

Exchange Rate Pass-Through to Consumer Prices in Algeria: an NARDL Model

انتقال أثر سعر الصرف الى أسعار المستهلك في الجزائر : نموذج الانحدار الذاتي للابطاء الموزع غير الخطي

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Received: 14/07/2025

Accepted: 17/09/2025

Published: 30/09/2025

Abstract:

This study aims to determine the potential effects of positive and negative changes in the effective nominal exchange rate of the Algerian dinar on the consumer price index during the period from 2004 to 2022. For this purpose, the NARDL model was used to test the asymmetric relationship between exchange rates and consumer prices. The results of the study showed that the relationship between these two variables is characterized by asymmetry, as the impact of the improvement in the value of the dinar is more strong and clear compared to the effects resulting from the deterioration of its value. These results call for the adoption of balanced economic policies that focus on enhancing the stability of the exchange rate and supporting domestic production in addition to working to improve inflation management in the short and long term.

Keywords : exchange rate, consumer prices, NARDL model, asymmetric effect.

JEL Classification Codes : E31, F31, F41, C22.

ملخص:

تهدف هذه الدراسة الى تحديد الآثار المحتملة للتغيرات الايجابية والسلبية في سعر الصرف الاسمي الفعال للدينار الجزائري على مؤشر أسعار المستهلك خلال الفترة الممتدة من 2004 الى 2022 حيث تم استخدام لهذا الغرض نموذج الانحدار الذاتي للابطاء الموزع غير الخطي بهدف اختبار العلاقة غير المتماثلة بين أسعار الصرف وأسعار المستهلك. وقد أظهرت نتائج الدراسة أن العلاقة بين هذين المتغيرين تتسم بعدم التماثل، حيث أن تأثير تحسن قيمة الدينار يكون أكثر قوة ووضوحا مقارنة بالآثار الناتجة عن تدهور قيمته وتدعو هذه النتائج الى تبني سياسات اقتصادية متوازنة تركز على تعزيز استقرار سعر الصرف ودعم الانتاج المحلي اضافة الى العمل على تحسين ادارة التضخم على المديين القصير والطويل.

كلمات مفتاحية : سعر الصرف، أسعار المستهلك، نموذج NARDL، التأثير غير المتماثل.

تصنيفات JEL : E31, F31, F41, C22.

Introduction:

With the growing levels of economic integration and the divergence of links at the level of international trade, there was a general trend that any shock at the level of exchange rates would affect the prices of imported goods for local use.

It is also expected that these effects will be transmitted to the prices of producers and consumers alike. Despite what is common among experts that the rise in the value of the local currency will lead to a decrease in the prices of imported goods, but on the other hand, this will be offset by adverse effects as the decline in the value of the local currency will cause a rise in import prices, which works to raise consumer prices.

On this basis, measuring the impact of exchange rate changes on price levels, or what is known economically as the phenomenon of “ passing the effects of the exchange rate ”, has become a must to understand the complex dynamic relationship between these two variables, as well as an important tool in the hands of policymakers that enables them to make optimal decisions regarding interest rates and other monetary policy tools to control inflation properly.

The concept of passing on exchange rate effects refers to the rate of change of domestic prices (imports, producer prices and consumer prices) in a country in response to changes in exchange rates. Despite the great importance of this concept in absorbing the impact of the exchange rate in pushing inflation, it goes beyond this goal to achieve other goals, such as measuring the extent to which spending levels result from exchange rate changes, which in turn affect economic activity in the real sector.

In this regard, many studies have contributed through the attempts of researchers to know the complex mechanisms by which the effects of the exchange rate are transmitted to local prices, with a focus on short- and long-term dynamics, taking into account economic conditions and structural changes in determining the behavior of the transfer of exchange rate effects in many economies, whether developed or developing.

Like many countries, Algeria faces many challenges in the face of inflation and high consumer prices domestically, especially with the collapse of oil prices starting in 2014 and then the ensuing economic recession caused by the Covid-19 pandemic at the end of the Russian-Ukrainian war in early 2022, as confronting these challenges requires working on price stability and balancing between inflation management and exchange rate policy, which requires appropriate and targeted political reactions, as well as promoting policies aimed at optimally assessing the effects of exchange rate changes on domestic prices.

Based on this, we tried through this research to estimate the potential effects of changes in the exchange rates of the Algerian dinar on consumer prices during the period 2004-2022 . In this study, we employed a self-regression model of distributed non-linear time slows with the aim of finding an adequate analysis of the effects of exchange rate changes on consumer prices in Algeria in the short and long term.

1- Literature Review :

Inflation is one of the economic phenomena affecting both developed and developing countries alike, similarly the exchange rate is considered of the key indicators reflecting the strength of a country's economy (Kadri, Tahraoui, 2022, p 507). Examining the relationship between these two indicators leads us to address the theoretical Concept known as exchange rate pass-through to consumer prices.

Exchange Rate Pass-Through (ERPT) is one of the most important models used by central banks to prepare monetary policy decisions, as this term refers to the degree to which consumer prices in a country can change in response to a change in the exchange rate.

Knowing the magnitude and duration of the transmission of this effect is also critical to understanding the impact of the exchange rate on local inflation levels (Ortega, Osbat, 2020, p 6).

It can be said that the concept of transferring the impact of the exchange rate to local prices refers to the impact that the change in the exchange rate of the local currency against foreign currencies has on the general level of prices and import prices in the first place because their prices affect the prices of local goods. Therefore, the exchange rate can be considered as a channel for transferring monetary and economic policy measures to market prices (Seddiqi, Benbouziane, 2017, p 295).

Currency value changes affect consumer prices directly and indirectly, as direct effects usually appear through changes in the prices of imported goods and the inputs of the production process, while indirect effects appear through effects on aggregate demand levels and the resulting inflationary pressures.

1-1 Direct effects :

Direct effects operate through two main channels:

- Prices of final imported goods: which become more expensive as a result of the decrease in the purchasing power of the local currency.
- Imported input prices: which also become more expensive, leading to increased production costs for local manufacturers, who in turn transfer these costs to consumers by raising prices.

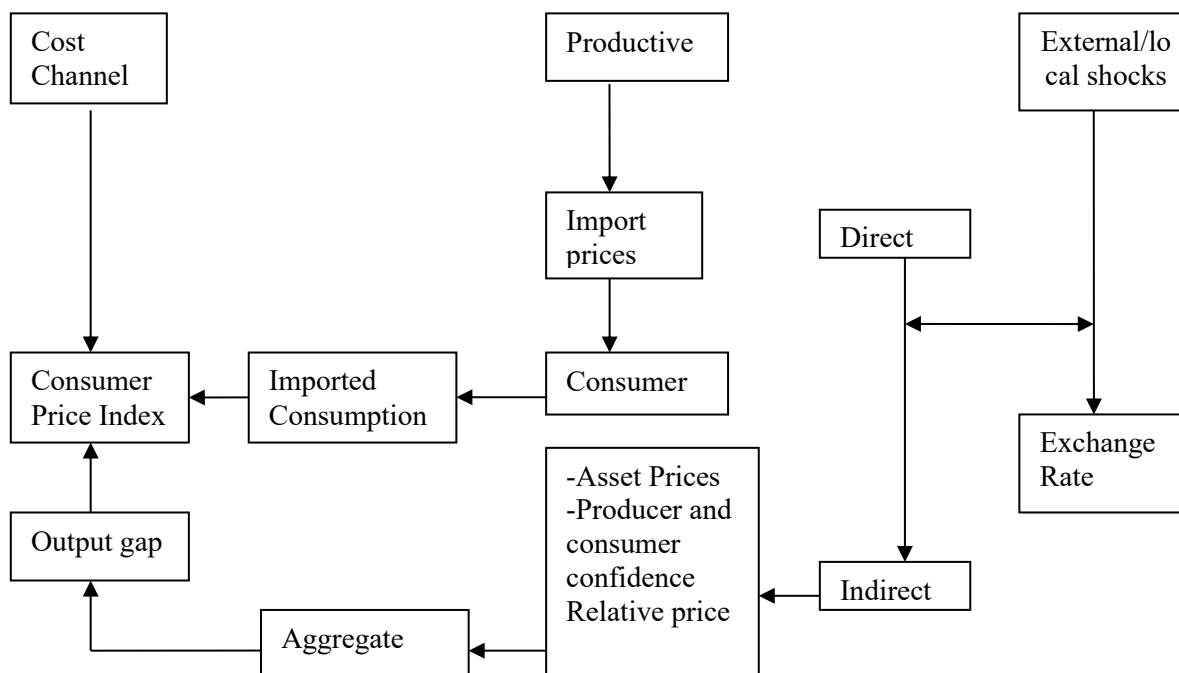
1-2 Indirect effects :

Indirect impacts are caused by changes in demand composition, aggregate demand levels and wages, through :

- Increasing demand for local goods: The high cost of imported goods drives consumers to look for local alternatives, and local exports become cheaper, which leads to increased foreign demand for them. As a result of all this, the high demand for local goods increases pressure on prices locally.
- Increasing demand for labor and wages : High demand for local goods leads to increased demand for labor, and as a result, wages can rise, which in turn reflects on consumer prices.

The following figure reflects the total direct and indirect effects that currency value changes have on consumer prices:

Fig (1) : Illustration of the channels of transmission of exchange rate shocks



Source : Cristhian Larrahondo et al, The exchange Rate Passthrough to Domestic Prices : New Evidence from Colombia, Inter-American Development Bank Working Paper, No. 01582, Washington, January 2025, p 13.

It is also worth noting that the transmission of the impact of the exchange rate may be more pronounced in certain countries compared to other countries, that is, its intensity and duration of impact are not the same, and this is in line with the nature of each economy as well as the level of trade openness, the degree of competitiveness and the nature of monetary policy in each country. Many studies in this regard suggest that exchange rate transmission is more pronounced and volatile in emerging markets due to structural economic differences and the magnitude of economic integration there as well as favorable inflationary environments (Aron and Others, 2014 , pp 102-104).

In this context, there are three theoretical insights that are interested in studying the determinants of the impact of exchange rate movement: (Central Bank of Iceland, 2011 , pp 46-47) :

- **Competitive Vision:** Increased competition in domestic markets pushes foreign producers to raise import prices within relatively acceptable limits. As a result, the prices of imported goods and consumer goods are higher to a lesser extent than they would have been if competition had been absent, making the transmission of the exchange rate effect less clear.

This type of analysis is based on the idea that exchange rate fluctuations affect consumer prices through import prices and prices of local goods that can compete in the market, so it is assumed that the greater the competition in the local market, the weaker the transmission of the exchange rate effect.

Changes in the exchange rate also affect consumer prices because of their impact on the prices of imported inputs of the production process, which are used in local production.

Therefore, the more competitive the local input market is, the weaker the impact of these changes, which reduces the transfer of the impact of the total exchange rate.

- **Cost-based vision:** According to this view, the incompleteness of the exchange rate transmission can be explained by highlighting marketing and distribution costs at the local level, which are an important factor in the composition of consumer prices. This can be explained by the fact that costs form an important part of retail prices, which limits the transmission of the exchange rate effect. For example, if the final product requires large marketing and distribution costs, any devaluation of the currency will not lead to a proportional increase in prices because a large proportion of the cost depends on internal factors.

- **Vision based on the role of the credibility of monetary policy:** This vision depends on explaining the transfer of the impact of the exchange rate on the important role played by monetary policy, as any uncertainty regarding this policy would affect the composition of wages and thus the costs of local production, and therefore this uncertainty will lead to a decrease in the amount of domestically produced goods that are priced based on internal conditions, which enhances the transfer of the impact of the exchange rate to import prices and then to consumer prices.

2- Some empirical Evidence :

- **Kehinde A. Tihamiyu 's 2022** study examining the symmetrical and asymmetrical effects of the exchange rate transition to inflation in Nigeria, using monthly data covering the period 2000 – 2021. It found that the transition of exchange rate effects to inflation is greater in the short term, with their gradual decline over time due to asymmetric effects.

- **The study of Saila Sarmin Rapti in 2024** , which aimed to analyze the effects of the transition of the exchange rate to inflation rates in the State of Bangladesh during the period 2010-2023 . The study concluded that there is no relationship between the exchange rate and the consumer price index for all commodity categories.

- **The study of Christina Andreu and Guglielmo Maria Caporale in 2023** , which aimed to find out the non-linear relationship between the transfer of the exchange rate to consumer prices and import prices in five inflation-targeting countries (the United Kingdom, Sweden, Canada, Australia and New Zealand) and three non-targeting countries (the United States, Switzerland and the Eurozone) during the period 1993-2021. It was found that the transmission of exchange rate effects is stronger in the non-linear model, and working to consolidate inflation expectations would help reduce the effects of this transition.

- **The study of Cristhian Larrahondo and others in 2025** , which aimed to estimate the impact of the exchange rate movement in the State of Colombia during the period 2006-2023, which showed that the devaluation of the currency leads to an increase in import price inflation and producer prices in addition to consumer prices in a manner consistent with the economic literature, and that the impact of this transition changes over time.

- **The study by Farouk Al-Jazzar and Adham Al-Barmawi in 2022** , which aimed to find out the effects of asymmetric exchange rate shocks on the inflation rate in the State of Egypt during the period 2016-2020 . The study concluded that the relationship between the exchange rate and the inflation rate is non-linear, and that the inflation rate in the short term is only affected by positive exchange rate shocks, while in the long term, the impact of both positive and negative shocks on the inflation rate is not significant.

- **The study of Benbouziane Mohamed and Seddiqi Abdel Karim in 2017** , which aimed to measure the extent to which the general level of prices is affected by the fluctuations in the exchange rate of the Algerian dinar using monthly data for the period 2014-2017 . The study concluded that the consumer price index is not significantly affected by changes in the official exchange rate.

- **The study of Ait Yahia Samir and Rice Fadil in 2017** , which tested the degree of transfer of the impact of fluctuations in the exchange rate of the Algerian dinar to consumer prices during the period 1995-2015 . The study concluded that the reflection of exchange rate fluctuations on the general price level was very important compared to other variables.

3- The Econometric study :

3-1 Methodology used :

In this study, we relied on the NARDL model, which is a powerful tool for analyzing asymmetric economic relations, as it can be used to understand the different effects of positive and negative changes in explanatory variables on the dependent variable. This model is also an extension of traditional co-integration models making it more suitable for dynamic economic analysis (Allen, McAleer, 2021, p 5).

The study presented by Shin et al. (2014) on modeling an asymmetric co-integration relationship between economic variables based on a non-linear ARDL model according to the following relationship :

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + u_t$$

$$x_t = v_t$$

x_t and y_t two complementary variables of the first degree I(1) so that the variable is decomposed x_t into its positive and negative components as follows :

$$x_t = x_0 + x_t^+ + x_t^-$$

x_t^+ and x_t^- Representing the total partial processes of positive and negative changes in the variable x_t , where :

$$x_t^+ = \sum_{j=1}^t \Delta x_j^+ = \sum_{j=1}^t \max (\Delta x_j, 0)$$

$$x_t^- = \sum_{j=1}^t \Delta x_j^- = \sum_{j=1}^t \min (\Delta x_j, 0)$$

3-2 Data :

Table (1) : Data used in the study

Variable	Type	Code	Data source	The study period
Consumer Price Index (CPI)	Variable, dependent (Maths.)	CPI	The Bank of Algeria	Quarterly data for the time period 2004- 2022
Effective Nominal Exchange Rate	Explanatory variable	NEER	IMF Database	
import prices	Explanatory variable	Import_price	National Bureau of Statistics	
Petroleum Price	Explanatory variable	Oil_price	Organization of Petroleum Exporting Countries (OPEC)	

This study aims to explore the possibility of an asymmetric co-integration relationship between changes in the Algerian dinar exchange rate and the consumer price index, using the non-linear ARDL model. At the same time, the standard model included two additional variables, namely oil prices and import prices, due to the great dependence of the Algerian economy on fuel revenues in economic policymaking on the one hand and on imported goods to meet the needs of the local market on the other.

Accordingly, the empirical equation used in this model is presented as follows :

$$CPI_t = \beta_1 + \beta_2 NEER_t^+ + \beta_3 NEER_t^- + \beta_4 Oil_price_t + \beta_5 Import_price_t + u_t$$

Whereas:

$\beta_1 \beta_2 \beta_3 \beta_4 \beta_5$ expresses the parameters of the model

$NEER_t^+ NEER_t^-$ Refers to partial totals of positive and negative changes in the effective nominal exchange rate NEER.

In order to analyze and improve the statistical characteristics of the model, in addition to maintaining the linear advantage in the non-linear relationship that we are studying, all variables have been converted to their logarithmic form, including the positive and negative components of the effective nominal exchange rate, so that the variables become as follows : logCPI, logNEER_POS, logNEER_NEG, logOil_price, logImport-price.

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3-3 Analyses and Discussions :

• Stability Tests :

Table (2) shows the results of the single root tests using the ADF test and the PP test, where the results show that the CPI, oil prices and import prices variables become stable at their first differences at a significance level of 5% and are therefore integrated of the first degree I(1) unlike the effective nominal exchange rate variable that appears stable at the level I(0) in the ADF test while it becomes stable after the first difference I(1) in the PP test.

Table (2) : Unit Root Test Results

Variable	ADF Testing			PP Test		
	c.Value (5%)	T-stat	P-value	c.Value (5%)	T-stat	P-value
logCPI	-3.473	-3.218	0.089	-3.473	2.623	0.272
logNEER	-3.473	-3.559	0.041	-3.473	-2.811	0.198
logOil_price	-3.473	-2.685	0.248	-3.473	-2.812	0.198
logImport-price	-3.473	-3.063	0.128	-3.473	-2.873	0.177
D(logCPI)	-3.473	-7.949	0.000	-3.473	-8.077	0.000
D(logNEER)	-	-	-	-3.473	-5.251	0.000
D(logOil_price)	-3.473	-7.590	0.000	-3.473	-7.525	0.000
D(logImport_price)	-3.473	-11.028	0.000	-3.473	-11.361	0.000

Source : Student's Calculations (Eviews Output)

• Boundary Approach Test :

Table (3) shows the results of the border approach test, through which F-statistics indicates a statistically significant relationship ($F = 16.467$) as it is greater than the upper limit of the test at all levels of significance, which means a joint integration relationship where independent variables collectively affect the consumer price index through a long-term equilibrium relationship.

Table (3) : Boundary Approach Test Results

		Critical bounds		
Statistical Value	F-Statistics	I(0)	I(1)	
		2.2	3.09	10%
		2.56	3.49	5%
		3.29	4.37	1%

Source : Student's Calculations (Eviews Output)

• **Form of long-term relationship and error correction model :**

Table (4) shows that there is a non-linear effect of exchange rates on the CPI, and these effects vary between positive and negative components of the exchange rate, which means that changes in the exchange rate of the Algerian dinar during the studied period affect consumer prices asymmetrically in the long term.

Through the table, it is also shown that positive changes in the effective nominal exchange rate do not have a significant impact on consumer prices in the long term. This is in contrast to negative changes that lead to a negative moral impact on consumer prices, as any increase in negative changes in the effective nominal exchange rate of the dinar (increasing the purchasing power of the currency) by 1% will lead to a decrease in consumer prices by 0.474%, which supports an asymmetric relationship between consumer prices and the exchange rate.

As for oil prices, their impact on consumer prices is immaterial, which reflects a weak impact compared to other factors. As for import prices, they show a significant and moral impact as they are associated with a positive relationship with consumer prices, which reflects the dependence of the Algerian economy on imports and thus their significant effects on local price levels.

Table (4) : Long-Term Relationship Transactions

Variable	Coefficient	t-Statistic	PROB
logNEER_POS	-0.130285	-0.546386	0.5867
logNEER_NEG	-0.474268	-3.980358	0.0002
logOil_price	-0.015228	-0.551741	0.5830
logImport-price	0.490798	5.051462	0.0000
(C)	2.296274	5.067109	0.0000

Source : Student's Calculations (Eviews Output)

The results of the following table also show the results of the short-term correction equation, through which it appears that the value of the error correction coefficient is negative and significant, which indicates the speed of adjustment towards long-term equilibrium, as the gaps resulting from the long-term relationship are corrected relatively quickly (14.87% per quarter).

Table (5) : Short-term relationship coefficients

Variable	Coefficient	t-Statistic	PROB
D(log_Import_price)	0.021691	1.220791	0.2266
D(log_Import_price (-1))	-0.061287	-2.834452	0.0061
D(log_Import_price (-2))	-0.046153	-2.321193	0.0235
CointEq(-1)	-0.148723	-10.32079	0.0000

Source : Student's Calculations (Eviews Output)

• Model Quality Tests :

All diagnostic tests showed that the model is statistically appropriate, and therefore it is devoid of known standard problems, as we note from Table 6 that the statistical value of Prob. $F=0.3457$ in the Breusch-godfrey LM test, which is greater than the significance level of 5%, which means that the model is free from the problem of self-correlation of errors. So is the value of Prob. $F=0.7719$ in the Breusch-Pagan-Godfrey test is greater than the significance level of 5% , which means that there is no problem of inconsistent error variation.

In addition, the result of the normal distribution test was significant, as the probability value of the test was 0.6526, which means that the model data is distributed normally.

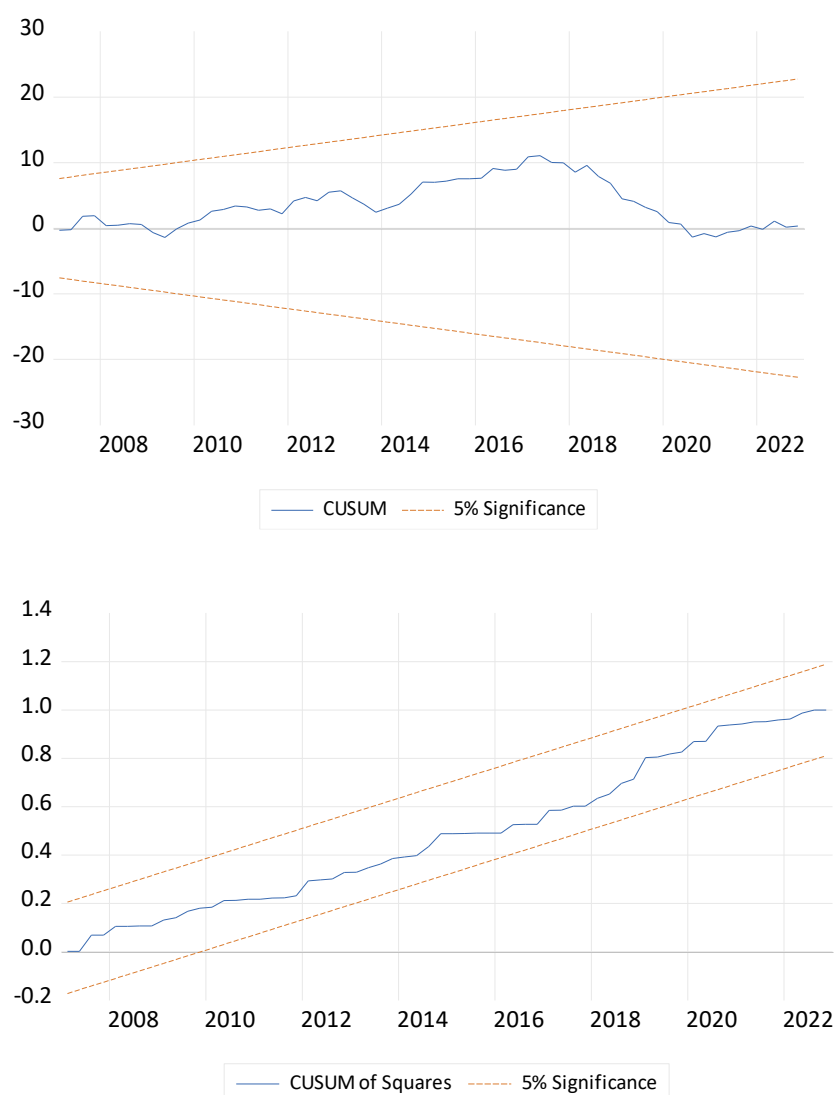
Table (6) : Results of Model Quality Tests

Breusch godfrey Serial correlation LM test			
F-Statistic	1.080677	PROB F(2.62)	0.3457
Obs*R-squared	2.459094	Prob Chi-Square(2)	0.2924
Breusch-Pagan-Godfrey Heterskedasticity test			
F-Statistic	0.603037	PROB F(8.64)	0.7719
Obs*R-squared	5.116995	Prob Chi-Square(8)	0.7450
Normality Distribution Test			
Jarque-Bera	0.853299		
Probability	0.652692		

Source : Student's Calculations (Eviews Output)

The graphs in Fig (2) show the results of the overall stability tests of the model through the tests of the cumulative sum of the residues CUSUM and the cumulative sum of the squares of the residues CUSUM OF squares, which showed that the graphical representation of the cumulative residues falls within the critical limits, which means the absence of structural changes and thus the stability of the model as a whole.

Fig (2) : Cumulative Residue and Cumulative Residue Squares Test



Source : Student's Calculations (Eviews Output)

• Effect of dynamic multipliers of exchange rates on the CPI :

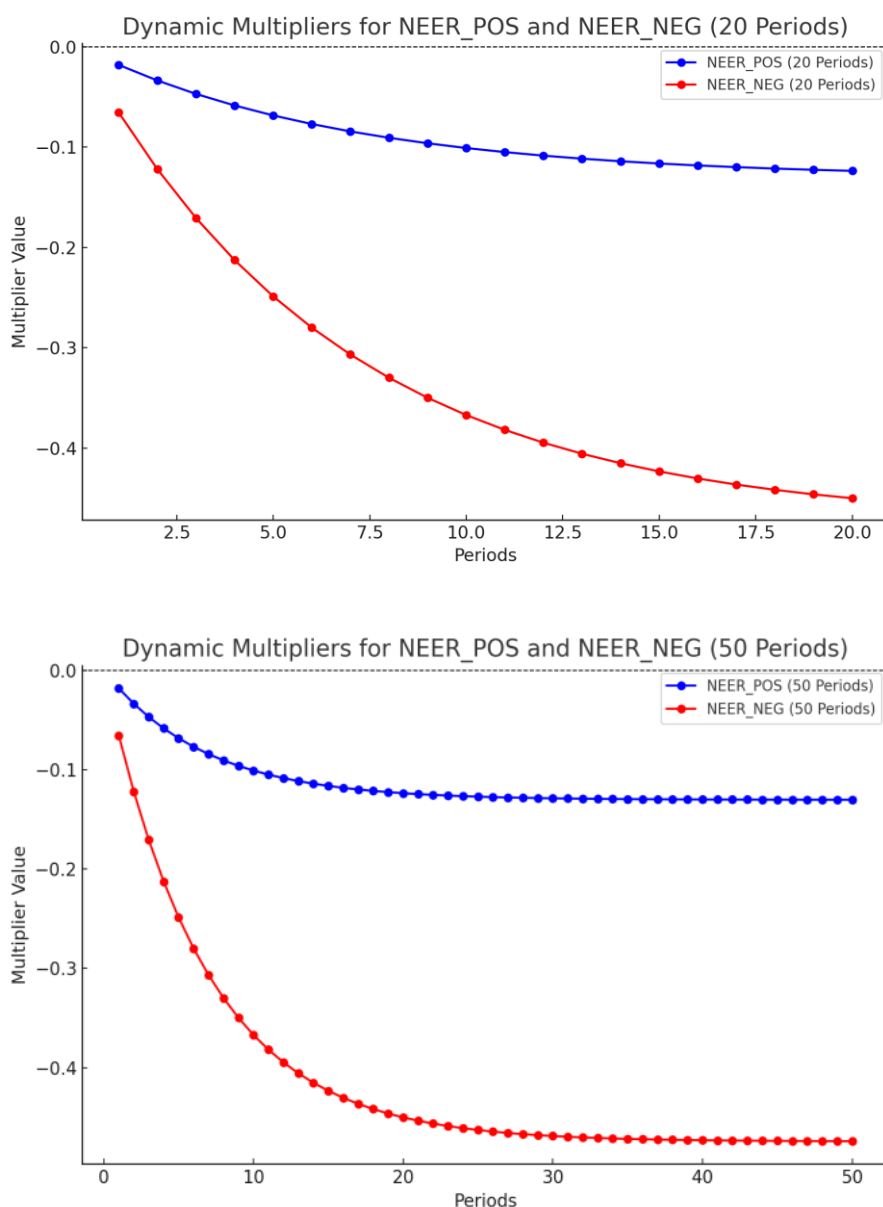
Fig (3) shows the dynamic multipliers of positive and negative changes in the effective nominal exchange rate of the Algerian Dinar and their effects on consumer prices in the short term and even achieve the full impact in the long term over different time periods (for the purpose of analysis we have chosen the time range of 20 and 50 time periods).

The two graphs show that the impact of positive changes in the exchange rate $NEER_POS$ on the CPI is very weak, as the values appear close to zero during all time periods, which is supported by the result of the coefficient in the long-term equation (-0.13). The impact is moving towards stability relatively quickly, which indicates that positive changes in the effective nominal exchange rate have a limited and non-permanent impact on consumer prices.

As for the negative changes in the exchange rate $NEER_NEG$, their impact on the consumer price index is significantly greater, as the index decreases to more negative values, to reach the final effect (-0.474), which means that the negative changes in the effective nominal exchange rate lead to a significant decrease in consumer prices. In addition, the impact of these changes takes a relatively longer time to stabilize, indicating that negative changes in the effective nominal exchange rate have a stronger and longer-lasting impact.

Fig (3) : Dynamic multipliers of the effective nominal exchange rate on the CPI

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Source : Student's Calculations

Conclusion :

In this study, we analyzed the expected effects of effective nominal exchange rate fluctuations of the Algerian dinar on the consumer price index using the NARDL model through which we aimed to explore the asymmetric relationship between the exchange rate and consumer prices in the Algerian economy.

The results reveal that the depreciation of the Algerian dinar did not have significant negative effects on consumer prices in the long term, contrary to what economic theory assumes, which may indicate that there are other factors that may contain the negative impact of this variable, perhaps the most important of which are the policies to support the prices of basic materials (such as fuel and food) pursued by the Algerian authorities, which constitute a barrier to potential shocks in the dinar exchange rate. In addition, the depreciation of the Dinar may stimulate economic activity by creating a competitive atmosphere between local

institutions, which makes the dynamics of production rise with the accompanying abundance of goods and products. Therefore, the effects of the depreciation of the Dinar do not fully transfer to consumer prices.

The results also proved that the impact of the improvement in the value of the Algerian Dinar has greater effects on domestic prices in the long term, reflecting the importance of exchange rate stability in reducing the inflation rate. On the other hand, the results of this study showed an asymmetry in the impact of changes in the Dinar exchange rate on consumer prices, as the negative changes that reflect the strengthening of the competitive currency position had a moral and direct impact on reducing consumer prices, while the positive changes that reflect the devaluation of the currency did not have an important impact.

Our reliance on oil prices and import prices in this study as additional explanatory variables showed that import prices had a significant moral impact on the price index, which reflects the dependence of the Algerian economy on imports, which enhances the possibility of the presence of imported inflation to a high degree. This is the opposite of oil prices, which had little moral impact, despite the Algerian economy's dependence on the hydrocarbon sector, which may be justified by regulatory barriers, subsidy policies and government spending.

Therefore, the following recommendations can be made:

- Working to strengthen the exchange rate of the Algerian Dinar through policies aimed at reducing exchange rate fluctuations, especially those related to avoiding the negative effects of currency devaluation.
- Working to reduce dependence on imported goods to meet the needs of the local market in order to reduce the sensitivity of the economy to the fluctuations in import prices and promote policies that support local production.
- Working to find practical mechanisms to manage the effects of imported inflation by adopting trade policies that contribute to protecting the local economy from the negative effects of high international prices, such as reviewing trade agreements and reducing the volume of unnecessary imports.
- Adopting flexible pricing policies that allow prices to change gradually in line with the real situation of changes in production costs, while working to find appropriate mechanisms to support pricing in the short term in order to mitigate the effects of potential shocks.

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