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# The impact of crude oil price fluctuations on Economic Growth and Non-oil exports in the Kingdom of Saudi Arabia: An ARDL approach

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**ABSTRACT**: *Using annual data covering the period from 2000 to 2020 the effect of volatility was estimated on economic growth and crude oil prices on Saudi non-oil exports, each of the two sectors was chosen, Exports from manufacturing industries, agricultural exports, and high-tech exports to represent Non-oil export, also we Measuring the impact of oil price fluctuations on economic growth in the Kingdom of Saudi Arabia. The study followed the application of the ARDL model to study the equilibrium relationship between all of the volatility in oil prices, the three export sectors. The results indicated that the sector Exports of manufacturing industries is the sector most affected by the fluctuation in the price of oil, while the results did not indicate the existence of a long-term equilibrium relationship through which the sectors of agricultural exports and high-tech products are affected by the change in oil prices.The study recommends the need to increase investments for these twoSectors to secure a stable export proceeds that guarantee the stability of the Kingdom's economic growth rates.To reach the above, we have relied on measuring the impact of the relationship between oil prices and economic growth of the Kingdom of Saudi Arabia during the period 2000-2020, based on a model the Autoregressive Distributed Lag (ARDL).*

**KEYWORDS**: Oil prices, Non-oil exports, ARDL model, Co-integration.

## INTRODUCTION

The vision of the Kingdom of Saudi Arabia aims to bring about a positive structural change in the relative balance of the elements of value added in the overall economy, so that a balance occurs among the oil sources, and non-oil sources in a way that achieves economic diversification in sources of income and economic growth.

The importance of achieving the goal of economic diversification comes as a response to the continuous fluctuation in oil prices crude, which makes the proceeds of Saudi oil exports volatile in a way that may harm growth objectives Sustainable Growth, which depends heavily on the need to provide resources stable funding is not fluctuating from year to year. Oil is a crude commodity whose price fluctuates from year to year like most primary exports, which suffer from fluctuating prices, whether by rise or decline. This is in contrast to manufacturing or High-Tech Exports, which is characterized by the stability of demand for it and its prices to secure stable income for its producers and exporters that can be relied on without risk in ensuring the stability of economic growth rates and other macroeconomic indicators. To achieve this, we will analyze and study the following:

First: **Measuring the impact of oil price fluctuations on economic growth in the Kingdom of Saudi Arabia.**

Preparing previous studies, we identified a set of variables, which are:

1- Gross domestic product per capita (GDP) and this indicator is used to measure the standard of living in the Kingdom of Saudi Arabia.

2- Oil prices (oil), obtained from the Organization of Petroleum Exporting Countries (OPEC).

3- Inflation rate (INF), which means the continuous rise in the general level of prices during a certain period of time for reasons that may be monetary, and it is relied upon as the consumer price index (CPI).

4- The real exchange rate (TCR), where:

$$TCR = \frac{pd}{e \times pf}$$

Where:

pd: Reflects the foreign price index.

pf: Reflects the local price index.

e: Reflects the nominal exchange rate.

The model was based on data during the time period from 2000 to 2020 for the Kingdom of Saudi Arabia through annual data for all the previous variables, as:

GDP = $\mathcal{F}(Oil, Tcr, inf)$

Thus we can formulate the ARDL model as follows:

$$\Delta(gdp)_t = B_0 + B_1(gdp)_{t-1} + B_2(oil)_{t-1} + B_3(inf)_{t-1} + B_4(tcr)_{t-1} + \sum p_{t-1} B_5 \Delta(gdp)_{t-1} + \sum q_{t=0} B_6 \Delta(oil)_{t-1} + \sum p_{t=0} B_7 \Delta(inf)_{t-1} + \sum r_{t=0} B_8 \Delta(ter)_{t-1} + \epsilon_4$$

Where $\Delta$ the first differential and $\epsilon$ is the logarithmic error term for all variables. As for the coefficients ($B_1$, $B_2$, $B_3$, $B_4$) that measure the long-term statistical relationships, while ($B_5$, $B_6$, $B_7$, $B_8$) represent the short-term coefficients for each of (r, q, p) , as the economic growth is explained by the previous values and affected by them.

Running the model, we tested the ADF for all the variables, as shown in the following table:

Table (1) ADF Variable Test

| Variables | Lag period | ADF | significance level 1% | significance level 5% | significance level 15% |
|---|---|---|---|---|---|
| **GDP** | 6 | -0.467 | -4.507 | -3.021 | -3.001 |
| **Oil** | 6 | -0.865 | -4.507 | -3.21 | -3.001 |
| **TCR** | 6 | -5.452 | -4.498 | -3.171 | -3.005 |
| **INF** | 6 | -3.125 | -4.507 | -3.421 | -3.301 |

Source: E views program.

It is clear to us from the previous table, that the ADF test for all variables (inf, oil, GDP) is less than the levels of significance, Thus, we reject the null hypothesis, and therefore the time series is unstable, except for the real exchange rate (TCR), as the value of ADF is greater than all three levels of significance and therefore the time series is stable at this variable. According to, we will calculate the ADF test for the differentiation first degree of the variables, as follows:

Table (2) ADF test for the first differentiation first degree of the variables

| Variables | Lag period | ADF | significance level 1% | significance level 5% | significance level 15% |
|---|---|---|---|---|---|
| GDP | 6 | -4.621 | -3.092 | -2.756 | -2.521 |
| Oil | 6 | -5.625 | -4.781 | -3.012 | -3.002 |
| TCR | 6 | -2.233 | -4.222 | -3.429 | -3.277 |
| INF | 6 | -5.899 | -4.507 | -3.424 | -3.300 |

Source: E views program.

It is clear to us from the previous table that the estimated ADF value for the differentiation first degree of the variables (GDP, Oil, INF) is greater than the three levels of significance, which reflects that the time series are stable at the first degree. However, the value of the ADF test is less than the three levels of significance for the tcr real exchange rate variable, and therefore the series is stable for this variable at degree zero.

We calculate the Phillips Peron test for all the variables, as shown in the following table:

Table (3) Phillips Peron test

| Variables | Lag period | ADF | significance level 1% | significance level 5% | significance level 15% |
|---|---|---|---|---|---|
| GDP | 6 | -0.621 | -4.507 | -3.021 | -3.002 |
| Oil | 6 | -0.822 | -4.504 | -3.021 | -3.004 |
| TCR | 6 | -8.733 | -4.392 | -3.171 | -3.007 |
| INF | 6 | -3.028 | -4.508 | -3.422 | -3.302 |

Source: E views program.

It is clear from the previous table, that the time series of the three variables (GDP, Oil, and INF) are unstable at the three levels of significance because the statistical value of the PP test is smaller than the three levels of significance, except for the TCR series, which is stable at zero degree. Based on the above, we will calculate the PP test for the differentiation first degree of the variables, as follows:

Table (4) Phillips Peron test for the differentiation first degree of the variables

| Variables | Lag period | PP | significance level 1% | significance level 5% | significance level 15% |
|---|---|---|---|---|---|
| Gdp | 6 | -4.631 | -3.092 | -2.754 | -2.521 |
| Oil | 6 | -5.621 | -4.701 | -3.012 | -3.002 |
| Tcr | 6 | -2.233 | -4.222 | -3.429 | -3.277 |
| Inf | 6 | -6.001 | -4.507 | -3.420 | -3.301 |

Source: E views program.

It is clear to us from the previous table, with the pp test of the first differential for the variables, that all three variables (GDP, Oil, INF) have a value of pp greater than the three levels of significance, which confirms that the time series are stable at the first degree. As for the real exchange rate TCR, the absolute statistical value of the pp.-test is smaller than the three levels of significance previously mentioned, which confirms that the time series of the exchange rate is stable at degree zero.

Accordingly, after making sure that the time series are not stable to the same degree, we apply the ARDL model based on the following indicators:

Sequential final Prediction.

Modified LR test statistic.

Schwarz.

Akaike information criterion.

Error Hanna- Quinn.

Where the length of the Lag period is tested, which reflects the lowest value of the indicators SC and AIC for the study variables, as shown of the following

Table (5) Determine the optimal lag period

| HQ | SC | AIC | FPE | LR | Log L | Lag |
|---|---|---|---|---|---|---|
| **2.856212** | 2.962442 | 2.499221 | 0.000138 | NA | -32.94402 | 0 |
| **-1.543267** | -0.802739 | -1.830487 | 2.16e-08 | 140.987 | 45.44896 | 1 |
| **-1.116892** | 0.178338 | -1.638542 | 2.62e-08 | 18.87367 | 58.73800 | 2 |
| **-1.833914** | 0.023548 | -2.360208 | 1.34e-06 | 30.88219 | 86.45997 | 3 |
| **-1.438660** | 0.925283 | -2.208277 | 2.93e-06 | 11.33577 | 98.26400 | 4 |

Source: E views program.

The results indicate that the optimal lag period for the variables is three by using the bounds test approach based on the ARDL model. We obtained the following results as shown in the following table:

Table (6) the bounds test approach

| levels of significance | Minimum I(0) | maximum I(1) |
|---|---|---|
| 10% | 2.82 | 3.88 |
| 5% | 3.32 | 4.55 |
| 2.5% | 3.71 | 4.89 |
| 1% | 4.31 | 5.79 |

Source: E views program.

It is clear to us that there is a co-integration relationship between the variables at the levels of 2,5% and 10%, and therefore we measure the long-term relationship through the ARDL model to reach the estimate of long-term transactions based on the Lag period of the Schwarz Bayesian Criterion indicator, and this can be clarified through the following table:

Table (7) Co-integration Form

| Variable | Coefficient | Std Error | t-statistic | prob |
|---|---|---|---|---|
| D(LGdp(-1)) | 0.50854 | 0.2300763 | 2.524023 | 0.0182 |
| D(LGdp(-2)) | 0.143286 | 0.122057 | 1.472466 | 0.1107 |
| D(Linf) | 0.006607 | 0.009882 | 0.449468 | 0.7212 |
| D(LOil)) | 0.464856 | 0.059605 | 9.885650 | 0.0000 |
| D(LOil(-1)) | -0.213546 | 0.110221 | -1.701775 | 0.0820 |
| D(LOil(-2)) | -0.188920 | 0.072719 | -2.901723 | 0.0222 |
| D(LTcr) | 0.565782 | 0.144759 | 5.442663 | 0.0001 |
| D(LTcr(-1)) | -0.346066 | 0.180854 | -2.201661 | 0.0353 |
| Coint-Eq | -1.32012 | 0.248730 | -4.290525 | 0.0003 |

Long Run Coefficients

| Variable | Coefficient | Std Error | t-statistic | prob |
|---|---|---|---|---|
| LInf | 0.004509 | 0.014573 | 0.405902 | 0.8072 |
| LOil | 0.881709 | 0.016997 | 45.442051 | 0.0000 |
| LTcr | 0.5089387 | 0.057903 | 11.201889 | 0.0000 |
| C | 3.739631 | 0.350194 | 11.088734 | 0.0000 |

Source: E views program.

Thus, the equation can be formulated as follows:

Coint-Eq = LGDP – (3.739631+0.004509 INF+0.881709 Oil +0.50894 Tcr

Thus, the inflation rate has a positive and insignificant effect, as whenever the inflation rate rises by 1%, it will lead to an increase in Saudi GDP by 0.45%. It is also clear to us that the largest effect in the long term is the oil price on the rate of economic growth, as the elasticity coefficient is 0.88, followed by the real exchange rate, with which the elasticity coefficient is 0.508.

As for the short-term level, it is clear that the variables most affecting the GDP per capita is the real exchange rate variable, which has a coefficient of elasticity of 0.565, followed directly by the price of oil, which has a coefficient of elasticity of 0.464 .Based on the previous results, the error correction term reflects how quickly the variables return to the equilibrium state, in addition to the negative sign showing the convergence of the model in the short term, as it confirms the existence of a co-integration relationship and supports the impact of oil prices on economic growth in the short and long-term kinetic models. The ratio in the model is 11.2%, which means that about 11.2% of the long-term shocks can be explained.

**Second: Oil prices and the evolution of the performance of oil and non-oil exports: The development of GDP in the oil and non-oil sectors.**

GDP growth suffers from high volatility from one year to another. This fluctuation is closely related to the fluctuation in the growth rates of oil output. The output of oil has reached negative levels, as the gross domestic product achieved the lowest negative growth to -2.8 percent in 2012, a year in which growth in the oil sector regressed to a lower level, Its levels during the study period, in which it reached -9.5%, This means that the sector's growth declines.

The oil sector clearly leads to a concomitant decrease in the growth of Saudi GDP. However, it was also noticed through the analysis of the data in Table No. (1) That the rate of growth of output decreased. The non-oil rate of 9.5% did not result in a decrease in the growth rates of the GDP of the total in the same percentage or even close to it, but the decrease came with a much smaller percentage, which is 2, 8%. That is, the elasticity of GDP in the Saudi economy has become less, and this is a good thing.

Table (8) Data description for growth rate of GDP, Oil GDP and Non-oil GDP for Saudi Arabia (2000-2020)

| Variable | GDP_GROWTH_RATE | NON_OIL_GDP_GROWTH_RATE | OIL_GDP_GROWTH_RATE |
|---|---|---|---|
| Mean | 3.644535 | 5.448322 | 2.116042 |
| Median | 3.678471 | 5.508927 | 2.849615 |
| Maximum | 11.24206 | 9.549023 | 17.40899 |
| Minimum | -2.819174 | 0.226617 | -9.544853 |
| Std. Dev. | 3.832392 | 2.854501 | 6.537952 |
| Skewness | 0.145733 | -0.140372 | 0.368548 |
| Kurtosis | 2.489145 | 1.852094 | 3.089585 |
| Jarque-Bera | 0.273857 | 1.105568 | 0.436475 |
| Probability | 0.872033 | 0.575346 | 0.803934 |
| Sum | 69.24617 | 103.5181 | 40.20480 |
| Sum Sq. Dev. | 264.3700 | 146.6671 | 769.4067 |
| Observations | 21 | 21 | 21 |

Source: Calculated by author depending on IMF (2021) .

Perhaps the reason for this is the relative stability in the GDP of the non-oil sectors, As this product achieved a positive average annual growth of 5.4%, which is double what was achieved in the oil sector, more than the general average growth rate of GDP Which amounted to 3.6% during the period from 2000to 2020 based on as shown in Table No. (1). This means that the growth rates in the sectors are stable in the non-oil sector contributed to reducing the exposure of the Saudi economy to negative shocks resulting from the volatility of oil prices during the study period.

**The evolution of oil prices and non-oil exports in the Saudi economy**.

The evolution of the annual rates of change for each of the world oil prices, As well as a number of exports in the Saudi non-oil sectors, such as exports from the industrial sector, Converting manufactures, agricultural exports, in addition to exports from High-tech exports. Considering the evolution of these four variables including oil prices, we note a clear fluctuation of all these variables during the study period (2000-2020), especially in high-tech exports, as shown in the table number (2), which contains many statistical properties of the four variables of the model, such as mean, standard deviation, and others.

Table (9): Data description of model variables (in natural logarithm)

| Variable | OIL_PRICE | MANUF | HTEC | AGRI |
|---|---|---|---|---|
| Mean | 3.927918 | 28.34243 | 25.63142 | 22.69265 |
| Median | 4.021167 | 28.42256 | 25.96028 | 22.60024 |
| Maximum | 4.516120 | 29.21683 | 27.51932 | 24.29422 |
| Minimum | 3.127199 | 27.03148 | 23.88439 | 22.09019 |
| Std. Dev. | 0.485083 | 0.729906 | 1.014165 | 0.547256 |
| Skewness | -0.335828 | -0.473990 | -0.299614 | 1.327375 |
| Kurtosis | 1.800011 | 1.861183 | 2.345037 | 5.101904 |
| Jarque-Bera | 1.418322 | 1.646678 | 0.591038 | 8.599276 |
| Probability | 0.492057 | 0.438964 | 0.744145 | 0.013573 |
| Sum | 70.70253 | 510.1637 | 461.3655 | 408.4676 |
| Sum Sq. Dev. | 4.000189 | 9.056965 | 17.48503 | 5.091316 |
| Observations | 21 | 21 | 21 | 21 |

Source: Calculated by author depending on World Bank (2021)

## METHODOLOGY

This study applies the ARDL methodology to study the long-run equilibrium relationship between oil prices and non-oil exports. Three sectors have been chosen to represent non-oil exports .They are: exports of manufacturing industries, raw agricultural exports, and exports of high- Technology products. The study covers the period from the year 2000 to the year 2020. The co-integration test depends on the application of the Autoregressive Distributed Lag (Pesaran, Shin, and Smith (2001)) as an alternative to traditional approaches to co-integration at (Johansen & Julius, 1990 (and) Gregory & Hansen, 1996)). The most important feature that distinguishes the ARDL methodology from those traditional methodologies is the possibility of conducting

The co-integration test regardless of the degree of integration of the time series as long as it does not exceed the first degree, and regardless of whether or not the degree of integration is equal among those variables, and this is equality in the degree of integration is a necessary condition, the absence of which results in the inability to conduct co-integration test according to the Johansen method. While the co-integration test can be performed according to the ARDL methodology, in light of the unequal degree of integration, which gives a great advantage in the case of the different levels of stability of the time series of the study variables.

The impact of fluctuations in oil prices on non-oil exports is estimated through an estimate the following equations:

$$manuf_t = a_1 + b_1 oil_t + e_{1t} \quad (1)$$

$$agri_t = a_2 + b_2 oil_t + e_{2t} \quad (2)$$

$$htec_t = a_3 + b_3 oil_t + e_{3t} \quad (3)$$

Where $manuf_t$ stand for the natural log of exports from the manufacturing sector , $agri_t$ of agricultural exports , and $htec_t$ of exports from high – teech industries . As for $e_{1t}$ , $e_{2t}$ , $e_{3t}$ represent the limits of error are normally distributed and their variance is constant .
Thus , three models will be estimated to determine the extent of impact of oil price volatility on non – oil exports in the Kingdom of Saudi Arabia , as the relationship with the economic growth of the same country has been estimated before , where the ARDL model can be presented as follows:
Model 1:

$$\Delta manf_t = \alpha_0 + \sum_{t=1}^{k} \emptyset_1 \Delta manuf_{t-1} + \sum_{t=0}^{l} \emptyset_2 \Delta oil_{t-1} + \varphi_1 manuf_{t-1} + \varphi_2 oil_{t-1} + \epsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Model 2:

$$\Delta agri_t = \alpha_0 + \sum_{t=1}^{k} w_1 \Delta agri_{t-1} + \sum_{t=0}^{l} w_2 \Delta oil_{t-1} + \Theta_1 agri_{t-1} + \theta_2 oil_{t-1} + u_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (5)$$

Model 3:

$$\Delta htec_t = \alpha_0 + \sum_{t=1}^{k} \lambda_1 \Delta htec_{t-1} + \sum_{t=0}^{l} \lambda_2 \Delta oil_{t-1} + \beta_1 htec_{t-1} + \beta_2 oil_{t-1} + r_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (6)$$

Where the coefficients $\emptyset\mathbf{1}$, $\emptyset\mathbf{2}$, $\boldsymbol{w1}$, $\boldsymbol{w2}$, $\boldsymbol{\lambda 1}$, $\boldsymbol{\lambda 2}$ represent the short-run elasticities of the model, While the coefficients $\boldsymbol{\varphi 1}$, $\boldsymbol{\varphi 2}$, $\Theta\mathbf{1}$, $\boldsymbol{\theta 2}$, $\boldsymbol{\beta 1}$, $\boldsymbol{\beta 2}$ represent the long-run model elasticity's. For example, the value of coefficient $\boldsymbol{\varphi 2}$ represents the relative change in the value of exports from the manufacturing sector as a result of the relative change in the price of oil by 1%. The coefficient $\boldsymbol{\theta 2}$ represents the relative change in the value of agricultural exports as a result of the relative change in the price of crude oil by 1%, and the coefficient represents $\boldsymbol{\beta 2}$ The relative change in the exports of Saudi high-tech products as a result of the relative change in the price of crude oil increased by 1%. Therefore, when estimating these transactions, we get the effect of price fluctuations

Crude oil on a number of non-oil exports in the manufacturing sector, agriculture and the high-tech sector.

In order to test the extent to which there is a long-term equilibrium relationship between the price of crude oil, And between all the non-oil exports of the manufacturing sector, the agricultural sector and high-tech products should test the following hypotheses:

, $H_0: \Theta_1 = \theta_2 = 0, H_0: \varphi_1 = \varphi_2 = 0$
$, H_0: \beta_1 = \beta_2 = 0$

Co-integration is achieved if the previous assumptions are rejected, but in the case of inability to rejecting the previous hypotheses, the results will indicate that there is no long-term equilibrium relationship between the price of oil and non-oil exports in the long term, in this case a model is applied short-term Vector Auto regression (VAR)
Fourth: The results of the study:

**Time series stability test: unit root .**
The degree of stability of the time series of the study variables must be ensured, as it is required to apply ARDL Model No time series integral is greater than first degree I(1), so It must be ensured that there is no integrated second degree time series I (2) and to achieve this unit Root test was conducted to determine the degree of integration of the time series. Where the ADF test, PP test as well as KPSS test were applied. The results of those tests indicated that all-time series are unstable at the level, while they have become stable after take the first difference, meaning it is an integral of the first degree, I(1) . So can ARDL model application.

## RESULTS OF ARDL MODEL APPLICATION

Tables 3, 4 and 5 present the results of applying the ARDL models for equations 4, 5 and 6, as the results of these tables indicate a co-integration between oil prices and exports of manufacturing sector only , While there is no effect or long-term equilibrium relationship between each of the fluctuations in crude oil prices and exports of the agricultural sector or exports of high-tech products in the Saudi economy during the period 2000-2020 .

Table (10)
Model1: Dependent Variable: MANUF
Method: ARDL
Selected Model: ARDL(1, 0)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| OIL_PRICE | 0.446063 | 0.797362 | 0.559423 | 0.5847 |
| C | 28.14553 | 3.772994 | 7.459735 | 0.0000 |

F-statistic= 10.64 (Co-integration)

Table (11)

Model2: Dependent Variable: AGRI
Method: ARDL
Selected Model: ARDL(1, 0)

| Levels Equation<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| OIL_PRICE | -0.261238 | 0.825217 | -0.316569 | 0.7566 |
| C | 23.88205 | 3.480876 | 6.860932 | 0.0000 |

F-statistic= 0.983248 (NO Cointegration)

Model3: Dependent Variable: HTEC
Method: ARDL
Selected Model: ARDL(1, 0)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| OIL_PRICE | 0.335717 | 3.332040 | 0.100754 | 0.9211 |
| C | 26.38252 | 15.56428 | 1.695068 | 0.1107 |

F-statistic= 1.983248 (NO Co-integration)

## FINDINGS AND RECOMMENDATIONS

The study showed the existence of a co-integration relationship and supports the impact of oil prices on economic growth in the short and long-term kinetic models. The ratio in the model is 11.2%, which means that about 11.2% of the long-term shocks can be explained. We also noticed that the results of applying the ARDL model indicate the estimation of the long-term equilibrium relationship between the price of crude oil and non-oil exports

represented in manufacturing exports and primary exports from the agricultural sector , as well as exports of high-tech products are not affected in long-term by fluctuations in oil prices .

Based on the foregoing , there is a long-term impact of oil prices on both the rate of economic growth and manufacturing industries , which requires the decision maker to take macroeconomic measures that ensure reducing the impact of oil prices on those industries due to their positive role influencing the economic growth rate of the Kingdom of Saudi Arabia , In addition to maximizing the benefits from the economic sectors that are not affected by fluctuating's in oil prices , such as the agricultural sectors and the high-tech products . Where the inevitability of increasing the volume of government and private investments in these sectors appears to ensure the stability of the trade balance and achieve higher economic growth rates in way that helps avoid the negative effects that it may arise from price fluctuations in crude oil prices , and interest in productive sectors to diversify the economy .

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