchants may dominate arms–oil trade if the latter are net oil importers. The merchants may be incentivized to sell more arms for mitigating their oil import deficits and, on the other hand, OPEC members may be prompted to import arms for safeguarding their oil fields and production against armed conflict and insurgent attacks that are common in the regions. In addition, one may deduce that there may be a kind of comparative advantage for OPEC countries members on crude oil trade over arms trade. Threat measured in military expenditure is found to have a positive and significant impact on arms imports. This implies, on average, the annual demand of OPEC countries for foreign arms may increase by US\$0.35 billion if prevalence of internal and external tensions increased by 1% over the previous.

This study provides evidence that the coefficients of the two regimes are negative and statistically significant. Thus, we can predict based on the threshold estimates obtained that if crude oil price in international oil market falls

below or equal to US\$68.13 per barrel, this would negatively affect OPEC country members' arms races, in line with Farzanegan (2018), and similar with Erdogan et al.'s (2020) short-run model. Erdogan et al. assert that the Gulf Countries Council (GCC) expenditures on arms imports were funded by oil revenues which is generated from oil trade, and found that oil price has a negative impact on military expenditures though in short-run. They concluded that oil price often responds swiftly to bad news more than the good news in the market. Though, this depends on the degree of unprecedented shocks, the main reason attributed to volatility of oil price. Adedeji et al. (2021) also observed that bad news depresses oil price, and thus slows down oil economies.

GDP coefficient is statistically significant and negative, suggesting that a high economic growth, other things being equal, may reduce conflicts, which consequently may reduce arms purchase. Trade openness and threat coefficients are 0.45 and 0.33, respectively, implying that the more OPEC countries engage in foreign trade, the more the inflow of petrodollar revenues that can be easily dispensed on arms imports, especially when arms dealer partners are incentivized to increase arms sales as a means of reducing their oil import related trade deficits. Likewise, the higher the fear of threats in OPEC countries, the more they are likely to be incentivized to race for weaponries. Meanwhile population is an insignificant determinant of arms imports.

Checking for robustness of these results, we conducted two estimations. First, we added two variables - inflation and exchange rate – commonly used in trade-related studies (Asimakopoulos, S., Kim, and Zhu, 2019; Law and Singh, 2014) to the regressors in the model specification to examine the sensitivity of the results. The results did not change substantially as the signs and coefficients are similar to those reported in Table 3. Also, the threshold values remain same. The coefficient of exchange rate is

insignificant while the coefficient of inflation is negative and statistically significant at the 10% level. Based on this, we conclude that the results are robust. These results are not tabulated in order to save space but available on request. Second, we further explore the impact of oil price on arms imports by applying conventional OLS

standard error (OLS SE) under assumption of homoscedasticity and the White-correlated standard errors (White SE) under assumption of heteroscedasticity with low-price regime and high-price regime as regressors, reported in Table 5.

Table 5. Estimated coefficients of single threshold model

Regressors	Coeff.	OLS SE	<i>t-stat_{ols}</i>	White SE	<i>t-stat_{white}</i>
GDP	2.772	1.052	2.64*	0.582	4.76*
POP	0.501	0.736	0.68	0.955	0.52
TRADE_O	0.381	0.521	0.73	0.965	0.39
THREAT	0.228	0.359	0.63	0.750	0.30
OILPRICE	-1.437	0.407	-3.52*	0.841	-1.71***
$\gamma_1 \leq 68.13$	0.005	0.016	0.29	0.012	0.38
$\gamma_2 > 68.13$	0.020	0.011	1.87***	0.006	3.37*

Note: * & *** denote significance at 1% & 10% levels, respectively. The sample comprises of 11 OPEC country members, time period from 1986 to 2021. γ_1 and γ_2 refer to first and second regime, respectively.

In our dataset, the estimation confirms only 3 out of the 11 countries exceed the threshold value. Presumably, these are OPEC high-income countries. This shows that low oil price does not overtly have an equal impact on OPEC country members. IMF report (2015) documents that low oil price reprehensible impact is not the same on high-income and low-income oil-dependent economies. This is probably owing to economic policies employed in each country for managing their economies when oil price is below the benchmark. Noticeably, we see that the oil price in Table 4 also has a negative and significant effect on arms imports. The coefficients of our primary interest are those regression coefficients of the regimes. The coefficient of low-price regime is given by 0.01 and the high-price regime is 0.02, both regimes show a positive relationship between arms imports and oil price. However, low-price regime when oil price falls below US\$68.13 per barrel is insignificant, while high-price regime, when the price is above the threshold US\$68 per barrel, is slightly

statistically significant at 10%. There is no evidence of oil price influencing arms imports when oil price is below US\$68.13 per barrel in the first regime. This implies that if oil price falls below the threshold value of US\$68.13 per barrel, oil price would not have any influence on OPEC countries' policy to import weapons. However, the second regime shows that there is a positive significant relationship between oil price and arms import. On average, arms imports of OPEC countries will increase by 0.02 percent with an increase of 1 percent in oil price when oil price is higher than US\$68.13 per barrel. The result is intuitive, suggesting that an increase in oil price beyond the threshold value of more than US\$68.13 per barrel would have a positive impact on arms races of OPEC countries. This is consistent with Weiner's (1991) regime hypothesis, which states that the influence of oil prices depends on policies and shocks on the market.

More so, our findings corroborate with Erdogan et al.'s (2020) findings that there is a

positive relationship between oil price and military expenditures of GCC countries, and their error correction model indicates that there is a reverse relationship between the two variables. They concluded that military expenditures would not reduce for GCC countries despite the volatile nature of oil price, but we argue that this may not be obtainable under a low-price regime that is persistent. Zhang et al. (2019) noted this when they observed that oil price is quick to drop in the event of a negative shock. The linear relationship between oil price and arms imports is also negative and statistically significant, confirming that OPEC countries may not increase their demand for foreign weapons if oil price hikes. This is probably because an increase in oil price is usually short-lived. For example, oil price was over US\$100 per barrel in 2011, but the price fell to less than US\$50 per barrel in 2014. Recently, OPEC reference basket in particular dropped to US\$17.66 per barrel in the first quarter of 2020 compared with US\$64.87 per barrel in the last quarter of 2019. This implies that an increase of oil price disappears before long which has no impact on arms imports of the country members. The estimated coefficient of economic growth is 2.77. It is positive and statistically significant at 1% level from both the results of OLS standard errors and White-corrected standard errors. This finding is consistent with Erdogan et al. (2020) who found a long-term, stable relationship between GDP and arms imports of Algeria, Iran, and Saudi Arabia.

5. Conclusion and Policy Recommendations

The philosophical view of arms trade is that it creates an interdependence between the buyers and sellers. The question is whether this is true for oil-rich countries who usually benchmark their expenditure on oil price that is volatile. This paper examines the relationship between arms imports and oil price, using panel threshold model with data spanning from 1986 to 2021 for 11 OPEC selected countries. One main contribution of the paper was the adoption of

Kremer et al.'s (2013) modified panel threshold framework, initially proposed by Hansen (1999), that capture the volatility effect of oil price in the equation. The empirical results indicated multiple thresholds in arms imports-oil price nexus. The high volatility nature of oil price preempts checking for tripartite threshold. Though the low power of our F statistics does lead us to reject the hypothesis of no threshold as the values are close to being statistically significant and all the three-point estimates of the thresholds are within the 95% confidence interval. The three F values exceed critical value 3.70 as given for minimum observation of 250 in Cancer and Hansen (2004) monte carlo simulation provided for threshold effect estimation, whereas our panel group units is 396. More so, the confidence intervals constructed for the single and double thresholds indicate the existence of thresholds in the regression. Thus, we conclude that there exist multiple thresholds in the relationship between oil price and arms imports. However, we employed double threshold model as its effect appears more realistic, and the significance of the threshold suggests that oil price has a turning point that splits the observations into two regimes. The robustness checks did not significantly change the coefficients and signs obtained from threshold regression.

Based on the empirical results, the paper concluded that oil price exerts a negative effect on arms races of OPEC countries, regardless of whether the price is below or above the threshold, implying that arms purchase will reduce when oil price increases. This has some important implications. First, an increase in oil price may not be proportional to increase in arms purchase of oil-rich cartel countries, even if the issue of security is a concern in these countries, and that they may need to protect their oil supply in the event of conflict. These countries are much more concern about education and health development and productive outlays for their long-term economic growth. More so, the paper observed

that no matter the barrel oil arms dealers import from oil-rich countries, they would be at advantage in as much the latter remain unstable. Second, it is clear from the evidence that low oil price regime can hinder arms purchase owing to income effect. This is true when the oil price is below the threshold level as the countries will be prudent in their spending that will curtail the risk of instability effects. On this, OPEC countries might increase their spending on restive groups that may be accustomed to destruction; expand job creation, and embark on development of social reforms that may quell conflicts; and offer foreign aid that may shield proxy wars.

Thus, OPEC countries should propose fiscal policies, such as oil production quota policy, that will strengthen and stabilize oil market for regulating the market than oil cut. Also, knowing the turning point of the relationship between arms trade and oil price, OPEC focus should be on market buffers that will make oil price resilient and less volatile, with a shift in spending toward economic growth and development especially low income counterparts. Low *F* statistics of the threshold might have resulted from small sample problem, which is a limitation of this study, as threshold equation requires large sample. Thus, OPEC-plus may be included in the future works to confirm the findings this present study.

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