# An Application of ARDL Bounds Testing Approach to the Estimation of Level Relationship between Inflation, Economic Activity and Oil Price in Algeria

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**Abstract:**

The present paper analyzesthe relationship between CPI, GDP& oil prices by adopting ARDL bounds testing approach in Algeria over the period 1970 - 2018. The findings indicate there isa cointegration relationship between variables, which allows us to estimate the error correction model (ECM), at the short run GDP affects consumer price inflation positively only after one lag period at 1% of significance. While, at the long run both oil prices and GDP have an impact on consumer price inflation and those effects are economically significant. Hence an increase in oil prices in Algeria would raise the volume of exports, which may increase the GDP and subsequently, CPI follows as well.

**Keywords**: Inflation, GDP, Oil Price, ARDL, Algeria

## I- Introduction:

Oil income in some developing oil-exporting countries like Algeria is the principal resource of financing business sectors. Therefore, this dependency has induced oil volatility to be the origin of macroeconomic fluctuations; oil is constituted as a component of the household consumption basket. Academics and policymakers confirmed that a higher level of inflation can be a result of an increase in oil prices. In fact, due to the increase in oil prices, the cost of production for companies' increases which drives them to charge raised prices for their commodities and cost-push inflation. Consequently, if the non-energy prices are kept stable, this situation can provoke to high inflation at the prevailing level of global demand which can take the country's economy into recession (Muhammad A. N. et al 2019 p 168). Hence, it is important to explain the relationship between oil prices and inflation levels as most monetary authorities attempt to put inflation under control.Higher oil revenues lead to an increase in real GDP. Despite, growth prospects are encouraging and economic indicators are satisfactory. Unfortunately, Algeria's economy is confronted to syndrome commonly referred to as the "resource curse" (Auty, 1993, pp 110-112). The unfavorable economic effects of oil price booms on other commercial goods in the remaining sectors (industry and agriculture), is known as Dutch Disease.Although a higher oil price in Algeria would raise exports revenues, which may increase the Gross Domestic Product (GDP) thus realize an economic growth in the country, and finally consumer price index follows as well. Consequently, a high GDP leads to higher CPI inflation in the short-run (Lacheheb, M., & Sirag, A. 2018 p 217). In this study, will try to answer this question:**How large is the influence of oil price and economic growth on domestic inflation?.**

For this reason, wedevise our plan of paper as follow: Section 2: Inflation , oil prices and GDP in Algeria**.** Section 3: Literature revue and Section 4 : Conclusion.

## 1. Inflation , oil prices and GDP in Algeria :

Following the 1973 war, crude oil prices quadrupled from $ 3 per barrel in 1972 to $ 12 per barrel at the end of 1974. This increase is due to the Arab oil embargo. In 1986, the price of oil fell from $ 27 to less than $ 10. During the period 1986-1989 Algeria experienced a very difficult economic situation, caused by the oil shock of 1986, which had a negative impact on macroeconomic indicators, real GDP rates fell from 3.7% in 1985 to -1% in 1988, the same for the percentage of quantities exported in the GDP going from 23% to 15%, on the other hand the consumer price index recorded high values going from 08.12% to 10.48% between 1985 and 1986.

The 1990-1999 phase is characterized by a fall in nominal oil prices from where prices reached their lowest level during this period of $ 13 in 1999, in this period we notice the magnitude of the increase in the CPI.

During the 2000s, as the world economy continues to grow, oil prices continue to trend upward, exceeding their highest levels since 1981. In 2003, they are estimated at 24.1 dollars, until reaching their highest price of 147.27 dollars in 2008, it is the oil shock of 2008 which was caused by the Saudi reduction of oil supply.

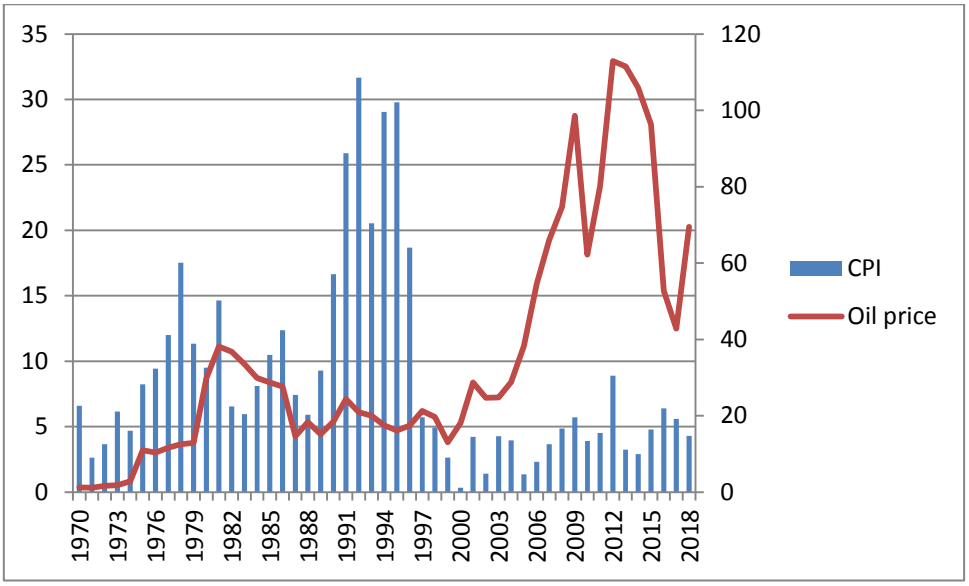
Between 2014 and 2018, it was a slight recovery in economic growth of 3.8% in 2014 against 2.8% in 2013 (from 16643.83 million dollars to 17205.1 million dollars) , in 2015, growth slowed slightly from 3.7%, it remained positive and above 2%.

Despite the slight drop in nominal oil prices from 96 dollars in 2015 to 52 and 42 dollars in 2016 and 2017 respectively, there is an increase in the consumer price indicators, rising from 2% in 2014 to 6.4% and 5.6% in 2016 and 2017 respectively.

The Algerian economy grew by 1.4% in 2018 (corresponds to $ 17380 million). This growth is slightly higher than that of 2017 (1.3%). Growth in 2018 is still positive despite the context of the current account deficit of the balance of payments, the decline in foreign exchange reserves and especially the decline in growth in the hydrocarbon sector.

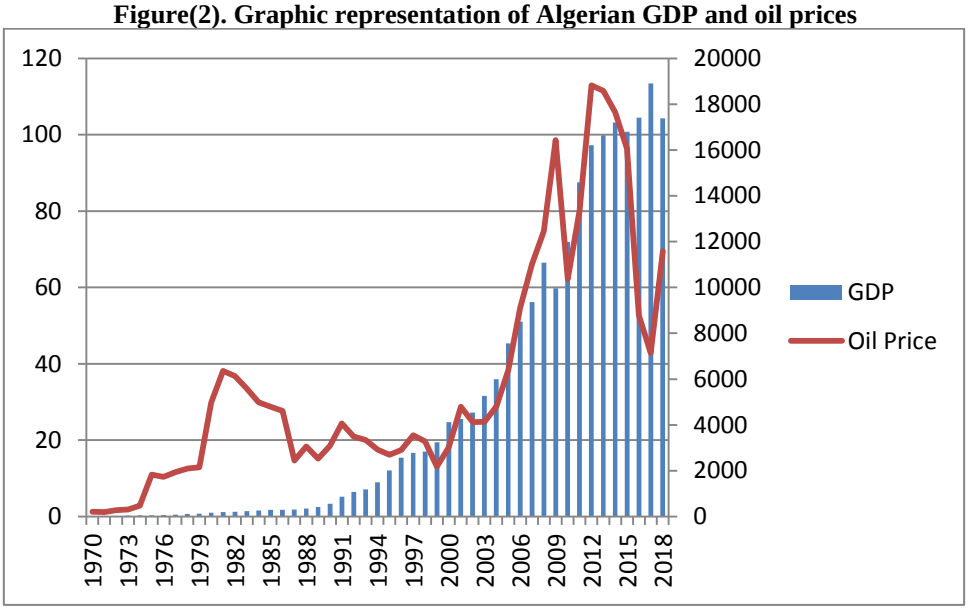
The graphics as below (Figure 01 Figure02)show the trend of CPI , oil prices and GDP during the period 1970-2018.

**Figure(1). Graphic representation of Algerian CPI and oil prices**




**Source. Elaborated by author from OPEC data and IMF using Excel 10**

**Figure(2). Graphic representation of Algerian GDP and oil prices**




**Source. Elaborated by author from OPEC data using Excel 10**

## 2. Literature revue :

The study of (Alexender Bass,2019, p 289) assesses the impact of global oil shocks on the rate of inflation and the exchange rate in Russia at the period 2000 to 2017, using Vector Error Correction Model (VECM), Granger causality and Johansen co‑integration test. The results of this study showed that all the variables are integrated in the same order and have similar trends in the movement in both long and short term, so changes in oil prices effect unmistakably inflation rate, where1 % rise in oil prices leads to a 1.21 % rise in inflation rate.

Choi , Davide Furceri , Prakash Loungani, Saurabh Mishra, Marcos Poplawski-Ribeiro (2018) examine the effect of global oil price fluctuations on inflation in 72 developed and developing countries by applying panel method during the period1970-2015. The main result of this study showed that the effects of oil prices on inflation are asymmetric: positive shocks are more significant than negative ones, and there is also a positive correlation between global oil prices and the domestic inflation rate of each country. The increase in international oil prices by 10 % leads to a rise of 0.4 % in domestic inflation. This impact disappears after two years of oil shock due to monetary policy and the decrease in energy imports.

(Jin Guo & all, 2016, p 72) investigate the relationship between the change in the coal price and inflation in China using Vector Autoregressive model (VAR), Granger causality and impulse response function analyses, using a monthly data for the period from June 1998 to September 2014, the results showed a negative causality of oil prices towards the inflation rate , and there are asymmetric effects of oil prices on the inflation rate, therefore negative oil prices change has more important effects on inflation rate than that positive coal price.

The paper of M. W. Madurapperuma, (2016), aims to analyze the relationship between inflation and economic growth in Sri Lanka from 1988 to 2015 using the Johansen co‑integration test and Error Correction Model (ECM) (Jin Guo & all, 2016, p 73). The results of this study showed a long-term negative relationship between variables, in the short-run, changes in inflation on GDP have a more significant negative impact while 47 percent GDP change has been explained by inflation. The main causes of inflation are mainly due to the energy crisis and weak agricultural production( Madurapperuma, 2016 ,p 05).

Shapan Chandra Majumder (2016) examines the relationship between inflation and economic growth in Bangladesh using Granger causality ,Johansen co‑integration test and the Vector Error Correction Model (VECM) for the period 1975-2013. The results show that the variables of the study are integrated in first order with a negative relationship between variables studied, which means that economic growth causes the rate of inflation, at the short and long run .

(Werner Roeger, 2005, p 29) studies the effect of oil prices on inflation in the European Union ( EU ) countries using Dynamic Stochastic General Equilibrium (DSGE ) model for the period 1970-2004. This paper aims to analyze the impact of the global oil price shocks on the inflation rate and economic growth (Jin Guo & all, 2016, p 74). The findings indicate that there is a negative relationship between oil shocks and both economic growth and inflation , knowing that there is no risk of inflation due to sharp monetary policy in these countries through the central bank, which has the ability to control inflation rates after any negative oil shocks prices.

(J. Cunado, F. Perez de Gracia, 2005, p 85) analyzes the impact of oil price shocks on inflation rates and economic growth rates in some Asian countries (Japan, Singapore, South Korea, Malaysia, Thailand, Philippines ) for the period 1975-2002 using panel method, Johansen co‑integration test, and Granger causality test, the applied results showed that there is no long-term relationship between oil prices and economic activity in these countries. In the short term, extensive shocks in oil prices cause economic growth rates in Japan, South Korea, and Thailand, if the price of oil is determined in local currency, oil price shocks have a significant and asymmetric impact on inflation in all countries(Werner Roeger, 2005, p 30).
Lawal Ganiyu Omoniyi, Aweda Nurudeen Olawale (2015), investigate the relationship between oil prices, exchange rate and the inflation rate in Nigeria using ARDL technique. The objective of this paper is to analyze the causal relationship between the variables studied during the period 2000-2015. The results show that oil prices have an opposite effect on the exchange rate, because of the intervention of the monetary authorities in maintaining exchange rate stability, knowing that the inflation rate is not effective in the stability of the exchange rate in the short term due to weak exports and increased demand for foreign exchange, where there is a negative relationship between oil price shocks and inflation rates as well.
(Lacheheb and Sirag, 2019, p 219) study the nexus between oil prices and the inflation rate in Algeria using the NARDL method during the period 1970-2014. The results indicate the existence of a significant relationship between high oil prices and inflation rate although there is no relationship in the case of low prices. In the short term, high oil price causes the rise in inflation in Algeria, and the absence of this effect in the long term because of the attempts of the monetary authorities to keep inflation under control by reducing the support directed and increase taxes by rationalizing expenditures to overcome the budget deficit.

## 3. Results and Discussion :

The macroeconomic variables that are chosen in our study are: Consumer Price Index (CPI) which is the variable of interest or the endogenous (dependent) variable , while the exogenous (independent) variables are : Gross Domestic Product (GDP) and oil prices. We use annual data for the period 1970 to 2018.The data has been collected from the World Bank Database (WDI), the International Monetary Fund (IMF) and National Statistics Office (ONS).

### 3.1.Unit root test :

A series are said to be non-stationary if they have non-constant means, variance and autocovariance over time. If a non-stationary serie has to be differenced *d* times to become stationary, then it is said to be integrated to the order of *d* .

The Augmented Dicky Fuller (ADF) andPhillips Perron (PP) tests suggest the presence of a unit root at level in LCPI, LGDP and LOil price, while first differencing the series yields an apparent lack of a unit root in any of the series. This order of integration allows us to apply ARDL bounds testing procedure.

**Table (01).Unit root test**

| Variables | ADF | | | PP | | | Stationarity |
|---|---|---|---|---|---|---|---|
| | Ⅰ | Ⅱ | Ⅲ | Ⅰ | Ⅱ | Ⅲ | |
| D(LCPI) | -9.81* | -9.69* | -9.60* | -9.86* | -9.75* | -9.67* | I(1) |
| D(LGDP) | -2.57* | -5.10* | -5.77* | -2.31** | -5.11* | -5.77* | I(1) |
| D(LOIL) | -5.62* | -5.82* | -6.18* | -5.66* | -5.81* | -6.18* | I(1) |

**Source. Elaborated by author**

Ⅰ. Refers to a model without Intercept & without trend, Ⅱ. Includes Intercept only, Ⅲ. Includes both intercept and trend

*, ** and *** Indicate significance at the 1%, 5% and 10% levels, respectively.

### 3.2. Bound test :

The results of the bound test confirm the existence of a strong cointegration relationship between the series of our study (the value of F-statistic is greater that of the upper bound), and it is highly significant at 1% ,5% and 10%, which gives the possibility of estimating the effects.

T-statistic is greater than the upper bound by absolute value which confirms the existance of conintegration .

**Table (02).Bound test results**

| **Variables** | **LCPI , LGDP, LOIL** | | | |
|---|---|---|---|---|
| **F-statistic** | 7.14 | | **t-statistic** | -4.59 |
| **Critical Values** | **Lower Bound** | **Upper Bound** | **Lower Bound** | **Upper Bound** |
| **1%** | 5.15 | 6.36 | -3.43 | -4.1 |
| **5%** | 3.79 | 4.85 | -2.86 | -3.53 |
| **10%** | 3.17 | 4.14 | -2.57 | -3.21 |

**Source. Elaborated by author**

### 3.3. Long run estimation :

Table (03) presents the estimation coefficients at the long run. The results indicate that the impact of $GDP_t$ on consumer price inflation is negative buteconomically insignificant.

The effect of $OIL_t$ appears to be positive and statistically significant at 10%, The results obtained suggest that 1% increase in oil price will lead approximately to 0.44% increase in consumer price index.The coefficient of $LOIL_t$ is positive which means that the CPI & oil prices have the same direction; when the oil prices increase the consumer price index rise also, (and vice versa). In this context, an increase in oil prices increases oil export revenues, moreover this can harm the Algerian economy by changing the prices of products intended for domestic consumption. Therefore, it would be more advantageous for Algeria to produce its main goods and commodities, in order to avoiding imports. Achieving this goal requires to provide aid from the government such as fuel subsidies which are very effective in reducing the adverse effects of oil prices volatilities on domestic inflation ( Baharumshah et al.,2017 p 457).

**Table (03).long run estimation**

| **Endogenous variable : $LCPI_t$** | | | |
|---|---|---|---|
| **Regressors** | **Coefficents** | **Std. Error** | **T-Statistic** |
| $LGDP_t$ | -0.30** | 0.11 | -2.66 |
| $LOIL_t$ | 0.44*** | 0.25 | 1.79 |

*, ** and *** Indicate significance at the 1%, 5% and 10% levels, respectively.

**Source. Elaborated by author**

### 3.4. Short run estimation :

The error correction coefficient shows how quickly the equilibrium is restored. This coefficient is 0.64 in absolute value, and is significant at 1% level of significance which means that once the model is deviated from equilibrium, it will adjust to 64% during the same period. It should be noted that if the coefficient is not significant the adjustment will not be made in the same period.

The results of Table (04) show that at the short run GDP affect consumer price inflation only after one lag period at 1% of signifincance and if $\Delta GDP_{t-1}$ increase with 1% so the consumer price index rise with 3.77% . On the other hand, oil price affect inflation nagatively which is economicly insignificant.

The coefficient of determination $R^2$ and the adjusted coefficient of determination $\overline{R^2}$ are equal to 0.40 and 0.34 respectively (see Table 04), which proves the average power of the independent (exogenous) variables to explain changes of the dependent variable (endogenous).

**Table (04).Short run dynamism ( ECM )**

| **Endogenous variable : $D(LCPI_t)$** | | | |
|---|---|---|---|
| **Regressors** | **Coefficents** | **Std. Error** | **T-Statistic** |
| *Intercept* | 1.12* | 0.30 | 3.73 |
| $ECM_{t-1}$ | -0.64* | 0.13 | -4.74 |
| $D(LGDP_t)$ | 0.45 | 0.88 | 0.51 |
| $D(LGDP_{t-1})$ | 3.77* | 1.19 | 3.18 |
| $D(LOIL_t)$ | -0.67*** | 0.38 | -1.75 |
| R-squared | 0.40 | | |
| Adjusted R-squared | 0.34 | | |
| AIC | 1.83 | | |
| SC | 2.03 | | |
| DW Statistic | 2.08 | | |

*, ** and *** Indicate significance at the 1%, 5% and 10% levels, respectively.

**Source. Elaborated by author**

### 3.5. Diagnostics tests and Stability Model :

According to the Table (05)below, the LM test based on the null hypothesis H0 : the absence of serial correlation. The $x_{SC}^2$ statistic is lower than the tabulated value corresponding to the estimated model. Therefore, the null hypothesis is accepted, there is no serial correlation.

Similarly, the autoregressive conditional heteroskedasticity ARCH (1) shows that the variance of the errors is constant over time. Also, the Jarque-Bera test indicates that the null hypothesis (the residuals are normally distributed) has not been rejected.

The results of the Ramsey RESET test indicate the rejection of the null hypothesis H0: "existence of model misspecification", hence, the model takes the appropriate functional and it is correctly specified.

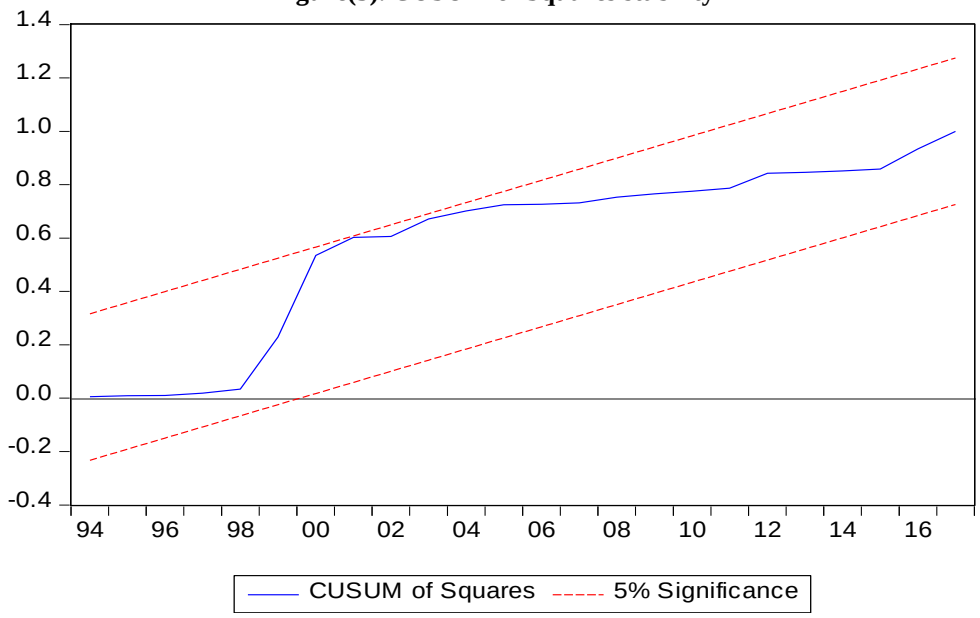
**Table (05). Results of diagnostics tests of the estimated model**

| Test | Statistic | Probability | Decision |
|---|---|---|---|
| LM test | $x^2_{SC} = 0.1210(1)$ | 0.8611 | Absence of autocorrelation |
| ARCH | $x^2_{FF} = 0.5828\ (1)$ | 0.4397 | Homoscedasticity |
| Normality test | $JB = 0.135$ | 0.934 | Normal distribution |
| Ramsey RESET | $F = 0.0036$ | 0.980 | The model is correctly specified |

**Source. Elaborated by author**

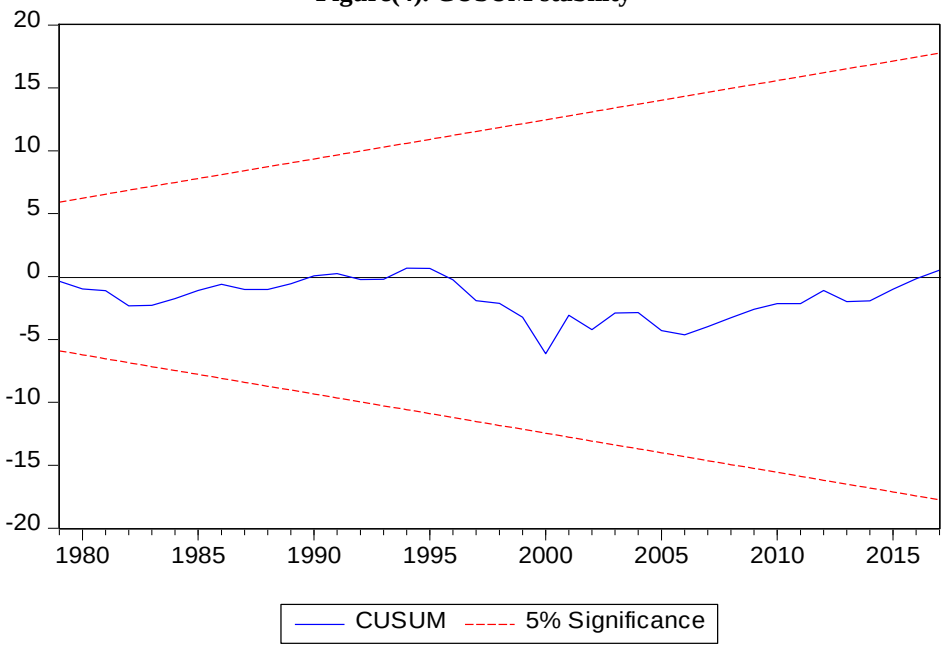
The stability of the model is tested by conducting CUSUM and CUSUM of squares tests as presented in Figure as below. Both tests reveal the stability of the model coefficients. Since the estimated model lies within the 5% significance line for CUSUM and CUSUM of squares tests.

**Figure(3). CUSUM of Squares stability**




**Source. Elaborated by author**

**Figure(4). CUSUM stability**




**Source. Elaborated by author**

### 3.6. Pairewise Granger Causality :

In order to analyze the short-term causal relationships between our variables, we considerthe follow hypotheses:

**Null Hypothesis :**No Granger causality

**Alternative Hypothesis :** null hypothesis is not true

**Decision Criteria :** Reject the NH if the probability value of the F statistic is lower than 1%, 5% or 10%.

Granger non-causality test results (Table) show that there exists unidirectional causality from GDP to CPI at 10% of significance. Although, oil prices remain highly insignificant in determining the future values CPI. In this case we can say that when the decline in oil prices seem to be unrelated to inflation in Algeria.

**Table (05).Pairwise Granger causality between CPI , GDP and CPI, oil price**

| Null hypothysis | F-statistic | Prob |
|---|---|---|
| GDP does not Granger cause CPI | 3.05 | **0.06** |
| CPI does not Granger cause GDP | 0.73 | 0.49 |
| Oil price does not Granger cause CPI | 1.16 | 0.32 |
| CPI does not Granger cause oil price | 2.21 | 0.12 |

**Source. Elaborated by author**

### Conclusion:

The impact of oil prices on inflation leads many researchers to analyze the inflationary effect of the oil price changes on macroeconomic indices including consumer price index. This paper investigates the relationship between CPI, GDP & oil prices by adopting ARDL bounds testing approach in Algeria over the period1970 - 2018. The results indicate the existence of cointegration relationship between our variables, which allows us to estimate the

Error Correction Model (ECM), at the short run GDP affects consumer price inflation positively only after one lag period at 1% of significance. While, at the long run both oil prices and GDP have an impact on consumer price inflation and those effects are economically significant (& insignificant , respectively) .

There are many various strategies have been adopted by the Algerian government to fight against inflation. These comprise financial help to small companies and the improvement of agricultural productivity through high technology adoption. In addition, it is necessary to create a stable financial environment to succeed the monetary instruments in order to keep up with developments.

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