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Asymmetric Effects of COVID-19 Deaths and Oil Price Shocks on Stock Market Returns in Some Selected African Countries: Evidence From Nonlinear ARDL Approach

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Abstract

This study investigates the asymmetric impact of oil price shocks and COVID-19 total deaths on Kenya, Morocco, Nigeria and South Africa stock market returns. To achieve this objective employing weekly time series data from March 13, 2020 to September 23, 2022, first, we apply the BDS test which confirm the nonlinearity of each series. Second, stationarity tests are used to investigate each series for unit root. The results show that series are stationary in level and in first difference. Third, the bounds test reveals that the series have a cointegration relationship and we apply the nonlinear autoregressive distributed lag (ARDL) ARDL framework to decompose oil price into positive and negative partial sum to investigate a possible asymmetric effect of oil price on stock market returns. The main findings of the asymmetric ARDL model reveal that, in the short-run dynamic, a positive shock in the oil price have a negative and positive effect on stock market returns in Morocco and South Africa respectively. The result is insignificant for Kenya and Nigeria. A negative shock in the oil price have a negative effect on the stock returns in Nigeria, South Africa and in Kenya, Morocco with one period lag. Furthermore, in the long-run, a positive shock in oil price exerts a negative effect on the stock market performance in Morocco and Nigeria while a negative shock in oil price leads to a negative effect also on the stock market returns. The total deaths present a counterintuitive result. Both in the long-run and short-run dynamic, the total number of deaths due to COVID-19 have a significant increasing effect on stock market returns in Kenya, Morocco and South Africa except for Nigeria.

Keywords: oil price shocks, COVID-19 total deaths, stock market returns, nonlinear ARDL

JEL Classification: C22, F31, G12

1. Introduction

High fluctuations in oil prices have an important impact on several commodity markets, mainly in the new context of coronavirus pandemic begun in 2019 (COVID-19) and Ukraine war since February 24, 2022. Oil is considered as one of the biggest economic drivers and most of the economies greatly depend on oil day-to-day operations and other economic activities like world’s industrialization and output production (Ali et al., 2022). Oil price change makes stock markets more sensitive and vulnerable (Lin et al., 2019).

Theoretically oil price shocks affect stock market returns or prices though their effect on expected earnings (Apergis and Miller, 2009). If oil prices affect economic activities, it follows oil prices will affect the stock market (Babajide, 2016). Since the pioneer study of Darby (1982) and Hamilton (1983), a large body of studies conclude that oil prices exert a significant impact on economic variables (Baumeister and Peersman, 2012; Segal, 2011; Hamilton and Herrera, 2004). However, the relationship between oil price shocks and stock market returns has until remained not conclusive in the literature. A great number of researcher found that oil price shocks have a negative impact on stock market performance (Filis and Chatziantoniou, 2014; Ciner, 2013; Miller and Ratti, 2009; O’Neill et al., 2008; Ciner, 2001; Papapetrou, 2001; Henriques and Sadorsky, 2008; Sadorsky, 1999; Jones and Kaul, 1996). Sadorsky, (1999) investigates the impact of oil prices and the stock returns for the USA and conclude that a growth in oil prices causes a fall in the stock returns in the short term. According to them, an increase in the oil price lead to a depletion in stock market performance. The increase in oil price translates increasing costs of production and sales decrease. When sales drop off, profits decrease also and the price investors will be willing to pay for a business like stocks or bonds will drop. Thus, when oil prices rise, stock declines (Babatunde, 2013).

On the other hand, some studies advocate in favor of a positive relationship between oil price and stock market performance (Luo and Qin, 2017; Zhu et al., 2014; Narayan and Narayan, 2010; Gjerde and Saettem 1999; Hung et al., 1996; Chen et al., 1986). Narayan and Narayan (2010) found that oil prices exert a positive and significant effect on stock prices in Vietnam. Zhu et al. (2014) found a positive association between oil prices and stock market returns in Asia-Pacific except in Hong Kong.

Moreover, a list of papers shows that there is an insignificant response of stock returns (stock prices) to oil price changes (Babatunde et al., 2013; Apergis and Miller 2009) and other studies retain a nonlinear relationship between oil prices and macroeconomic variables ((Wen et al., 2018; Huang et al., 2017; Salisu et al., 2017; Hatemi-J et al., 2017; Ajmi et al., 2014; Afshar et al., 2008; Hamilton, 2003). Observing the nonlinear effect of oil price on stock market, Afshar et al. (2008) conclude that the oil price shock has a significant asymmetric effect on the US stock market.

Since February 29, 2008 to September 26, 2008, the average of oil price was 115.82 dollars per barrel compared to same period in 2007 where oil prices were 69.7075 dollars per barrel. In 2020, after COVID-19 beginning, the average of oil price was 41.8980 dollars per barrel and it became 108.8961 by average from February 24, 2022 corresponding to the start point of Ukraine war to September 23, 2022. Moreover, the total number of deaths due to COVID-19 is 5675, 16278, 3155 and 102169 for Kenya, Morocco, Nigeria and South Africa respectively.

In light of the disruptions caused by COVID-19 on the financial market, a central question arises: Are there any asymmetric effects of the oil price shock and COVID-19 deaths on stock returns in the chosen countries? Thus, the main objective of this paper is to examine the asymmetric impact of oil price shocks and COVID-19 total deaths on stock market returns in Kenya, Morocco, Nigeria and South Africa.

The general objective is divided into two specific objectives as follows: (i) to investigate a possible asymmetric association between oil price shocks, COVID-19 deaths and stock market returns in the selected countries; (ii) to examine both in short and long-run, the dynamic effect of the aforementioned two variables on stock market returns. To this end, we test the following hypotheses in alignment with our main objectives: (i) the three time series under study exhibit asymmetric characteristics; (ii) the total number of COVID-19 deaths impacts stock returns in both short- and long-term dynamics.

Several studies have focused on Asia, Gulf Cooperation Countries (Arouri and Fouquau, 2009; Hammoudeh and Aleisa, 2004), Australia (Faff and Brailsford, 1999), Canada (Sadorsky, 2001), Malaysia (Ibrahim and Aziz, 2003), Turkey (Eryigit, 2009), the UK (El-Sharif et al., 2005), the USA (Sadorsky, 1999; Kling, 1985) and others, leaving a gap in the literature addressing African countries. To address this gap, our study will focus on selected African countries, namely Kenya, Morocco, Nigeria, and South Africa. Two main contributions are presented in the literature. The first is the consideration of the total number of deaths resulting from COVID-19 in four selected African countries. The second contribution is the use of nonlinear ARDL to capture both positive and negative changes in oil prices.

The paper is structured as follows: Section 2 outlines the data and methodology used in the study, Section 3 presents the empirical findings, and Section 4 concludes the study.

2. Data and Econometric Methodology

2.1 Data

To conduct the econometric analysis, we collect in this paper, oil prices, Kenya, Morocco, Nigeria and South Africa stock market returns for the period from March 13, 2020 to September 23, 2022 on weekly basis. The stock index prices have been taken from www.investing.com. The Brent have been mostly used as benchmark for pricing in the crude oil market and represent the world oil prices, expressed in US dollar per barrel are obtained from the Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/series/DCOILWTICO). The stock returns are measured as $r = \log(r_t / r_{t-1})$. The number of total deaths of Covid-19 is taken from 'Our world in data' (https://ourworldindata.org/grapher/daily-cases-Covid-19).

Table 1. Description of the data series

Variables	Description
Sr	Represent stock returns based on stock market closing prices for Kenya, Morocco, Nigeria and South Africa.
Oil	Europe crude oil prices (Brent)
Deaths	Total deaths due to COVID-19

Source: Author's compilation

2.2 Methodology

Nonlinear ARDL models is used in this study. To emphasize the nonlinear nature of the data, BDS test is applied.

2.2.1 BDS Test

To detect nonlinearity, one of the most popular test used is the Brock and al. (1987) BDS test. This test requires no distributional assumption on the data (it is a statistic) and can be used to detect the remaining dependence and the presence of omitted nonlinear structure when it is applied to the residuals from a fitted linear time series model. It is used because it is powerful than a large number of linear and nonlinear alternatives (Brock and al., 1991; Barnett and al., 1997) and based on the following procedure:

Let x_t a time series with $t = 1, 2, \ldots, Z$ and consider its m history as $x_t^m = \left(x_t, x_{t-1}, \ldots, \mathrm{x}_{t-m+1}\right)$. The correlation integral at dimension m can be estimated as follows:

$$C_{m,\in} = \frac{1}{Z_m\left(Z_m - 1\right)} \sum_{m \le s \prec z \le Z} \sum I\left(x_t^m, x_s^m; \in\right) \tag{1}$$

Where $Z_m = Z - m + 1$ and $I(.)$ is the indicator function which is equal to one if $\left|x_{t-i} - x_{s-i}\right| \prec \in$ for $I = 0, 1, \ldots, m-1$ and zero otherwise. It is estimated the joint probability as follows:

$$\Pr\left(\left|x_t - x_s\right| \prec \in, \left|x_{t-1} - x_{s-1}\right| \prec \in, \ldots, \left|x_{t-m+1} - x_{s-m+1}\right| \prec \in\right).$$

The BDS test statistic can be written as:

$$BDS_{m,s} = \sqrt{Z}\,\frac{C_{m,\in} - C_{1,\in}^m}{s_{m,\in}} \tag{2}$$

where $s_{m,\in}$ is the standard deviation of $\sqrt{Z}(C_{m,\in} - C_{1,\in}^m)$ and the test converges in distribution to $N(0,1)$.

2.2.2 Nonlinear ARDL

A prerequisite for the ARDL test is to solve the problems that the mixture of different time series $I(0)$ and $I(1)$ present so there is no spurious regression, but it cannot be applicable for sequence $I(2)$ or higher (Liu *et al*., 2013). Following Pesaran and al. (2001), Shin and al. (2009), Nimmo and al. (2010, 2014), Lin and al. (2019) consider nonlinear ARDL model. Nonlinear ARDL model is essentially an asymmetric extension of the linear ARDL approach to modelling long-run levels relationships developed by Pesaran et al. (2001). Following Bildirici (2013) and Bildirici and Turkmen (2015) the ARDL model can be stated as:

$$\Delta y_t = c + \delta y_{t-1} + \beta x_{t-1} + \sum_{i=1}^{m-1} b_i \Delta y_{t-i} + \sum_{i=0}^{m} \gamma_i \Delta x_{t-i} + \varepsilon_t \tag{3}$$

We then considered the following nonlinear cointerpreting regression $y_t = \gamma^+ x_t^+ + \gamma^- x_t^- + u_t$, where γ^+ and γ^- are the associated long run parameters and x_t is a $k \times 1$ vector of regressors decomposed as:

$$x_t = x_0 + x_t^+ + x_t^- \tag{4}$$

Where, x_t^+ and x_t^- are partial sums of positive and negative changes in x_t

$$x^+ = \sum_{i=1}^{t} \Delta x_i^+ = \sum_{i=1}^{t} \max\left(\Delta x_i, 0\right) \tag{5}$$

$$x^- = \sum_{i=1}^{t} \Delta x_i^- = \sum_{i=1}^{t} \min\left(\Delta x_i, 0\right) \tag{6}$$

The nonlinear error correction model between variables, after inserting these previous equations into ARDL model, becomes:

$$\Delta y_t = c + \sum_{i=1}^{m-1} b_i \Delta y_{t-i} + \sum_{i=0}^{m} \left(\varphi_i^+ \Delta x_{t-i}^+ + \varphi_i^- \Delta x_{t-i}^-\right) + \delta y_{t-1} + \beta^+ x_{t-1}^+ + \beta^- x_{t-1}^- + \varepsilon_t \tag{7}$$

Where Δ and ε_t are the first difference operator and the white noise term respectively with $\varphi^+ = -\delta\gamma^+$ and $\varphi^- = -\delta\gamma^-$. The rest of analysis is finalized in three steps:

(i) The long-run relation between the levels of variables y_t, x_t^+, x_t^- is explored by means of a modified F tests. $\delta = \beta^+ = \beta^-$ joint null is tested;

(ii) Long run symmetry $(\beta = \beta^+ = \beta^-)$ and short run symmetry $(\varphi_i^+ = \varphi_i^- \; or \sum_{i=0}^{m} \varphi_i^+ = \sum_{i=0}^{m} \varphi_i^-)$ can be tested by using standard Wald tests. The null hypothesis of no cointegration among the variables $\left(H_0 : \delta = \beta = \beta^+ = \beta^- = 0\right)$ which imply no long run relationship, can be tested by the bounds test of Pesaran and al. (2001);

(iii) The standard asymmetric cumulative dynamic multiplier effects, which are defined as: $Z_\rho^+ = \sum_{i=0}^{\rho} \frac{\kappa y_{t+i}}{\kappa x_t^+}$ and $Z_\rho^- = \sum_{i=0}^{\rho} \frac{\kappa y_{t+i}}{\kappa x_t^-}$, $i = 1, 2, \ldots, \rho$ can be used by using the asymmetric ARDL model. When $\rho \to \infty$,

$Z_{\rho}^{+}=\gamma^{+}$ and $Z_{\rho}^{-}=\gamma^{-}$. The asymmetric long run coefficients are measured as $\gamma^{+}=-\beta^{+}/\delta$ and $\gamma^{-}=-\beta^{-}/\delta$.

Before testing the nonlinear ARDL model, the appropriate lag structure of the variables must be selected. We choose the model with the minimum Schwarz's Bayesian information criterion (SBC). Then, if the F value of the test statistic exceeds the upper limit $I(1)$, there will be long-term equilibrium cointegration between variables; if the test statistic is lower than the lower limit, the null hypothesis of cointegration will be rejected, but if the test statistic is between the upper and the lower limits, it will be impossible to make a judgment (Lin and al., 2019).

3. Empirical Results and Discussion

To investigate the cointegration and granger causality between oil prices, stock market returns and Covid-19 total deaths, the empirical analysis includes the descriptive statistics of series, unit root test, BDS test, the nonlinear Bounds test, nonlinear ARDL and nonlinear causality tests.

3.1 Descriptive Statistic and Unit Root Test Results

Descriptive statistics illustrate the basic characteristics of the data series in Table 1. In this table, the average returns of Kenya NSE20 (Ken_{NSE20}), Morocco MSCI ($Moro_{MSCI}$), Nigeria NGE (Nga_{NGE}) and South Africa ASEANPAN ($S.AF_{ASEAPAN}$) were 7.530, 5.727, 2.322 and 7.045 percent respectively. Oil price ($Oilp$) mean is 4.167 US dollars per barrel weekly. The maximum price was US dollar 4.847 on June 10, 2022 and the minimum was 2.656 on April 24, 2020. Kenya's ($deaths_{Ken}$), Morocco's ($deaths_{Mor}$), Nigeria's ($deaths_{Nga}$) and South Africa's ($deaths_{Sou}$) total deaths average were 7.425, 8.438 and 7.266 respectively. All of data series have 131 observations are in natural logarithm.

To avoid spurious regression problems of time series of variables used, Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) test and Andrews-Zivot (AZ) unit root tests are implemented. The first two tests examine the time-series properties without detecting structural breaks in the series while the last test (AZ) accounts for structural breaks in the series. The results show that oil prices, Kenya NSE 20, Morocco MSCI, Nigeria NGE and South Africa ASAEAPAN exhibit I (1), whereas total deaths for the four countries exhibit I (0). The results are shown in Table 2. None of these variables are I (2).

Table 2. Descriptive statistics of the data series

Variables	Mean	Median	Maximum	Minimum	Std. Dev.	Obs#
$Oilp$	4.167	4.262	4.847	2.656	0.458	131
Ken_{NSE20}	7.530	7.540	7.632	7.360	0.054	131
$Moro_{MSCI}$	5.727	5.731	5.886	5.500	0.096	131
Nga_{NGE}	2.322	2.298	2.543	2.074	0.125	131

$S.AF_{ASEAPAN}$	7.045	7.038	7.674	6.081	0.143	131
$deaths_{Ken}$	7.425	8.176	8.643	0.000	1.745	131
$deaths_{Mor}$	8.438	9.130	9.697	0.000	1.867	131
$deaths_{Nga}$	7.266	7.658	8.056	0.000	1.344	131
$deaths_{Sou}$	10.248	10.995	11.534	0.000	2.0819	131

Source: Author's computation

3.2 Brock-Dechert-Scheinkma (BDS) Results

The oil price could hide or contain a nonlinear relationship with stock returns (Lin et al., 2019). If this nonlinear relationship is not detected and take in account by an appropriate approach, the estimation result could provide estimation bias because of nonlinearity. Thus, in Table 4, the null hypothesis in the BDS test with independent and identical distribution (i.i.d) was rejected at 5% significant level, meaning that series had nonlinear characteristics under different dimensions (m=2, 3, …, 6).

Table 3. Results of Brock-Dechert-Scheinkma (BDS) statistics from VAR residuals

Dimension	**BDS Statistic**				
	Ken_{NSE20}	Moc_{MSCI}	Nga_{NGE}	$SouthA_{ASEAN}$	$Oilp$
2	0.1524***	0.1760***	0.1597***	0.1793***	0.1904***
3	0.2542***	0.3084***	0.2708***	0.3015***	0.3244***
4	0.3180***	0.3993***	0.3491***	0.3812***	0.4153***
5	0.3582***	0.4600***	0.4017***	0.4307***	0.4785***
6	0.3772***	0.4988	0.4335***	0.4587***	0.5207***

Notes: *, **, *** denote significance at 1%, 5% et 10% respectively.

Table 4. Unit root tests

	Augmented Dickey-Fuller test (ADF)		Phillips-Perron test (PP)		Andrews-Zivot (AZ)	
Variables	Level	First diff	Level	First diff	Level	First diff
Oil	-1.3002	-6.8043***	-1.3940	-10.5877***	-2.5127 (11/06/20)	-10.8151*** (03/04/22)
Ken_{NSE20}	-1.5194	-11.8691***	-1.8931	-11.8437***	-3.0167 (4/15/22)	-12.3580*** (6/17/22)
$Moro_{MSCI}$	-1.1519	-13.1500***	-1.2607	-12.9615***	-2.6449 (9/18/20)	-14.3088*** (2/18/22)

Nga_{NGE}	-1.0637	-10.5537***	-0.9505	-10.5808***	-2.2409 (10/22/21)	-10.9839*** (11/06/20)
$S.AF_{ASEAPAN}$	-2.2814	-8.2788***	-2.9841**	-13.4048***	-2.9925 (8/14/20)	-9.7279*** (6/26/20)
$deaths_{Ken}$	-4.1465***	-5.2461***	0.9886	-11.4365***	-5.6236*** (8/14/20)	-21.6280*** (8/07/20)
$deaths_{Mor}$	-6.6440***	-7.1019***	-6.7924***	-5.9724***	-8.1036*** (7/10/20)	-24.9574*** (7/17/20)
$deaths_{Nga}$	-9.8071***	-4.1368***	-14.5454***	-4.0928***	-18.6315*** (1/15/21)	-10.1212*** (9/24/21)
$deaths_{Sou}$	-3.0048**	-4.9400***	-14.4881***	-12.4265***	-4.7204** (12/04/20)	-5.8876*** (7/24/20)

Note: ***, **, * denote significance at 1, 5 and 10% level respectively. First diff. represents first difference.

3.3 Nonlinear Autoregressive Distributed Lag (NARDL) Bounds Tests Results

This study employed the nonlinear ARDL bounds test to investigate the co-integration relationship of oil price, stock returns and total deaths due to COVID-19. The Table 5 provides the nonlinear critical values for lower and upper bound test at different levels of significance. According to the Table 5, the result of the asymmetric bound test in the case of Kenya, shows that the F-statistical value (31.247) is greater than the upper bound critical value (5.61) at 1% level of significance. In the Morocco case, the asymmetric bound test F-statistical value (36.686) is greater than the upper bound critical value (5.61) also at 1% level of significance. Furthermore, in Nigeria and South Africa cases, the asymmetric bound tests F-statistical values are 27.653 and 50.807 for 5.06 and 5.61 respectively as critical values. So the results obtained in Table 5 indicate statistically significant evidence in favor of asymmetric cointegration.

Table 5. Findings of NARDL bounds test

		Critical Values			
	F-Statistic	Level of significance	I(0)	I(1)	Decision
	31.2479	10%	2.72	3.77	Co-integration
Kenya		5%	3.23	4.35	exists at 1% of
	K=2	2.5%	3.69	4.89	significance
		1%	4.29	5.61	
	36.6862	10%	2.72	3.77	Co-integration
Morocco		5%	3.23	4.35	exists at 1% of
	K=3	2.5%	3.69	4.89	significance
		1%	4.29	5.61	
	27.6530	10%	2.45	3.52	Co-integration
Nigeria		5%	2.86	4.01	exists at 1% of
	K=4	2.5%	3.25	4.49	significance

		1%	3.74	5.06	
South Africa	50.8070	10%	2.72	3.77	Co-integration exists at 1% of significance
		5%	3.23	4.35	
	K=3	2.5%	3.69	4.89	
		1%	4.29	5.61	

Note: Author's computation, ***, **, * show level of significance at 1%, 5% and 10%, respectively.

3.4 Estimates From the Short and Long-run Non-linear Model

In order to explore the short and long-run symmetric/asymmetric impact of oil price and COVID-19 total deaths cases on stock market returns in Kenya, Morocco, Nigeria and South Africa, this study employed the nonlinear ARDL approach. Then, the existence of long-run and/ or short-run asymmetric relationship can be detected by the Wald test. The long-run symmetry and short-run symmetry for the Wald test are denoted by W_{LR} and W_{SR} respectively. The fourteen and fifteen rows of Table 6 exhibit the results of the short and long-run symmetry tests for oil price. The Wald test results obtain reject the null hypothesis of no long/short-run asymmetry fluctuation in oil price. This result is in line with those of Bildirici and Turkmen (2015).

The findings of the nonlinear ARDL model in Kenya, Morocco, Nigeria and South Africa are reported in Tables 6-9. Kenya' asymmetric ARDL findings are reported in Table 6. The sign and the size of D(lnoil_pos) and D(lnoil_neg) also call positive partial sum and negative partial sum respectively, show how positive and negative changes in oil price can affect the stock market performance in Kenya. The results show that the partial sum of positive shock or the sign of the coefficients in the short-run estimates show that a positive shock in oil prices have a negative and insignificant effect on stock returns. The result of contemporary negative shock of oil prices is also insignificant. Only the one period lag of a negative shock in oil prices (D (lnoil_neg (-1))) and COVID-19 total deaths exhibit significant coefficients in the short-run. These estimates result show that a 1% decrease in negative oil price shock with one period lag, increases Kenya stock market returns by 0.043% in the short-run. This result is contrary to those of Okere et al., (2021) who find a positive effect of negative oil price shock on stock market returns in Nigeria. Surprisingly, the total deaths due to COVID-19 exert a positive and significant effect on the stock market returns. Thus, an increase of 1% of total deaths increase the stock market returns by 0.002%. The ECM (-1) is negative and significant at 1% level taking an average of 93% to converge to the long-run equilibrium in the next time period. The long-run coefficient of the oil price is statistically insignificant respectively for the positive and negative oil price shocks. This result corroborates Babatunde et al., (2013) study which highlight an insignificant relationship between oil price and stock returns. Only the COVID-19 total deaths cases exert a positive and statistically significant effect on Kenya stock returns. Indeed, a 1% increase in total deaths increases stock market returns surprisingly. This result is innate. We also use the Breusch-Godfrey serial correlation LM test, the Breusch-Pagan-Godfrey test, the Jarque-Bera test, the Ramsey Reset test to verify the estimated model for serial correlation, the heteroskedasticity, the normality issue in the residuals and the functional form of the model respectively. The results show that the asymmetric ARDL model considered have good properties namely that the model is well specified without serial correlation and heteroskedasticity. Residuals are also normally distributed.

Table 6. Results of non-linear autoregressive distributed lag (NARDL) model (1, 0, 2, 0)

Dependent variable: Sr (Kenya)				
Variable	coefficient		Std. Error	Prob.
$t-$statistic				
		Short term		
D(loil_pos)	-0.0048	0.0004	-1.1102	0.2691
D(loil_neg)	0.0063	0.0152	0.4138	0.6797
D(loil_neg(-1))	-0.0429	0.0157	-2.7253	0.0074
D(ltotdeaths)	0.0020	0.0009	2.1393	0.0344

$ECM(-1)$	-0.9313	0.0844	-11.0326	0.0000
		Long term		
Loil_pos	-0.0052	0.0047	-1.1128	0.2679
Loil_neg	-0.0039	0.0072	-0.5410	0.5894
Ltotdeaths	0.0021	0.0010	2.1255	0.0355
C	-0.0119	0.0063	-1.8750	0.0632
W_{LR}	9.6112			0.0024
W_{SR}	0.1608			0.0891
R^2	0.8981	F–statistic		2.0234
$Adj.R^2$	0.9154	Prob(F-statistic)		0.0674
		Durbin-Watson stat		1.9149

Diagnostic tests for asymmetric ARDL (Kenya)		
	Tests	Values (Probabilités)
Serial correlation LM	Breusch-Godfrey	0.6666 (0.5153)
Heteroskedasticity	Breusch-Pagan-Godfrey	2.3487 (0.2350)
Normality	Jarque-Bera	7.2187 (0.6270)
Specification	Ramsey (Fisher)	0.7426 (0.3905)

Note: H_0 : normal distribution (Jarque-Bera), H_0 : no serial correlation (Breusch-Godfrey), H_0 : homoscedasticity (BPG). P-values are in brackets.

Table 7 presents the asymmetric ARDL findings for Morocco. The optimal lag length for the models is 2. Focusing on the short-run dynamic, the positive oil price shock has a positive impact on the stock market returns while the negative oil price shock is insignificant. The one period lag of positive/negative oil price shock exert a positive and negative and statistically significant at 1% and 5% level respectively. Moreover, the total number of deaths is statistically significant with two period lags at 5% level. A 1% increase in the positive oil price shock and the its one period lagged shock lead to 0.0386% decreases and 0.0570% increase in the stock returns. The negative one period lagged oil price shock increases the stock returns around of 0.4090%. considering two lags for total deaths, the stock returns decrease of 0.0139% with 1% increasing in total deaths in Morocco. The error correction model ECM (-1) is negative and statistically significant at 1% level suggesting a convergence to a long-run equilibrium. In the long-run, only the positive oil price shock and total deaths are statistically significant at 10% and 5% level. When the positive oil price shock in Morocco increases by 1%, the stock returns decreases around of 0.0058%. This result is consolidating by those of Filis and Chatziantoniou (2014). Similarly, to Kenya case, a 1% growth of total deaths raise the stock returns to 0.0014%. The Wald tests reject the null hypothesis of no long-run/short-run asymmetric correlation between price changes.

Table 7. Results of non-linear autoregressive distributed lag (NARDL) model (1, 2, 2, 2, 3)

Dependant variable: Sr (MOROCCO)				
Variable $t-$statistic	coefficient	Std. Error		Prob.
		Short term		
D(loil_pos)	-0.0386	0.0182	-2.1183	0.0362
D(loil_pos(-1))	0.0570	0.0177	3.2098	0.0017
D(loil_neg)	-0.0308	0.0189	-1.6310	0.1055
D(loil_neg(-1))	-0.0490	0.0196	-2.4925	0.0141
D(ltotdeaths)	0.0205	0.0196	1.0456	0.2978
D(ltotdeaths(-1))	0.0043	0.0088	0.4926	0.6232
D(ltotdeaths(-2))	-0.0139	0.0075	-1.8382	0.0685
$ECM(-1)$	-1.1212	0.0937	-11.9565	0.0000
		Long term		
Loil_pos	-0.0058	0.0034	-1.7188	0.0883
Loil_neg	-0.0028	0.0056	-0.5018	0.6167
Ltotdeaths	0.0014	0.0007	1.8639	0.0648
C	-0.0054	0.0077	-0.7069	0.4810
W_{LR}	8.8404			0.0413
W_{SR}	10.6453			0.0011
R^2	0.5986	F$-$statistic		2.9115
$Adj.R^2$	0.5612	Prob(F-statistic)		0.0000
		Durbin-Watson stat		1.8494

Diagnostic tests for asymmetric ARDL (Morocco)		
	Tests	Values (Probabilités)
Serial correlation LM	Breusch-Godfrey	1.6585 (0.1949)
Heteroskedasticity	Breusch-Pagan-Godfrey	0.9087 (0.5344)
Normality	Jarque-Bera	13.3242 (0.8751)
Specification	Ramsey (Fisher)	0.1117 (0.7388)

Note: H_0 : normal distribution (Jarque-Bera), H_0 : no serial correlation (Breusch-Godfrey), H_0 : homoscedasticity (BPG). P-values are in brackets.

Nigeria asymmetric ARDL results are presented in Table 8. In the short-run dynamic, the one lag positive price shock exerts a positive and statistically significant effect on the stock returns. Thus, an increase of 1% of oil price in this case raises the stock returns around of 0.0813%. A growth of 1% of negative oil price increase the stock returns around of 0.0271% in Nigeria NGA. The ECM (-1) suggest a convergence to the long-run equilibrium. Focusing on the long-run, the positive and negative price shocks are statistically significant at 5% and 10% level. Ceteris paribus, a positive shock of 1% of oil price depletes the stock returns by 0.0228%. The effect of negative oil price shock by 1% increase the stock returns by 0.0257%. The total deaths are not significant. The Wald test is used to verify the equality of positive and negative shocks of oil price and the result suggest the long and short asymmetric.

Table 8. Results of NARDL model (1,2, 0, 2, 0)

Dependant variable : Sr (Nigeria)				
Variable	coefficient	Std. Error	$t-$statistic	Prob.
		Short term		
D(loil_pos)	0.0217	0.0332	0.6533	0.5148
D(loil_pos(-1))	0.0813	0.0317	2.5625	0.0116
D(loil_neg)	-0.0271	0.0151	-1.7953	0.0752
D(ltotdeaths_pos)	-0.0194	0.0350	-0.5547	0.5801
D(ltotdea_pos(-1))	-0.0032	0.0239	-0.1356	0.8923
D(ltotdeaths_neg)	-1.3647	4.7953	-0.2845	0.7765
$ECM(-1)$	-1.0522	0.0928	-11.3383	0.0000
		Long term		
Loil_pos	-0.0228	0.0094	-2.4081	0.0176
Loil_neg	-0.0257	0.0144	-1.7891	0.0762
Ltotdeaths_pos	0.0073	0.0071	1.0285	0.3058
Ltotdeaths_neg	-1.2969	4.5666	-0.2839	0.7769
C	-0.0568	0.0490	-1.1606	0.2481
W_{LR}	2.6830			0.0041
W_{SR}	6.5882			0.0115
R^2	0.7432	F$-$statistic		2.1922
$Adj.R^2$	0.7779	Prob(F-statistic)		0.0271
		Durbin-Watson stat		1.9234

Diagnostic tests for asymmetric ARDL (Nigeria)		
	Tests	Values (Probabilités)
Serial correlation LM	Breusch-Godfrey	1.5285 (0.2212)
Heteroskedasticity	Breusch-Pagan-Godfrey	1.5427 (0.1409)
Normality	Jarque-Bera	16.0358 (0.1483)
Specification	Ramsey (Fisher)	0.5983 (0.4408)

Note: H_0 : normal distribution (Jarque-Bera), H_0 : no serial correlation (Breusch-Godfrey), H_0 : homoscedasticity (BPG). P-values are in brackets.

Table 9 presents the findings of the asymmetric effects of oil price and total deaths on South Africa ASEAPAN stock returns. According to these findings, the asymmetric effect of oil price in South Africa shows a positive a negative change in oil price impact on stock market returns. Positive and negative change in oil prices in the short-run dynamic exert a positive and negative effects on stock returns. Ceteris paribus, 1% positive shock in oil price raises the stock returns in South Africa by 0.2863%. The examined result is the same with previous researchers like Luo and Qin (2017); Zhu et al. (2014) and Narayan and Narayan (2010). Furthermore, 1% negative shock in oil price increases the stock returns by 0.1714%. The total deaths due to the coronavirus pandemic exert a positive effect on stock returns. A 1% increases in total deaths lead to an increase of stock returns by 0.0067%. the ECM (-1) coefficient is negative and statistically significant. Comparatively to the short-run dynamic results, the positive and negative change in oil prices in the long-run are insignificants. But, the total deaths coefficient is positive and significant at 5% level.

Table 9. Results of NARDL model (1, 1, 1, 0)

Dependant variable : Sr (South Africa)				
Variable	coefficient	Std. Error	$t-$statistic	Prob.
		Short term		
D(loil_pos)	0.2863	0.0736	3.8867	0.0002
D(loil_neg)	-0.1714	0.0733	-2.3382	0.0210
D(ltotdeaths)	0.0067	0.0028	2.3975	0.0180
$ECM(-1)$	-1.0605	0.0842	-12.5930	0.0000
		Long term		
Loil_pos	-0.0065	0.0151	-0.4332	0.6656
Loil_neg	0.0026	0.0247	0.1075	0.9146
Ltotdeaths	0.0063	0.0026	2.4023	0.0178
C	-0.0562	0.0311	-1.8066	0.0732
W_{LR}	13.2756			0.0004
W_{SR}	13.6493			0.0003
R^2	0.8438	F$-$statistic		4.0458
$Adj.R^2$	0.8516	Prob(F-statistic)		0.0040
		Durbin-Watson stat		2.0389

Diagnostic tests for asymmetric ARDL (South Africa)

	Tests	Values (Probabilités)
Serial correlation LM	Breusch-Godfrey	0.4534 (0.6365)
Heteroskedasticity	Breusch-Pagan-Godfrey	1.1268 (0.3469)
Normality	Jarque-Bera	1.3027 (0.5213)
Specification	Ramsey (Fisher)	3.7881 (0.5390)

Note: H_0 : normal distribution (Jarque-Bera), H_0 : no serial correlation (Breusch-Godfrey), H_0 : homoscedasticity (BPG). P-values are in brackets.

A raise of 1% of total deaths increases South Africa stock returns by 0.0063%. Moreover, the result of the symmetric test with null hypothesis of oil price shock are symmetric is rejected. The magnitude (signs and coefficients) of negative asymmetric is greater than positive asymmetric.

The stability and validity of the parameters were checked by CUSUM and CUSUMQ recursive residual, the validity of the regression and residual diagnostic for Kenya, Morocco, Nigeria and South Africa was confirmed by Durbin-Watson statistic, Breusch-Godfrey serial correlation LM test, Breusch-Pagan-Godfrey heteroskedasticity test, Jarque-Bara normality test and Ramsey Reset test. The dynamic multiplier graphs of oil price are shown in appendix.

4. Summary and Conclusion

This paper investigates the asymmetric impact of oil price shocks and COVID-19 total deaths on Kenya, Morocco, Nigeria and South Africa stock market returns. Stock market returns are sensitive to oil price shocks. Employing weekly data from March 13, 2020 to September 23, 2022, we examine the effect of positive and negative changes in oil prices on some selected stock market returns. To achieve this, first, we apply the BDS test which confirm the nonlinearity of each series. Second, stationarity tests are used to investigate each series for unit root. The results show that series are stationary in level and in first difference. Third, the bounds test reveals that the series have a cointegration relationship and we apply the nonlinear ARDL framework to decompose oil price into positive and negative partial sum to investigate a possible asymmetric effect of oil price on stock market returns.

According to the nonlinear ARDL approach, three forms of asymmetry in line with the oil price shocks are mentioned: the short-run asymmetry, the long-run asymmetry and the adjustment asymmetry. The results of the asymmetric ARDL model reveal that, in the short-run dynamic, a positive shock in the oil price have a negative and positive effect on stock market returns in Morocco and South Africa respectively. The result is insignificant for Kenya and Nigeria. A negative shock in the oil price have a negative effect on the stock returns in Nigeria, South Africa and in Kenya, Morocco with one period lag. Furthermore, in the long-run, a positive shock in oil price exerts a negative effect on the stock market performance in Morocco and Nigeria while a negative shock in oil price leads to a negative effect also on the stock market returns. The total deaths present a counterintuitive result. Both in the long-run and short-run dynamic, the total number of deaths due to COVID-19 have a significant increasing effect on stock market returns in Kenya, Morocco and South Africa except for Nigeria.

The key policy implications of the results are threefold and important for policy makers. First one is to keep watch on the movements in oil prices in the international oil market. Some international economic events and political, such as Ukraine war, investor sentiments, geopolitical risks could change oil prices. Positive and negative shocks in oil price significantly affect stock market returns in the selected countries for this study. Second, reduce national share of fossil fuel consumption by using alternative energy technologies in the process of production and consumption to be less depending on oil price fluctuations.

This study's weakness lies in the choice of explanatory variables used, as other variables, such as global economy policy uncertainty (GEPU) have a significant impact on stock market returns.

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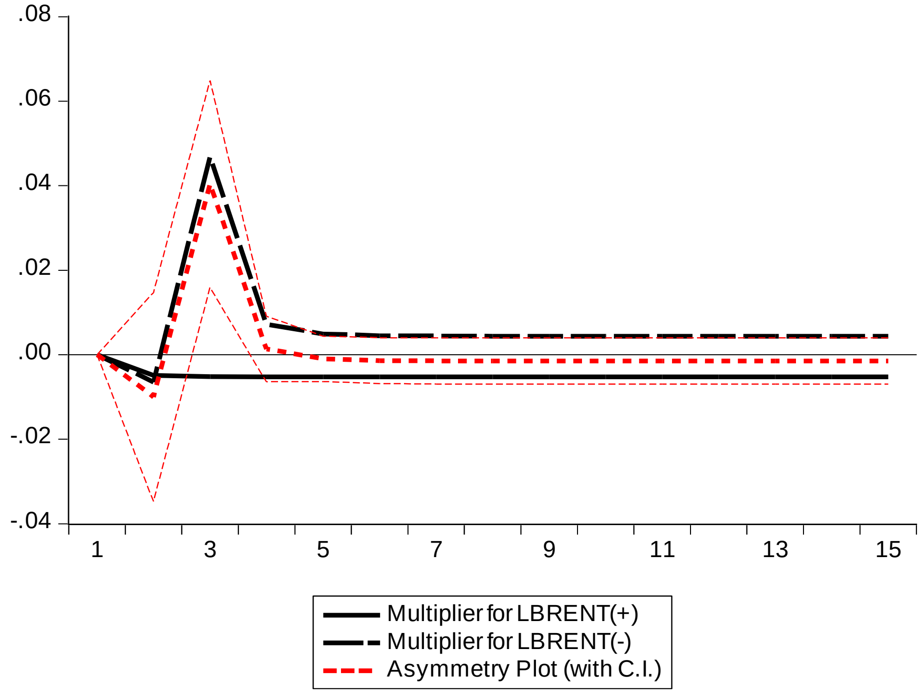
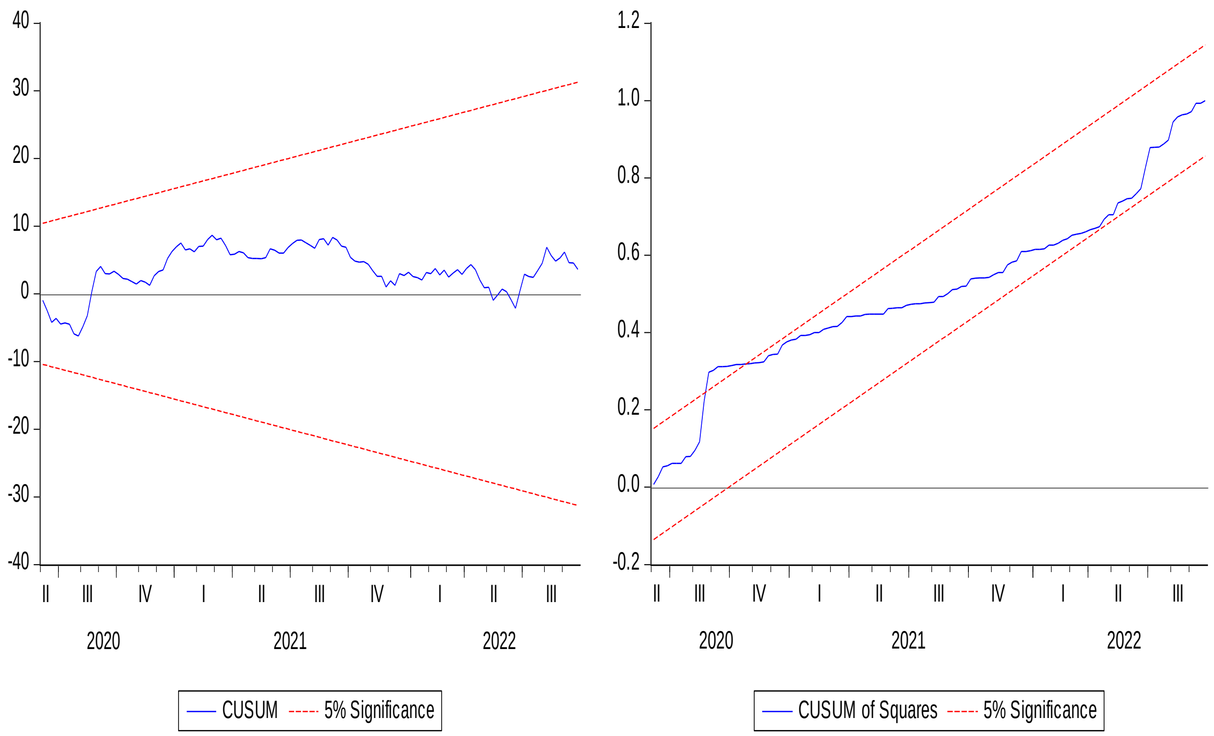
Appendix

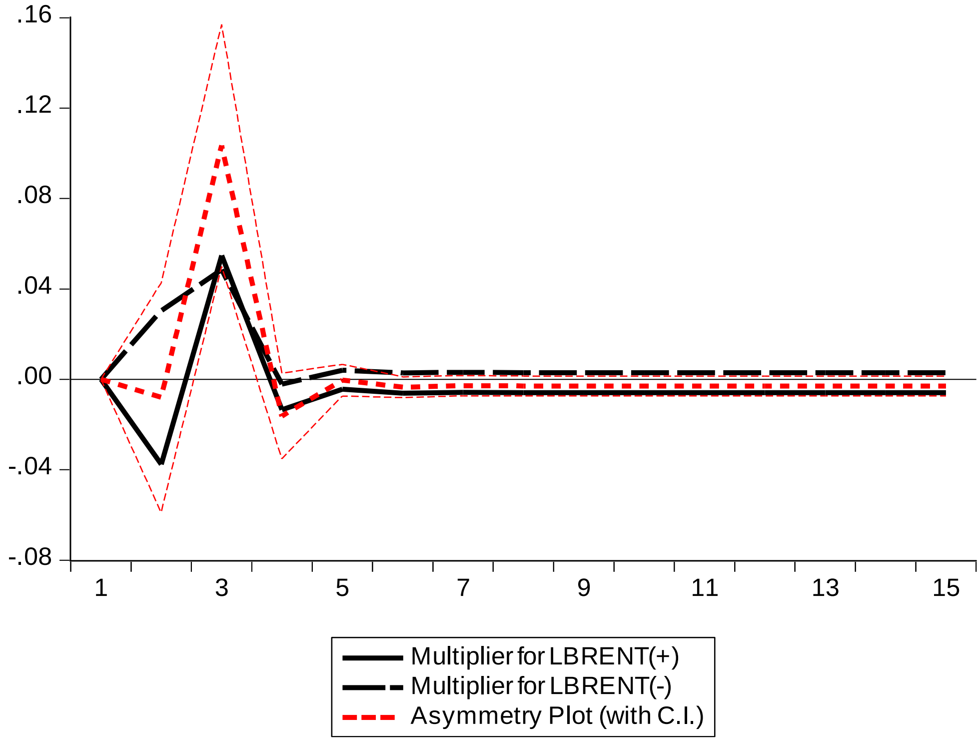
Figures



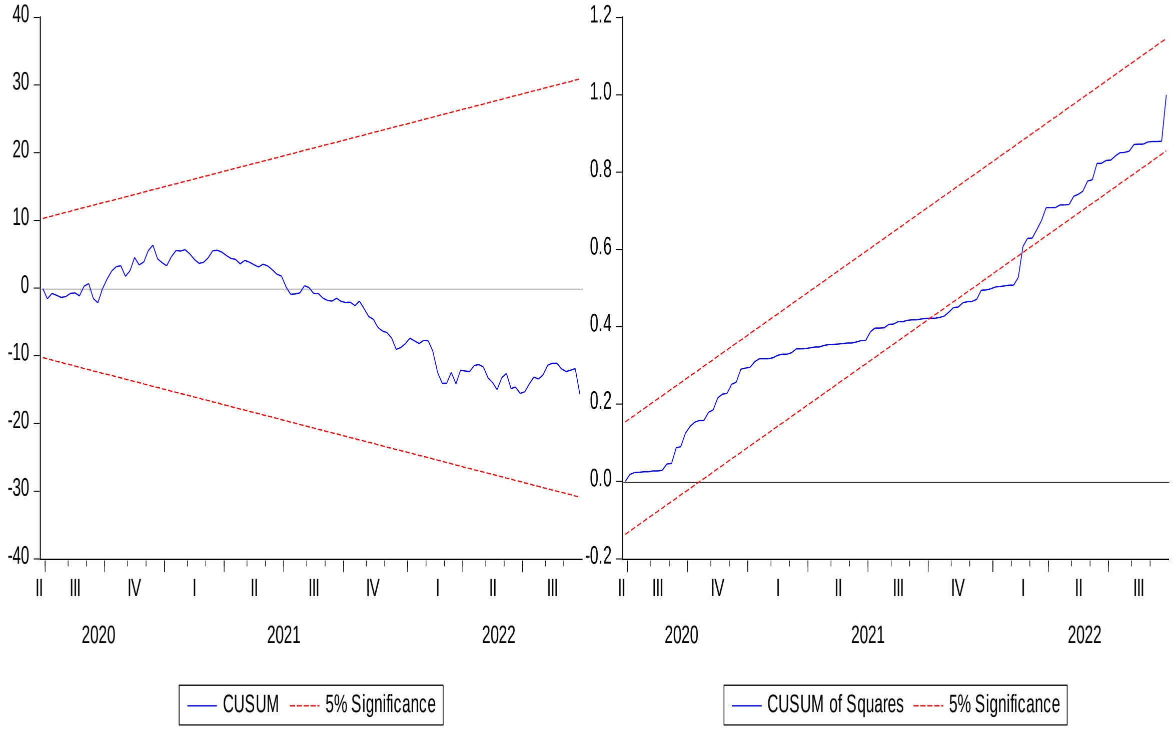
Dynamic multiplier graph (Kenya)



Nonlinear CUSUM and CUSUMSQ (Kenya)



Dynamic multiplier graph (Morocco)



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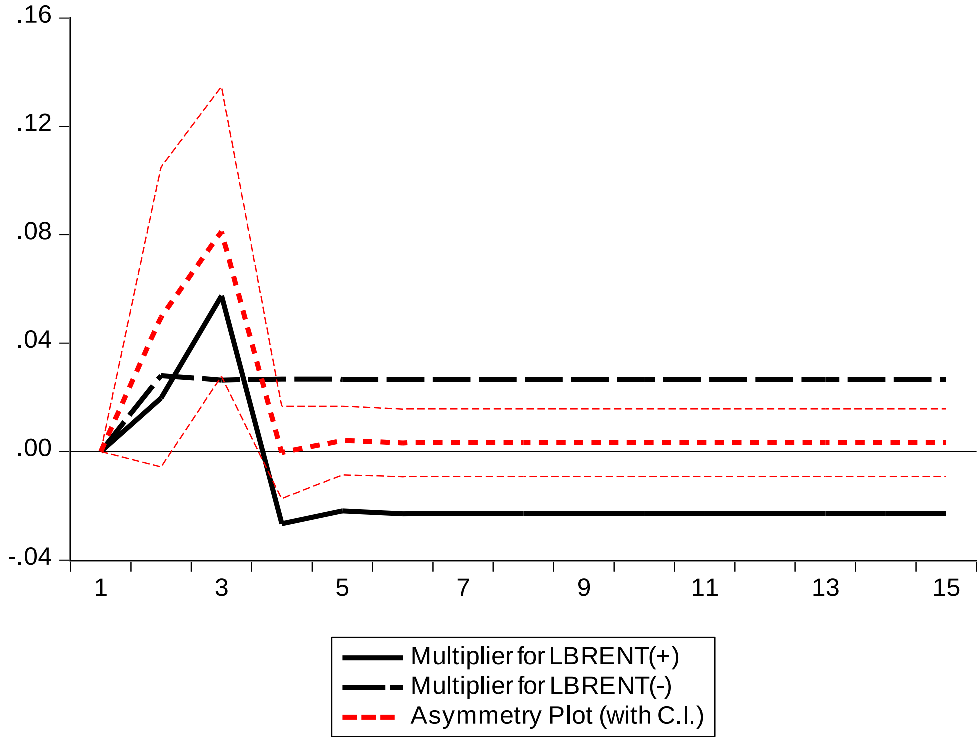
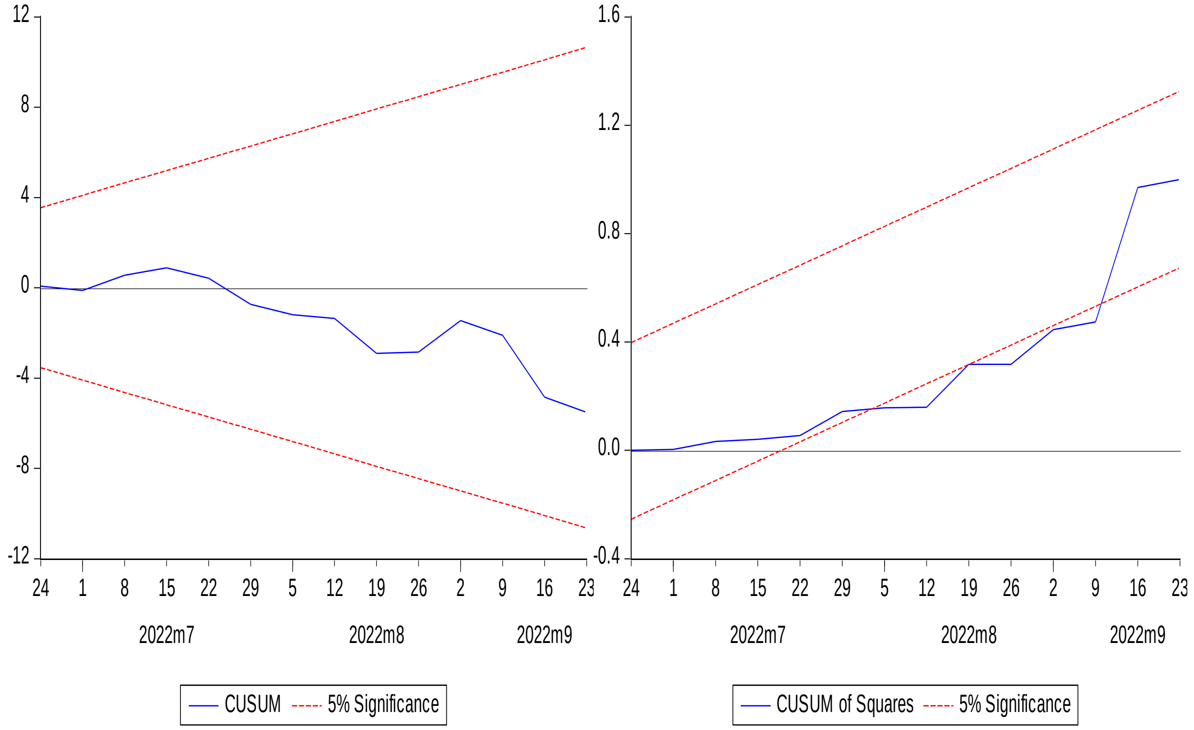


Dynamic multiplier graph (Nigeria)



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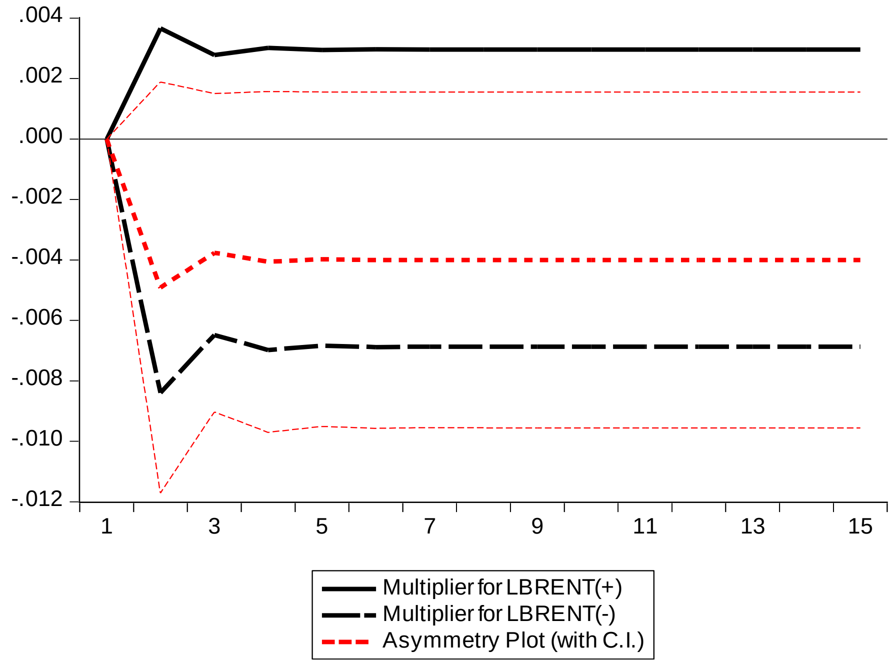
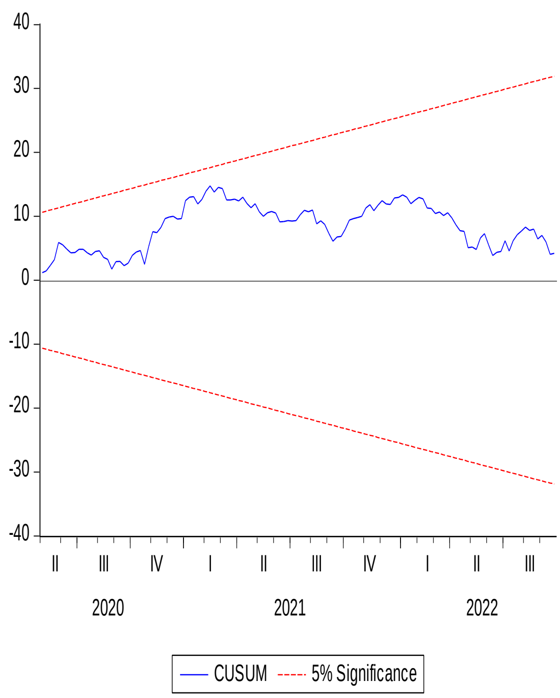
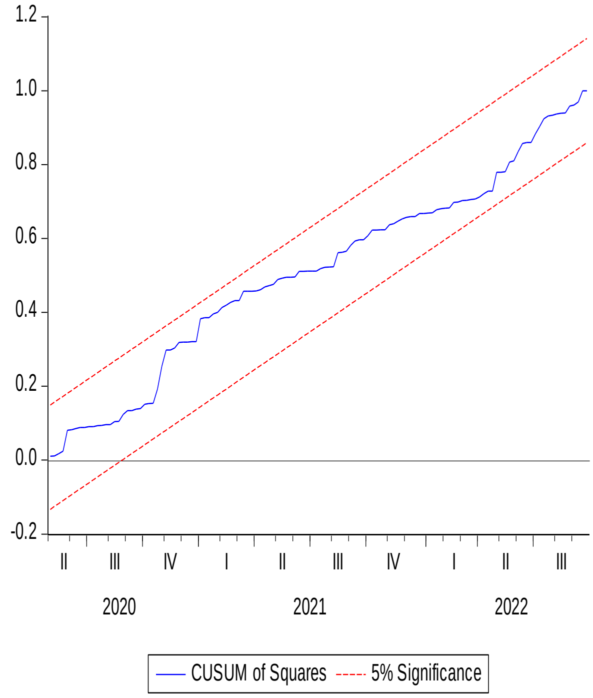


Dynamic multiplier graph (South Africa)





Nonlinear CUSUM and CUSUMSQ (South Africa)