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RESEARCH PAPER

Asymmetric Impact of Oil Price on the Consumer Price Index in Saudi Arabia

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Abstract

This study aims to examine the impact of oil price variations on the consumer price index (CPI) in Saudi Arabia by employing the Nonlinear Autoregressive Distributed Lag (ARDL) model. The model estimation revealed a nonlinear relationship between the price of oil and the Consumer Price Index (CPI). The long-term estimates' findings indicate a significant impact of oil price variations on the Consumer Price Index (CPI) over an extended period. The research reveals that a partial escalation in oil prices leads to a decrease in the Consumer Price Index (CPI). Likewise, a reduction in oil prices leads to a corresponding decline in the Consumer Price Index (CPI). Based on the findings of the asymmetric impact, it can be observed that long-term variations in global prices, both positive and negative, have implications for the Consumer Price Index (CPI). Specifically, an upward movement in international oil prices is associated with a downward movement in the CPI, whereas a downward movement in oil prices is associated with an upward movement in the CPI.

Keywords: Cpi, Long Run Estimations, Oil Price Fluctuations, Nardl Model, Short Run Equilibrium.

JEL Classification: D12, C51.

1. Introduction

In light of the economic changes and the divergence of the pace of the global economy in recent years between recovery and recession that the world witnessed, a primary goal has emerged for many countries with natural resources, which is often the primary sector of production and export. Consequently, it is called the countries of rentier economies relying on a single resource, especially oil-producing countries.

Being an abundant commodity with a high demand in the global markets, it enabled countries to generate sizable and significant revenues that helped in financing and executing economic as well as social projects; unlike Arab oil-producing/ exporting countries such as Saudi Arabia, this natural resource also enabled them to obtain huge profits, however, it leads them often and many times to ignore some of the productive sectors including agriculture, industry, and services.

Due to the significant drop in world oil prices, these countries were persuaded not to continue their dependency on one sector as a primary source of wealth. In addition, the price decline prompted the demand for some serious fundamental reviews, which aim at increasing economic diversification and production expansion, and it was all due to the direct impact on the government's budget, its stability, economic growth, and warnings from the International Monetary Fund to address the imbalance resulting from the price drop.

Because energy is so crucial to economic activity, authorities are investigating the link between oil prices and inflation, which has sparked a heated discussion over the years regarding the exact role that fluctuating oil prices play in driving consumer prices.

All economic activities are directly or indirectly related to the price of oil, as oil occupies an important place among the production inputs of the economy, including the supply of air and sea transport and household consumption, so an increase will follow the rise in oil prices in production costs.

An increase in production costs resulting from the rise in oil prices has led to the emergence of inflationary trends, so it has become necessary for policymakers in Saudi Arabia to answer the main question, namely whether changes in oil prices play an important role in inflationary trends in some oil economies such as Saudi Arabia, And if so, to what extent is this change in domestic inflation attributed to changes in oil prices, and do oil prices affect inflation rate in a symmetric or asymmetric effect?

1.1 Importance and Relevance of the Study

Despite the existence of numerous studies that have addressed the topic of the asymmetric impact of oil price fluctuations (Adebayo, 2020; Husaini and Lean, 2021; Köse and Ünal, 2021), the novelty and importance of our study are evident in that it is the first of its kind where we attempt to shed light on the extent of asymmetric impact of oil prices on consumption price indices during the period 1988-2022 in Saudi Arabia. The Kingdom of Saudi Arabia was chosen as it represents the third-largest oil producer in the world and has the second-largest confirmed reserves of crude oil ($326.16 billion in 2022, compared to $202.05 billion in 2021). Given that the Saudi economy is almost entirely dependent on oil, we aim to study the impact of any shocks in oil prices on macroeconomic variables, especially inflation. Throughout this research paper, we will rely on the Nonlinear Autoregressive Distributed Lag (NARDL) model presented by (Shin et al., 2014a), as it allows for evaluating the potential asymmetry in the long and short-term relationship between oil prices and inflation. For developing countries, especially those that export oil, previous studies on the effects of oil price volatility on economic dynamics have produced inconclusive and ambiguous results. Our study stands out with its detailed analysis and some additions compared to previous studies that addressed the same topic. This work fills a gap in the literature by focusing on estimating the nonlinear NARDL model, which outperforms the linear ARDL model, making it a significant contribution to the modern literature that has rarely been applied in the case of Saudi Arabia with nonlinearity testing. Furthermore, choosing an appropriate standard economic methodology can make the economic effects of the analysis more reliable. The paper also used unit root tests for structural breaks. (Perron et al., 1989) pointed out that the problem of unit roots in the time series may be due to structural changes. Therefore, traditional unit root tests may provide ambiguous results due to their low interpretative power and weak distribution of the size (Shahbaz et al., 2017). This problem is solved by applying a unit root test that accommodates structural breakpoints, and the paper will examine time series using various unit root tests, including the Zivot and Andrews (1992) test and the Broock et al. (1996) test.

2. Theoretical Background

2.1 The Significance of Oil in the Saudi Arabia's Economy

Saudi Arabia is one of the leading oil-exporting countries in the world and ranks as the second-largest in global production. Oil constitutes approximately 60% of the Kingdom's Gross Domestic Product (GDP), equivalent to 238.5 billion Saudi Riyals at the end of the second quarter of 2021. (Gross Domestic Product | General Authority for Statistics, n.d.) Oil also accounts for around 62% of government revenues (The Kingdom of Saudi Arabia's Budget, n.d.), and more than 84% of Saudi exports, totaling 456 billion Saudi Riyals in 2020 (Export Performance Report, n.d.). Saudi Arabia is a prominent member of the G20 and has one of the world's strongest economies. It is also a significant member of the Organization of the Petroleum Exporting Countries (OPEC) since 1960, and it is a member of the Gulf Cooperation Council (GCC) since 1981.

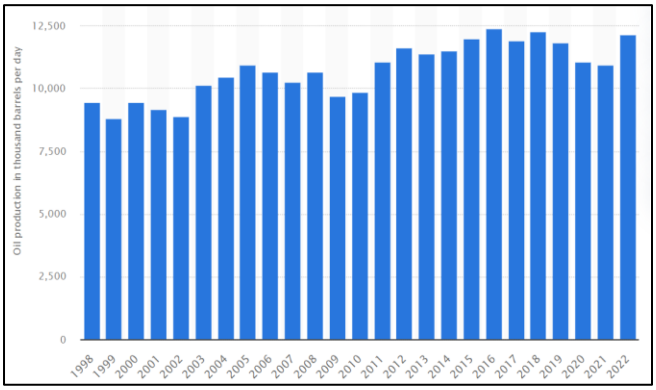

Figure 1. Saudi Arabia's Oil Production from 1998 to 2022 (in 1,000 Barrels per Day)
Source: (Saudi Arabia: Oil Production 2022 | Statista, n.d.).

In 2022, Saudi Arabia's oil production increased from 10.95 million barrels per day in 2021 to 12.14 million barrels per day. The volume of production in the world's most important oil-producing country rose by 2.6 million barrels per day between 1998 and 2021, reaching its peak at 12.4 million barrels per day in 2016.

2.2 Evolution of Inflation and Oil in Saudi Arabia

Some studies have confirmed that inflation in the Kingdom is of the imported type (Alogeel and Hasan, 2008), and a decrease in oil prices will have a positive effect on reducing local inflation rates (Algamdi et al., 2021). This, in turn, may have a positive impact on consumption (Alogeel and Hasan, 2008). Some studies suggest that the stronger impact of oil price fluctuations lies in reducing investments (Baek and Young, 2021).

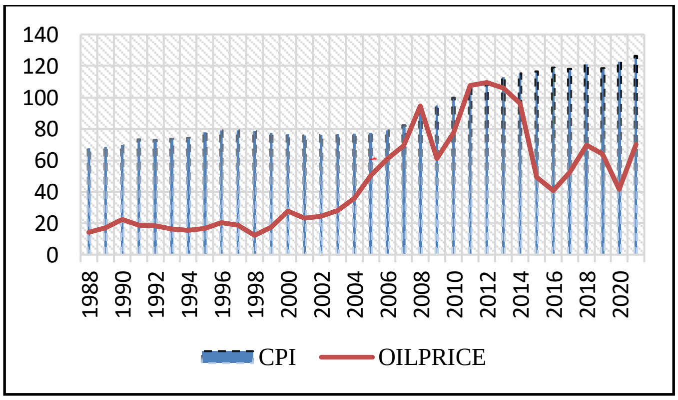

Figure 2. Inflation and Oil Saudi Arabia's from 1998 to 2020
Source: (Saudi Central Bank Portal For Open Data, n.d.).

As a result of the dominance of the oil sector in the local economy in Saudi Arabia, the performance of the economy depends significantly on developments in global oil markets. Improved oil prices and increased global demand for oil have a clear positive impact on export values and government revenues, but they may also bring inflationary pressures. The significant increase in financial flows from oil revenues has allowed the Kingdom to achieve high growth rates in recent years, but it has also contributed to inflationary pressure.

3. Previous Studies on the Subject

Oil price fluctuations have contributed to all economic activities, as they have contributed to the advent of numerous recessions in numerous economies. Numerous empirical studies have analyzed the effects of oil price fluctuations on macroeconomic stability and the efficacy of monetary policies in dealing with them, and the following is a summary of the most significant relevant studies.

Table 1. An Expedited Systematic Review of Literature

Author	Title of Study	Time Frame & Sample	Methodology	Key Findings
(Davari and Kamalian, 2018b)	Iran's Oil Price and Inflation: Nonlinear ARDL Exploration	Seasonally in Iran from 2003-2015	Utilising a nonlinear autoregressive distributed lag model with inflation rate as dependent, and oil price, GDP, and money supply as independent variables	A strong connection was found between falling oil prices and rising inflation, but not between growth in oil prices and the inflation rate.
(Osei, 2022)	Brazil's Inflation Reacts Differently to Shifts in Oil Prices	Quarterly in Brazil between M1 in 2000 and M4 in 2021	NARDL stands for the "Nonlinear Autoregressive Distributed Lag" model.	The empirical findings indicate a nonlinear or asymmetric relationship between oil prices and inflation, observed across different time horizons ranging from short-term to long-term.
(Sek, 2017)	Analysing the Effect of Rising Oil Prices on Consumer Price Inflation Using Linear and Nonlinear ARDL Models	Oil exporting and importing nations	Nonlinear autoregressive distributed lags (NARDL) with CPI as dependent and GDP, wholesale price index, and Brent crude oil price as independent variables	The results indicate that oil price fluctuations asymmetrically influence the consumer price index (CPI)
(Lacheheb and Sirag, 2019a)	Algerian Inflation and Oil Prices: A Nonlinear ARDL Approach	Algeria, 1970-2014	A nonlinear autoregressive model with CPI as dependent and oil price, exchange rate, GDP, and money supply as independent variables	There was a substantial correlation between oil price increases and inflation, but not between oil price falls and inflation.
(Bala and Chin, 2018a)	The Impact of Oil Prices on Inflation in OPEC Member Countries in Africa	Those four nations are Algeria, Angola, Libya, and Nigeria, and they all produce oil.	Analysing the relationship between oil prices and GDP, exchange rate, and money supply using short- and long-term autoregressive distributed lag (ARDL) dynamic panels	Both increases and decreases in oil prices were shown to have similar effects on inflation and a positive association was discovered between inflation and money supply, exchange rate, and GDP.
(S. Alimia et al., 2020)	The Impact of Oil Prices on Inflation in Nigeria: An Unbalanced Analysis	Nigeria, 2009Q1 to 2018Q4	Model the relationship between CPI and oil prices using a nonlinear autoregressive distributed lags (NARDL) structure.	The study found that long-term international oil prices had a nonlinear connection with inflation in Nigeria, with both price increases and declines having a deflationary effect.
(Okere et al., 2021)	The Impact of the Crude Oil Price and the Exchange Rate on Nigeria's Stock Market, Both Symmetric and Asymmetric	Nigeria, 1995Q1 to 2019Q12	Using a technique called nonlinear autoregressive distributed lag (NARDL)	Positive shocks in crude oil prices were found to significantly affect the growth of the Nigerian stock market, while negative shocks also increased stock market performance
(Chou and Lin, 2013)	Taiwanese Producer Prices and Oil Price Shocks: A Nonlinear Error-Correction Model	Taiwan, 1981M1-2011M5	Nonlinear error-correction models	The research revealed significant effects of oil prices on Taiwan's producer pricing indices, both in the short-term and long-term. These effects were observed to follow nonlinear error-correction relationships with oil prices.
(Nusair, 2019)	The Effects of Oil Price Shocks on the Economies of the Gulf Cooperation Council (GCC)	GCC Countries	Nonlinear analysis	The results suggest varied responses, with significant positive changes in oil prices causing real GDP growth, and only Kuwait and Qatar showing significant negative changes in oil prices causing GDP falls.
(Ayisi, 2021)	Impact of Oil Price Fluctuations on Inflation and Well-Being in Ghana: An Asymmetric Relationship	Ghana	Nonlinear approach	The research found an asymmetric response of inflation to oil prices in the long term but not in the short term, with an increased welfare cost due to the asymmetric response.

4. Data and Methodology

4.1 Data Description

Our study investigated the connection between the consumer price index, oil price, money supply and exchange rate in Saudi Arabia using annual data from 1988 to 2022. All data were collected from the World Bank data (Saudi Arabia | Data, n.d.) except the data for Brent crude oil price, which was collected from (Brent et al. Annually 1976-2022 | Statista, n.d.). Among the variables used in the study, the money supply variable is integrated with the model excited by (Rhee, 2006) and (Senda, 2001), the exchange rate inspired by (Nasir and Vo, 2020), (Balcilar et al., 2021), (Pham et al., 2023).

The model's variables are summarised in

Table 2 below.

Table 2. Components in the Model

Symbols	Variables	Explanation
CPI	Consumer Pricing Index (base year 2010 = 100)	The Consumer Pricing Index (CPI) tracks the mean change in costs urban customers pay for a standard set of goods and services, serving as an inflation proxy.
OILPRICE	Price of Oil (Brent)	Mean yearly price of Brent crude oil (denominated in U.S. dollars per barrel)
M2	Supply of Money	M2 encompasses currency, checking accounts, and readily convertible deposits, like Certificates of Deposit (CDs).
EXCH	Rate of Exchange	Genuine, effective exchange rate index (base year 2010 = 100)

Source: Research finding.

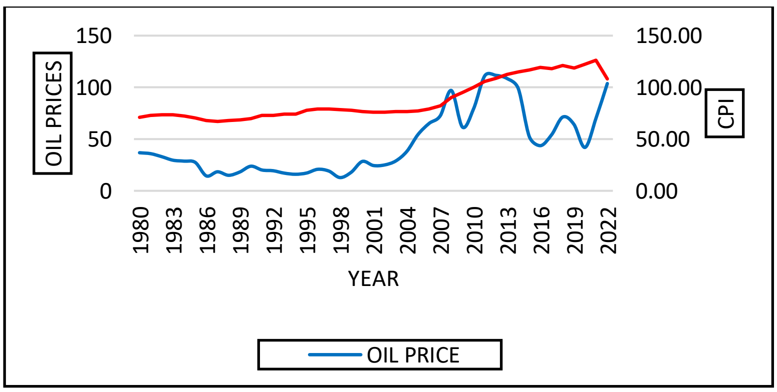

Figure 3. The Trend of Oil Price (Brent) and CPI in Saudi Arabia (1980-2022)

Source: Data on oil price was sourced from (Brent Crude Oil Price Annually 1976-2022| Statista, n.d.), where data on CPI was sourced from (Inflation, Consumer Prices

(Annual%) - Saudi Arabia | Data, n.d.).

We use annual data from 1988 to 2022 on the Consumer Price Index, oil price, Exchange rate, and Money Supply. All of the variables are expressed in natural log form.

4.2 Methodology

Following (Osei, 2022) and (Bawa et al., 2020a), the asymmetric nonlinear ARDL link between CPI rate and oil price will be specified as:

$$CPI_t = a_0 + a_1 OIL\ PRICE^{\ +} + a_2 OIL\ PRICE^{\ -} + a_3 M2 + a_4 EXCH + e_t \quad (1)$$

In the equation above, (a_0, a_1, a_2, a_3, and a_4) are the parameters capturing the long-term connection. Where $oil\ price^{+}$ and $oil\ price^{-}$, these are the partial sums of both negative and positive oil price fluctuations.

$$oil\ price^{+} = \sum_{i=1}^{t} \Delta oil\ price^{+} = \sum_{i=1}^{t} \Delta max(\Delta oil\ price_t, 0) \quad (2)$$

$$oil\ price^{-} = \sum_{i=1}^{t} \Delta oil\ price^{-} = \sum_{i=1}^{t} \Delta min(\Delta oil\ price_t, 0) \quad (3)$$

Where:

$$oil\ price = \ oil\ price_0 + oil\ price^{+} + oil\ price^{-} \quad (4)$$

a_1 and a_2 represent the long-term asymmetries between CPI and oil prices.

If a_1 is significantly positive, it indicates a (Osei, 2022) direct relationship between oil price and CPI, and vice versa. In the same way, a positive value for a_2 means that oil prices are going down, which makes CPI go down, and vice versa. But (Bawa et al., 2020a) if both a_1 and a_2 are insignificant, the increase and reduction in oil prices do not affect CPI.

Inspired by the work of (Shin et al., 2014b), we develop the following NARDL equation to predict the long term.

$$\Delta cpi_t = \sum_{i=1}^{p} \beta_i cpi_{t-1} + \sum_{i=1}^{q} (\beta_j + oil\ price^{+} + t - j + \beta_j - oil\ price^{-} - t - j) + e_t \quad (5)$$

where cpi_t is the respondent variable, $oil\ price_t$ Is a K x 1 vector of multiple regressors representing the partial positive and negative sums of oil $price_t$ such that

$$oil\ price = oil\ price_0 + oil\ price^{+} + oil\ price^{-} \quad (6)$$

The β_i coefficient *is* the autoregressive parameter, β_j^{+} and β_j^{-} represent the asymmetric distributed-lag parameters.

The dynamic ECM of the NARDL specified in (4) can be written as follows:

$$\Delta cpi_t = \rho cpi_{t-1} + \varphi^{+} oil\,price^{+}_{t-1} + \varphi^{-} oil\,price^{+}_{t-j} + \sum_{i=1}^{p-1} \beta_i \Delta cpi_{t-1}$$
$$+ \sum_{j=0}^{q-1} \left(\beta^{+}_j \Delta oil\,price^{+}_{t-j} + \beta^{-}_j \Delta oil\,price^{-}_{t-j}\right) + e_t \quad (7)$$

In this case, ρ and q represent the lag orders of the dependent and independent variables.
The equation denotes the nonlinear error correction term (ECT):

$$\omega = cpi_t + \beta^{+} oil\,price^{+}_t + \beta^{-} oil\,price^{-}_t \quad (8)$$

5. Empirical Results and Discussion

This study presents its empirical findings in the following order: Descriptive statistics and visual analysis are used in the first part of the study to look at the correlation between oil prices and the CPI in Saudi Arabia. The integration degree of the utilised series is then evaluated using unit root tests, notably the Augmented Dickey-Fuller and Phillips-Perron tests. Cointegration tests, Nonlinear Autoregressive Distributed Lag (NARDL) outcomes, and other diagnostic tests comprise the last stage.

5.1 Descriptive Statistics

This section focuses on the initial analysis, which involves the examination of descriptive statistics and graphical representations of the relationship between oil prices and the Consumer Price Index (CPI) in Saudi Arabia within the specified time frame.

According to the data presented in

Table 3, the average price per barrel of Brent crude oil is $46.12, with a range spanning from $67.64 to $126.23. In contrast, the average Consumer Price Index (CPI) stands at 90.64%, with the highest value observed at 126.23 and the lowest at 67.64. Notably, the standard deviation indicates that the CPI exhibits lower volatility throughout the study period, while crude oil prices demonstrate greater volatility in comparison to oil prices. This implies that the volatility of prices in Saudi Arabia's oil market is more significant than the fluctuations observed in the country's general consumer price index.

Only the exchange rate is negatively skewed, while the Brent crude oil price, CPI, money supply, and exchange rate are all positively skewed. Compared to what would be predicted from a normal distribution, all of these variables have smaller kurtosis values, indicating less dispersion. The Jarque-Bera test showed that all of the study's variables followed a normal distribution (Table3).

Table 3. Descriptive Statistics

	CPI	**OILPRICE**	**M2**	**EXCH**
Mean	90.64727	46.12471	750089.3	114.3454
Median	78.88238	38.40500	428390.9	115.1237
Maximum	126.2311	109.4500	2059809.	137.8487
Minimum	67.64888	12.28000	134142.8	94.30739
Std. Dev.	19.64868	30.89295	645356.9	11.83680
Skewness	0.578681	0.720970	0.694338	-0.008783
Kurtosis	1.662734	2.268562	1.941220	2.065858
Jarque-Bera	4.431000	3.703438	4.320038	1.236651
Probability	0.109099	0.156967	0.115323	0.538846
Sum	3082.007	1568.240	25503038	3887.743
Sum Sq. Dev.	12740.33	31494.36	1.37E+13	4623.626
Observations	34	34	34	34

Source: Research finding, using Eviews10.

5.2 Stationarity Test

5.2.1 Unit Root Testing Using ADF and PP Tests

The augmented Dickey-Fuller (ADF) and Phillips-Perron procedures are employed to ascertain the stationarity of a variable. The analysis reveals that all variables exhibit non-stationarity in the level form, as indicated in Table 4. However, they attain stationarity when transformed into a different form. The proposition being put forth is that the series exhibits an integrated order *I(1)*. Consequently, the variable integration order justifies the utilisation of the nonlinear autoregressive distributed lag (NARDL) model in this study.

Table 4. Stationarity Test

			LNCPI	LNOILPRICE	LNM2	LNEXCH
ADF test	Level	T-Stat	-0.0470	-1.3726	-0.3194	-2.2159
		Prob	0.9470	0.5835	0.9111	0.2048
	First Diff	T-Stat	-3.2533	-5.3007	-3.5410	-4.4364
		Prob	0.0259***	0.0001***	0.0132**	0.0013**
PP test	Level	T-Stat	0.0382	-1.2956	0.0914	-1.8901
		Prob	0.9556	0.6198	0.9602	0.3327
	First Diff	T-Stat	-3.2719	-5.1404	-3.5285	-4.4481
		Prob	0.0248**	0.0002***	0.0136*	0.0013***
Order of integration			1	1	1	1
Optimal Lag lenght[1]			3	1	2	2

Source: Research finding, using Eviews10.

Note: (**) significant at 5%, (***) significant at 1% and (no) not significant.
[1]Optimal Lag length selections follow the Akaike Information Criteria AIC.

5.2.2 Unit Root Testing with Structural Breaks

The application of the augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and Phillips-Perron (PP) unit root tests (Phillips and Perron, 1988) doesn't consider the structural breaks within the series, potentially leading to incorrect conclusions. The Zivot and Andrews (ZA) test (Zivot and Andrews, 1992) from 1992 is implemented to address this issue Table 5 reveals the ZA statistical results, affirming the stationarity of the series once the first difference is removed. This finding aligns with the results of the conventional unit root examinations (ADF and PP tests) and highlights different structural breaks, explicitly identifying two breaks in the years 2001 and 2015.

During 2008-2009, significant price fluctuations occurred in the oil market, attributed to the financial crisis of 2008. This crisis led to a slowdown in the growth rates of major global economies, resulting in reduced worldwide demand for oil, particularly impacting Saudi Arabia, one of the world's leading oil exporters. The crisis profoundly influenced Saudi Arabia's public spending and growth rates, with the latter declining to a mere 1.4% across all sectors.

Furthermore, the latter half of 2014 witnessed a collapse in oil prices, causing a loss of nearly 45% of their value. The price of Brent, the European standard, plummeted from $115 to $62 per barrel. This price drop led to Saudi Arabia experiencing the most substantial reduction in revenue in its local currency, attributable to the sharp decline in oil prices.

Table 5. Results of the Structural Breaks Unit Root Test by Zivot and Andrews (1992)

Variables	At level		At first difference	
	T-Statistic	Breaks	T-Statistic	Breaks
LNCPI	-6.06	2007	-5.22***	2007
LNOILPRICE	-3.55	2003	-6.05***	2015
LNM2	-3.55	2003	-4.04***	2014
LNEXCH	-3.23	2001	-5.05***	2008

Source: Research finding.
Note: (***) significant at the 5%.

5.3 BDS Test for Nonlinearity

The nonlinearity is examined using the BDS test, which was established by Broock (Broock et al., 1996) The results of the BDS test, as shown in Table 6, indicate that the series are characterised by non-identical and dependent distribution. Upon verifying the presence of structural breakdowns and nonlinearity, coefficients are estimated using the NARDL model.

Table 6. BDS Test for Nonlinearity

BDS Statistics					
Series	**Dimension2**	**Dimension3**	**Dimension4**	**Dimension5**	**Dimension6**
LNCPI	0.1803***	0.2862***	0.3469***	0.3708***	0.3684***
LOILPRICE	0.1350***	0.2524***	0.3139***	0.3520***	0.381263***
LM2	0.1925***	0.3184***	0.4015***	0.4559***	0.4887***
LNEXCH	0.1587***	0.2611***	0.3178***	0.3328***	0.3154***

Source: Authors' calculation. Triple asterisks denote the rejection of the null hypothesis of the residual of being (iid) at1% significance level.

5.4 Optimal lag-length Selection Criteria

We continue investigating common trends among variables using an unlimited cointegration system, which is determined by minimising the AIC with a maximum lag length of eight lags. According to the AIC criteria, the optimal lag lengths for CPI, OIL PRICE, M2, and EXCH are 3.1.2.2 lags. As shown in the last section of Table 4, Cointegration Test.

The results of the Nonlinear Autoregressive Distributed Lag (NARDL) bounds test for asymmetric cointegration are detailed in Table 7. The findings point to an associated F-statistic value of 5.103946, with corresponding lower and upper bound values of 2.56 and 3.49, respectively, at a 5% significance level. This information underscores the statistical relationships being examined and provides insight into the asymmetric nature of the cointegration within the series under study.

Table 7. Bounds Test for Nonlinear Cointegration

Model Specification	F-statistic	Lower Bound	Upper Bound	Conclusion
Nonlinear	5.103946	2.56	3.49	Cointegration

Source: Research finding, using Eviews10.

When compared to the maximum bound of 3.49, the F-Statistic value of 5.103946 indicates that the Consumer Price Index (CPI) in Saudi Arabia has an asymmetric long-run connection with the other exogenous variables. In light of Saudi Arabia, this result bolsters the importance of the asymmetry between oil price, M2 (money supply), EXCH (exchange rate), and CPI (consumer price index).

5.5 NARDL Long-Run and Short-Run Estimations

In this investigation, we look into the asymmetric relationship between the oil price and the CPI. To eliminate the possibility of making an error in the specification, different variables, such as M2 and EXCH, are utilised as control variables, which are explained as follows:

$$CPI_t = a_0 + a_1 OIL\ PRICE^+ + a_2 OIL\ PRICE^- + a_3 M2^{\mp} + a_4 M2^- + a_5 EXCH^- + a_6 EXCH^- + e_t \quad (7)$$

Having identified evidence of cointegration in the models, we evaluate CPI dynamics and explore the influence of positive and negative oil price fluctuations on Saudi Arabia's CPI. Table 8 demonstrates the asymmetrical relationship between the oil price and the CPI. The error correction term reaches a level of 5%, which is statistically significant (0.007<0.05) and indicates a convergence rate of 47.80%. This consumer price index convergence is quicker than the rates of inflation observed in oil-importing and exporting countries (Kun Sek, 2019) which indicates a rate of 19,19% and 24.32%, respectively. Salisu et al. (2017) reached a rate equal to 19.32%; Bala and Chin (2018b) (23%), and inferior to Ibrahim (2015), who arrived at a rate of 55.92%.

According to the findings, in the short term, an increase in the oil price is positively related to the CPI by 0.3765%. These results are consistent with (Bawa et al., 2020b) and (Lacheheb and Sirag, 2019b).

The wave of inflation that prevailed in the oil-exporting countries, led by Saudi Arabia, after the significant rises in barrel prices, contributed to by many external and domestic factors. Firstly, there is an increase in the prices of imported commodities resulting from the increase in prices in the producing country, notably the price rise in the country of origin is, in turn, caused by the doubling of oil prices, which left unprecedented inflationary effects in the industrialised countries themselves, which are the main suppliers of most of the oil-producing countries' needs of goods and services. Secondly, in Saudi Arabia, local products depend on raw materials imported from abroad and oil energy sources. The prices of these locally manufactured products have increased, exacerbating inflation rates and rising prices, which constitutes the third factor that pushed prices upward in Saudi Arabia. In the same way, a decrease in the oil price leads to a 3.84% decrease in CPI. These findings are congruent with (Salisu et al., 2017).

In the near term, a surge in oil prices exhibits a positive correlation with the CPI, signifying that a rise in oil prices boosts the CPI temporarily. This occurs as the escalation in oil prices amplifies the production costs, thereby curtailing the quantity of other producible goods. This observation aligns with the findings of (Lacheheb and Sirag, 2019b), who concluded that short-term oil price hikes exacerbate inflation in Algeria. Conversely, the study demonstrates that a global decrease in oil prices adversely affects inflation in the short span. This supports the conclusion reached by (Salisu et al., 2017), who determined that a price dip triggers a spike in inflation in oil-reliant nations.

Regarding other independent factors, an elevation in the EXCH is inversely correlated with the CPI in both short and long durations, by 67.21% and 127.26%, respectively. These findings are similar to (Bawa et al., 2020c). This implies that a rise in foreign exchange rates renders domestic goods more economically accessible to international buyers, thus spurring exports, overall demand, and pricing. Consequently, an upward shift in the foreign exchange rate leads to inflationary pressures, which also holds for a descending exchange rate.

A positive correlation exists between an increase in the M2 in both the short and long term and the CPI, with respective percentages of 10.35% and 39.42%. This implies that if the M2 expands beyond the size of the economy, the currency's unit value declines, resulting in a decline in purchasing power and an increase in prices. This accords with what was found by (Davari and Kamalian, 2018a) and (Bawa et al., 2020b)

The results of the estimates for the long term are presented in Table 8. displays the projected outcomes of these analyses. This shows that long-term changes in oil prices also impact CPI. Long-term, the research reveals that a rise in oil prices mitigates the CPI by 5.52%. The same 10.92% drop in CPI is seen when oil prices drop. Conclusions can be drawn about the long-term asymmetry between changes in oil prices and CPI.

The long-term findings also show that both an increase and a drop in the price of oil will reduce the CPI by 0.055% and 0.109%, respectively; hence, neither an increase nor a decrease in oil price will cause CPI in the long run. This positive oil price result contradicts the findings of (Xuan and Chin, 2015), (Bala and Chin, 2018a), and (Long and Liang, 2018), which claimed that increasing oil prices increase CPI. In contrast, the negative oil price result supports the findings of (Salisu et al., 2017) and (Nusair, 2019), which found that falling oil prices lower inflation in oil-exporting countries.

Table 8. NARDL Results on the Oil Price- Cpi Nexus in Saudi Arabia (Brent)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long Run Estimate				
C				
LNCPI (-1) (ECT)	-.4780746	0.1436508	-3.33	0.007***
LNOILPRICE_POS	-0.0552049	0.0416776	-1.32	0.212
LNOILPRICE_NEG	-0.1092683	0.0794211	-1.38	0.196
LNM2_POS	0.3942837	0.09865	4.00	0.002***
LNM2_NEG	-2.660838	2.576006	-1.03	0.324
LNEXCH_POS	-1.272627	0.3709168	-3.43	0.006***
LNEXCH_NEG	0.582949	0.2332649	2.50	0.030***
Short Run Estimate				
DLNOILPRICE_POS	0.0037653	0.0313608	0.12	0.907
D LNOILPRICE_NEG	-0.0384515	0.0437158	-0.88	0.398
D LNM2_POS	0.1035961	0.1099597	0.94	0.366
D LNM2_NEG	1.609529	2.460722	0.65	0.526
D LNEXCH_POS	-0.672115	0.3851763	-1.74	0.109
D LNEXCH_NEG	0.4192519	0.1987488	2.11	0.059
C	2.095294	0.627325	3.34	0.007 ***
Number of Observation	32	R-squared	0.8800	
F (20, 11)	4.03	Adj R-squared	0.6618	
Prob > F	0.0107	Root MSE	0.01462	

Source: Research finding, using Stata 17.
Note: *** Prob<0.05, Meaning that the variable is significative. The ECT is the error correction term.

Table 9 reports the asymmetric result on oil price and CPI. According to the findings, increases in oil prices are negatively related to CPI, whereas drops in oil prices are positively associated with CPI. These findings are contrary to the results obtained by (Babuga and Naseem, 2021)

The findings in Table 9 demonstrate that the positive and negative long-run variation in global price, DLNOILPRICE_POS and D LNOILPRICE_NEG, suggests that an increase in international oil price leads to a 0.115% fall in CPI, while a decrease in oil price leads to a 0.229% increase in CPI.

Furthermore, the R^2 indicates that Brent oil price, money supply and exchange rate explain 88% of the variation in CPI in Saudi Arabia. In contrast, the F-statistics (F=4.03) indicates that the estimated regression coefficient is statistically significantly different from zero.

Table 9. Asymmetric Short and Long-run Estimates

	Long-run Effect [+]			Long-run Effect [-]		
Exog. var	**Coeff**	**F-stat**	**P>F |**	**Coeff**	**F-stat**	**P>F |**
LNOILPRICE	-0.115	2.161	0.170	0.229	1.977	0.187
LNM2	0.825	19.87	0.001***	5.566	.9682	0.346
LNEXCH	-2.662	7.059	0.022***	-1.219	6.099	0.031***

Asymmetric	**Long-run asymmetry**		**Short-run asymmetry**	
	F-stat	P>F |	F-stat	P>F |
LNOILPRICE	0.6618	0.433	0.0003604	0.985
LNM2	1.226	0.292	1.656	0.225
LNEXCH	10.06	0.009***	0.3894	0.545
Cointegration test statistics			t_{BDM}	-3.3280
			F_{PSS}	5.0155
Model diagnostics			**Stat**	**P-value**
Portmanteau test up to lag 14 (chi2)[a]			10.54	0.7215
Breusch/Pagan heteroskedasticity test (chi2)[b]			0.0693	0.7924
Ramsey RESET test (F)[c]			2.346	0.1490
Jarque-Bera test on normality (chi2)[d]			0.2197	0.8960

Source: Research finding, using Stata 17.
Note: *** Prob<0.05, Meaning that the variable is significant
[a]. The null hypothesis is there is no serial correlation in the residuals up to the specified order.
[b]. The null hypothesis is no heteroskedasticity.
[c]. Miss Specification.
[d]. The null hypothesis is that there are normally distributed errors.

Several diagnostic tests are utilised to assess the reliability and consistency of the NARDL model. The diagnostic test conducted in the final section of Table 9 indicates the absence of serial correlation. Simultaneously, it is ensured that the stochastic disturbance term exhibits constant variance, a property known as homoscedasticity. Furthermore, it is affirmed that the specification of the NARDL model is accurate. Moreover, the test statistics CUSUM and CUSUMSQ depicted in Table 2 are utilised to assess the stability of the model. Based on the analysis, it can be inferred that both the CUSUM and CUSUMSQ test statistics do not surpass the lower and upper bounds, visually represented by two straight lines, at a significance level of 5%. As a result, it can be concluded that the NARDL model exhibits stability and efficiency.

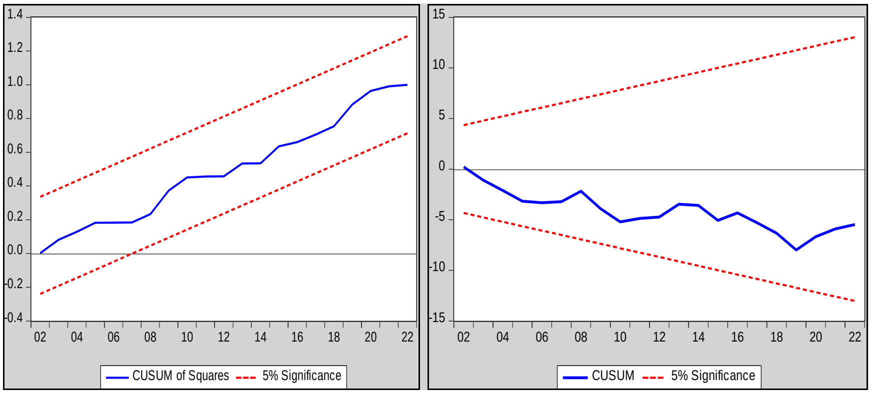

Figure 4. Cusum Stability Test
Source: Research finding, using Stata 17.

5.6 Dynamic Multiplier Effect

Asymmetric cumulative dynamic multipliers were devised per the methodology proposed by Shin et al. (2014b) to analyse the asymmetric adjustment patterns that occur in response to positive and negative oil price changes concerning the explanatory variable.

Figure 5 illustrates the dynamic multiplier effect of an increase in oil prices on the Consumer Price Index (CPI) in Saudi Arabia. It is observed that the impact of a decrease in oil prices is negligible in both the short and long term. It is important to acknowledge that the transmission of an oil price increase to the domestic price level occurs gradually over 4-5 years, eventually converging with the long-run coefficient of 0.055. This phenomenon resembles the findings of (Lacheheb and Sirag, 2019b), who have demonstrated that the complete manifestation of an initial oil price fluctuation requires a time of 4-5 years.

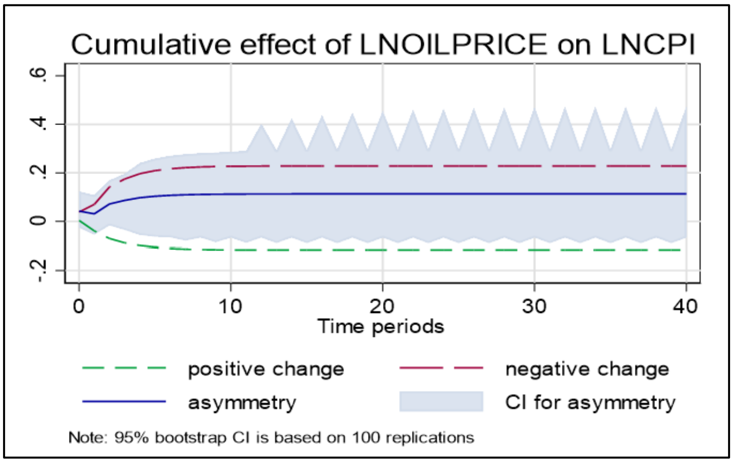

Figure 5. Multiplier Impact of the Oil Price Increase and Decrease on CPI
Source: Research finding, using Stata 17.

6. Conclusion and Policy Implication

This research aimed to assess the asymmetric influence of oil price variations on Saudi Arabia's Consumer Price Index (CPI), employing yearly data from 1980 to 2022. The analysis engaged a nonlinear Autoregressive Distributed Lag (ARDL) methodology to probe both long- and short-term impacts, exploring how oscillations in oil prices bear upon the country's consumer price index.

The study's findings reveal that a rise in oil prices in the short run corresponds to a 0.3765% increase in the CPI, whereas a decline in oil prices results in a 3.84% reduction in CPI.

For the long-term estimates, the results manifest that oil price swings also have an enduring effect on the CPI. The research uncovers that a marginal escalation in oil prices diminishes the CPI, while a contraction in oil prices prompts a decrease in the CPI. The conclusion can be drawn that long-term variations in oil prices exert a direct, asymmetric influence on the CPI.

Regarding the asymmetric impact, the outcomes denote that both positive and negative long-term changes in the global price, termed DLNOILPRICE_POS and DLNOILPRICE_NEG, imply that an uptick in international oil prices leads to a 0.115% drop in the CPI, whereas a downturn in oil prices results in a 0.229% ascent in CPI.

Price stability and maintaining inflation within a certain reasonable range are crucial goals for macroeconomic policy, as they reflect the strength and stability of a country's economy. Conversely, price instability leads to uncertainty, resulting in distortions and inefficiencies in resource allocation. Therefore, understanding and knowledge of the inflationary effects of oil price shocks is a matter of utmost importance. Policymakers can use this knowledge to coordinate their policies to accommodate oil price shocks when they occur, especially during periods of excessive oil price increases. Additionally, the Saudi Central Bank should enhance its efforts to increase domestic production of foodstuffs by ensuring more financing through its interventions in the agricultural sector. This can help reduce the volume of imports contributing to imported inflation. Furthermore, exploring alternative energy sources to mitigate the impact of global oil price shocks on local prices in Saudi Arabia is essential.

Expanding into other productive sectors, such as agriculture and industry, is vital for economic diversification, aiming to achieve enhanced growth and mitigate the negative repercussions of global oil price fluctuations. This approach is important to avoid excessive reliance on this single resource, especially with Saudi Arabia's membership in the BRICS group of countries.

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- Conflict of interest: The authors declare they have no identifier's financial interest or personal matters that may affect the work presented in this study.
- Data: The data used is generated from a publicly available source.

References

Adebayo, T. S. (2020). Dynamic Relationship between Oil Price and Inflation in Oil Exporting Economy: Empirical Evidence from Wavelet Coherence Technique. *Energy Economics Letters*, *7*(1), 12–22. Retrieved from https://doi.org/10.18488/JOURNAL.82.2020.71.12.22

Algamdi, A., Brika, S. K. M., Musa, A., & Chergui, K. (2021). COVID-19 Deaths Cases Impact on Oil Prices: Probable Scenarios on Saudi Arabia Economy. *Frontiers in Public Health*, *9*, 620875. Retrieved from https://doi.org/10.3389/fpubh.2021.620875

Alogeel, H., & Hasan, M. (2008). Understanding the Inflationary Process in the GCC Region: The Case of Saudi Arabia and Kuwait. *IMF Working Papers*, Retrieved from https://ideas.repec.org/p/imf/imfwpa/2008-193.html

Ayisi, R. K. (2021). The Asymmetry Effect of Oil Price Changes on Inflation, and the Welfare Implication for Ghana. *African Journal of Economic and Management Studies*, *12*(1), 55–70. Retrieved from https://doi.org/10.1108/AJEMS-01-2020-0009

Babuga, U. T., & Naseem, N. A. M. (2021). The Asymmetric Effect of Oil Price Change on Inflation: Evidence from Sub-Saharan Africa Countries. *International Journal of Energy Economics and Policy*, *11*(1), 448–458. Retrieved from https://doi.org/10.32479/IJEEP.10764

Baek, J., & Young, T. B. (2021). A New Look at the Crude Oil Prices and Economic Growth Nexus: Asymmetric Evidence from Alaska. *Mineral Economics*, *34*(3), 339–344. Retrieved from https://doi.org/10.1007/S13563-020-00225-4

Bala, U., & Chin, L. (2018b). Asymmetric Impacts of Oil Price on Inflation: An Empirical Study of African OPEC Member Countries. *Energies*, *11*(11), 3017. Retrieved from https://doi.org/10.3390/en11113017

Balcilar, M., Roubaud, D., Usman, O., & Wohar, M. E. (2021). Testing the Asymmetric Effects of Exchange Rate Pass-Through in BRICS Countries: Does The State of the Economy Matter? *The World Economy*, *44*(1), 188–233. Retrieved from https://doi.org/10.1111/twec.12990

Bawa, S., Abdullahi, I. S., Tukur, D., Barda, S. I., & Adams, Y. J. (2020). Asymmetric Impact of Oil Price on Inflation in Nigeria. *CBN Journal of Applied Statistics*, *11*(2), 85–113. Retrieved from https://doi.org/10.33429/Cjas.11220.4/8

Brent Crude Oil Price Annually 1976-2022 | Statista. (n.d.).

Broock, W. A., Scheinkman, J. A., Dechert, W. D., & LeBaron, B. (1996). A Test for Independence Based on the Correlation Dimension. *Econometric Reviews*, *15*(3), 197–235. Retrieved from https://doi.org/10.1080/07474939608800353

Chou, K., & Lin, P. (2013). Oil Price Shocks and Producer Prices in Taiwan : An Application of Non-Linear Error-Correction Models. *Journal of Chinese Economic and Business Studies*, *11*(1), 59-72. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/14765284.2012.755302

Davari, H., & Kamalian, A. (2018). Oil Price and Inflation in Iran: Non-Linear ARDL Approach. *International Journal of Energy Economics and Policy*, *8*(3), 295–300. Retrieved from https://ideas.repec.org/a/eco/journ2/2018-03-35.html

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, *74*(366), 427. Retrieved from https://doi.org/10.2307/2286348

Export Performance Report. (n.d.). Retrieved October 4, 2023, from https://www.saudiexports.gov.sa/en/Exporter-Development/Pages/Performance-Reports.aspx

Gross Domestic Product | General Authority for Statistics. (n.d.). Retrieved October 4, 2023, from https://www.stats.gov.sa/en/tags/gdp

Husaini, D. H., & Lean, H. H. (2021). Asymmetric Impact of Oil Price and Exchange Rate on Disaggregation Price Inflation. *Resources Policy*, *73*, Retrieved from https://doi.org/10.1016/j.resourpol.2021.102175

Ibrahim, M. H. (2015). Oil and Food Prices in Malaysia: A Nonlinear ARDL Analysis. *Agricultural and Food Economics*, *3*(1), 1–14. Retrieved from https://doi.org/10.1186/s40100-014-0020-3

Inflation, Consumer Prices (annual %) - Saudi Arabia | Data. (n.d.).

Köse, N., & Ünal, E. (2021). The Effects of the Oil Price and Oil Price Volatility on Inflation in Turkey. *Energy*, *226*, Retrieved from https://doi.org/10.1016/j.energy.2021.120392

Kun Sek, S. (2019). Effect of Oil Price Pass-Through on Domestic Price Inflation: Evidence from Nonlinear ARDL Models. *Panoeconomicus*, *66*, 69–91. Retrieved from https://doi.org/10.2298/PAN160511021S

Lacheheb, M., & Sirag, A. (2019). Oil Price and Inflation in Algeria: A Nonlinear ARDL Approach. *The Quarterly Review of Economics and Finance*, *73*, 217–222. Retrieved from https://doi.org/10.1016/j.qref.2018.12.003

Long, S., & Liang, J. (2018). Asymmetric and Nonlinear Pass-Through of Global Crude Oil Price to China's PPI and CPI Inflation. *Http://Www.Tandfonline.Com/Action/AuthorSubmission?JournalCode=rero20&page=instructions*, *31*(1), 240–251. Retrieved from https://doi.org/10.1080/1331677X.2018.1429292

Nasir, M. A., & Vo, X. V. (2020). A Quarter Century of Inflation Targeting & Structural Change in Exchange Rate Pass-Through: Evidence from the First Three Movers. *Structural Change and Economic Dynamics*, *54*, 42–61. Retrieved from https://doi.org/10.1016/j.strueco.2020.03.010

Nusair, S. A. (2019). Oil Price and Inflation Dynamics in the Gulf Cooperation Council Countries. *Energy*, *181*, 997–1011. Retrieved from https://doi.org/10.1016/j.energy.2019.05.208

Okere, K. I., Muoneke, O. B., & Onuoha, F. C. (2021). Symmetric and Asymmetric Effects of Crude Oil Price and Exchange Rate on Stock Market Performance in Nigeria: Evidence from Multiple Structural Break and NARDL Analysis. *The Journal of International Trade & Economic Development*, *30*(6), 930–956. Retrieved from https://doi.org/10.1080/09638199.2021.1918223

Osei, J. (2022). The Asymmetric Impact of Oil Price Dynamics on Inflation in Brazil. *European Journal of Economics*, *2*(2), 39–50. Retrieved from https://doi.org/10.33422/eje.v2i2.251

Perron, P., Perron, & Pierre. (1989). The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis. *Econometrica*, *57*(6), 1361–1401. Retrieved from https://econpapers.repec.org/RePEc:ecm:emetrp:v:57:y:1989:i:6:p:1361-1401

Pham, T. A. T., Nguyen, T. T., Nasir, M. A., & Duc Huynh, T. L. (2023). Exchange Rate Pass-Through: A Comparative Analysis of Inflation Targeting & Non-Targeting ASEAN-5 Countries. *The Quarterly Review of Economics and Finance*, *87*, 158–167. Retrieved from https://doi.org/10.1016/j.qref.2020.07.010

Phillips, P. C. B., & Perron, P. (1988). Testing for a Unit Root in Time Series Regression. *Biometrika*, *75*(2), 335-346. Retrieved from https://doi.org/10.1093/biomet/75.2.335

Rhee, W. (2006). Asymmetric Effects of Money on Inflation: Evidence from Korean Data. *International Economic Journal*, *9*(4), 31–43. Retrieved from https://doi.org/10.1080/10168739500000027

S. Alimia, A., D. Olaniranb, O., & Ayubac, T. (2020). An Asymmetric Evaluation of Oil Price- Inflation Nexus: Evidence from Nigeria. *Energy Economics Letters*, *7*(1), 1–11. Retrieved from https://doi.org/10.18488/journal.82.2020.71.1.11

Salisu, A. A., Isah, K. O., Oyewole, O. J., & Akanni, L. O. (2017). Modelling Oil Price-Inflation Nexus: The Role of Asymmetries. *Energy*, *125*, 97–106. Retrieved from https://doi.org/10.1016/j.energy.2017.02.128

Saudi Arabia: Oil Production 2022 | Statista. (n.d.). Retrieved October 4, 2023, from https://www.statista.com/statistics/265190/oil-production-in-saudi-arabia-in-barrels-per-day/

Saudi Arabia | Data. (n.d.).

Saudi Central Bank Portal For Open Data. (n.d.). Retrieved October 2, 2023, from https://www.sama.gov.sa/en-us/economicreports/pages/database.aspx

Sek, S. K. (2017). Impact of Oil Price Changes on Domestic Price Inflation at Disaggregated Levels: Evidence from Linear and Nonlinear ARDL Modelling. *Energy*, *130*, 204–217. Retrieved from https://doi.org/10.1016/J.ENERGY.2017.03.152

Senda, T. (2001). Asymmetric Effects of Money Supply Shocks and Trend Inflation. *Journal of Money, Credit and Banking*, *33*(1), 65-89. Retrieved from https://doi.org/10.2307/2673872

Shahbaz, M., Hoang, T. H. Van, Mahalik, M. K., & Roubaud, D. (2017). Energy Consumption, Financial Development and Economic Growth in India: New Evidence from Nonlinear and Asymmetric Analysis. *Energy Economics*, *63*, 199–212. Retrieved from https://doi.org/10.1016/J.ENECO.2017.01.023

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework. In *Festschrift in Honor of Peter Schmidt* (281–314). Retrieved from https://doi.org/10.1007/978-1-4899-8008-3_9

The Kingdom of Saudi Arabia's Budget. (n.d.). Retrieved October 4, 2023.

Xuan, P. P., & Chin, L. (2015). Pass-through Effect of Oil Price into Consumer Price : An Empirical Study. Retrieved from https://mpra.ub.uni-muenchen.de/96865/1/MPRA_paper_96865.pdf

Zivot, E., & Andrews, D. W. K. (1992). Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis. *Journal of Business & Economic Statistics, 10*(3), 25-44. Retrieved from https://doi.org/10.2307/1391541

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