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The Asymmetric Relationship between the Exchange Rate and Inflation in Algeria from 1980-2022

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Abstract

This study deals with estimating the relationship between inflation and the exchange rate in Algeria during the period (1980-2022) using the ARDL method, then studying the non-linear (asymmetric) relationship using the NARDL methodology in the short and long term, while tracking the stability of the functions estimated in the standard model.

The study found that the relationship between the exchange rate and inflation in Algeria is asymmetric in the short and long term through the WALD symmetry test.

Keywords *: Inflation, exchange rate, ARDL, NARDL.*

1. Introduction

Inflation and exchange rate play a prominent role in all developed, emerging and developing economies alike. Economic stability will not be achieved in isolation from exchange rate stability and inflation. Therefore, we find that there is a wide interest by governments to reduce fluctuations in the monetary balance (inflation and exchange rate). Maintaining a stable and low inflation rate is one of the most important responsibilities and challenges faced by the monetary authorities in any country to maintain price stability.

In an effort to achieve price stability, many countries (including Algeria) adopted explicit inflation targeting. However, the dynamics of inflation in open economies does not depend only on internal balances, but also on external balances. In addition, there are clear effects of exchange rates on the efforts of monetary policy makers to achieve price stability. In this regard, we find great interest by academics and policy makers in the exchange rate implications that are transmitted

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to local prices (Exchange Rate Pass Through), as there was controversy stating that ERPT has diminished due to the adoption of an inflation targeting policy, while some studies see the presence of an ERPT effect even in the case of inflation targeting.

Algeria, by the nature of its rentier economy, is closely linked to the outside world, which remains in need of many goods and services necessary to meet the overall demand, whether these goods are intended for direct consumption or related to production inputs, the majority of which are imported either because they are not available locally or because they are not sufficient to meet the demand. Since the cost of production is one of the factors that increases inflationary pressures, it is self-evident that the high cost of imported production inputs plays a role in increasing domestic inflation rates. In addition to the above, the structural composition of the Algerian economy and the high dependence on imports can affect local inflation rates through exchange rate changes (an increase in the price of one unit of foreign currency against the local currency) and undoubtedly leads to an increase in the cost in the national currency of imported production inputs, which prompts producers to increase the prices of goods and services. The deterioration in the value of the dinar in recent years has made the Algerian economy vulnerable to changes in the prices of goods and services that occur on the global market. Therefore, we decided, through this study, to demonstrate the effect of the exchange rate on local inflation.

1.1 The Study Problem

The problem of the research is that the Algerian economy has been suffering from high inflation rates and fluctuations in dollar exchange rates since the beginning of the 1990s. This is because Algerian revenues depend on the dollar as a global currency, and the exchange rates in those countries depend on the unstable global stock market price. The exchange rate of the Algerian dinar against the dollar is stable and fixed by the Central Bank of Algeria.

From the above, the problematic features of our study emerge as follows: **Do changes in the dinar's exchange rates against the dollar affect inflation in Algeria? Is there a relationship between inflation and the exchange rate in Algeria? What type of relationship is this?**

1.2 Hypotheses

To answer the problem raised, the hypotheses that serve as the starting point for the study can be formulated as follows:

- Changes in the Algerian dinar exchange rate with respect to foreign currencies can affect local inflation by increasing the cost of imports and imported products, which leads to an increase in prices in the local market.

- The change in the Algerian dinar's exchange rate with respect to foreign currencies (the dollar) affects local inflation. (Increasing the cost of imports and imported products lead to an increase in prices in the local market).

- The existence of an inverse long-term equilibrium relationship between the exchange rate and inflation in Algeria.

- There is symmetry between inflation and the exchange rate. That is, there is similarity in the effect of positive and negative shocks that occur to the independent variable (exchange rate) on the dependent variable (inflation).

1.3 The Research Importance

The exchange rate is one of the monetary policy tools determined by the Central Bank of Algeria. In addition, the issue of the exchange rate is a complex topic. The importance of this research lies in studying the impact of exchange rates on inflation in the Algerian economy by researching and studying the fluctuations that occur in the exchange rate during the study period. The exchange rate has an important role in monetary stability because changes in local exchange rates affect inflation rates. Therefore, raising the exchange rate of the dollar against the dinar has a clear effect in increasing the general level of prices. Thus, achieving stability in exchange rates contributes to reducing inflation and controlling its growth rates, especially since the Algerian economy does not enjoy the flexibility of its production system, its lack of diversification, and its limitation to exporting oil. Economic stability can be achieved if the variables affecting the exchange rate are controlled, and the stability of the exchange rate helps achieve stability in inflation rates in the long term.

The study of inflation and the exchange rate is also a topical topic, especially in light of the circumstances we are going through of the rise in prices of all materials and changes in currency rates in the international market.

1.4 The Research Aims

Through our research we aim to estimate the relationship between inflation and the exchange rate using the ARDL method to test the hypothesis of a long-term relationship between the variables of the adopted model and then study the non-linear (asymmetric) relationship using the NARDL methodology in the short and long term while tracking the stability of the functions estimated in the standard model.

1.5 The Study Limits

The study is applied to the Algerian economy during the period (1980-2022) because the study requires a large sample to obtain a more accurate model and better results.

1. Literature Review

1.1 The study by Jar al-Nabi Babu Jar al-Nabi Dahiyya and Zubaida Nour al-Din Abdo, entitled "The Impact of Asymmetric Exchange Rate Shocks on the Inflation Rate in Sudan during the Period from 1990-2021 using a Non-Liner Autoregressive Distributed Lag NARDL" (Jar al-Nabi Dahiyya & Nour al-Din Abdo, 2022). The study aimed to prove that the positive and negative shocks of the exchange rate on the inflation rate are asymmetric in the short and long term during the period from 1990-2021. Using the NARDL proved that the relationship between the exchange rate and the inflation rate is non-linear, which means that positive and negative shocks to the exchange rate are not symmetrical on the inflation rate and that positive shocks have a significant impact on the inflation rate in the short and long term while negative shocks have no significant impact. That is, a decrease in the exchange rate does not lead to reduce the inflation rate. The study recommended developing monetary policies based on accurate information about the impact of positive and negative exchange rate shocks on the inflation rate and targeting inflation to achieve price stability and reduce the severity of the imbalance in internal and external balance.

1.2 The study by Farouk El-Gazzar and Adham El-Baramawy entitled "The Impact of Asymmetric Exchange Rate Shocks on the Inflation Rate using the NARDL model". (El-Gazzar & El-Baramawy, 2022) An applied study on the Egyptian economy. This paper provides applied evidence that exchange rate shocks on the inflation rate are asymmetric. Using NARDL and through monthly time series from January 2016 to December 2020, the study reached the following results:

1) The relationship between the exchange rate and the inflation rate is non-linear, which means that the effect of exchange rate shocks on the inflation rate is asymmetric.
2) The study analogically proved that the short-term inflation rate is affected only by positive exchange rate shocks, while it is not affected by financial shocks. So, the inflation rate rises with exchange rate increase, while exchange rate declines do not reduce the inflation rate.
3) The effect of both positive and negative exchange rate shocks on the inflation rate in the long term is insignificant.
4) The study also analogically proved, through dynamic multipliers, that the effect of a 1% change in positive shocks on the inflation rate is greater than the effect of a 1% change in negative shocks on the inflation rate for each individual item in the study sample.

1.3 The study (Pham, T.A.T., T. T. Nguyen, M. A. Nasir, T. L. D. Huynh: 2023) examined the relationship between exchange rate pass-through to inflation rate and inflation targeting and non-targeting for a group of five Asian countries during the period from 2000-2019 using NARDL analysis. (Pham, Nguyen, Nasir, & Huynh, 2023) It proved that exchange rate shocks lead to significant changes in inflation and that they are asymmetric in the inflation rate in Singapore, the Philippines, and Indonesia. Results varied between inflation-targeting countries and non-targeting countries. The results also differed in the short and long term, as in the long term the effect of asymmetric shocks to the real exchange rate persists only in Indonesia and Singapore.

1.4 The study (Miguel A. Kiguel: 1994) dealt theoretically with the relationship between the exchange rate, the real exchange rate, and the inflation rate, applying it to Latin American countries. (Miguel, 1994) The study found that exchange rate policies have a limited impact on real

exchange rates when the adjustment of prices and wages locally is slow. The study also found that there is usually a trade-off between policies that aim to keep exchange rates below their value - to stimulate exports - and policies that aim to maintain low inflation rates. The study concluded that the exchange rate can be an effective tool in controlling inflation, but this depends on the macroeconomic policies accompanying it.

2.5 The study by Abdel Moumen Ben Ali and Hisham Labza entitled "The Mutual Impact between the Exchange Rate and Inflation Rates in the Algerian Economy, an Econometric Study for the Period (1990-2016)" (Ben Ali & Labza, 2019) It aims to identify the mutual impact between the exchange rate and inflation rates. It used Granger causality and concluded that there is no long-term equilibrium relationship between the exchange rate and the inflation rate.

2.6 The study by Ahmed Salmi entitled "Testing the Co-integration Relationship between the Exchange Rate and Inflation Rates in Algeria, an Applied Study for the Period (1970-2014). (Salmi, 2015) It aims to study the relationship between the exchange rate and inflation rates using the Granger causality test. It concluded that there is no equilibrium relationship in the long term and the absence of a causal relationship in both directions between the exchange rate and the inflation rate.

2.7 The study by Lafdal Salima entitled "Imported Inflation and Exchange Rate Fluctuations and their Impact on Domestic Inflation in Algeria" (Lafdal, 2021). This thesis aimed to study the impact of imported inflation and exchange rate fluctuations on domestic inflation through an econometric study of the case of Algeria. It aimed to test the impact of both the exchange rate and imported inflation on the development of the domestic price level within the framework of joint integration and the ARDL and NARDL models in the period (1986-2019). The results of estimating the ARDL model and the results of the NARDL method showed that there is a direct relationship between the domestic inflation rate and imported inflation, and a direct relationship between changes in the dinar exchange rate and the general level of local prices (inflation). While the results showed that the relationship between them in the long term was inverse. The response of inflation to positive changes in global oil prices was direct in the short term, while the response was inverse in the long term.

3 Estimation Results and Results Analysis

This study is based on most of the previous studies in terms of the factors that play a significant role in influencing the exchange rate, whether they are internal factors related to monetary policy or external factors. More specifically, within the framework of the aggregate supply and demand model, the study assumes that the exchange rate is influenced by local inflation rates(**inf)** and the level of economic activity represented by the real GDP growth rate(**txgdp)**. The study also considers the broad money supply as a percentage of real GDP to highlight the role of monetary policy in influencing exchange rates(**MGDP)**. The economic openness rate(**XGDP**), which was calculated as follows, was also taken into account:

$$XGDP = \frac{X + M}{GDP} \times 100$$

X: exports

M: Imports

3.1 Testing the Stability of Time Series (Unit Root Test):

The study of stability is considered one of the important conditions when studying time series because the absence of stability may cause several standard problems, including the problem of false regression. This problem makes most statistical tests misleading despite the high various statistical coefficients (coefficients of determination and correlation) and testing the significance of the estimated parameters that make the model statistically acceptable. In order to avoid this, stability must be restored to unstable time series. From this, two methods were known to detect the stability or instability of the variables of any time series. Respectively, a study of "correlogram" through which the general trend component and the quarterly component are revealed. And the stability test (single root test), through which these two components are not only detected, but also the most effective way to return the series to stability is demonstrated, and then the degree of its complementarity is determined.

The stability of time series is considered a basic condition for co-integration. For this reason, we relied on two basic tests to study the stability of time series: The Augmented Dickey-Fuller test ADF and PP test.

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3.1.1 THE AUGMENTED DICKEY-FULLER (ADF) TEST

It is among the most important tests in detecting the unit root in the time series. The stability hypothesis is tested by testing the significance of the unit root. This test, in its original simple form DF, is used to test the stability of time series on the following three formulas:

$$\Delta Y_t = \lambda \Delta Y_{t-1}$$

$$\Delta Y_t = \lambda \Delta Y_{t-1} + c + u_t \quad \ldots\ldots\ldots\ldots\ldots (2)$$

$$\Delta Y_t = \lambda \Delta Y_{t-1}$$

However, the Augmented Dickey-Fuller test added differences with a time gap to get rid of the problem of autocorrelation according to the following three formulas:

$$\Delta Y_t = \lambda Y_{t-1} - \sum_{j=1}^{p} \varphi_{j+1} \Delta Y_{t-j} + u_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$\Delta Y_t = \lambda Y_{t-1} - \sum_{j=1}^{p} \varphi_{j+1} \Delta Y_{t-j} + c + u_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$\Delta Y_t = \lambda Y_{t-1} - \sum_{j=1}^{p} \varphi_{j+1} \Delta Y_{t-j} + c + bt + u_t \ldots\ldots\ldots\ldots\ldots (6)$$

H_0: Null hypothesis: The time series of the variable contains a unit root. That is, it is unstable. ($0 = \lambda$)

H_1: Alternative hypothesis: The time series for the variable does not contain a unit root. That is, it is stable.

The hypothesis of the existence of a unit root can be rejected (accepting the hypothesis of stability) in the three equations (without a constant term and a general trend, with a constant term only, with a constant term and a general trend);

However, if the calculated statistic for the test τ_{φ_1} is less than the critical values $\tau_{tabulé}^{\%}$ at the significance level (set by the tables of Dickey-Fuller test and developed by MacKinnon in 1991) or the probability value Prob is less than the specified significance level.

The level of delays p sufficient to eliminate the autocorrelation of errors is chosen according to the lowest value of the information criteria «**Hannan-Quinn, Schwarz (SC), Akaik (AIC)**».

✓ **The Augmented Dickey Fuller Test ADF:**

Table 1. Results of the ADF test for stability of time serie

Time series in their original state			
Without a constant term and general trend	Constant term	Constant term and general trend	Variable
-1.327980	-1.975411	- 2.152233	**INF**
2.163768	1.192363	** -4.559024	**TCH**
-0.745240	-1.806608	-1.848271	**XGDP**
* -1.858695	-2.206578	-2.145648	**MGDP**
-* 1.615900	*** -4.359975	*** -4.321772	**TXGDP**
Time series after taking initial differences			
Without a constant term and general trend	Constant term	Constant term and general trend	Variable
*** -5.898025	***- 5.827467	***- 5.760765	**INF**
***- 3.262331	***-4.267972	***-4.392284	**TCH**
*** -6.179902	***- 6.110776	***-5.150729	**XGDP**
*** -6.970093	***- 6.880209	***-6.836897	**MGDP**
***- 6.570203	***- 6.495474	***- 6.311264	**TXGDP**

Source: created by researchers using Eviews 12

(***) Significant at 1% level

(**) Significant at 5% level

(*) Significant at 10% level

The results of the Dickey-Fuller unit root test show us that the time series of the exchange rate (constant and general trend), the rate of economic openness (constant only), are stable at the level, while the rest of the series contain a unit root. Therefore, it is not stable at the level.

The previous table also shows that after taking the first differences of the time series for the variables of the inflation rate (without a constant and a general trend), the internal product (without a constant and a general trend) and the monetary mass (without a constant and a general trend), it turns out that they do not contain a unit root. That is, it is stable at different significant levels: 1%, 5%, and 10% considering that its calculated values are completely greater than MacKinnon's critical values.

Therefore, we can say that the time series of the study variables are integrated of degree I (1) and degree (0) I.

3.1.2Phillips-Perron Test:

Table 2. Results of the PP test for stability of time series

Time series in their original state			
Without constant and general trend	Constant	Constant and general trend	Variable
-1.327980	-2.101782	-2.309324	**INF**
2.860820	0.657380	-1.710916	**TCH**
-0.731972	-1.874309	-1.917993	**XGDP**
* -1.858695	-2.207771	-2.141682	**MGDP**
**-2.441087	***-4.457869	***- 4.423255	**TXGDP**
Time series after taking initial differences			
Without constant and general trend	Constant	Constant and general trend	Variable
*** -5.898025	***-5.820465	***-5.753914	**INF**

***-3.198078	***- 4.25350	-5.753914 ***	**TCH**
*** -6.186053	***-6.110513	***-6.025205	**XGDP**
*** -7.029177	***-6.933286	***-6.898520	**MGDP**
***-10.54778	*** -10.37175	***-10.21688	**TXGDP**

Source: created by researchers using Eviews 12

(***) Significant at 1% level

(**) Significant at 5% level

(*) Significant at 10% level

The previous table, based on Philippe Peron's unit root test, shows us the stability of the time series in its original state for the internal product growth rate variable (constant only), as its calculated value is completely greater than MacKinnon's critical values at different significant levels of 1%, 5%, and 10%. While the rest of the time series for other variables contain a unit root, whether there is a constant, a constant and a general trend, or without a constant and no general trend, as their calculated values are completely less than MacKinnon's critical values. Therefore, it is not considered stable at the level.

The previous table also shows that after taking the first differences of the time series for the variables of the inflation rate (without a constant and a general trend), the monetary supply (without a constant and a general trend), the exchange rate (constant only) and the rate of economic openness (without a constant and a general trend), it turns out that it does not contain a unit root. That is, it is stable at different significant levels of 1%, 5%, and 10%, given that its calculated values are completely greater than MacKinnon's critical values. Therefore, we can say that the time series for the study variables is a mixture of (1) I and (0) I.

3.2 ARDL Estimation Results

Bounds Test

To test the existence of a long-term equilibrium relationship between the variables of the study, Pesaran (Pesaran & al: 2001) suggests that counting Fisher's statistic to test the null hypothesis (H_0): the coefficient levels of the slow variables are equal to zero, in other words; nonexistence of a long-term equilibrium relationship, against the alternative hypothesis (H_1): the existence of a long-term equilibrium relationship, Pesaran & others suggested critical values for the bound test of the co-integration complementarity, according to the degree of variables complementarity i.e. are the variables complementary of the first degree (1)I, or the degree (0) I, or a mixture of both. However according to this test; if the counted F-Statistic was bigger than the highest bound of the critical values, the null hypothesis is then rejected which states the nonexistence of a long-term equilibrium relationship, but if the counted value was less than the least bound of critical values, so the null hypothesis is accepted, the following table shows the Bound Test results, we see that the counted F-Statistic (4.92) is bigger than the highest bound of the table value (4.37) with a significance value of 1%, these results confirm the rejection of the null hypothesis stating nonexistence of a long-term equilibrium relationship, based on that ; the existence of a long-term equilibrium relationship between the variables of models.

3.3. Long-Term Results Analysis

Table N°03 shows the ARDL estimation results(Autoregressive Distributed Lag), as results show that there is an equilibrium relationship on the long-term and that the mechanism of error correction does exist within the model; it is reflected by negative signal and the significance of error correction coefficient, the value of which has reached (0.73). The afore-mentioned coefficient measures the speed of return to the equilibrium over the long-term, which means 73% of short-term shocks should be corrected over long-term by a time unit estimated at 1.36 year, in other words we need more than a year to overcome this shock. The results in the table below show that the signal of the estimated coefficients has all appeared as expected; compatible with the hypothesis of the economic theory, in addition, all of them are significant with the significance level of 5%, except the variable of economic openness i.e. real economic growth impacts the inflation rate negatively, in fact, it is the same result that most previous studies has concluded. In addition, the monetary policy has had a clear and significant impact on inflation rates in Algeria because the money-supply value appeared- in its broadest sense, with a positive and significant statistical signal within significance level of 5%, this corresponds with the monetary point of view; claiming that inflation increases along with monetary growth. Furthermore, the signal of exchange rate appeared with the expected signal (negative), and significant statistically i.e. the increase in exchange rate means an increase in Dinar value and eventually exports prices will decrease, this might relieve pressure on local prices

One of the note-worthy results in table(03): the openness of economy appeared with its expected signal (positive, which means the existence of positive relationship between local inflation and economic openness) but non-significant with the level of significance of 5%, this result is expected in the case of the Algerian Economy for its link with the international market i.e. highly in importing and exporting, as the rise of prices in the parent state contributes to rising the prices of imports, and eventually local prices will rise because the local market depend on the foreign market in satisfying the needs whether with consumer goods or producer goods- manufacturing and recycling products.

Error Correctional Model Results Analysis ECM

Concerning ECM, we notice through the results shown in the table below that short-term coefficients are all compatible within the same significance and signals with long-term results. It is also noticeable that the variable of the exchange rate appeared in the short-term with a positive signal and a statistical significance unlike the results obtained in the long-term (negative signal), may be because the decrease of currency has a significance impact on inflation rates over the short-term, as decline of Dinar price undoubtedly leads to an increase of the cost with the local currency, for the inputs of products in one hand, and leads to a direct increase in imported consumer products on the other hand. All the previous mentioned reasons enhanced the local inflation; in addition, an instant impact of economic openness has appeared significant in the short-term, may be because of heavy dependence on production inputs that are imported from outside the country, and eventually this caused production costs to rise along with local prices levels.

Table 3. Results of Estimation ARDL Model

Variable	Coefficient	t-test	Sig
Estimation Results of long-term Coefficients (Dependent Variable INF)			
TCH	-0.1003	-3.87	0.00
XGDP	-1.088	-0.67	0.05
MGDP	1.15×10^{-11}	2.81	0.01
TXGDP	-4.07	-4.50	0.00
C	24.38	6.28	0.00
Results of Error Correction (ECM) Dependent Variable (Δ**INF**)			
DINF(-1)	0.54	4.21	0.00
DINF(-2)	0.26	1.86	0.07
DTCH	0.28	2.82	0.01
DXGDP	-0.40	-3.30	0.00
DXGDP(-1)	-0.005	-0.04	0.96
DXGDP(-2)	-0.32	-2.85	0.00
DMGDP	3.59×10^{-12}	1.65	0.11
DTXGDP	-0.14	-0.95	0.55
DTXGDP(-1)	2.09	3.95	0.007

DTXGDP(-2)	1.90	4.6	0.00
DTXGDP(-3)	1.48	4.34	0.00
Cont-eq(-1)	-0.73	-6.04	0.00

Normal Error Distribution (J-B)	Autocorrelation of Errors (Lm-test)	Homoscedasticity Test ARCH
0.46 (0.79)	0.78 (0.47)	0.057 (0.81)

Source: Created by the researchers using Eviews 12

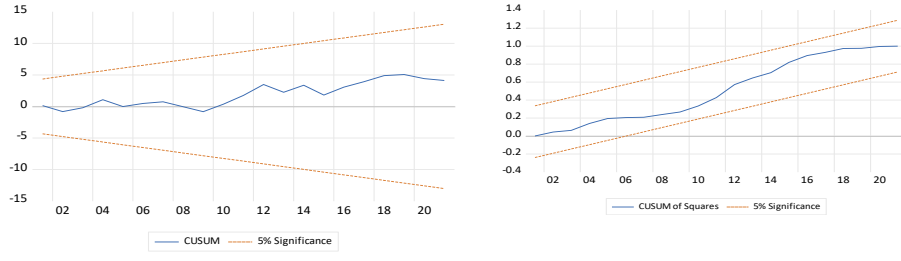
Analysis of Diagnosis Tests Results

The results of diagnosis tests in the table **N°**3 show that the model does not bear the autocorrelation problem, since the statistical value of the Test LM is equal to 0.78 and that the probable value (prob=0.47) is bigger 0.05, therefore we accept the null hypothesis stating that the model does not bear the error autocorrelation problem, in addition the same results (same table) show that errors follow the normal distribution, as the probability value of the test JB=0.79 is bigger than 0.05. Yet for the test of Heteroscedasticity, the results show that there is a homoscedasticity (the value of the test reached 0.57= Breush-pagangoldfrey) and the value of this test is equal to 0.81 which is bigger than 0.05 and therefore we accept the homoscedasticity hypothesis.

Stability Test

To confirm the nonexistence of structural changes in the current study, we used the cumulative sum of recursive residuals (cusum) and the cumulative sum of squares, as these two aim to test the existence of any change in the structure of data, the extent of stability and homogeneity of the long-term coefficients with the short-term coefficients, since the structural stability of the estimated transactions of error correction formula for the auto-regressive model of the distributed time gaps, so the Figure of these two tests is inside the critical bounds with a significance level of 5%.

Figure 1. Cumulative Sum of Recursive residuals (cusum) & the Cumulative Sum of Squares



Source: created by researchers based on Eviews 12 Outputs

NARDL Estimation Results

Table **N°04** shows NARDL estimation results, as inflation is the dependent variable, and results show that there is a co-integration and a long-term relationship reflected by negative signal and the error correction coefficient, which has reached 0.69, whereas the statistical value of the test reached t=6.60 which is bigger than the critical value with the significance level of 1%. In addition, the bound test statistical-using Wild Test refer to the existence of an equilibrium long-term relationship, whereas F=4.93 is bigger than the critical value with the significance level of 1%.

Through this test, positive shock coefficients are to be tested if they were equal to negative shocks coefficients or no, in other words whether there is a linear relation between the inflation rate and the exchange rate. The above table results show that statistical test WALD has reached a value of 2.40, which is non-significant with a significance value of 5%, this leads us to accept the null hypothesis stating that the relationship between variables is linear. But, on the short-term, WALD-Test statistic has reached 2.72-significant with a significance level of 5%, meaning that the relationship is asymmetric on the short-term between inflation and the exchange rate; nonlinear relationship. In addition, diagnosis tests show that residuals of regression equation are normally distributed using J-B test, besides it does not bear the auto-correlation problem using LM test and does not bear heteroscedasticity with the error bound using ARCH Test.

Through the table below, it is clear that positive shocks of the exchange rate has a positive relationship and a statistical significance with the inflation rate, because when the exchange rate changes by increasing with one unit, the inflation rate increases about 0.45 with the significance level of 1%, on the contrary, the negashorttive shocks impact of the exchange rate on the inflation rate is significant with a bigger coefficient that is bigger than positive shocks, meaning that prices in Algeria are rapidly influenced with decreases-negative shocks- happening in the exchange rate; decline of the currency value. However, they are less responding to improve the currency value, but over the long-term of the exchange rates positive shocks –they have a negative statistically significant relationship with inflation rate over the long-term, as when the exchange rate increases with one unit, the inflation rate decreases with about 0.15 with a significance level of 1%, yet on the contrary negative shocks impact of the exchange rate on the inflation rate over the long-term is non-significant, meaning that the rate of inflation does not get impacted by decreases happening in the exchange rate.

Table 4. Results of NARDL Model Estimation

Variable	Coefficient	t-test	Sig
Estimation Results of long-term Coefficients (Dependent Variable INF)			
TCH_POS	-0.15	-3.13	0.00

TCH_NEG	-0.36	-1.27	0.91
XGDP	-0.16	-1.09	0.28
MGDP	6.22×10^{-12}	-4	0.00
TXGDP	-3.15	-4.50	0.00
C	24.38	6.28	0.00
Results of Error Correction (ECM) Dependent Variable **(ΔINF)**			
DINF(-1)	0.32	2.79	0.01
DINF(-2)	0.31	2.31	0.02
DTCH_POS	0.45	4.19	0.00
DTCH_NEG	-1.07	-2.7	0.01
DTXGDP	-0.07	-0.35	0.55
DTXGDP(-1)	1.50	3.70	0.007
DTXGDP(-2)	1.24	3.92	0.00
DTXGDP(-3)	1.38	4.59	0.00
Cont-eq(-1)	-0.69	-6.60	0.00
Symmetry Test on Long Term WL and Short Term WS			
WS	1.90 (0.6)	WL	2.72 (0.01)

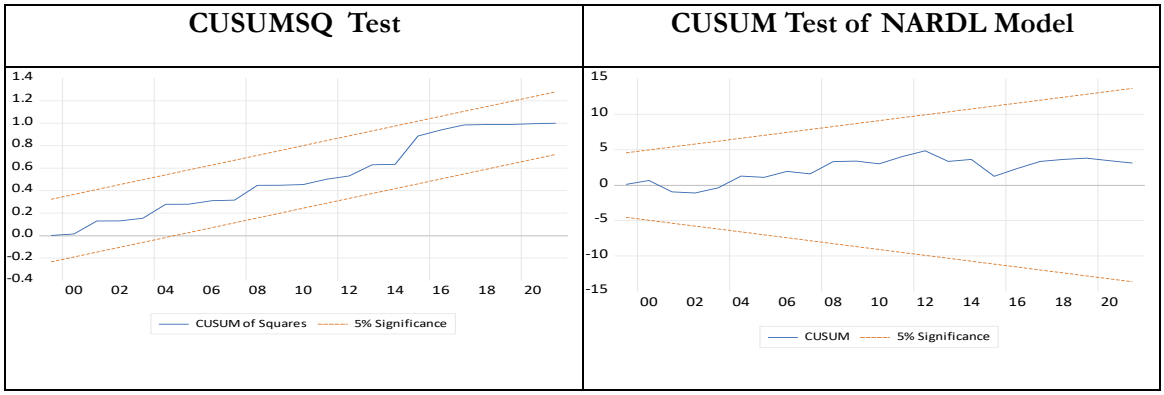
Results of Diagnosis Tests of the Estimative Model		
Normal Error Distribution (J-B)	Autocorrelation of Errors (Lm-test)	Homoscedasticity Test ARCH
0.90 (0.63)	0.76 (0.47)	0.003 (0.95)

Source: created by researchers based on Eviews 12 Outputs

Structural Stability Test of NARDL Model

The results of CUSUMSQ & CUSUM tests, show that the Figure of the two tests statistics falls inside the critical bounds with the expected significance level of 5%, which confirms the stability of estimated model coefficients on the short and long term, meaning the existence of structural stability in the model during the study period

Figure 2. Structural Stability Test of NARDL Model



Source: created by researchers based on Eviews 12 Outputs

4. CONCLUSION

This paper has focused on econometric study of the relationship between exchange rate and inflation, after confirming the stability of time series of the current study variables applying ADF Test, PP and ARDL- which showed that there is complementarity relationship between inflation and exchange rate. In addition, NARDL model, as this last has the ability to deal with time series even if it has different results. This study has come to many findings; most of them comply with the economic theory and the findings of the prior studies mentioned in the current paper. Whereas the results showed that a co-integration relationship between the exchange rate and the inflation do exist. Then, through the use of the NARDL model, we concluded that positive shocks to exchange rates are statistically negative and significant with the long-term inflation rate. On the contrary, the impact of negative shocks to the exchange rate on the long-term inflation rate is not significant, which means that the long-term inflation rate is not affected by the declines that occur in the exchange rate.

In the short-term, we have also noticed that the positive shocks of the exchange rate are statistically positive and significant with the inflation rate. On the contrary, the impact of negative shocks of the exchange rate on the inflation rate is significant and with a greater coefficient than positive shocks, this implies that prices in Algeria are affected quickly by the deterioration of the value of the currency, while they are less responsive to the improvement of the value of the currency.

Finally, it was concluded that the relationship between the exchange rate and inflation in Algeria is an asymmetric relationship in the short and long-term through the WALD test.

5. Appendices

Estimation Results

NARDL model

Long Term

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TCH_POS	-0.153674	0.049050	-3.132993	0.0047
TCH_NEG	-0.366261	0.287682	-1.273149	0.2157
TXGDP	-3.152778	0.786825	-4.006964	0.0006
MGDP	6.22E-12	3.89E-12	1.599298	0.1234
XGDP	-0.166905	0.151768	-1.099737	0.2828
C	24.22621	4.170884	5.808410	0.0000

EC = INF - (-0.1537*TCH_POS -0.3663*TCH_NEG -3.1528*TXGDP + 0.0000 *MGDP -0.1669*XGDP + 24.2262)

short Term

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF(-1))	0.324626	0.116011	2.798234	0.0102
D(INF(-2))	0.313794	0.135524	2.315412	0.0299
D(TCH_POS)	0.450264	0.107383	4.193052	0.0003
D(TCH_NEG)	-1.072615	0.395914	-2.709210	0.0125
D(TXGDP)	-0.077440	0.216893	-0.357045	0.7243
D(TXGDP(-1))	1.504416	0.405639	3.708756	0.0012
D(TXGDP(-2))	1.242609	0.316213	3.929656	0.0007
D(TXGDP(-3))	1.382779	0.300940	4.594869	0.0001
CointEq(-1)*	-0.692516	0.104921	-6.600330	0.0000

ARDL model

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TCH	-0.100383	0.025937	-3.870201	0.0009
XGDP	-0.108888	0.160818	-0.677088	0.5057
MGDP	1.15E-11	4.08E-12	2.813209	0.0104
TXGDP	-4.076675	0.904365	-4.507775	0.0002
C	24.38084	3.878088	6.286821	0.0000

EC = INF - (-0.1004*TCH -0.1089*XGDP + 0.0000*MGDP -4.0767*TXGDP + 24.3808)

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF(-1))	0.544304	0.129256	4.211039	0.0004
D(INF(-2))	0.267407	0.143154	1.867975	0.0758
D(TCH)	0.281472	0.099577	2.826663	0.0101
D(XGDP)	-0.403811	0.122143	-3.306053	0.0034
D(XGDP(-1))	-0.005326	0.117703	-0.045248	0.9643
D(XGDP(-2))	-0.325587	0.114088	-2.853820	0.0095
D(MGDP)	3.59E-12	2.17E-12	1.659082	0.1120
D(TXGDP)	-0.141946	0.236767	-0.599518	0.5552
D(TXGDP(-1))	2.099701	0.530262	3.959744	0.0007
D(TXGDP(-2))	1.907543	0.414556	4.601412	0.0002
D(TXGDP(-3))	1.488439	0.342855	4.341302	0.0003
CointEq(-1)*	-0.739357	0.122290	-6.045916	0.0000

Diagnosis Tests

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.760991	Prob. F(2,21)	0.4797
Obs*R-squared	2.567949	Prob. Chi-Square(2)	0.2769

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

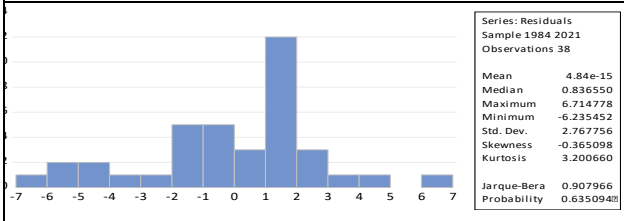
F-statistic	0.783639	Prob. F(2,19)	0.4710
Obs*R-squared	2.895694	Prob. Chi-Square(2)	0.2351

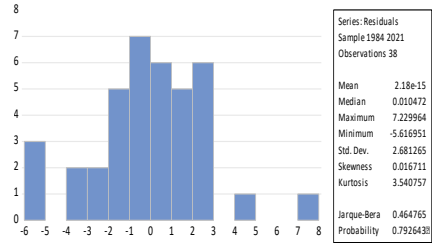
Heteroskedasticity Test: ARCH

F-statistic	0.003935	Prob. F(1,35)	0.9503
Obs*R-squared	0.004159	Prob. Chi-Square(1)	0.9486

Heteroskedasticity Test: ARCH

F-statistic	0.057461	Prob. F(1,35)	0.8120
Obs*R-squared	0.060644	Prob. Chi-Square(1)	0.8055





Bounds Test Results

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	4.935864	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	4.920609	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

6. Bibliography List :

Ben Ali, A. M., & Labza, H. (2019). The Mutual Impact between the Exchange Rate and Inflation Rates in the Algerian Economy, an Econometric Study for the Period (1990-2016). *Economic Development Review*, 1-16.

El-Gazzar, F., & El-Baramawy, A. (2022). The Impact of Asymmetric Exchange Rate Shocks on the Inflation Rate using the NARDL model. An applied study on the Egyptian economy. *Journal of the Faculty of Economics and Political Science, Cairo University*, 7-34.

Jar al-Nabi Dahiyya, J., & Nour al-Din Abdo, Z. (2022). The Impact of Asymmetric Exchange Rate Shocks on the Inflation Rate in Sudan during the Period from 1990-2021 using a Non-Liner

Autoregressive Distributed Lag NARDL, *African Journal of Advanced Studies*. 281-292.

Lafdal, S. (2021). *Imported Inflation and Exchange Rate Fluctuations and their Impact on Domestic Inflation in Algeria.* Algeria: University of Algiers 3.

Miguel, A. (1994). Exchange Policy,The Real Exchange Rate, and Inflation: Lessons from Latin America, Cuadernos de Economia, Instituto de Economia. *Pontificia Universidad Catolica de Chile*, 229-249.

Pham, T., Nguyen, T. T., Nasir, M. A., & Huynh, T. L. (2023). Exchange rate pass-through: A comparative analysis of inflation targeting & non-targeting ASEAN-5 countrie. *The Quarterly Review of Economics and Finance*, 158-167.

Salmi, A. (2015). Testing the Co-integration Relationship between the Exchange Rate and Inflation Rates in Algeria, an Applied Study for the Period (1970-2014). *The Algerian Business Performance Review the faculty of economic and commercial sciences and management*, 27-42.