Symmetric and asymmetric effect of exchange rate on economic growth in Algeria during the period (1990-2020)

Brakni Soumia [1*]

[1] University of Blida 02, Algeria (Alger), soumiabrakni@gmail.com

Abstract:

This study examines both symmetric and asymmetric effect of exchange rate on economic growth in Algeria from 1990 to 2020 using ARDL and NARDL model. The ARDL model results showed that exchange rate does not affect economic growth in the long-run. But after the separation of the real effective exchange rate into positive and negative changes in the NARL model, the results showed that the overvaluation of the Algerian Dinar negatively affect economic growth but the depreciation of the Dinar promote the economic growth.

Keywords: Exchange rate; Economic growth; Symmetry; Asymmetry; Algeria.

Jel Classification Codes : C22, F31, F43, O11.

1. INTRODUCTION

Exchange rate can be defined as the domestic price of a foreign currency. Consequently, a rise in the nominal or the real exchange rate implies a nominal or a real depreciation, while a fall in the nominal or the real exchange rate implies a nominal or a real appreciation (Frrenkel & Rapetti, 2014, p. 02). According to (Frieden, 2008, p. 344) exchange rates powerfully affect cross-border economic transactions. Trade, investment, finance, tourism, migration and more are all profoundly influenced by international monetary policies and since economies become globalized, they find themselves linked to exchange rate. For that there is good reason and much evidence to suggest that the real exchange rate matters for economic growth, however the nature of this relationship and the policy implications are far from settled.

---

[*] **Auteur correspondant**

Since all economic agents are concerned with the behavior of exchange rate as it affects them directly or indirectly. Proper alignment of the real exchange rate (RER) is recommended for economic growth and development. So, the RER misalignment which refers to a situation in which a country's actual RER deviates from some notion of an implicit "ideal" RER is important for economic performance and development. Knowing that an exchange rate is labeled "undervalued" when it is more depreciated than this ideal, and "overvalued" when it is more appreciated than this ideal. Those misalignments are widely believed to influence economic behavior, in particular, overvaluation is expected to hinder economic growth while undervaluation is sometimes thought to provide an environment conducive to growth. But unless the ideal is explicitly specified, the concept of RER misalignment remain subjective (Razin & Collins, 1997, p. 01).

Many studies attempt to examine the relationship between undervalued or overvalued RER and economic growth and empirical literature has reported mixed results. Based on the above, the problem of this study can be formulated in the following question:

What is the impact of exchange rate on economic growth in Algeria?

The objective of this paper is to demonstrate the impact of the Algerian Dinar exchange rate on economic growth, while the importance of this paper is to try to demonstrate this impact in two different ways using two methodological measurements.

2. Previous research

Several studies have tried to identify the relationship between exchange rate and growth, many works find negative correlations, the more overvalued the currency, the smaller the per capita growth rates. Other studies have found positive correlations (Gala & Claudio, 2006, p. 167). However, recent studies seek to test for possible asymmetric effect of exchange rate on GDP growth, since they assume that the impact of appreciation and depreciation of the currency on GDP are different. Some of them will be discussed in this item.

(Bahmani-Oskooee & Mohammadian, 2016) used quarterly data of Australia from 1973Q1to 2013Q4. The logarithm of real gross domestic product was used as dependent variable, while logarithm of real M3, real

government spending, real effective exchange rate, oil prices and wage rate were used as independent variables. The results of the NARDL model reveals that the real effective exchange rate of the Australian dollar is asymmetric in the short run and in the long run, but the unique finding of this paper is that in the short run both appreciations and depreciations have a significant effect on domestic production; while only effects of appreciation last into the long run.

(Bahmani-Oskooee & Mohammadian, 2017) using quarterly data over the period 1973Q1 to 2015Q4 of the index of real GDP as a dependent variable and real money supply(M2), government spending, real effective exchange rate, oil prices and the overall index of wages as independent variables, the linear ARDL approach confirmed that currency depreciation does not have a significant effect on domestic production in Japan. But the use of the nonlinear ARDL showed that exchange rate changes do have asymmetric effect on domestic production and the study concluded that strong yen hurt domestic production while weak yen have no effect on it.

(Bahmani-Oskooee, Halicioglu, & Mohammadian, 2017) since the use of linear models to assess the impact of changes in lira on Turkish domestic production did not find significant long-run effects, the authors engage in asymmetry analysis. Using the same model as for Japan, they discover that the real effective value of lira has asymmetric effects in the short and in the long run, so, both depreciation and appreciation have expansionary effects on domestic production in Turkey.

(Bahmani-Oskooee & Arize, 2018) used the same variables as for the study of Japan but without the overall index of wages. The time series varies by county between 1985Q3 and 2016Q1. Both linear and nonlinear model for each of the 13 African countries were estimated and the results reveals that exchange rates have short-run and long-run asymmetric effects on economic growth in most countries. In some of them, depreciation is expansionary but appreciation is not significant; in others, appreciation hurts economic growth and depreciation are not significant.

(Hussain, Hussain, Ali Khan, & Khan, 2019) assessed the asymmetric effect of exchange rate fluctuations on GDP in Pakistan from 1972 to 2014. The Ln GDP was used as dependent variable, Ln real effective exchange rate, Ln broad money and Ln government total expenditures were used as

explanatory variables. The results of the ARDL model showed that the cointegration is poor when symmetry is taken into consideration. On the contrary, the cointegration were confirmed by the NARDL technique and the results confirmed that week currency hurt GDP while strong currency boosts it.

(Behroz, Hossein Sharifi, & Saeed Daei, 2020) investigated the asymmetric short-run and long-run effects of the exchange rate on GDP of selected countries using NARDL-PMG approach from 1990 to 2018. The results showed that positive and negative shocks of exchange rate have asymmetric effect on GDP, since positive shocks lead to a decrease and negative shocks lead to an increase in GDP.

(Nusair, 2021) used annual data from 1973 to 2018 to examine the asymmetric effect of exchange rate on domestic output of selected Asian countries. Using real money supply, real government spending real exchange rate and real price of oil as explanatory variables, the study concluded that exchange rate has asymmetric effect meaning that currency appreciations have different effects from currency depreciations.

(Ghosia Ayaz & D.Javed, 2021) examined the impact of both overvalued and undervalued exchange rates on economic growth in Pakistan using the NARDL approach. The results indicates that the asymmetric effect of exchange rate on economic growth is significant, so, the undervaluation spurs the economic growth and the over-valuation hampers it.

(Barguellil, 2021) used an asymmetric ARDL panel model on Middle Eastern and North African (MENA) countries from 1990 to 2018 to investigate the effect of real exchange rate on economic growth. By using government consumption, trade openness and population as explanatory variables, the results showed that the linear model cannot be used to adjust variables from the short-run dynamic to the long-run equilibrium. Finally, the nonlinear model point to a positive asymmetric effect of both upward and downward movements in exchange rate on economic growth.

3. The linear model estimation

In order to examine the relationship between exchange rate and economic growth in Algeria, the study employs annual time series from 1990 to 2020. Based on the previous studies and the data availability, the gross

domestic production growth (GDP) was used as a dependent variable. In the other hand, reel effective exchange rate (REER), the growth of money supply (M2) and oil prices (Oil) were used as independent variables. All time series were obtained from the World Bank database, except for oil prices, which were obtained from the Organization of Arab Petroleum Exporting Countries (OAPEC) database

To analyze the relationship between economic growth and the mentioned variables, the following linear simple equation was made:

$$GDP = f (REER , M2 , Oil)$$

As a first step, we will test the presence of the unit root in time series. Both augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests whose null hypothesis is the non-stationarity were applied. Thus, the results for the endogenous variable (GDP) and its determinants are presented in the following table.

Table 1. ADF and PP tests results

Variables		Level			1ˢᵗ Difference		
	Test	T and C	C	None	T and C	C	None
Gdp	ADF	-2.0182	-1.4355	-1.0290	-8.0645*	-7.4737*	-7.5981*
	PP	-1.8231	-2.2565	-1.5172	-9.0737*	-7.6536*	-7.7894*
Reer	ADF	-9.4795*	-3.5683*	-2.2451*	-	-	-
	PP	-9.4795*	-5.6140*	-2.5479*	-	-	-
M2	ADF	-5.2349*	-4.2936*	-2.1097*	-	-	-
	PP	-5.2394*	-4.2975*	-2.1097*	-	-	-
Oil	ADF	-1.3860	-1.4506	-0.6129	-4.5188*	-4.5285*	-4.6102*
	PP	-1.3860	-1.4887	-0.6237	-4.4120*	-4.4132*	-4.5154*

Source: Based on EViews 9 output.

Note: (*) denotes statistical significance at one of the levels (1%, 5%, 10%).

The results of both (ADF) and (PP) tests for time series of economic

growth (GDP) and oil prices (Oil) indicate that we fail to reject the null hypothesis (H_0) of the presence of a unit root in levels, which means that they are non-stationary in levels. But we reject it for the first-differenced series, meaning that they are integrated in order one I(1).

For the time series of the reel effective exchange rate (REER) and the growth of money supply (M2), both tests (ADF) and (PP) results showed that the null hypothesis (H_0) is rejected, meaning that they are stationary in levels and integrated in order zero I(0).

Since the times series used in this study are integrated in order zero I(0) and order one I(1), the study will adopt the Autoregressive Distributed Lag (ARDL) approach which is proposed by (Pesaran, Shin , & Smith, 2001) to estimate the long run and the short run among variables.

In order to distinguish short-run effects from long-run effects we used the following equation:

$$\Delta \text{GDP} = \alpha_0 + \delta_1 \text{GDP}_{t-1} + \delta_2 \text{REER}_{t-1} + \delta_3 \text{M2}_{t-1} + \delta_4 \text{Oil}_{t-1} + \sum_{i=1}^{p} \emptyset i \, \Delta \text{GDP}_{t-i} + \sum_{j=0}^{q1} \gamma j \, \Delta \text{REER}_{t-j} + \sum_{j=0}^{q2} \varphi j \, \Delta \text{M2}_{t-j} + \sum_{j=0}^{q3} \vartheta j \, \Delta Oil_{t-j} + \varepsilon_t$$

Where: (α_0) is the intercept, (δ_i) are the long run coefficients, ($\emptyset i, \gamma j, \varphi j, \vartheta j$) are the short run coefficients, (Δ) is the first difference operator and (ε_t) are the white noise errors.

By applying the Akaike Information Criterion (AIC) on many models, the selected model was ARDL (2.3.4.4). Then, to determine if a cointegrating relationship exists among variables in the long term the bounds test was applied on this model and the results were as follows.

Table 2. Bounds test results

F-statistic	Lower critical value	Upper critical value	Level of significance
8.5224	2.72	3.77	10%
	3.23	4.35	5%
	3.69	4.89	2.5%
	4.29	5.61	1%

Source: Based on EViews 9 output.

The value of F-statistic is above the upper critical values at all levels of significance, the null hypothesis (H_0) of no long-run relationship is rejected, consequently, a long run relationship among the study variables is confirmed.

Since the long run relationship between economic growth and its determinants is confirmed, the parameters of the selected ARDL model were estimated.

Table 3. The estimated long-run coefficients

Variable	Coefficient	t-statistic	Prob
REER	0.1125	1.1730	0.2680
M2	0.4891	3.2054	0.0094*
OIL	0.0478	1.2797	0.2295
C	-18.4670	-1.3572	0.2046

Source: Based on EViews 9 output.

Note: (*) denotes statistical significance at all levels (1%, 5%, 10%).

The long-run coefficients reveal that:

- The probability of the real effective exchange rate (REER) is estimated at (0.2680), which is greater than (0.01, 0.05 and 0.1). The null hypothesis is accepted, thus, the estimated parameter of (REER) is not statically significant at all levels of significance, meaning that the real effective exchange rate is not considered as one of the determinants of economic growth in the long-run in Algeria.
- The probability of the money supply growth (M2) which is estimated at (0.0094) is less than (0.01, 0.05 and 0.1), we reject the null hypothesis and accept the alternative one (H_1). Hence the parameter is statistically significant at all levels of significance, meaning that if the money supply growth rises by one unit the economic growth will rise by (0.4891) unit, because the increase of money supply stimulates consumption and thus economic growth.
- For the parameter of oil prices (Oil), the probability (0.2295) is greater than (0.01, 0.05 and 0.1), the null hypothesis is accepted, meaning that the parameter is not statistically significant, so, oil prices do not affect economic growth in the long term. These results do not correspond to the reality of the Algerian economy which is considered as a rentier economy.

To investigates the short-run relationship between variables, the error correction model was estimated, and the results of the short-run dynamic coefficients are given in the table below.

Table 4. The estimated short-run coefficients

Variable	Coefficient	t-statistic	Prob
D(GDP(-1))	-0.2532	-1.2549	0.2380
D(REER)	0.1668	2.6325	0.0251**
D(REER(-1))	-0.1924	-4.2310	0.0017***
D(REER(-2)	0.0955	2.2911	0.0449**
D(M2(-1))	-0.0908	-2.8034	0.0187**
D(M2(-3))	-0.1093	-3.5327	0.0054***
D(OIL)	0.0106	0.5868	0.5703
D(OIL(-3))	-0.0191	-1.0235	0.3302
CointEq(-1)	-0.6032	-2.3601	0.0399**

Source: Based on EViews 9 output.

Note: (***, **, *) denotes statistical significance at levels (1%, 5%, 10%) respectively.

According to the short-run coefficient we can conclude that:

- The parameters of the lagged real effective exchange rate (REER) showed that in the short-run the effect sign of the (REER) on economic growth changes between negative and positive depending on the number of lags.
- The parameters of the lagged money supply growth (M2) are statistically significant and their sign is negative, meaning that money supply has a negative effect on economic growth in the short-run. This is explained by the fact that loans granted by the Algerian authorities to the private sector in order to finance investment negatively affected the gross domestic product.
- The parameters of the lagged oil prices (OIL) are not statistically significant; therefore, oil prices do not affect economic growth in the short-run.
- The equilibrium error correction coefficient which is the most important parameter in the short-run model is estimated at (-0.6032), its probability (0.0399) is less than (0.1 and 0.05). The null hypothesis is rejected; thus, the parameter is statistically significant at (10% and 5%) level of significance. It has the correct sign which is negative. So, this means that there is a speed of adjustment to equilibrium after a shock,

and (60.32%) of disequilibrium in the economic growth converge back to the long run equilibrium in the following year.

To test the estimated ARDL model, we employed the Breusch-Godfrey test for the autocorrelation, the Jarque-Bera test for normality and the ARCH test for heteroskedasticity.

Table 5. Diagnostic tests results

Test	Value	Probability
Breusch-Godfrey	1.6838	0.2453
Jarque-Bera	0.6085	0.7376
ARCH	1.7130	0.2030

Source: Based on EViews 9 output.

The residuals of the model passed all the diagnostics tests, since all probabilities are upper than (0.01, 0.05 and 0.1); thus, the residuals are normally distributed, they are not correlated and heteroskedasticity is assumed.
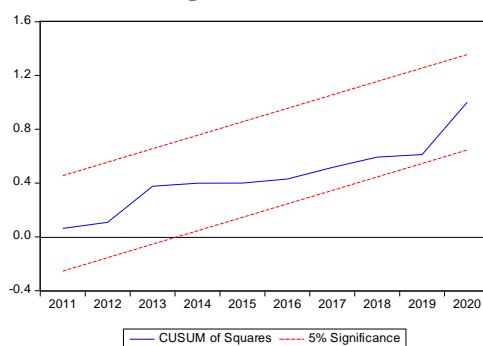
To examine the long-run and short-run stability of the coefficients, the stability tests for the residuals were applied.
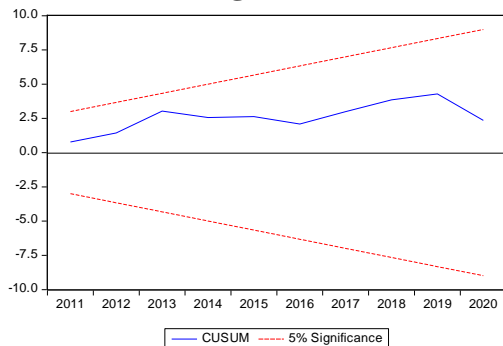
Fig.1. Cusum test

Fig.2. CusumQ test

Source: EViews 9 output.

Source: EViews 9 output.

The plot of CUSUM and CUSUMQ stays within the critical 5% significance lines bound, which suggests the stability of the residual variance, thus, the absence of any instability of ARDL error correction model coefficients.

4. The nonlinear model estimation

In the previous ARDL model all variables are assumed to have symmetric effect on the dependent variable which is economic growth. For asymmetric effects, in this study, the real effective exchange rate is separated into positive changes which indicates an appreciation of domestic currency (REER_POS),

and negative changes which indicates depreciation of domestic currency (REER_NEG).

Two new series are constructed on reflecting appreciation and depreciation of the Algerian Dinar, and the partial sum of positive and negative changes are formulated by (Shin, Yu, & Greenwood-Nimmo, 2014):

$$\text{REER\_POS}_t = \sum_{j=1}^{t} \Delta \ \text{REER}_J^+ = \sum_{j=1}^{t} Max \ (\Delta \text{REER}_j, 0)$$

$$\text{REER\_NEG}_t = \sum_{j=1}^{t} \Delta \ \text{REER}_J^- = \sum_{j=1}^{t} Min \ (\Delta \text{REER}_j, 0)$$

To analyze the relationship between economic growth and the mentioned variables, the following linear simple equation was made:

$$\text{GDP} = f \ (\ \text{REER\_POS} \ , \ \text{REER\_NEG} \ , \ \text{M2} \ , \ \text{Oil} \ )$$

In order to distinguish short-run effects from long-run effects we used the following equation:

$$\Delta \text{GDP} = \alpha_0 + \delta_1 \text{GDP}_{t-i} + \delta_2 \text{REER\_POS}_{t-i} + \delta_3 \text{REER\_NEG}_{t-i} + \delta_4 \text{M2}_{t-i} + \delta_5 \text{Oil}_{t-i} + \sum_{i=1}^{p} \emptyset i \ \Delta \text{GDP}_{t-i} + \sum_{J=0}^{q1} \omega j \ \Delta \text{REER\_POS}_{t-j} + \sum_{J=0}^{q2} \gamma j \ \Delta \text{REER\_NEG}_{t-j} + \sum_{j=0}^{q3} \varphi j \ \Delta \text{M2}_{t-j} + \sum_{j=0}^{q4} \vartheta j \ \Delta Oil_{t-j} + \varepsilon_t$$

Where: (α_0) is the intercept, (δ_i) are the long run coefficients, ($\emptyset i, \omega j, \gamma j, \varphi j, \vartheta j$) are the short run coefficients, (Δ) is the first difference operator and (ε_t) are the white noise errors.

The Akaike Information criterion (AIC) was used to determine the best NARDL estimated model.

Fig.3. Akaike Information Criterion results

Akaike Information Criteria (top 20 models)
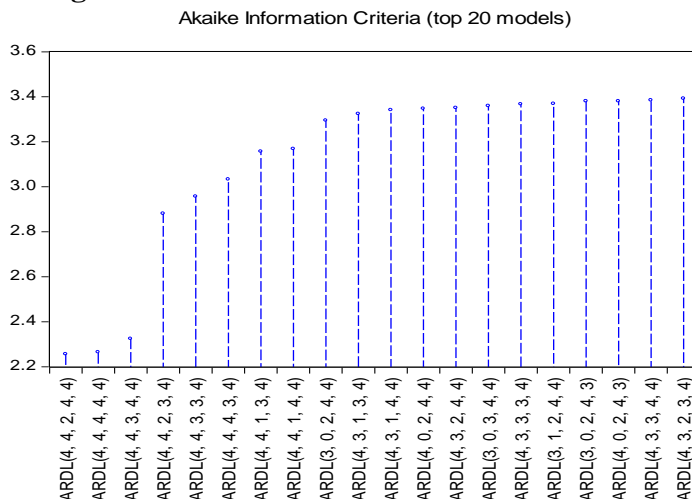
Source: EViews 9 output.

The results show that among the 20 estimated models, the best one is NARDL (4.4.2.4.4), which means four lags for economic growth, positive changes of exchange rate, money supply and oil prices, and two lags for the negative changes of exchange rate.

To confirm the existence of long-run asymmetric association between exchange rate and economic growth, we utilized the Wald test.

Table 6. Wald test for the NARDL equation results

Test Statistic	Value	Probability
t-statistic	4.2331	0.0241*
F-statistic	17.9192	0.0241*
Chi-Square	17.9192	0.0000*

Source: Based on EViews 9 output.

Note: (*) denotes statistical significance at 5% level of significance.

The probabilities of all statistic tests are less than (0.05), the alternative hypothesis which states that there is a long-run asymmetry is accepted at 5% level of significance, thus, the impact of the real effective exchange rate on economic growth is asymmetric.

Bounds test for cointegration was used to test the existence of long run relationship among variables and its results are shown as follows.

Table 7. Bounds test results of nonlinear cointegration

F-statistic	Lower critical value	Upper critical value	Level of significance
	2.45	3.52	10%
7.7740	2.86	4.01	5%
	3.25	4.49	2.5%
	3.74	5.06	1%

Source: Based on EViews 9 output.

The F-statistic value (7.7740) lie above upper bound critical value at (10%, 5%, 2.5% and 1%) levels of significance, the null hypothesis is rejected, thus, the test concludes that the cointegrating relationship is valid.

Since the long run equilibrium relation exists among variables the long run asymmetric impact of exchange rate on economic growth can be estimated as follow.

Table 8. Results of asymmetric long-run coefficients

Variable	Coefficient	t-statistic	Prob
REER_POS	-1.1369	-2.7947	0.0681*
REER_NEG	-0.7664	-2.6134	0.0794*
M2	0.6701	3.1662	0.0506*
OIL	-0.0499	-2.0209	0.1365
C	-68.2335	-2.3237	0.1027

Source: Based on EViews 9 output.

Note: (*) denotes statistical significance at 10% level of significance.

From the results table we can conclude:

- The probability of positive changes in the real effective exchange rate (REER_POS) is estimated at (0.0681) which is less than (0.10) meaning that the null hypothesis is rejected and the estimated parameter is statistically significant at 10% level of significance. Since the estimated parameter is (-1.1369), we conclude that positive changes in exchange rate negatively affect economic growth in the long-run, any increase in the (REER_POS) by one unit will lead to a decrease in economic growth by (1.1369) unit since the overvaluation of the currency affects the economic performance of the country by reducing the economic growth.

- The probability of negative changes in real effective exchange rate (REER_NEG) which is estimated at (0.0681) is also less than (0.10), so, the alternative hypothesis is accepted and the parameter is statistically significant at 10% level of significance. Its value (-0.7664) means that there is a negative relationship between negative value of exchange rate and economic growth in the long-run, since any decrease in the (REER_NEG) by one unit will lead to an increase in the GDP growth by (0.7664) unit. Because when the currency is depreciated it will gain competitiveness, the country will export more and eventually enjoy an increase in domestic production.

- The estimated parameter of money supply (M2) has a probability of (0.0506) which is less than (0.10) meaning that the parameter is statistically significant at 10% level of significance. Its value (0.6701) means that if money supply increases by one unit the GDP growth will

increase by (0.6701) unit. This positive relationship is due to the fact
that the increase in money supply leads to an increase in consumption
and thus enhance economic growth.

- The last variable which is oil prices (OIL) has a probability of (0.1365)
which is greater than (0.10). In this case we accept the null hypothesis
meaning that the variable is not statistically significant at 10% level of
significance. So, the oil prices cannot be taken as an explanatory
variable of economic growth in the long-run.

We estimate the nonlinear short-run model and the results are shown in
table (9).

Table 9. Results of asymmetric short-run coefficients

Variable	Coefficient	t-statistic	Prob
D(GDP(-1))	1.2392	1.8031	0.1691
D(GDP(-2))	3.0883	2.6911	0.0743*
D(GDP(-3))	2.8749	2.9339	0.0608*
D(REER_POS)	-2.7072	-2.7443	0.0711*
D(REER_POS(-1))	-1.6921	-2.7458	0.0710*
D(REER_POS(-2))	1.4969	2.9766	0.0588*
D(REER_POS(-3))	0.9709	2.5843	0.0815*
D(REER_NEG)	1.1921	3.1702	0.0505*
D(REER_NEG(-1))	0.8625	2.2508	0.1099
D(M2)	0.2371	2.4409	0.0924*
D(M2(-1))	-0.3248	-3.9151	0.0296**
D(M2(-2))	0.2196	2.8687	0.0641*
D(M2(-3))	0.1546	1.7465	0.1790
D(OIL)	-0.1127	-2.3760	0.0980*
D(OIL(-1))	0.0866	2.3550	0.0998*
D(OIL(-2))	-0.0266	-1.3413	0.2723
D(OIL(-3))	-0.0864	-3.0400	0.0559*
CointEq(-1)	-1.2749	-2.8271	0.0663*

Source: Based on EViews 9 output.

Note: (**, *) denotes statistical significance at levels (5% and 10%)
respectively.

Looking at the asymmetric short-run results, it can be observed that:

- The parameter of the D(GDP(-1)) is not statistically significant which
means that the lagged GDP for one year do not affect economic growth

for the present year. In the contrary, the parameters of the lagged GDP for 2 and 3 years are statistically significant at 10% level of significance, their sign is positive meaning that economic growth take 2 to 3 years to be invested to influence the current economic growth positively.

- All the parameters of the lagged positive changes of exchange rate are statistically significant at 10% level of significance. Their sign in the first 2 lagged years is negative, which means that the increase of exchange rate leads to a decrease of economic growth. After that their sign become positive, meaning that the increase of positive changes of exchange rate will lead to an increase of economic growth; this can be explained by the fact that the appreciation of the Algerian Dinar leads to the transfer of domestic spending from foreign goods to domestic goods thus reduce imports, the trade balance deficit is reduced, and the economic growth is enhanced.

- The parameter of the lagged negative changes of exchange rate is statistically significant, meaning that the decrease of exchange rate by one unit will lead to a decrease of economic growth by (1.1921) unit.

- The sign of the estimated parameters of the lagged (M2) varies between positive and negative. In the case that the increase of money supply affects economic growth positively, we can say that the money supply reduces the value of the currency which is the Algerian Dinar; consequently, it increases the demand for petroleum which lead to rise of the economic growth rate. But when the increase of money supply affects economic growth negatively it means that the decrease of the value of the Dinar makes imports a larger burden.

- The estimated parameter of the lagged oil prices for one period positively affects economic growth since it is the most important source of income in Algeria, then the effect become negative with time because this oil income was used to cover import expenses instead of using it in investment.

- The coefficient of ECT(-1) is estimated at (-1.2749), its probability (0.0663) is less than (0.1) which means that it is statistically significant at 10% level of

significance. Its sign is negative, which supports the adjustment towards the long-run equilibrium. So, nearly 127.49 % of instability in the economic growth is corrected within a year.

To make sure that the estimated NARDL model is stable and trustworthy relevant some diagnostic tests were made.

**Table 10.** Diagnostic tests results for the NARDL model

Test	Value	Probability
Breusch-Godfrey	1.1560	0.3640
Jarque-Bera	0.1106	0.9462
ARCH	2.5614	0.1231

Source: Based on EViews 9 output.

All probabilities of diagnostic tests are superior than (0.10, 0.05 and 0.1), thus, alternative hypotheses are accepted at all levels of significance. Accordingly, the serial correlation LM test (Breusch-Godfrey) reveals the absence of autocorrelation in residuals. The Jarque-Bera test indicate that the errors tend to follow normal distribution, and finally the heteroskedasticity ARCH test shows that residuals have constant variance over time.
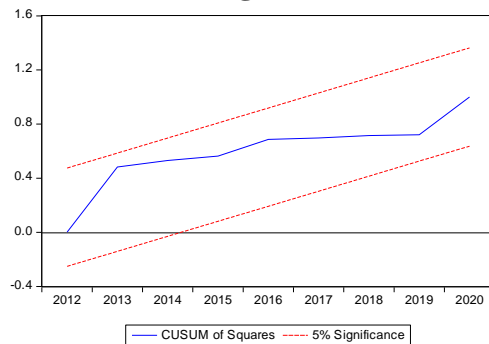
Furthermore, the results of both Cusum and CusumQ tests shown in figures 4 and 5 reveals that the model coefficients of short-run and long-run are stable since the plots are within the critical bounds at 5% significance level.
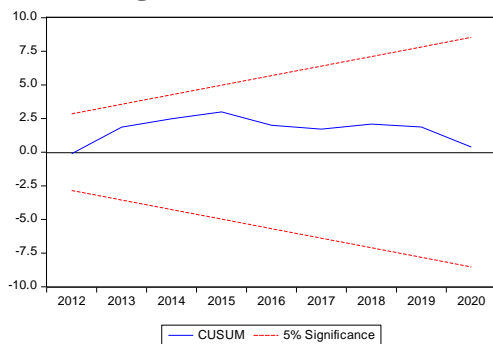
Fig.4. Cusum test   **Fig.5. CusumQ test**

Source: EViews 9 output.   **Source**: EViews 9 output.

5. CONCLUSION

This study aimed to examine the symmetric and asymmetric effect of exchange rate on economic growth in Algeria during the period (1990-2020). Both (ARDL) and (NARDL) methodologies were used to estimate this relationship. The results of the empirical study revealed that:

- The (ADF) and (PP) tests indicates that the times series used in the study are integrated in order one and order zero, which allowed us to use the (ARDL) and the (NARDL) methodologies;
- The bounds test results for the (ARDL) model confirmed the long-run relationship among variables;
- The results of the long-run model revealed that economic growth is only affected by money supply growth (M2);
- The short-run model showed that there is a speed of adjustment to equilibrium after a shock, and (60.32%) of disequilibrium in the economic growth converge back to the long run equilibrium in the following year;
- Diagnostic tests have shown that the estimated (ARDL) model is trustworthy;
- The Wald test results revealed that the impact of the real effective exchange rate on economic growth in the long-run is asymmetric;
- The bounds test of nonlinear cointegration showed that a long run relationship among variables do exist;
- The long-run coefficients demonstrated that the overvaluation of the Algerian Dinar negatively affect economic growth, and its depreciation enhance it;
- The short-run model supported the adjustment towards the long-run equilibrium, and clarify that nearly 127.49 % of instability in the economic growth is corrected within a year;
- Finally, the (NARDL) model passed all diagnostic and stability tests which makes it a trustworthy model.

  Comparing the results of the symmetric and asymmetric model we found that:
- The (REER) did not have a long-run impact on economic growth in the symmetric model, but when appreciations and depreciations were separated, the results showed that there is an asymmetric effect of exchange rate on economic growth in Algeria. Since the overvaluation of the Algerian Dinar affect economic growth negatively, and the undervaluation of the Dinar enhance economic growth in the long-run;

- The effect of overvaluation of the Dinar on economic growth varies between negative and positive in the short-run depending on numbers of lags, but became negative in the long-run;
- The depreciation of the Dinar affects economic growth positively in the short-run then it became positive in the long-run;
- In the (ARDL) model the effect of (M2) was negative in the short-run then became positive in the long-run; In the (NARDL) model its effect varies between negative and positive then it became positive;
- In the (ARDL) model oil prices were not statistically significant neither in the short nor in the long-run, but in the (NARDL) model it has a positive effect in the short-run but it does not last to the long-run.

5. Bibliography List:

Bahmani-Oskooee, M., & Arize, A. (2018). Asymmetric response of domestic production to exchange rate changes: Evidence from Africa. *Economic change and restructuring*, pp. 01-24.

Bahmani-Oskooee, M., & Mohammadian, A. (2016). Asymmetry effects of exchange rate changes on domestic production: Evidence from nonlinear ARDL approach. *Australian economic papers*, pp. 01-11.

Bahmani-Oskooee, M., & Mohammadian, A. (2017). Asymmetry effects of exchange rate changes on domestic production in Japan. *International Review of applied economics* , pp. 01-17.

Bahmani-Oskooee, M., Halicioglu, F., & Mohammadian, A. (2017). On the asymmetric effects of exchange rate changes on domestic production in Turkey. *Econ change restruct*, pp. 01-16.

Barguellil, A. (2021). The asymmetric indirect impact of real exchange rate on economic growth through foreign trade: An asymmetric ARDL Panel Model. *Asian Economic and Financial Review, Vol 11, Issue 08*, pp. 658-671.

Behroz, N., Hossein Sharifi, R., & Saeed Daei, K. (2020). Investigating the asymmetric effects of short-run and long-run exchange rates on gross domestic product of selected countries: NARDL-PMG approach. *The journal of economic studies and policies, Vol 07, N°01, Issue 13*, pp. 233-256.

Frieden, J. (2008). *Globalization and exchange rate policy. In the future of globalization.* New York: Routledge: Edited by Ernesto Zedillo.

Frrenkel, R., & Rapetti, M. (2014). The real exchange rate as a target of macroeconomic policy. *Munich Personak RePEc Archive (MPRA), N° 59335*, pp. 01-17.

Gala, P., & Claudio, R. (2006). Exchange rate misalignment and growth: Old and new econometric evidence. *Economia, Vol 07, N04*, pp. 165-187.

Ghosia Ayaz, A., & D.Javed, I. (2021). The asymmetric impact of RER-misalignment on economic growth: An application of Hodrick-Prescott Filter technique. *The Singapore Economic Review*, pp. 01-29.

Hussain, I., Hussain, J., Ali Khan, A., & Khan, Y. (2019). An analysis of the asymmetric impact of exchange rate changes on GDP in Pakistan: Application of non-linear ARDL. *Economic Research-Ekonomska Istrazinvanja, Vol 32, N° 01*, pp. 3100-3117.

Nusair, S. A. (2021). The asymmetric effects of exchange rate changes on output: Evidence from Asian Countries. *The international trade journal*, pp. 01-26.

Pesaran, M., Shin , Y., & Smith, R. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics, Vol 16, N° 03, special issue in memory of John Denis Sargan, 1924-1996*, pp. 289-326.

Razin, O., & Collins, S. (1997). Real exchange rate misalignment and growth. *International finance and macroeconomics, NBER working paper N 6174*, pp. 01-31.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. *In Horrace William and Sickles Robin (Editors),The festschrift in honor of Peter Schmidt: Econometric methods and applications, New York, Springer*, pp. 281-314.