IJFBS
Finance & Banking Studies

Finance & Banking Studies

IJFBS, VOL 10 NO 4 ISSN: 2147-4486

Contents available at www.ssbfn.net/ojs

<https://doi.org/10.20525/ijfbs.v10i4.1499>

Trade Balance and Oil Shocks in African Oil Exporting Countries: A Panel Threshold Regression

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Abstract

This paper is driven by the vast influence oil money have on the current account balance of major oil producing countries in Africa and the role policy measures could play to soften these effects. Dwelling on the nonlinear techniques, two types of Threshold Regression were used to estimate data on 8 African countries from 1995-2019. The results show evidence of nonlinear impacts of oil revenue on the current account balances of the 8 countries. The nature of the impact relies significantly on the levels of the threshold variable. Precisely, the estimated threshold benchmark for financial development was 33.34; below this threshold the sensitivity of current account balance to crude-oil shocks is higher and the probability of policy measures to mitigate the effects is low and, beyond the threshold the sensitivity of current account balance to crude-oil shocks is low and the probability of policy measure to mitigate the effects is higher. The finding suggested among others that crude-oil shocks is not the primary problem of the current account imbalance of oil-exporting countries rather the nature of the domestic economic policy environment.

Keywords: Threshold; Financial-Deepening; Oil-Revenue; Current-Account-Balance; Rig-Count

JEL Classifications: F18; F40

Introduction

Trade balance is the difference in the receipts of a country transaction of goods and services and the rest of the world. This difference is the current account balance. In the oil exporting countries, the balance of trade is often boosted by the revenue from sales of crude-oil, (Krugman, 1983). For example, Central Bank of Nigeria (2012) had revealed that crude oil generated about 75.3% of the total public revenue of Nigeria and contributed 96.6% to her total export earnings. However, fluctuation in oil prices had severe effects on the trade balance of both the exporting and the importing countries (Golub, 1983; Krugman, 1983; Kilian, 2008, 2014; and Baumeister & Kilian, 2016). Oil exporting countries ensured favourable trade balance through the management of the excess revenue from oil sales. But the dual role of stabilization and saving gap of oil revenues have become counterproductive on the investigation of oil shocks on current account balance of net oil exporting countries. Because of the incident of unrepentant deficits in the current account balance of major African oil exporting countries, the effect of revenue utilization from crude sales is counter-cyclical on the current account either in consumption or amplifying its effect on trade through precautionary saving. Oil revenues are interestingly viewed as an expanding source of financing consumption and bridging external gap. This was demonstrated by the large current account surplus of Oil exporting countries which suggested that they benefited from the increased oil prices of 2008 to 2014, during the triple digits of oil price in the four consecutive years of 2011 to early 2014. The sudden decline in oil prices in the middle 2014 left oil price to average \$50, \$41, \$52, \$70 and \$64 per barrel in 2015, 2016, 2017, 2018 and 2020 respectively. The event and the 2019 novel epidemic show that oil price will not improve substantially soon. Husain, et al., (2015) argued that global economy will benefit from the price drop at the expense of major oil supplies. The effect is seen already on the current account position of the net oil exporters, especially the low-income countries and had led to revenue gap, subsequently, Fiscal deficits, debts servicing and exchange rate policy are under immense pressure. Financing of these economic distortions remained serious problem to economic policy makers given the divergency across countries wealth and net foreign assets positions, (Behar & Fouejieu, 2016 and Versailles, 2015).

In theory and practice the exchange rates is seen as the natural instrument for current account adjustment and could led to significant contribution, (Cardarelli & Rebucci, 2007). However, African major crude-oil exporting countries had characteristics that may unsharpened exchange rate policy instruments to bring about the necessary current account adjustment. The undiversified nature of these countries could hinder currency depreciation policy and limit the scope of import substitution as well as revenue density. Also, export gain could be negligible because they are price-takers producing at full capacity. On a theoretical viewpoint Bems & Carvahio, (2011) argued with the Permanent income hypothesis that net oil supplies could build up saving for uncertainty and precautionary purposes with the temporary oil price increased. Other, thesis on current account saving gluts dealt extensively on the soundness of countries financial system and show how financial soundness indicators decrease external balance position in the long run, (Basher & Fachin, 2001; Chinn & Ito, 2007; Arezki & Hasanov, 2013 and Allegret, et al., 2014; Ozlale & Pekkurnaz, 2010; Vermeulen & de-Haan 2013; and Huntington, 2015). In these thesis three channels was expressed for mitigation (i) larger size of financial deepening to ensure technical efficiency through increasing return to scale; (ii) Financial system being able to mobilized the minimum resource to finance projects offering higher rates of return; and (iii) increased the size of the financial sector to mitigate distinctive risks and risk diversification, (Acemoglu and Zilibotti, 1997 and Bencivenga & Smith, 1991). Does the oil exporting countries of Africa financial system have the capacity to mitigate the effects of oil shocks on trade balance through a threshold that ensure the expansion of financial mobilization and intermediation during the period of oil boom and reallocation of the financial resource to investment and consumption during damping oil price. This paper investigated how financial deepening could mitigate the effect of crude oil shocks on the trade position of African major oil exporting countries. The paper also determines the threshold at which financial deepening will soften the response of trade balance to oil shocks in the African major oil exporting countries. The paper belongs to the aspect of the literature that examined domestic economic response to internal and external forces; social and economic forces. To address the relationship between oil shocks and current account balance, our empirical analysis relied on the Panel Threshold Regression (PTR) framework. A major strength of the approach is the derivation of the threshold values that could moderate the current account balance responses to oil shocks. However, the threshold values could vary among countries depending on the country specific. Thus, the method allows us to capture countries heterogeneity and time variability of oil shocks-current account nexus and the justification for nonlinearities. The paper is structured into five sections such that section one is the introduction, sections two and three are issues in literature and methodological issues. Whereas section four and five discusses the findings and concluded the paper with recommendation drawn from the discussions.

Literature Review

Studies had shown that the movement in crude-oil prices significantly impacted all the fabrics of the business cycle, a vast literature has focused on the mechanisms on how crude oil shocks affected the macroeconomic performance, economic growth and the financial markets (see Mukhtarov, Humbatova, Mammadli and Hajiyeve 2021; Gylych, et al 2020; Kandil & Markovski 2019; Osuma, Babajide, Ikpefan, Nwuba, & Jegede, 2019; Alekhina & Yoshino, 2018; Vohra, 2017; Emenike 2017; Medee & Ikue-John, 2017; Adam, Rianse, Cahyono, & Rahim, 2015; Narayan & Narayan, 2010; Campbell, 1991; Campbell & Shiller 1988; among others). Some other studies have specifically examined how oil prices impacted on the current account in a panel and single country case, (see Basher & Fachin, 2001; Chinn & Ito, 2007; Arezki & Hasanov, 2013; Allegret, et al., 2014 Bernanke, 2005; Mendoza, Quadrini & Rios-Rull, 2009; Ozlale & Pekkurnaz, 2010; Vermeulen & de-Haan 2014; and Huntington, 2015).

These studies examined the role policy instruments could played to softening the impact of crude-oil on economic performance. Some have argued in the favour of financial instruments and demonstrated how a sound financial system trigger economic growth, causes economic integration within and outside the continent, and how strong financial system mitigated the effect of crude-oil shocks on the current account position. (Asongu, Nnanna & Acha-Anyi, 2020; Allegret et al., 2014; Abu & Abah 2011 and Levine, 2003). They expressively show that net oil exporting countries' current account balance responses depend on the strength of their financial system. However, the Africa oil exporting countries have been mostly ignored in a study of this nature. Also, most studies on the threshold analysis of oil shocks trade balance nexus did not see to the 2015 to 2019 oil crises. Table1 shows the summary of selected empirical findings as it relates to our paper.

Table 1: Summary of Empirical Findings

S/n	Author	Title Objectives	Sample Period	Estimation Technique	Result
1	Jin & Xiong (2020)	The study examined fiscal stress and monetary policy stance in oil-exporting countries.	2003Q1 to 2016Q4	Markov-switching Process	They observed strong significant negativity between exchange rate and oil price variation (persistent oil price drop). They equally show that strong monetary policy measures could isolate exchange rates from oil price variation with the penalty of allowing certain level of depreciation and inflation to support fiscal deficit during the period of drop in oil price. The method use fails to explicitly model the value of the threshold at which monetary policy instrument could perform the isolation.
2	Allegret, et al., 2014	Oil price shocks current account relationship. The study sample 27 oil exporting countries	1980-2010	Panel Smoothing Transitional Regression Model.	Their result shows significant positive nonlinear relationship between current account balance and oil price. They provided the threshold at which financial measure contribute to the response of current accounts of these countries to variation in oil prices. They employed an intervention design and provided the threshold at which policy regime change could affect the relationship between macroeconomic variables. But fail to account for the 2011-2014 oil boom, 2015-2017 oil price crises and 2019 economic crises

3	Varlik & Berument (2020)	The study examined oil price shocks and current account balance composition	December 2001 to March 2018	BEFAVAR	due to Coronavirus. The present study is closely related to this study. Included recent happening in the oil industry but a single country case
4	Khalifa, Caporin, & Hammoudeh, (2017).	The relationship between oil prices and rig counts in USA	Monthly data 1990 to June 2015	Quantile Regression Analysis	Demonstrate that rig-count play a role in oil price fluctuation. But only as correlation with price. The study also is single country case and could not explain the nonlinear relationship.
5	Longe, Adelokun & Omitogun (2018)	The correlation between oil price fluctuations and the current account balances in Nigeria	1977 – 2015	ARDL	The nature of relationship is time variant (short-term and long-term). But fails to account for the 2011-2014 oil boom, 2015-2017 oil price crises and 2019 economic crises due to Coronavirus.
6	Gnimassoun Joets & Razafindrabe (2017)	Analysis of the nexus between oil price variations and current account balances in Canada To analyse the nexus between oil price variations and current account balances	1974-2016	TVP-VAR	Canada crude-oil supply insignificantly affect the current account. However, the study show that crude-oil demand significant affect the current account and further shows that financial deepening plays a significant role in the position of Canadian current account. But the method use did not allow for explicit role of the financial variable as a threshold measure.
7	Alberto & Fouejieu (2016)	External Adjustment in Oil Exporters: The Role of Fiscal Policy and the Exchange Rate To analyse the determinants of the current account balance and of the trade balance in the GCC	1986–2014	Panel Fixed Effects, GLS and GMM-system	The method use did not allow for explicit role of the exchange rates and fiscal variables as a threshold measure.
8	Huntington (2015)	Crude Oil Trade and Current Account Deficits of 91 countries	1984-2009	GLS and Fixed-effect model	The contribution of this study is massive in literature but Fail to account for the 2011-2014 oil boom, 2015-2017 oil price crises and 2019 economic crises due to Coronavirus. It equally did not provide for the medium of moderation.
9	Oseni &	Empirical	1980-	SVAR	Expansionary fiscal policy shock

	Onakoya (2013)	Analysis of 2010 Fiscal Policy Shocks and Current Account Dynamics in Nigeria			has a positive effect on output, exchange rate and negative impacts on current account balance and interest rate. Did not address the role crude-oil plays in fiscal policy decision in Nigeria.
10	Abbas, Bouhga-Hagbe, Fatas, Mauro & Velloso (2011)	Fiscal Policy and the Current Account To examine the relationship between fiscal policy and the current account	1970-2007	Panel regression, P-VAR and S-VAR	Demonstrate a direct significant relationship between fiscal policy and current account balance in emerging markets and low-income countries. but fails to provide for the 2008-2009 financial crises that led to oil price drop, the 2011-2014 oil boom, 2015-2017 oil price crises and 2019 economic crises due to Coronavirus. Thus, periods used are restricted to recent economic activities.

Research and Methodology

This paper is a cross-country analysis of Major oil exporting countries of Africa. Eight African (Nigeria, Libya, Gabon, Equatorial Guinea, Egypt, Republic of Congo, Angola and Algeria) countries where selected for the study. The countries are selected because their net crude oil trade position is positive. However, these are not the only African positive net exporter of crude-oil in the world. These countries are chosen because they produced at least 50,000 barrel/day as at 2010 and had remained in a net positive position to 2019. The paper used annual data for the period of 1995-2019. The included variables are derive from theories and previous empirical studies on current accounts (Calderón *et al.*, 2002; Chinn & Prasad 2003; Gruber & Kamin 2007; Calderón *et al.*, 2007; Chinn & Ito, 2007; Cheung *et al.* 2010; Brissimis *et al.*, 2012; Allegret, *et al.*, 2014; Versailles, 2015; Behar & Fouejieu, 2016; Khalifa, *et al.*, 2017 and Anietie, *et al.*, 2020). Table 2 shows the measurement of the variables and reason for inclusions in the models.

Table 2: Variables Measurement, Theoretical Relationship and Sources

Variables	Description and Measurement	Theoretical Relationship	Sources
Current Account Balance (CAB)	As the ratio of current account balance to nominal GDP.	Dependent Variable	United Nations Conference on Trade and Development (UNCTAD)
Oil Price (OIP)	Recognizing that there are different prices of crude oil and products which could affect the revenue accrue to the net exporter, this study relied on spot prices in most cases and the Brent-Crude Price	$\frac{\partial CAB}{\partial OILP} > 0$	OPEC Statistics and BP Statistical Review of World Energy
Total Crude Oil Revenue (OPR)	This is the measures of all the revenue from crude oil sales, Price*Total Quantity Produced		Authors computation from the OPEC Statistics
Factor Variable (NGRR)	This is the total number of active rigs used for exploration of crude oil (offshore and onshore) multiply by oil production. This is used as measure of industrial shock. Theoretically the employment of rigs in an oil field is a function of	$\frac{\partial CAB}{\partial NGRR} > 0$	Authors computation from the OPEC Statistics and Baker Hughes Rig Count.

	price and safety of the productive environment. Since price is determined exogenously, we concentrated on the interaction of rig employment with production which is an endogenous factor.		
Financial System Soundness (FSE)	Ratio of Broad money supply to nominal GDP. This financial indicator is considered because its measurement captured financial intermediation from three institutions: other Financial Institution, Deposit Money Banks and Central Bank.	$\frac{\partial CAB}{\partial FSE} < 0$	World Bank (WDI), World and Economic Outlook, IFS (WEO).
Fiscal Coordination (GVT)	The ratio of the expenditure of the states (government) to nominal GDP. The relationship between government consumption or expenditure is expected to negate the COB.	$\frac{\partial CAB}{\partial FSE} < 0$	UNCTAD
Net Foreign Asset (NFA)	Stock of Net foreign Assets as ratio of GDP.	$\frac{\partial CAB}{\partial NFA} > 0$	WDI and IFS, WEO.
Globalization Effect (OPN)	This is measured as the ratio of total trade (Merchandise trade and service) to nominal GDP.	$\frac{\partial CAB}{\partial OPN} > 0$	UNCTAD
Terms of trade (TOT)	this is the ratio of export prices to import price express in terms of their logarithm. This is the nature of the elasticity of the country international trade	$\frac{\partial CAB}{\partial TOT} > 0$	UNCTAD
Economic Potential (ECP)	this is measured as Economic Growth Rate.	$\frac{\partial CAB}{\partial ECP} > 0$	UNCTAD
Market Size or Buying Power (MKZ)	this is measured as the ratio of GDP to Total population.	$\frac{\partial CAB}{\partial MKZ} < 0$	UNCTAD
Dependency ratio dpr=(pop<14, pop>65)	this is measured as the ratio of population below 15 and 65 above to working age. Accordingly, current account surpluses are more likely in countries with a greater share of workers in their population (Higgins 1998).	$\frac{\partial CAB}{\partial DPR} < 0$	WDI and IFS, WEO.
Population Growth (PopG)	The rates of growth of population	$\frac{\partial CAB}{\partial popg} < 0$	WDI and IFS, WEO

Source: Authors Computation

The Model

The analytical technique of this paper relied on the Hansan (1999) threshold regression. The technique is applied because the study seeks to model a financial threshold that moderate the responses of trade balance to oil shocks and, the heterogeneity of the data employed.

The framework of Hansen demonstrated the nonlinear relationship between economic variables in a regime switching mechanism that depends on a threshold and was adopted by Wang & Shao (2019), Ndoricimpa, (2017) and Allegret *et al.*, (2014) with modification of smooth transition. The Hansen nonlinear regime switching model is different from the Markovian Regime Switching Models because the switching process is observable ex-post and are adopted for the following reasons;

- The models allow for the heterogeneity of the slope parameters of the regimes.
- The model determined a threshold value that justify the regime switching,
- the variable used as the threshold are exogeneous or at least predetermined

- iv) The model gives a parametric approach of the heterogeneity which is associated to an economic interpretation.

Thus, a single panel threshold model is setup as follows:

$$y_{it} = \alpha_i + \beta'_0 \Delta x_{it} + \beta'_1 x_{it} * \rho(q_{it}; c) + \phi' Z_{it} + \varepsilon_{it} \quad (1)$$

Where;

$Y_{i,t}$ the current account balance of each of the countries.

$x_{i,t}$ crude oil related variables (Oil-Revenue and Oil-Prices).

$t = 1 \dots T$ (study period) and $i = 1 \dots N$, N (number of country or cross – section)

Z_{it} = vector of control variables or determinants of Current Account Balance

α_i = fixed effect representing the heterogeneity of the countries. This separate effects or intercept will be address as variables because it provides justification for the country's variation.

$\rho(q_{it}; c)$ = a transition function,

q_{it} = threshold variable, define here as level of financial openness (ratio of Broad Money Supply to Nominal GDP) variables

c = location parameter

ε_{it} = Error term which variance is σ^2 ($\varepsilon_{it} \sim iid(0, \sigma^2)$).

$$\rho(q_{it}; c) = [1 + \exp(-\gamma \prod_{j=1}^m (q_{it} - c_j))]^{-1} \quad (2)$$

Equation (2) is a normal equation showing that the transition within regime are discrete rather than smooth $c_j, j=1, \dots, m$ are the threshold parameters ($c_1 \leq c_2 \leq \dots \leq c_m$)

$$\frac{\partial y_{it}}{\partial x_{it}} = \beta_0 + \beta_1 \rho(q_{it}; c) \quad (3)$$

In situation where there are more than two regimes say $(r+1)$ regime then equation (1) can be rewritten as

$$y_{it} = \alpha_i + \beta'_0 \Delta x_{it} + \sum_{j=1}^r \beta_j \Delta x_{it} * \rho(q_{it}; c) + \phi' Z_{it} + \varepsilon_{it} \quad (4)$$

Equation 5 shows the magnitude of change of trade balance to oil price shocks:

$$\frac{\partial y_{it}}{\partial x_{it}} = \sum_{j=1}^r \beta_j * \rho(q_{it}; c) \quad (5)$$

Testing for a threshold

This thesis hypothesizes that there is a threshold effect of policy variables on the relationship between oil shocks and current account position of oil exporting countries, and it is important to determine whether these thresholds are statistically significant or not. The null and alternative hypotheses can respectively be represented as

$$\begin{cases} H_0: \alpha_1 = \alpha_2 \\ H_1: \alpha_1 \neq \alpha_2 \end{cases} \quad (6)$$

Where α_1 and α_2 the estimated threshold coefficients.

If $\alpha_1 = \alpha_2$ there is no threshold effect

If $\alpha_1 \neq \alpha_2$ threshold effect between oil shocks and current account position of oil exporting countries does exist.

Under the null hypothesis of no threshold, the model is:

$$v_{it} = u_i + \theta' h_{it} + \alpha' d_{it}(\gamma) + \varepsilon_{it} \quad (7)$$

After the fixed-effect transformation is performed, we have:

$$V_{it}^* = \alpha_1' H_{it}^* + e_{it}^* \quad (8)$$

The regression parameter is estimated using the OLS, which yields estimate $\tilde{\alpha}_1$ residuals $\tilde{e}^*$ and the sum of the square errors.

$$SSE_0 = \tilde{e}^{*'} \tilde{e}^* \quad (9)$$

The Hansen (1999) framework uses the relevant F-test and the sup-Wald for hypothesis examination of threshold effects for the null and alternate, respectively.

That is:

$$F = \sup F(\gamma) \quad (10)$$

$$F(\gamma) = \frac{(SSE_0 - SSE_1(\hat{\gamma}))/1}{SSE_1(\hat{\gamma})/n(T-1)} = \frac{SSE_0 - SSE_1(\hat{\gamma})}{\hat{\sigma}^2} \quad (11)$$

There are precarious situations in this analysis (nuisance parameter exists) or the situations where the threshold values do not exist. Such existence of nuisance parameter makes the F-statistic to be a non-

standard test for distribution, Davies, (1977, 1987). The bootstrap procedure constructed by Hansen (1996) shows a 1st-order asymptotic distribution that make the Probability-values asymptotically unbiased. In the construct x_{it} and q_{it} are treated as given and fixed in the repeated bootstrap samples. $\hat{e}_{it}^*$ is sum based on individual countries: $\hat{e}_i^* = (\hat{e}_{i1}^*, \hat{e}_{i2}^*, \dots, \hat{e}_{it}^*)$ and the procedure are bootstrapped by the samples errors under H_0 . From the bootstrap sample the hypothetical model for the null and alternate equations are estimated and alongside the calculation of the likelihood ratio statistic of the sup-Wald. The process is repeated at least up to 300 times to the point where the simulated statistic exceeds the actual calculated.

Thus:

$$P = P(\tilde{F}(\gamma) > F(\gamma) \mid \zeta) \quad (12)$$

where ζ is the conditional mean of $\tilde{F}(\gamma) > F(\gamma)$.

Asymptotic distribution of the threshold estimates

Equation (13) shows the hypothesis under which the distribution of the threshold is rejected. The Log-likelihood ratio is used to form the confidence intervals for the threshold distribution.

$$\begin{cases} H_0: \gamma = \gamma_0 \\ H_1: \gamma \neq \gamma_0 \end{cases} \quad (13)$$

we construct the testing model:

$$LR_1(\gamma) = \frac{SSE_1(\gamma) - SSE_1(\hat{\gamma})}{\hat{\sigma}^2} \quad (14)$$

The null is rejected if the value of $LR_1(\gamma_0)$ is too large and exceeds the confidence interval, (i.e., reject $H_0: \gamma = \gamma_0$),

then:

$$LR_1(\gamma) = d\zeta \quad (15)$$

as $n \rightarrow \infty$, where ζ

are random variables with a distribution function

$$P(\zeta \leq x) = (1 - \exp(-x/2))^2 \quad (16)$$

Thus:

Because the distribution is based on log likelihood, we can write equation (11) as

$$c(\alpha) = -2 \log(1 - \sqrt{1 - \alpha}) \quad (17)$$

Equation (17) is used to the critical values for the rejection of the threshold value if $LR_1(\gamma)$ exceeds $c(\alpha)$.

Findings

Table 3: Descriptive Analysis of Data

		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG.	ECP
Panel	Mean	0.93	50908.29	89.25	34.24	16.69	92.33	69.54	6.06	2.70	6.20
	Max	46.69	225424.00	125.05	251.62	101.79	235.54	95.50	10.43	4.65	148.00
	Min	-124.6	47.62	27.62	5.74	0.91	20.72	40.56	4.00	0.55	-66.70
	P-Value	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.22	0.00
	Obs.	174	174	174	174	174	174	174	174	174	174
Nigeria		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG	ECP
	Mean	6.37	107381.30	108.23	18.15	4.86	38.21	82.44	5.22	2.59	5.34
	Max	32.95	225424.00	125.05	27.38	9.45	53.28	83.65	5.43	2.68	14.60
	Min	-13.18	24763.60	90.36	9.06	0.91	20.72	81.38	5.12	2.49	-1.60
	P-Value	0.35	0.36	0.25	0.24	0.36	0.80	0.36	0.06	0.29	0.66
Libya		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG	ECP
	Mean	10.96	64109.82	81.52	83.87	29.83	98.05	48.05	6.17	1.33	1.95
	Max	46.69	166381.00	105.03	251.62	101.79	235.54	63.84	6.61	1.92	124.70
	Min	-53.70	16610.40	61.19	26.00	10.53	40.25	41.60	5.84	0.55	-66.70
	P-Value	0.01	0.17	0.41	0.03	0.00	0.00	0.11	0.63	0.20	0.00
Gabon		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG	ECP
	Mean	8.41	12634.96	95.75	18.63	14.76	82.92	68.82	7.98	2.88	2.14
	Max	21.53	22747.90	106.08	24.93	22.33	92.34	79.84	10.43	3.79	7.10
	Min	-12.47	5060.54	83.76	14.45	12.01	70.13	60.51	5.98	2.38	-8.90
	P-Value	0.39	0.34	0.28	0.25	0.00	0.42	0.27	0.30	0.22	0.02
E.C.A		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG	ECP
	Mean	-19.50	11250.44	86.45	10.31	12.32	132.50	68.49	5.48	4.16	21.31
	Max	19.23	29536.10	107.09	16.33	26.02	208.17	80.27	7.45	4.65	148.00

Egypt	Min	-124.6	47.62	27.62	5.74	2.95	92.60	60.97	4.00	3.53	-9.10
	P-Value	0.00	0.40	0.00	0.45	0.25	0.22	0.42	0.40	0.57	0.00
		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG	ECP
	Mean	-1.13	29797.01	22.47	83.72	10.81	47.39	57.80	8.21	1.99	4.52
	Max	5.05	60729.40	45.19	98.14	12.21	71.68	70.67	8.67	2.27	7.16
Congo	Min	-7.58	8231.85	6.32	69.72	7.66	30.25	51.96	7.65	1.75	1.76
	P-Value	0.70	0.30	0.41	0.29	0.00	0.21	0.15	0.33	0.56	0.73
		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG	ECP
	Mean	-3.58	13733.08	98.92	19.20	17.87	125.81	76.12	4.79	2.86	3.34
	Max	20.13	27318.50	113.00	31.71	30.81	157.23	79.92	5.20	3.44	8.70
Angola	Min	-54.11	3308.19	91.44	11.55	10.09	93.00	74.52	4.52	2.44	-2.80
	P-Value	0.09	0.33	0.14	0.33	0.38	0.77	0.01	0.38	0.53	0.61
		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG	ECP
	Mean	-0.19	81354.01	91.92	27.50	20.60	106.28	93.45	4.83	3.43	5.86
	Max	20.41	191019.00	101.81	45.61	52.81	178.69	95.50	5.15	3.71	15.00
Algeria	Min	-28.65	8357.37	55.08	13.30	10.47	52.26	91.10	4.30	3.21	-2.60
	P-Value	0.41	0.35	0.00	0.55	0.00	0.79	0.84	0.30	0.30	0.46
		CAB	OPR	DOPE	FSE	GVT	OPN	POP14	POP65	POPG	ECP
	Mean	3.63	64239.96	62.10	61.61	16.51	61.67	49.08	7.91	1.69	3.32
	Max	24.74	134190.00	91.39	82.00	21.56	76.68	70.19	10.42	2.05	7.20
Algeria	Min	-16.40	10770.60	44.10	33.01	11.23	46.34	40.56	6.40	1.28	1.00
	P-Value	0.51	0.37	0.37	0.40	0.67	0.71	0.09	0.35	0.29	0.55

Source: Author Computations. Note that DOPE=Percentage oil export revenue.

The statistical properties of the variables are reported in table 3. The table is divided into nine panel on the horizontal. The first panel displayed the descriptive statistical behaviour of all the countries combined and others display the descriptive statistics outcome of the individual countries. It was observed in table 3 panel one that the net average current account balance position of the selected African net crude oil exporting countries is positive, with a maximum of 46.69 and minimum of -124.64 ratio to nominal GDP. Within this period, revenue gotten from crude sales average 50,908.29 million of United State Dollars. The average financial deepening (broad money supply as a percentage of nominal GDP) in these countries was 34.24. the maximum was 251.62 and a minimum of 5.74 implying that financial system development significantly varies among the eight countries. The participation of fiscal measurement, that is government consumption to Gross Domestic Product average 16.69 with a range of 0.91 to 101.79, it was equally observed that the average rates of Trade openness (freedom of the movements of goods and services across-borders with trade partners) was 92.33 with a range of 20.72 to 235.54. These clearly shows that the trio of fiscal, monetary and trade policies in these countries differs with higher degrees, and the nature of the common commodity among them could not ensure policy harmonization. Although, these countries are branded by different degrees of socio-economic characteristics. The huge resources from the sale of crude which account for 89.25% of total crude-oil export revenue did not significantly harmonized the socio-economic outlook of the economies in the continent. The table revealed that dependency ratio, especial 0-14 years average 69.54 with a range of 40.56 to 95.50, it implies that larger parts of the population living in these countries are children or persons outside the productive sector.

For instance, in the Algerian economy, the analysis shows that within the period, the economy exported an average of 62.10% of total crude oil produced with negative average of net current account position to GDP of 3.63. The economy on an average or year on year accumulated 64,239.96 million US Dollar from oil sales. This revenue is not steady, it fluctuated due to the movement in the product price and ranges between 10,770.60 to 134,190.00 million US Dollar. The analysis shows that dependency ratio significantly dropped from 70.19% to 40.56% for persons between the age of 0-14, and 10.42 to 6.4% for persons between the ages of 65 and above. The dropped in dependency ratio could contribute to man-hour work and in turn further decreases the dependency ratio, especially persons between 0-14. In line with the improvement in revenue from oil sales, the economy of Algeria grew on an average of 3.32% but fluctuated between a peak of 7.20 and low of 1.00 within the period. The economy also witness improvement in the financial system as money supply contribution to GDP grew to 83.00 from 33.01 and sustained at 61.61 during the period. The significant improvement in oil revenue translated to increase government consumption form 11.23 to 21.56 percent of Nominal GDP but was sustained at 16.51. the economy manages to keep inflows and outflows of goods and service at a degree of 61.67, which grew from 46.34 percent of GDP to 76.68 percent of GDP. It could be said that the improved revenue was seen in policy measures as well as social economic activities within the period.

The Angolan economy exported an average of 91.92% of total crude oil produced with a negative average of net current account position to GDP of -0.19. On year on year the economy accumulated 81,354.01 million US Dollar from oil sales. This revenue is not steady but fluctuated between 191,019.00 and 8,357.37 million US Dollar. The analysis shows that dependency ratio insignificantly dropped from 95.50% to 91.10% for persons between the age of 0-14, and 5.15 to 4.30% for persons between the ages of 65 and above. The dropped in dependency ratio insignificantly contributed to man-hour work. In line with the improvement in revenue from oil sales, the economy of Algeria grew on an average of 5.86% but fluctuated between a peak of 15.03 and low of -2.60 within the period. The improvement in oil revenue could not significantly improve the financial system as money supply contribution to GDP grew to 45.61 from 13.3 and sustained at 27.5 during the period. The significant improvement in oil revenue only translated to increase government consumption form 10.47 to 52.81 percent of Nominal GDP but was sustained at 20.60. The economy manages to keep inflows and outflows of goods and service at a degree of 106.28, which grew from 52.26 percent of GDP to 178.69 percent of GDP. It could be said that the improved revenue never gives clear direction for policy measures as well as social economic activities within the period.

In the Nigerian economy, the analysis shows that within the period, the economy exported an average of 108.23% of total crude oil produced with positive average of net current account position to GDP of 6.37. The economy on an average or year on year accumulated 107,381.30 million US Dollar from oil sales. This revenue is not steady, it fluctuated due to the movement in the product prices and ranges between 24,763.60 and 225,424.00 million US Dollar. The analysis shows that dependency ratio insignificantly dropped from 83.65% to 81.38% for persons between the age of 0-14, and 5.43 to 5.12% for persons between the ages of 65 years and above. The insignificant dropped in dependency ratio could not contribute to man-hour work. In line with the improvement in revenue from oil sales, the Nigeria economy grew on an average of 5.34% but fluctuated between a peak of 14.60 and low of -1.60 within the period. The improvement in oil revenue could not significantly improve the financial system as money supply contribution to GDP grew to 27.38 from 9.06 and sustained at 18.15 during the period. The significant improvement in oil revenue only translated to increase government consumption form 0.91 to 9.45 percent of Nominal GDP but was sustained at 4.86. The economy manages to keep inflows and outflows of goods and service at a degree of 38.21%, which grew from 20.72 to percent of GDP to 53.28 percent of GDP. It could be said that the improved revenue never gives clear direction for policy measures as well as social economic activities within the period. The analysis shows the Algerian economy to be standout in terms current account management, demographics characteristics and macroeconomic indicators. The information on the descriptive behaviour for Libya, Gabon, Egypt, etc are reported. Table 4 shows the relationship among the variables. There was no trace of multicollinearity as none of the relationship among the explanatory variables exceed 0.70. the results reviews that the variables were independent except that they correlated more with our objective variables.

Table 4: Correlation Metrics and Test for Multicollinearity

	CAB	OP	OPR	NFA	MZ	TET	POP14	POP65	POPG	ECP	FSE	GVT
CABG	1.00											
OP	0.29	1.00										
OPR	0.33	0.57	1.00									
NFA	0.07	0.38	0.38	1.00								
MZ	0.30	0.58	0.14	0.30	1.00							
TET	-0.13	0.53	0.15	0.09	0.39	1.00						
NGRR	0.38	0.17	0.67	0.23	-0.15	-0.30						
POP14	-0.15	-0.24	0.05	-0.19	-0.46	-0.22	1.00					
POP65	0.00	-0.16	-0.16	-0.15	0.08	0.04	-0.49	1.00				
POPG	-0.25	0.09	-0.15	-0.24	0.09	0.34	0.61	-0.45	1.00			
ECP	-0.21	-0.18	-0.09	-0.23	-0.18	0.28	0.16	0.03	0.31	1.00		
FSE	-0.03	0.11	0.07	0.50	0.07	-0.04	-0.61	0.40	-0.65	-0.18	1.00	
GVT	-0.20	0.02	-0.08	0.52	0.14	-0.15	-0.23	-0.04	-0.28	-0.34	0.49	1.00
OPN	-0.39	-0.02	-0.29	0.16	0.07	0.29	0.14	-0.30	0.40	0.19	-0.22	0.42

It has become customarily compulsory to evaluate the econometrics properties of the time-series used in a model for some reasons. Firstly, it tells the stability properties of the data and how to use them in an analysis and secondly it guides on the type of methods needed for the cointegration analysis and the estimators for estimation. The unit root analysis has been used severally to conduct the stability and stationarity test of time-series (see Neaime, 2014; Gnimassoun & Coulibaly, 2014; Chen, 2014; Chen & Xie 2015 and Ikue *et al.*, 2021 in this regard). Stationarity implies that a series is mean reverting, that is, the responses of the

series to shocks is temporal. This paper relied on the panel unit root method by Levin, Lin and Chu (LLC), (Levin, Lin, & Chu,2002).

Table 5: Unit Root Test

Variable	Level	P-Value	1 st -Diff	P-Value	I(d)
CABG	-2.202	0.0138	-8.553	0.0000	I(0)
OLP	-1.552	0.0603	-9.147	0.0000	I(1)
OPR	-1.507	0.0659	-7.749	0.0000	I(1)
NFA	-0.702	0.2419	-1.929	0.0268	I(1)
MZ	-1.789	0.0368	-4.568	0.0000	I(0)
TOT	-2.379	0.0087	-8.829	0.0000	I(0)
NGRR	-1.028	0.1519	-5.425	0.0000	I(1)
POP14	-7.086	0.0000	-0.828	0.2039	I(0)
POP65	-2.922	0.0017	0.7764	0.7812	I(0)
POPG	-11.37	0.0000	-5.839	0.0000	I(0)
DPR	-6.934	0.0000	-0.629	0.2646	I(0)
ECP	-0.959	0.1688	-10.79	0.0000	I(1)
FSE	-1.249	0.1059	-7.752	0.0000	I(1)
GVT	0.8914	0.8137	-4.782	0.0000	I(1)
OPN	-0.618	0.2682	-5.481	0.0000	I(1)

Source: Author Computations. **Note;** P-Value =Probability Values

The results are reported on table 5 and it shows that the current account balance of the countries is stationary. The crude oil related variables-oil price and total-Oil-revenue were nonstationary. Outside the crude-oil related variables, the policy measures and economic growth rates were also nonstationary for the period of the study. to verify that the models temporally responded to shocks we conducted the cointegration test. The result is on table 6 it verified the argument of stability of the variables and the overall model. Thus, the model has both long-term and short-term properties.

Table 6: Cointegration Test

Kao Residual Test	t-Statistic	P-Value
ADF	-4.433128**	0.0000
Residual variance	0.326872	
HAC variance	0.300001	

Source: Author Computations

The panel threshold models are presented on table 7. Financial deepening is used as the threshold variable. The argument surrounding the threshold is that an increased in financial development or financial deepening will reduce the negative effects of crude oil revenue shocks on the current account balance of the African net oil exporting countries. There are two conditions followed to select the threshold values. The first condition was to access the statistical properties of the estimated models and the significance of the threshold values; secondly the robustness checks of the threshold values by using different indexes of crude oil (total crude oil revenue and crude oil prices). The Hansen Heterogeneous threshold Regression model uses the christened fixed effect estimator of the panel framework. The interpretations of the diagnostic properties of the models are based on the properties of the Within Estimator. One of the major assumptions about the model is that the countries differences are heterogeneous which are captured by the intercept of the models. This implies that the different intercept of the countries is time invariant as such they are treated as variable in the models. The statistics reported are the Fisher Ratio (F-Stat) for overall model significance, the intraclass correlation (ρ) and the Fisher Ratio ($f_{all}u_i$) for differences in intercept.

Table 7: Estimation of Panel Threshold Models

Variables	All-Countries		OPEC-Countries	
	Coefficient	T-Stat.	Coefficient	T-Stat.
$opr_{i,t}$	0.3692**	4.68	0.3521**	6.78
$nfa_{i,t}$	0.0201**	2.94	0.0021**	2.91
$tot_{i,t}$	0.9591**	4.60	0.8425**	3.69
$mz_{i,t}$	-0.6450**	-2.91	-0.5323**	-3.24
$pop > 65_{i,t}$	0.2297**	3.69	0.2065**	3.26
$pop \leq 14_{i,t}$	-0.8048**	-2.59	-0.8615**	-2.64
$pop_grth_{i,t}$	-0.0237**	-2.11	-0.0716*	1.78
$ecp_{i,t}$	0.0028	0.10	0.0054	0.20
$ngrr_{i,t}$	0.0971**	3.11	0.1691**	2.38
$opn_{i,t}$	0.3699**	3.09	0.4050**	3.48
$govt_{i,t}$	0.4553**	3.38	0.4141**	3.14
$fse_{i,t}$	-0.4975**	-2.46	-0.5432**	-2.65
α	-6.4404	-1.64	-5.8958	-1.52
Model Diagnostics				
Threshold $\widehat{fse}$	32.44<33.34<34.77		32.44<33.34<34.78	
F-Stat.	19.95**		20.01**	
ρ	0.7505		0.7320	
$f_{all}u_i = 0$	4.85**		4.71**	

Source: Author Computations

The results on table 7 shows that the Fisher Ratio (F-Stat) are 19.95 and 20.01 for oil-revenue and oil price models receptively. The two ratios are statistically significant at less than or equal to 0.05 level, implying that the models are better-fits for the explanations of the moderating role of financial deepening of crude-oil current account nexus in the net oil exporting countries of Africa. The intraclass correlation coefficients are 0.7505 or 547.05% and 0.7320 or 73.26% for the both models. The correlation coefficients imply that 75.05 and 73.20 per cent of the variation in current account, oil-shocks and financial deepening in are due to the differences among groups. The values reported for $f_{all}u_i$ are 4.85 and 4.71. The ratios are statistically significant at less than or equal to 0.05 level, implying the invalidation of pooled regression or random effect estimator. Consequently, countries specific characteristics are important in determining the role of policy variables of current accounts-crude-oil nexus of crude oil exporting countries of Africa.

The estimated threshold value is 33.34 for the both models. The value is significantly positive at the probability level less than 5%. It shows that African oil exporting countries could use policy instrument to moderate the impacts of oil revenue on current accounts, this could happen if the ratio of financial deepening is maintained within the range of 33.34 or more. With the threshold of 33.34 financial deepening could reduce the effect of oil revenue on current account by 0.1231 in the first regime. The implication is that the higher the ratio of Money supply to GDP the more the significant policy instrument could soften the effects of oil shocks on current accounts. Table 8 shows the estimated threshold values for the 8 countries. We observed that Algeria, Angola, Egypt, and Libya estimated threshold values is above the benchmark. As stated early, the implication is that low income countries have underdeveloped financial market that makes policy option inconsistent and inefficient. The north African countries that have threshold of financial deepening above the benchmark have shown considerable strength in their management of monetary policy framework over the years as compare to their counterparts in the model.

Table 8: Individual Countries Dynamic Threshold Values

Countries	FSE	OPR	INT	FSE	OLP	INT
Nigeria	24.78	0.2985	7.40	24.78	0.3284	8.14
Libya	131.72	0.2625	34.58	131.72	0.2872	37.83
Gabon	19.66	0.1477	2.90	20.7	0.2378	4.92
Equatorial. Guinea	7.53	0.0156	0.12	7.53	0.0516	0.39
Egypt	84.54	0.1254	10.60	89.31	0.1334	11.91
Republic of Congo	18.5	0.0714	1.32	20.46	0.1558	3.19
Angola	35.68	0.0154	0.55	39.16	0.3608	14.13
Algeria	53.83	0.2052	11.05	67.95	0.2386	16.21

Source: Author Computations. Note that ** ≤ 0.05 level of significance; INT=the intervention rates of the threshold variables or the percentage at which the threshold Variables softens the effect of oil shocks on the current account balance of the net oil exporting countries.

Looking at the impact of the control variables on the current account. Theoretically its assumed that the direct impact of financial development index (financial deepening) will relate negatively with trade balance of oil exporting countries. Reason being that development of financial system will accelerate domestic spending through the reduction of excessive saving. High ratio of financial deepening is assumed to induce the efficiency of the financial markets which in turn, reallocates excess saving into domestic spending and softening the impact on oil shocks on the current account position. Following the observation from the models, with the affirmation from theory, this paper shows that financial deepening significantly impacted the current account negatively. this implies that the financial market can accommodate the excessive revenue from crude sale, and channel it to improve domestic spending. The inference reached here are verifiable with the discoveries of Allegrate, *et al.*, (2014), Arezki & Hasanov (2013), Cheung *et al.* (2010), Gruber and Kamin (2007) and Kennedy & Slok (2005). However, Aristovinin, (2007) find a contrary result, he shows that financial deepening impacted on the current account positively. The difference in results could be attributed to the nature of the data employed, since his study was a five years average or medium -term information.

The results revealed that fiscal expenditure as a ratio of the GDP have a positive effect on the ratio of current account to GDP in the net oil exporting countries of Africa. This implies that 1 percent increase in the ratio of fiscal spending to GDP increases the ratio of the current account to GDP by less than 1 percent. This finding is in line with the discovering of Huntington, (2015), Bluedorn & Leigh, (2011), Kumhof & Laxton (2009) and Chinn & Ito (2007), whose study supported a positive relationship between fiscal consolidation and the current account GDP ratio. However, Chinn & Ito (2007) were able to demonstrate that the relationship was insignificantly positive in the low-income economy. The discovering of Chinn & Ito (2007) was not far from the findings we observed in our Model.

The models revealed a positive relationship between degree of trade openness and current account balance. This implies that a 1 percent increase in the degree of the trade movements (movement of goods and services) current account balance position will improve but the proportional increment is inelastic. The idea is, countries reductions of degree of Autarky (such things as trade barriers) will contribute to flows of foreign direct investment, making the countries to attractive foreign capital and investment. The result obtained here have a different position with the findings of Allegret, *et al.*, (2014), Arezki & Hasanov, (2013) and Chinn & Prasad, (2003). Similar results were noticed in the empirical findings of Huntington, (2015), Gruber & Kamin, (2007). The result obtained could be attributed to the increase trade participation among countries which have improved the degree of openness to average over 70 percent.

The models show that the ratio of Net Foreign Asset to GDP impacted the ratio of current account balance to GDP of net oil exporting countries positively. This result is expected because the surplus revenue from crude oil sales are saved by the net exporters as sovereign wealth, as such improved their net asset positions. The conclusion reached here is strongly supported by the finding of Gruber & Kamin, (2007) which in their check for the determinant of current account balance observed Net Foreign Asset as a strong positive factor. The observation of Allegret, *et al.*, (2014) also supported this report.

Looking at the demographic variables, dependency ratio (the sum of population between 0-14 and persons above 65 divided by population of persons between 15-65) significantly impacted current account ratio to GDP negatively. Considering the life-cycle hypothesis these results are expected: The Lifecycle hypothesised that as dependency ratio increases aggregate domestic saving decreased. This happen because the individual saving behaviour varies with their ages, countries with more dependent persons save

little compare to countries with less dependent persons. Thus, negative relationship is expected between current account position and dependency ratio for countries having higher dependency ratios and could be positive for countries with lower dependency ratio. This conclusion is consistent with the works of Masson et al. (1998), Chinn & Prasad (2003), Gruber & Kamin (2007), Chinn & Ito (2008), Allegret, et al., (2014) among others, whose finding shows a strong negative relationship between dependency ratio and current account position, especially in the low income countries. We also observed that the relationship between ECP and the current account positions of the net crude-oil exporting countries are insignificantly positive. Aristovnik, (2007) and Allegret, et al., (2014) observed same position with the finding of this study. However, their result supports the grand of insignificant effects of GDP growth on the current account position. This result is sometime observed in literature see Chinn & Prasad, (2000) and, there is no clear-cut of the lasting impact of economic growth on current account position.

Conclusion

Following the evidence from empirical models that fluctuations in oil prices impacted significantly on the current account balance of the major crude-oil exporting countries; this study uses an intervention design approach to investigate the role policy measures could play to soften the already established impact of crude-oil shocks on the current account balances of 8 net oil exporting African countries for the period of 1995-2019. Dwelling on the nonlinear techniques, two types of Threshold Regression were estimated, which are heterogeneous (Panel or multi-country Analysis) and Homogeneous (single-country Analysis). The results show evidence of nonlinear impacts of oil revenue on the current account balances of the selected countries. The nature of the impact depends significantly on the level of their financial system development. Precisely, the estimated benchmark thresholds for financial deepening was 33.34. Below this threshold the sensitivity of current account balance to crude-oil shocks is higher and the probability of policy measures to mitigate the effects is low and, beyond the thresholds the sensitivity of current account balance to crude-oil shocks is low and the probability of policy measures to mitigate the effects is higher. Consequently, the study shows that the current account balances of less developed financial system, are susceptible to crude-oil shocks, while the current account balances of augmented financial system are less vulnerable to these shocks. The analysis equally shows that higher threshold values are reported for high-income countries such as Algeria, Egypt, Libya and Angola which are mostly the north Africa oil producing countries. It shows that the financial market of these countries is strong enough to absorb any excessive gains from the increase in crude-oil price that may translate to the current account more than the low-income countries. Conclusively the study reports that the primary driver of oil exporting countries current account surpluses is not the nature of oil prices fluctuations but rather systemic development of policy institutions, instruments and mechanism of transmission. This conclusion is reached because countries with higher financial development indexes demonstrated a higher percentage of reducing the effect of crude-oil revenue on their current account balances. Thus, what matters is the role played by the financial institutions to reallocate the amassed revenues from crude-oil sale to domestic consumption and investments and the ability of the institutions to isolate their economy from oil price fluctuations.

The findings of this study have useful policy recommendations for the net crude-oil exporting countries. However, the policy recommendations are not universal since our findings are nonlinear and vary along economies. For the current account balance to be sustainable the study recommended that the apex banks of the studied oil exporting countries, especially the low-income countries aggressively pursue monetary base or monetary target above the benchmark earmarked for this study.

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