Econometric Modeling of the effect of some macro variable determinants of exchange rate on economic growth in Algeria autoregressive distributed LAG (ARDL) analysis

LAMRI Khadidja
PHD student . University Dr. Tahar Moulay .Saïda/
ITMAM Laboratory
khadidja.lamri@univ-saida.dz

TAIBI Boumedyen [1]
Associate Professor .University Dr. Tahar Moulay.Saïda
MECAS laboratory
didenmajor@yahoo.fr

Received date : 20.09.2020 / Accepted date : 04.11.2020/ Publication date:11.12.2020

Abstract:
This article aims to study the relationship of the macroeconomic variables determining the exchange rate and GDP in Algeria for the period 1985 - 2018, where we used the Autoregressive Distributed Lag (ARDL) to test the Long-term equilibrium relationship between the variables. We employed annual time series data for six variables (Gross domestic product, exchange rate, External balance, oil prices, real interest rate and inflation).
The results of the study concluded that there is a long-term relationship between the macroeconomic variables determined for the exchange rate and the GDP.
Keywords: Macro variable, Exchange rate, Economic growth, ARDL.
Jel Classification Codes: C01C32E30F43

Introduction :
In today's world, after the emergence of an open economy that requires coordination between different policies and programs to maintain economic balances inside and outside the country, so that the most important tool for achieving this is the exchange rate policy because of its effectiveness in affecting all internal and external sectors. Thus, the exchange rate is of great importance in influencing the country's incomes and improving economic performance. It is considered one of the most sensitive macroeconomic indicators, as its price fluctuates day after day, and is affected by many factors, such as supply and demand, inflation, balance of payments, interest rates.
Algeria seeks to increase its growth and improve its economic performance, so that the macro economic variables determined for the exchange rate are the most

[1] **Corresponding Author:** TAIBI Boumedyen, **E-Mail:** didenmajor@yahoo.fr

important factors affecting economic growth. Thus, we investigate the relationship between GDP and some macro variable determinants of exchange rates in Algeria using Auto-regressive Distributed Lag (ARDL) bound testing for the period 1985-2018 and make use of annual data. In this sense, our main problem in this paper is:

What is the impact of some macro variable determinants of exchange rate on economic growth in Algeria?

The paper is structured as follows: a brief review of literature part is presented; the next section describes the developments of some macroeconomic variables **(GDP, ER, EB, OIL, RIR, INF),** the last section presents the methodology and data employed in this study. This is followed by results and interpretation.

Review of literature:

In this section, we will try to present the most important results of the review of literature related to the study of economic growth and exchange rate determinants.

- **The Study of Fouad MEDJENAH & El Nouri HACHI entitled "Econometric modeling of the impact of some determinants of the exchange rate - dollar - on the economic growth in Algeria during the period (1980 – 2017)** (MEDJENAH & HACHI, 2019)

This study aims to identify the effect of some exchange rate determinations - the dollar - on economic growth in Algeria during The period (1980 - 2017) using the Autoregressive Distributed Lag (ARDL), depending on the macroeconomic variables (exchange rate, exports, inflation, real interest rates, oil prices, and real GDP).

The study concluded that there is a long-term relationship between the selected economic variables and their effect on Algeria's real GDP in the short or long term.

- **The Study of Ly Phuong TRAN & Binh Thanh DAO entitled "macro variable determinants of exchange rates in Vietnam"** (Ly Phuong & Binh Thanh, 2020)**:**

This article aims to take a closer look at the roles of many economic variables in the exchange rate movement by analyzing the causality of Granger and conducting the test of ARDL and ECM. This research is based on the fluctuations of the three exchange rates, "the Japanese yen and the US dollar and the euro to the Vietnamese dong". The total variables selected for the analysis include "economic growth, export, import, inflation, foreign direct investment, budget deficit, stock market index, crude oil price and balance of payments" between Vietnam and other countries during the period of 2003 - 2017 quarterly.

1- Developments of macroeconomic variables (GDP, ER, EB, OIL,RIR, INF) :

The Algerian economy is heavily dependent on exports of petroleum and natural gas. So that hydrocarbons account for about 60% of budget revenues, 30% of GDP, and more than 95% of export earnings, therefore, in this section, the development of macroeconomic variables will be studied and an analysis of the extent of their contribution to increasing the country's revenues.

1-1 Development of gross domestic product (GDP):

Figure n° (01) and (02) illustrate the evolution of the GDP during the period 1985-2020

Figure 1: Developments of GDP (1985-2018)

Source: The achievement of researchers based on Eviews 9

Figure 2: Developments of GDP (2019-2020)

Source: (Trading economics)

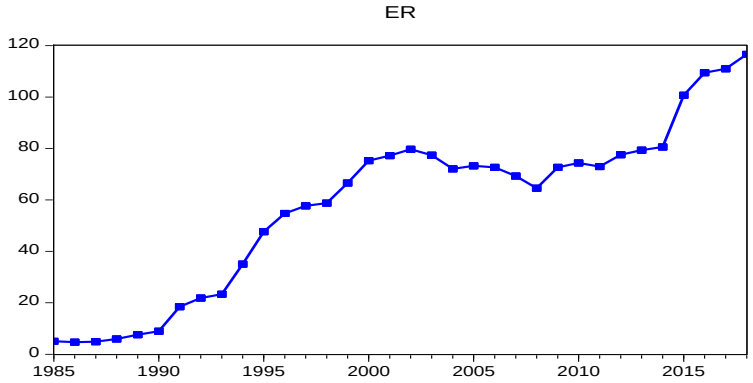
Through figure n° (01), we notice that the GDP has evolved since 1986 to reach in 2008 about 6.4607E + 12 $, as it decreased in 2009 and then started to increase from 2010 to 2016 and the main driver of growth was the recovery of the oil and gas sector In 2014, it continued to rise, but in weakest proportions. In 2017, the economy contracted by 0.4% due to the contraction of the oil sector.

Considering the full 2019, GDP grew 0.7%, down from 1.4% in 2018. According to the updated IMF forecasts from 14th April 2020, due to the outbreak of the COVID-19 GDP is expected to decrease by -5.2% in 2020 (Office National des Statistiques) and pick up to 6.2% in 2021 (lloydsbank)

1-2 Development of exchange rate (ER) during the period 1985-2020:

Figure n° 3 illustrates the evolution of the ER during the period 1985-2018

Figure 3: Developments of ER (1985-2018)



Source: The achievement of researchers based on Eviews 9

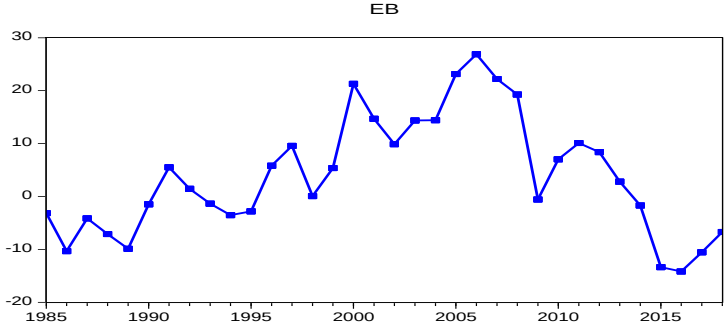
Through figure n° 3, we note that the exchange rate of the DZD / USD has deteriorated from 1985 to 2003 due to the devaluation of the Algerian dinar by the central bank for several reasons, most notably limiting the development of the money circulating in 2003, then the exchange rate witnessed a slight increase in 2004 from 77.394 $ to right 72.06 $, The Algerian dinar continued to rise, reaching in the year 2008 around $ 64,582 due to the financial crisis that negatively affected the huge economies. Therefore, Algeria achieved a surplus in its balance of payments, which helped it to form exchange reserves of 143,102 $. The exchange rate started to rise from 2012, when its value in 2018 was about 116,593 $.

Due to the spread of the Corona virus, the value of the Algerian dinar has decreased, as reports indicate that the exchange rate of the Algerian dinar against the US dollar reached in December 2019 about 119,622 $, as well as in April 2020 at 121,251 $.

1-3 Development of external balance (EB) during the period 1985-2020:

External balance on goods and services (formerly resource balance) equals exports of goods and services minus imports of goods and services (previously nonfactor services), The following graphique illustrates the evolution of the EB during the period 1985-2018

Figure 4: Developments of EB (1985-2018)



Source: The achievement of researchers based on Eviews 9

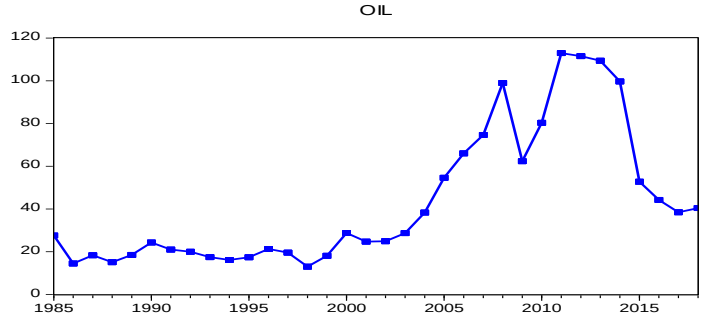
Through figure n° 4, we note that the external balance is negative from 1985 to 1995, with the exception of 1991 and 1992, and this indicates that Algeria's imports of goods and services are greater than its exports, so that the Algerian external

balance witnessed a positive development from 1996 to 2008, this indicates an increase in oil prices because it takes a large proportion of Algeria's exports. Starting in 2009, the external balance became volatile, recording a deficit in 2018.

1-4 Development of Oil prices (OIL) during the period 1985-2020:

Oil is considered the main engine of the Algerian economy. In 1971, Algeria became one of the oil exporting countries and a member of the OPEC organization, figure n° 5 illustrates the evolution of the OIL prices during the period 1985-2018

Figure 5: Developments of OIL (1985-2018)



Source: The achievement of researchers based on Eviews 9

Figure n° 5 shows that the development of oil prices was not constant due to the global oil monopolies. The price of oil in 1985 was estimated at 27.63 $ to witness A decrease of about 13,019 $ in 1998 due to the wrong reasons presented by the OPEC organization regarding the increasing shares of OPEC countries in the face of the economic recession in Asia. Prices began to rise, reaching the year 2008 to 98.00 $ a barrel and 112.92 $ a barrel in 2011, and then began to decline.

With the beginning of the year 2015, Algeria experienced a collapse in oil prices, and this made it reconsider the new economic program and diversify the economy.

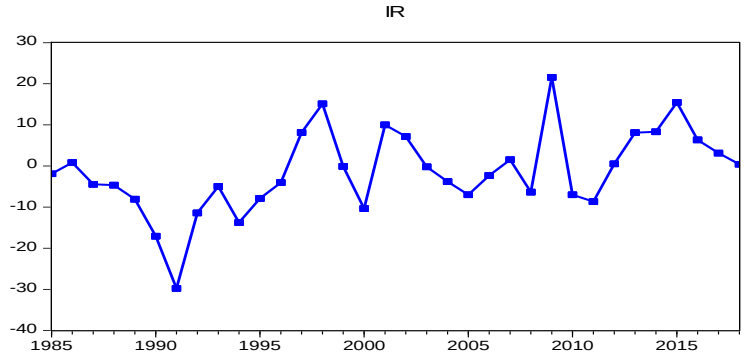
And at the end of the year 2019, due to Corona Virus, there was a significant decline in oil prices and a slowdown in global demand for oil, and this would increase the troubles of the government, given that oil is the main source of income for Algeria, as reports stated that Algeria lost approximately 2.17 One billion $, this is from oil revenues alone, during the first trio of the year 2020.

In light of the spread of the Corona virus, OPEC reviewed its estimates of the rate of global oil demand financing, which reflects the slowdown in global economic growth.

1-5 Development of real interest rates (RIR) during the period 1985-2018:

"Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator" (The global economy), figure n° 6 represents the evolution of real interest rates during the period 1985-2018

Figure 6: Developments of RIR (1985-2018)



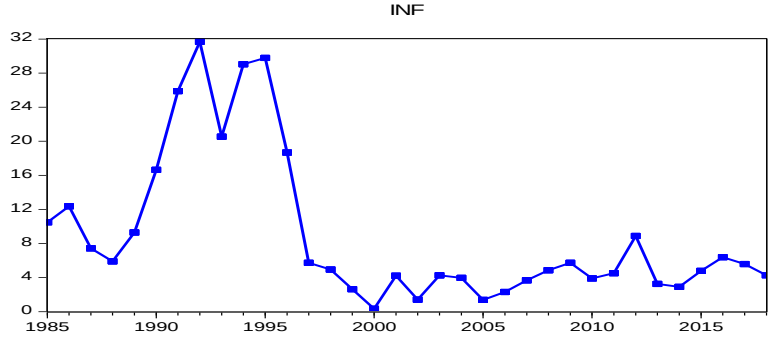
Source: The achievement of researchers based on Eviews 9

Through figure n° 6, we note that the real interest rates are negative during the period 1985 to 1996, with the exception of the year 1986, and this is due to the high rates of inflation, where the year 1995 reached a ratio of 29.77% with a decrease in the rate of re-discounting, then the real interest rates increased to reach the year 1998 around 15.10% and then it decreased to reach the year 2018 about 0.41%.

1-6 Development of inflation (INF) during the period 1985-2020:

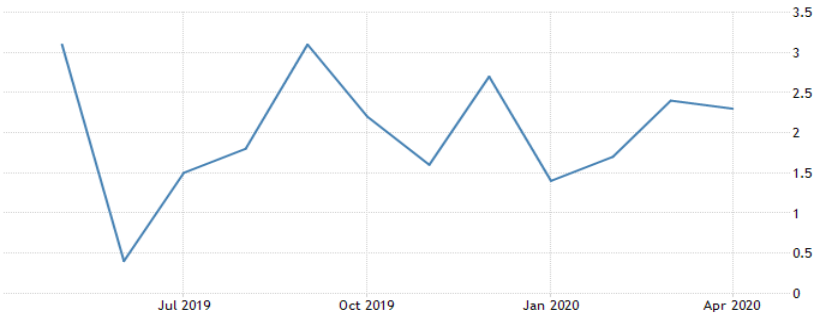
Figure n° 7 and 8 represent the evolution of inflation during the period 1985-2020

Figure 7: Developments of INF (1985-2018)



Source: The achievement of researchers based on Eviews 9

Figure 8: Developments of INF (2019-2020)



Source: (Trading economics)

The inflation rate measures a broad rise or fall in prices that consumers pay for a standard basket of goods, through figure n° 7, we note that inflation rates were fluctuating during the study period, as the highest rate in 1992 achieved about 31%, This is due to several reasons, the most important of which are measures to reduce the value of the Algerian dinar.

With the beginning of the year 1993, inflation rates began to decline reaching around 0.2% in the 2000s, and then it started to rise until it reached a loss rate of 8.89% in 2012. And with the beginning of 2013 and 2014, the inflation rate witnessed a slowdown of 3.25 and 2.9 respectively what leads to monetary stability.

In October 2019, the inflation rate was estimated at about 2.2%, and witnessed a slight fluctuation in the year 2020, when it was estimated in April 2020 about 2.3%. (TRADING ECONOMICS)

2- Econometric study:

In this section, we will study the impact of some macro variable determinants of exchange rates in Algeria for the period 1985-2018, using the ARDL model. In this regard, we will present the methodology and data employed in this study. This is followed by results and interpretation.

2-1 Econometric methodology:

In this study, the Autoregressive Distributed Lag (ARDL) methodology that was developed by Pesaran (1997), Shinand & Sun (1998) and Pesaran & Al (2001) (Teng & Khan, 2019, p. 07) will be followed so that this model gives the best results in the long term and it has several advantages over the method of cointegration presented by Engle and Granger, so that the variables are integrated from the first degree and the zero degree Or a combination between the first degree and the second degree and the dependent variable is not from the twoo degree.

An ARDL model can be written as: (Carter Hill & others, 2011, p. 365)

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{m} \beta_i \Delta y_{t-i} + \sum_{i=0}^{n} \theta_i \Delta x_{t-i} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \varepsilon_t$$

With:

- $\lambda_1, \lambda_2,$: The estimated coefficients of Long- run relationship
- β_i, θ_i : The estimated coefficients of short- run relationship
- n, m: Lags
- ε_t: Error term

The AR component of the name ARDL comes from the regression of y on lagged values of itself; the DL component comes from the distributed lag effect of the lagged x's

2-1-1 Correlation Matrix:

" When two phenomena have a common evolution, we say that they are "correlated". Simple correlation measures the degree of connection between these two phenomena represented by variables. If we are looking for a relationship between three or more variables, we will then use the concept of multiple correlation." (Bourbonnais, 2015, p. 19)

The correlation coefficient between two variables can be calculated according to the following relationship**:**

$$r_{x,y} = \frac{cov\ x,y}{\delta_x \delta_y} = \frac{\sum_{i=1}^{n} x_i - x \quad y_i - y}{\sum_{i=1}^{n} x_i - x \ ^2 \quad \sum_{i=1}^{n} y_i - y \ ^2}$$

$$r_{x,y} = \frac{n \sum_{i=1}^{n} x_i y_i - \sum_{i=1}^{n} x_i \sum_{i=1}^{n} y_i}{\sqrt{n \sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2} \sqrt{n \sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2}}$$

With:

- **Cov(x, y):** covariance between x and y
- $\boldsymbol{\delta_x \delta_y}$**:** standard deviation of x and standard deviation of y
- **n:** number of observations.

The correlation coefficient is between 1 and -1, and cases can be summarized as follows:

- R= 1, the variables are positively correlated;
- R= −1, the variables are negatively correlated;
- R= 0, the variables are not correlated.

2-1-2 Time Series Stationarity Test: Unit Root Test:

For the purpose of treating time series, stationarity must be studied, and in this study time series will be tested by the augmented Dickey-Fuller (ADF) test and the Phillips-Perron test (PP)

2-1-2-1 Augmented Dickey-Fuller (ADF) test:

The Augmented Dickey-Fuller (ADF) test was performed on each time series and the level teams were continuously selected until the probability value presented in the level was smaller than the 5% level. (Tran & Thanh, 2020, p. 28).

The forms of the ADF test are given by the following equations**:**

$$\Delta \boldsymbol{yt} = \boldsymbol{y y_{t-1}} + \sum_{\boldsymbol{i=1}}^{\boldsymbol{p}} \boldsymbol{\beta_i \Delta y_{t-i}} + \boldsymbol{u_t}$$

$$\Delta \boldsymbol{yt} = \boldsymbol{\alpha_0} + \boldsymbol{y y_{t-1}} + \sum_{\boldsymbol{i=1}}^{\boldsymbol{p}} \boldsymbol{\beta_i \Delta y_{t-i}} + \boldsymbol{u_t}$$

$$\Delta \boldsymbol{yt} = \boldsymbol{\alpha_0} + \boldsymbol{y y_{t-1}} + \boldsymbol{\alpha_2 t} \sum_{\boldsymbol{i=1}} \boldsymbol{\beta_i \Delta y_{t-i}} + \boldsymbol{u_t}$$

The lag determined by the Akaike Information Criterion (AlC) or Schwartz Bayesian Criterion (SBC), or more usefully by the lag length necessary to whiten the residuals (i.e. after each case we check whether the residuals of the ADF regression are autocorrelated or not through LM tests and not the DW test). (DIMITRIOS & G.HAL, 2007, p. 297)

2-1-2-2 Phillips-Perron test (PP) test:

The PP test is based on a non-parametric correction of Dickey Fuller's statistic with the aim of overcoming the problem of autocorrelation between random errors.

2-1-3 Cointegration test (test of Bounds):

The bounds test reveals a long-term relationship based on the following two hypotheses: (Kibala Kuma, 2018, p. 09)

$$H_0: \lambda_1 = \lambda_2 = 0 \ (Absence\ of\ a\ cointegration\ relationship)$$
$$H_1: \lambda_1 \neq \lambda_2 \neq 0 \ \ (Existence\ of\ a\ cointegration\ relationship)$$

The rejection of the null hypothesis depends on a comparison of the F value calculated with the tabular values within the critical bounds, as the table consists of the minimum value (Lower Critical Bound, (LCB)) that considers the variables to be integral of degree I(0) and the maximum value (Upper Critical Bound, (UCB)) which is considered to be integral variables of degree I(1), and therefore**:**

- F > UCB **:** Hypothesis 1 will be accepted (Estimation of the long-term model)
- F < UCB **:** Hypothesis 0 will be accepted

2-1-4 ECM :

The approach of this model allows us to determine properties of the short term and long term at the same time and to obtain information on the speed of adjustment to equilibrium. The error correction equation can be written as follows**:**

$$\Delta \boldsymbol{y_t} = \boldsymbol{c} + \sum_{\boldsymbol{i=1}}^{\boldsymbol{p}} \boldsymbol{\vartheta_1 \Delta y_{t-1}} + \sum_{\boldsymbol{i=0}}^{\boldsymbol{q}} \boldsymbol{\delta_i \Delta x_{t-1}} + \boldsymbol{\omega ECT_{t-1}} + \boldsymbol{\varepsilon_t}$$

With:

- ECT**:** Error correction term
- $\boldsymbol{\omega}$: Error correction coefficient

2-1-5 Model validation :

In this section, the autocorrelation test, the heteroskedasticity test, normality and stability tests will be used to confirm the validation of the model

2-1-5-1Lagrange multiplier Test (LM):

LM test, is first introduced by Silvey (1959) (Lee, 2014, p. 32), the Breusch (1978)–Godfrey (1978) test is a Lagrange multiplier test of: (Greene, 2002, p. 269)

$$H_0: no\ autocorrelation$$
$$H_1: \varepsilon t = AR\ \ p\ \ or\ \varepsilon t = MA(P)$$

- The test statistic is **:**

$$LM = T\ \ \frac{ex_0\ \ x_0 x_0\ \ ^{-1} x_0 e}{ee} \ \ = TR_0^2$$

With:

- LM: Lagrange multiplier

- x_0: the original **X** matrix augmented by *P* additional columns containing the lagged OLS residuals, *et*−1, . . . , *et*−*P*

2-1-5-2 Normality test (J-B test):

In order to test the normality of the residuals, we use the JARQUE & BERA test (J-B). This test follows a distribution of "Chi-square" with two degrees of freedom. It is frequently used to determine whether the residuals of a linear regression follow a normal distribution.

The J-B test formulates the null hypothesis of normal distribution of the residues and this hypothesis is accepted only if the critical probability is superior to the 5% threshold (Mignon, 2002, p. 275)

2-1-5-3 Stability test (Cusum & Cusumsq Test):

In order to examine the stability of the long-run parameters together with the short-run movements for the equations, we apply the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests proposed by Brown & Al. (1975) to the residuals of the error-correction model. These tests are based on the recursive residuals and squared recursive residuals, respectively, of the evaluated model and are plotted against break points (the absence of any instability of the coefficients when the plots of the CUSUM and CUSUMSQ statistics fall inside the critical bands of the 5% confidence intervals of parameter stability) (Ravinthirakumaran & others, 2015, p. 253)

2-2 Data sources and variables:

We employed annual time-series data for the period 1985 to 2018, with a total of 35 observations for each variable. The variables are as follows: (world bank)

- GDP: Gross domestic product
- ER: exchange rate
- Eb: External balance
- Oil: oil prices
- RIR: real interest rate
- INF: inflation

2-3 Econometric results:

This section will present the correlation between variables. Additionally, the results from all techniques is presented thoroughly "Unit root test, Bounds Test, Error Correction Model (ECM)" and we will present some tests for the validation of model.

2-3-1 Correlation matrix:

In order to test the relationship between the determinants of exchange and economic growth, it is necessary to look at the correlation matrix.

Table 1: Correlation matrix

	GDP	ER	EB	OIL	IR	INF
GDP	1					
ER	0.7	1				
EB	0.1	0.2	1			
OIL	0.8	0.4	0.3	1		
RIR	0.3	0.5	-0.1	0.1	1	
INF	-0.5	-0.5	-0.3	-0.4	-0.5	1

Source: Prepared by the researchers, based on outputs of Eviews 9

Through the correlation matrix, we note that there is a strong positive correlation between the dependent variable and the explanatory variables (ER & OIL) and a weak correlation with the rest of the other variables.

2-3-2 Lag time period:

The lag time period is chosen in the ARDL model according to the Akaike information criterion (AIC) standard, this is shown in the following table

Table 2: Number of lag time period

Variables	GDP	ER	Eb	OIL	RIR	INF
Number of lag	01	01	02	0	02	02

Source: The achievement of researchers based on Eviews 9

The table n° 2 shows the optimum number of lag time period, ARDL (1, 1, 2, 0, 2, 2) using AIC standard (appendice n° 1).

2-3-3 Unit Root Test:

It is necessary to conduct stationarity testing by relying on the various commonly used tests represented in the ADF & PP tests so that we applied them to each variable separately and we reached the results shown in the following table:

Table 3: Results of Unit root test (ADF & PP) for all variables:

Variable	t-Statistic		Critical values		Probability		Order
	ADF	PP	ADF	PP	ADF	PP	
GDP	-5.372803	-5.377032	-3.557759	-3.557759	0.0006	0.0006	I(1)
ER	-3.953029	-3.880240	-3.557759	-3.557759	0.0211	0.0248	I(1)
EB	-5.294815	-11.59526	-3.562882	-3.557759	0.0008	0.0000	I(1)
POIL	-5.141861	-5.134248	-3.557759	-3.557759	0.0012	0.0012	I(1)
RIR	-4.213904	-4.083952	-3.552973	-3.552973	0.0112	0.0153	I(0)
INF	-4.825293	-4.837223	-3.557759	-3.557759	0.0026	0.0025	I(1)

Source: Prepared by the researchers, based on outputs of Eviews 9

The table n° 3 illustrates the finding results of the ADF & PP tests for the six variables, we note from the table that the variables are stationary at the first difference, except for IR which is stationary at the level.

2-3-4 Cointegration test (test of Bounds):

Table 4 : Bounds test

F-Bounds Test	Null Hypothesis: No long-run relationships exist			
Test Statistic	Value	Significant	I(0)	I(1)
F-statistic	5.078037	5%	2.62	3.79
		1%	3.41	4.68

Source: Prepared by the researchers, based on outputs of Eviews 9

Through the table n° 4, we notice that F-statistic is more than the critical value of the minimum threshold of 1% (5.078037 > 3.41), so there is a long-term relationship (the null hypothesis will be rejected) (appendice n° 2).

2-3-5 Error correction model (ECM):

After the estimation of ECM model (appendice n° 3) we obtained the following dynamic equation:

GDP = -1.33E+9*D(ER) + 1.85E+10* D(E) – 2.04E+10*D(EB(-1)) +5.29E+9*D(OIL) -1.55E+10*D(RIR) +1.03E+10*D(RIR(-1) - 1.18E+10*D(INF) – 1.24E+10*D(INF) – 0.213*(GDP-(6.35E+10*ER(-1) – 3.11E+10*EB(-1) + 2.48E+10*OIL(-1) -2.25+11*RIR(-1) – 1.36E+11*INF+ 1.48E+11))
(1)

Depending on appendice n° 3, and looking at the short-term relationship, we find that all variables are significant (T-statistic < 5%), which indicates the strength of the influence of independent variables on the dependent variable (GDP), in addition, the results showed that the error correction coefficient is negative and significant (t-student< 5%), so we conclude that there is a short-term adjustment of 21.30% (accuracy of long-term equilibrium relationship).

Through equation n° 1, the long-term relationship equation can be inferred as follows:

GDP= 6.35E+10 ER – 3.11E+10 EB + 2.48E+10 OIL -2.25+11 RIR – 1.36E+11 INF + 1.48E+11 (2)

Based on appendice n° 3, the results show that all variables are significant (T-statistic < 5%), and consequently the results can be explained as follows:

- The effect of ER on the GDP is positive, so the increase in the value of the Algerian dinar encourages an increase in the GDP (a decrease in the exchange rate leads to a rise in the GDP);
- We note that there is negative relationship between EB and the GDP;
- We note that there is a positive relationship between OIL prices and the GDP, and this is reflected in the Algerian economy, given that oil is the main sector approved in Algeria;
- the equation n° 2 shows that there is a negative relationship between RIR and GDP; This means that there is an increase in inflation rates with values greater than nominal interest rates, which negatively affects the GDP;
- Through the equation n° 2, we note that there is a negative relationship between INF and the GDP, and this means that lower inflation rates lead to an increase in the gross domestic product, just as low inflation rates achieve monetary stability in the country.

2-3-6 Model validation :

The autocorrelation test and the heteroskedasticity test will be used to confirm the validation of the model.

2-3-6-1 Autocorrelation test (LM test):

To detect the existence of autocorrelation problem, we rely on LM test, and this is shown in the following table:

Table 5: Breusch-godfrey serial correlation LM Test

F-statistic	0.781973	Prob. F(2,16)	0.4742
Obs*R-squared	2.849375	Prob. Chi-Square(2)	0.2406

Source: Prepared by the researchers, based on outputs of Eviews 9

From table n° 5, we notice that value of Prob. Chi-Square (2) is greater than 5% (0.2406 > 0.05) and this means that there is no autocorrelation between the residuals (acceptance of the null hypothesis)

2-3-6-2 Heteroskedasticity test.:

To detect the problem of heteroskedasticity, we relied on the Breusch-Pagan-Godfrey test, and this is shown in the following table:

Table 6: Heteroskedasticity test: Breusch-Pagan-Godfrey

F-statistic	0.482427	Prob. F(13,18)	0.9075
Obs*R-squared	8.268519	Prob. Chi-Square(13)	0.8257

Source: Prepared by the researchers, based on outputs of Eviews 9

From table n° 6, we notice that value of Prob. Chi-Square (13) is greater than 5% (0.8257 > 0.05) and this means that there is lack of an asymmetry of residuals (acceptance of the null hypothesis)

2-3-6-3 Normality test :

In order to test the normality, J-B test was applied, and this is shown in the following table:

Table 7: Normality test

Jarque – Bera	Probability
2.018676	0.364460

Source: Prepared by the researchers, based on outputs of Eviews 9

According to table n° 7 the J-B statistic is 2.01 with a probability of 36%. We conclude that the residuals are normally distributed.

2-3-6-4 Stability test (Cusum & Cusumsq Test):

In order to make sure that there are no structural changes over time, we studied the stability of long-term parameters with short-term movements of equations. For test, we relied on cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) tests proposed by Borensztein & Al. (1998), which is illustrated in the following figures

Figure 9: Cusum test

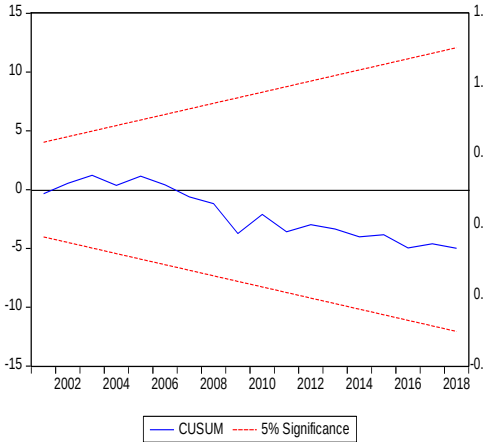
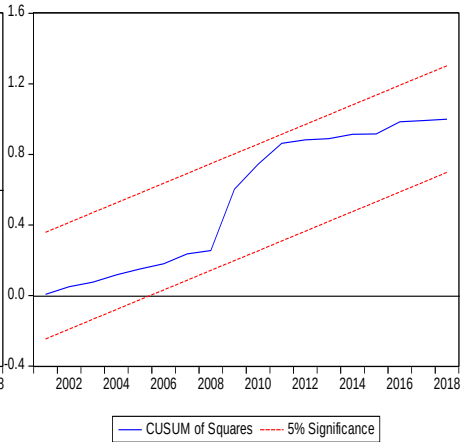


Figure 10: Cusum of squares test



Source: The achievement of researchers based on Eviews 9

We notice from figures n° 9 and 10 that the parameters of the model are stable because the curve occurred between the two critical lines at the level of significance of 5%.

Conclusion:

This article investigates the effect of exchange rate determinations on GDP in Algeria, and this through econometric modeling which determines the relationship between GDP and other independent variables (ER, EB, OIL, RIR, INF) during the period 1985-2018. For this, we proceeded to an econometric methodology to have a better modeling which interprets this relationship well, two tests were used: the stationarity test and the cointegration test (test of Bounds). The results showed that:

- Using the stationarity test, we found that the time series of the variables (ER, EB, OIL, INF) are stationary in the first difference I (1). As for the RIR variable, it is stationary at the level I(0)
- After applying Bounds test, we concluded that there is a long-term relationship between the GDP and exchange rate determinants
- The ECM model estimate shows that there is a short-term error adjustment of 21.30%

It is universally recognized that Algeria has a rentier economy, considering that oil is the main sector of Algeria's income, and this is confirmed by the results of our study, where oil prices and exchange rates take the largest percentage in the impact on GDP and this is due to the fact that the exchange rate depends a lot on The country's exports. In this regard, oil and gas account for the largest percentage of Algerian exports. By analyzing the development of macroeconomic variables, we found that most of them witnessed fluctuations due to some crises to which the Algerian economy is exposed, especially the oil crisis, as it is the main sector that Algeria depends on in increasing its income, and given what Algeria is experiencing today in light of the Corona crisis, it must search for ways to reduce its dependence on gas to generate energy through investing in solar energy and the government should also follow a policy of diversifying the economy, fighting corruption and encouraging local investors and directing them to production rather than importing.

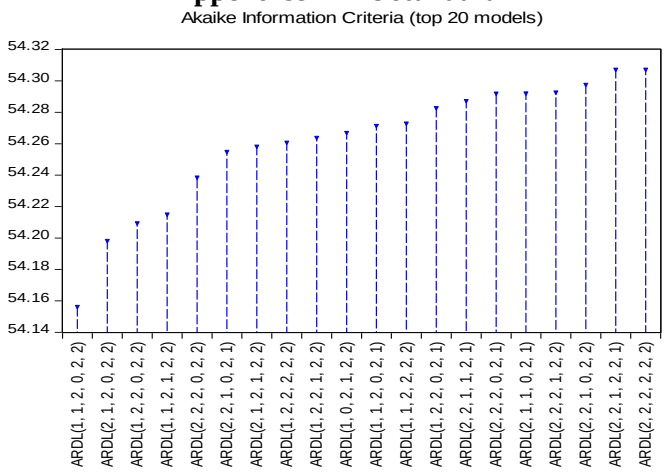
References :

- Bourbonnais, R. (2015). Économétrie Cours et exercices corrigés. Paris: Dunod.
- Carter Hill, R., & others. (2011). Principles of econometrics. John Wiley & Sons.
- DIMITRIOS, A., & G.HAL, S. (2007). Applied econometrics. Revised.
- Greene, W. H. (2002). Econometric analysis. Prentic hall.
- IMF. (2020). IMF Managing Director Kristalina Georgieva's Statement Following a G20 Ministerial Call on the Coronavirus Emergency.
- Kibala Kuma, J. (2018). Modélisation ARDL, Test de cointégration aux bornes et Approche de Toda-Yamamoto : éléments de théorie et pratiques sur logiciels. Retrieved 07 10, 2020, from https://hal.archives-ouvertes.f
- Lee, M.-Y. (2014). Adequacy of lagrange multiplier test. European Economics Letters .
- lloydsbank. (n.d.). Retrieved 06 05, 2020, from https://www.lloydsbanktrade.com/
- Ly Phuong, T., & Binh Thanh, D. (2020). macro variable determinants of exchange rates in Vietnam. International Finance and Banking .
- MEDJENAH, F., & HACHI, E. N. (2019). Econometric modelling of the impact of some determinants of the exchange rate - dollar - on the economic growth in Algeria during the period (1980 – 2017). aggregates of knowledge magazine .
- Mignon, L. (2002). Econométrie des séries temporelles macroéconomiques et financières. Paris.
- Office National des Statistiques. (s.d.). Consulté le 07 05, 2020, sur http://www.ons.dz/

- Ravinthirakumaran, K., & others, a. (2015). Determinants of foreign direct investment in sri lanka. South Asia Economic journal .
- Teng, J.-Z., & Khan, M. I. (2019). Cointegration between macroeconomic factors and the exchange rate USD/CNY. Financial Innovation .
- The global economy. (n.d.). Retrieved 07 10, 2020, from www.theglobaleconomy.com
- Trading economics. (n.d.). Retrieved 07 30, 2020, from https://tradingeconomics.com/
- TRAN, L. P., & DAO, B. T. (2020). macro variable determinants of exchange rates in Vietnam. International Finance and Banking .
- Tran, P., & Thanh, B. (2020). Macro Variable Determinants of Exchange Rates in Vietnam. International Finance and Banking .
- world bank. (n.d.). Retrieved 07 07, 2020, from https://data.worldbank.org/

Appendices

Appendice 1: AIC standard



Appendice 2: Bounds Test

ARDL Bounds Test
Date: 06/28/20 Time: 22:50
Sample: 1987 2018
Included observations: 32
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	5.078037	5

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

Test Equation:
Dependent Variable: D(GDP)

Method: Least Squares
Date: 06/28/20 Time: 22:50
Sample: 1987 2018
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ER)	-1.01E+10	6.56E+09	-1.533117	0.1417
D(EB)	2.46E+10	1.07E+10	2.311804	0.0322
D(EB(-1))	-1.07E+10	7.63E+09	-1.403671	0.1766
D(IR)	-1.58E+10	8.76E+09	-1.798270	0.0880
D(IR(-1))	8.52E+09	4.41E+09	1.931477	0.0685
D(INF)	1.50E+10	8.02E+09	1.866099	0.0775
C	3.58E+11	1.65E+11	2.169172	0.0430
ER(-1)	1.24E+10	3.58E+09	3.473702	0.0025
EB(-1)	-3.58E+09	4.70E+09	-0.761988	0.4554
OIL(-1)	6.00E+09	2.77E+09	2.169195	0.0430
IR(-1)	-3.51E+10	1.45E+10	-2.419730	0.0257
INF	-2.19E+10	9.72E+09	-2.251167	0.0364
GDP(-1)	-0.219289	0.081964	-2.675435	0.0150

R-squared	0.890755	Mean dependent var	1.40E+11
Adjusted R-squared	0.821757	S.D. dependent var	3.32E+11
S.E. of regression	1.40E+11	Akaike info criterion	54.45992
Sum squared resid	3.73E+23	Schwarz criterion	55.05538
Log likelihood	-858.3588	Hannan-Quinn criter.	54.65730
F-statistic	12.91002	Durbin-Watson stat	1.927364
Prob(F-statistic)	0.000001		

Appendice 3: ECM model

ARDL Cointegrating And Long Run Form
Dependent Variable: GDP
Selected Model: ARDL(1, 1, 2, 0, 2, 2)
Date: 06/29/20 Time: 01:58
Sample: 1985 2018
Included observations: 32

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ER)	-1339292620.843151	5492045822.431278	0.000000	0.0000
D(EB)	1850679918 6.841449	9360699641.956932	0.000000	0.0000
D(EB(-1))	-2042121374 6.095792	8502897699.384366	0.000000	0.0000
D(OIL)	5295118264.000762	1917188204.775256	0.000000	0.0000

D(IR)	-1550164915 2.282060	7535503247.3 39668	0.000000	0.0000
D(IR(-1))	1030244875 3.104148	3832283363.8 39339	0.000000	0.0000
D(INF)	-1181770514 8.450440	10304143509. 305666	0.000000	0.0000
D(INF)	-1248607600 8.067920	6674744052.7 97415	0.000000	0.0000
CointEq(-1)	-0.213015	0.057712	-3.691024	0.0017

Cointeq = GDP - (63531824215.7504*ER -31174141956.2768*EB + 24857904676.2432*OIL -225470006675.0965*IR -136014670746.5182 *INF + 1482019995800.5396)

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ER	6353182421 5.750440	10608393276. 152726	5.988826	0.0000
EB	-3117414195 6.276764	15246393861. 748054	-2.044690	0.0558
OIL	2485790467 6.243240	5100935371.4 79373	4.873205	0.0001
IR	-2254700066 75.09648	71553820505. 867176	-3.151055	0.0055
INF	-1360146707 46.51818	39612642310. 856784	-3.433618	0.0030
C	1482019995 800.5396	42251496881 9.42832	3.507615	0.0025