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Abstract:

This article aims to study the effectiveness and symmetry of the transmission of monetary policy in Algeria through the channels of interest rates, credit, and exchange rates in both the short and long term, using the Nonlinear Autoregressive Distributed Lag (NARDL) method. The study of asymmetric effects of monetary policy channels on both output and prices stability is of paramount value for monetary policy analysis and implementation. The results have shown that the transmission of monetary policy in Algeria exhibits an asymmetric nature, except for the effect of bank lending interest rates on real gross domestic product and inflation and that the traditional interest rate channel is the most effective in transmitting the effects of monetary policy to real gross domestic product, while positive variations in credit volume are most effective in the long term, and negative changes in the exchange rate are the most efficient in the short-term concerning the transmission to inflation.

Key words: Monetary Policy, NARDL, Monetary Policy Transmission Channels, Inflation, Gross National Produc.

JEL Classification Codes : E42, E52, E58, F31.

Introduction :

Algeria is characterized as a small open economy, exhibiting a substantial reliance on the exportation of hydrocarbon commodities. Throughout its history, commencing from the year of its independence in 1962, Algeria had steadfastly adhered to a planned economy framework. However, by the late 1980s and early 1990s, the Algerian authorities deemed it necessary to embark on a series of reforms with the objective of transitioning towards an open-market liberal model. This transformation was instigated by a profound economic crisis, predominantly precipitated by inefficiencies in resource allocation, manifested primarily in the form of a substantial escalation in inflation rates. Notably, the inflation rate surged from 5.91% in 1986 to 29.78% in 1995, with a zenith recorded at 31.67% in 1990, as documented by the World Bank Database. One of the foremost challenges confronting the Algerian economy pertains to the unregulated oscillation of its economic cycles and the prominence of both external and internal output and monetary disruptions. These challenges are intrinsically linked to Algeria's pronounced dependency on hydrocarbon resources (Economic Research Forum, 2017), fiscal imbalances (Kazianga, 2016), the dearth of economic diversification (Bouzid, 2016), and the prevalence of an informal economic sector (Benachenhou, 2013).

Among other actions, efficient planning and the effective implementation of monetary policy measures hold paramount significance in achieving both economic growth and price stability (Mishkin, F. S. 2009) Consequently, it is imperative that the monetary authorities in Algeria, notably the Bank of Algeria, possess a profound understanding of the characteristics, efficacy, and ramifications associated with the prospective measures they enact. Such insight is essential for discerning the tangible impact of these measures on both economic output and price levels.

The primary aim of this paper is to investigate the impact of monetary transmission channels on both real gross domestic product (GDP) and the inflation rate, measured as the year-over-year growth of the consumer price index, in Algeria. This analysis is

conducted in the context of the monetary reforms initiated in the country since 1990. The study seeks to address two fundamental questions:

To what extent did the short-term interest rates, credit, and exchange rate channels exert a substantial influence on economic output and price levels in Algeria during the period spanning from 1995 to 2019?

Was this impact characterized by an asymmetric nature, implying differential effects under positive and negative monetary policy adjustments?

The significance of this research is underscored by the central role played by monetary policy transmission channels in influencing the dynamics of price stability, as elucidated by (Woodford, 2003), and the pursuit of output stabilization within an economy, as emphasized by (Romer and Romer, 2002). The efficacy of these channels in conveying policy signals from central banks to the broader economic milieu has garnered significant attention within the academic sphere, encompassing both developed and developing nations. Furthermore, it is noteworthy that the utilization of nonlinear models in economic analysis holds the potential to provide more precise insights into the repercussions of policy interventions. Economic policies frequently engender nonlinear effects on critical variables such as inflation, employment, and economic growth. Thus, gaining a comprehensive understanding of these nonlinearities assumes pivotal importance in the context of crafting policies that are efficacious in design and implementation, a point articulated by (Uhlig, 2005). Within the Algerian economy context, the study of monetary policy transmission channels got a lot of traction, many scholars have used different econometric frameworks mainly vector autoregressive models (Boudriga and Taktak, 2009); (Ben Abdallah and Kichian, 2007); (Benhlima and Guttierrez, 2011); (Boutalouni and Boutalouni, 2019). In the other hand, the study of the asymmetric transmission of monetary policy needs more attention, as per our survey of existing literature only few research had covered the subject (Mokhtari et AL., 2021) and we hope that this study will complete and enrich these initiatives.

Within the articles we will try to answer to the following questions:

- Does the short-term credit rates, credit volume and real effective exchange rate channels of monetary policy transmission effective in Algeria.
- Is the effect on monetary policy transmission channels showing an asymmetric pattern.

We make the hypothesis that the short-term credit rate, credit volumes and real effective exchange rate will show an asymmetric impact on output and inflation in the short and long term. Along the article we will start by a literature review section highlighting some of the important research works relevant to our study in the second section we will present the methodology and data used for the research, in the third section we will present the results and discussions finally we will provide a conclusion including key findings and recommendations.

1. Theoretical concepts and literature review:

Monetary policy transmission channels play a pivotal role in shaping the dynamics of price stability and output stabilization within an economy. The effectiveness of these channels in transmitting policy signals from central banks to the broader economic landscape has been a subject of keen scholarly interest. This section aims to underscore the paramount importance of comprehending and harnessing these channels to attain macroeconomic stability, by briefly describing the importance of monetary policy in the process of output and price stabilization, highlighting the role of monetary policy transmission channels, enumerating the generally identified channels of transmission, emphasise the importance of studying non-linear behaviour of economic phenomenon and finally review some academic research pertaining to the transmission monetary transmission channels in Algeria to put in perspective the aim of our study.

1.1 The role of monetary policy in price and output stability:

The role of monetary policy in price stabilization stretches over a range of topics, including inflation targeting, inflation dynamics, and the interaction between monetary

policy and exchange rates. Ben S. Bernanke and Frederic S. Mishkin (1997) introduces the concept of inflation targeting as a framework for conducting monetary policy their article discusses the role of central banks in maintaining price stability and outlines the benefits and challenges of inflation targeting. The study highlights the importance of a clear and transparent monetary policy framework focused on price stability. It emphasizes that anchoring inflation expectations is crucial for effective price stabilization. On the same direction Lars E. O. Svensson (2010) research assesses the impact of inflation targeting as a monetary policy framework in various countries. It analyses whether inflation targeting helps central banks achieve their price stability objectives. The study finds that inflation targeting can be effective in reducing inflation and stabilizing prices when implemented with commitment and credibility. It also highlights the importance of communication and transparency in achieving these goals. Monetary policy also plays a major role in the reduction of exchange rate volatility especially for small open economies as it is the case of Algerian economy Devereux and Engel (2003) showed that that small open economies may face trade-offs between exchange rate stability and inflation control. It suggests that a credible commitment to price stability is essential for minimizing exchange rate volatility.

Moreover, output stabilization, involving the mitigation of economic fluctuations and the pursuit of full employment, is another key objective. The study by Romer and Romer (2002) explores how monetary policy can contribute to output stabilization by countering adverse economic shocks.

1.2 The role of monetary policy in price and output stability:

Monetary policy transmission channels, encompassing mechanisms such as the interest rate channel, bank lending channel, asset price channel, and exchange rate channel, act as conduits through which central bank policy actions influence key economic variables. The literature has extensively explored their efficacy in affecting price levels and economic output.

For instance, research by Bernanke and Gertler (1995) has emphasized the significance of the bank lending channel in transmitting monetary policy impulses to credit markets and, consequently, to real economic activity. On the other hand, Mishkin and Schmidt-Hebbel (2001) have highlighted the role of the exchange rate channel in influencing inflation dynamics through its impact on import prices.

According to established literature monetary policy is transmitted through the following channels:

Interest Rate Channel: This is one of the most fundamental channels of monetary policy transmission. When a central bank changes its policy interest rates (like the federal funds rate in the U.S.), it influences the interest rates in the broader economy. Lowering interest rates encourages borrowing and spending, which can stimulate economic activity, while raising rates can have the opposite effect.

Bank Lending Channel: Central bank policy changes can also affect the behavior of banks. Lower interest rates can reduce borrowing costs for banks, making it cheaper for them to lend to consumers and businesses. This can stimulate lending and investment. Conversely, higher rates can make borrowing more expensive, potentially leading to reduced lending and economic slowdown.

Asset Price Channel: Changes in monetary policy can influence the prices of financial assets such as stocks and bonds. When interest rates are low, investors may be more inclined to invest in riskier assets like stocks, potentially boosting equity markets. Conversely, higher interest rates may lead to a shift towards safer assets like bonds.

Exchange Rate Channel: Alterations in interest rates can affect a country's exchange rate. For example, if a central bank raises interest rates, it can attract foreign capital seeking higher returns, leading to an appreciation of the domestic currency. A stronger domestic currency can have various effects on exports and imports, impacting a country's trade balance and overall economic activity.

Expectations Channel: Central banks often use forward guidance to signal their future policy intentions. When people and businesses anticipate the central bank's actions, they may adjust their behaviour accordingly. For instance, if the central bank communicates a commitment to low-interest rates for an extended period, it can encourage borrowing and spending.

Credit Channel: Changes in monetary policy can affect the availability and cost of credit for households and businesses. When interest rates are lowered, it can lead to easier credit conditions, making it easier for consumers to finance purchases and businesses to invest.

Balance Sheet Channel: Central banks can influence the size and composition of their balance sheets through various policy tools, such as quantitative easing (QE). Expanding the balance sheet by purchasing assets can inject liquidity into the financial system, lower long-term interest rates, and stimulate economic activity.

1.3 The Importance of asymmetric modeling in monetary policy assessment context:

As for all economic perspectives the non-linear modeling of monetary policy related aspects has shown substantial benefits that can be summarized in the following points:

Realism and Complexity: Real-world economic systems are often characterized by nonlinear relationships and complex interactions among various factors. Studying nonlinear phenomena allows economists to develop models that better reflect the intricacies of economic behaviour (Brock & Durlauf, 2001).

Better Policy Analysis: Nonlinear models can provide more accurate insights into the effects of policy interventions. Economic policies often have nonlinear effects on variables like inflation, employment, and growth, and understanding these nonlinearities is crucial for effective policy design (Uhlig, 2005).

Risk Management: Nonlinear models are essential for assessing and managing economic risks. Financial crises, for example, often result from nonlinear dynamics in financial

markets, and understanding these nonlinearities is vital for risk assessment (Dungey et al., 2010).

Asset Pricing: In finance, the pricing of assets and derivatives often involves nonlinear models. Studying nonlinearities is crucial for understanding asset price movements and developing more accurate pricing models (Duffie, 2001).

Behavioural Economics: Nonlinear models can help explain deviations from rational economic behaviour. Behavioural economics often relies on nonlinear models to capture decision-making processes that depart from standard economic assumptions (Kahneman & Tversky, 1979).

Complex Systems: Nonlinear dynamics are a fundamental feature of complex systems, including economic systems. The study of nonlinear phenomena is essential for understanding emergent behaviours and systemic risks (Haldane, 2011).

2. Methodology and data.

2.1 Methodology.

In the realm of econometrics, understanding the intricate relationships between economic variables is imperative for accurate modelling and informed policy decisions. Conventional linear models, while valuable, often fall short in capturing the complexities of real-world interactions. The Nonlinear Autoregressive Distributed Lag (NARDL) methodology, introduced by Shin, Yu, and Greenwood-Nimmo in their seminal work "Modelling Asymmetric Cointegration and Dynamic Multipliers in an ARDL Framework" (Shin Et. AL. ,2014), offers a pioneering approach that transcends the limitations of linearity.

We will estimate two models using the NARDL fundamental equation as below :

Model 1 : will be used to capture the effects of monetary transmission channels on real gross domestic product and will be of the form :

$$\Delta Y_t = \alpha_0 + \sum_{j=0}^{q} \beta_j \Delta X_{t-j} + \sum_{K=1}^{r} \gamma_K \Delta X_{t-K}^{+} + \sum_{l=1}^{s} \delta_l \Delta X_{t-K}^{-} + \varepsilon_t \quad \text{Eq. (1)}$$

Where:

Y_t : represents the differentiated real gross domestic product.

ΔX_{t-j}: Represents a vector of differentiated values of independent variables of monetary transmission channels with a lag of j (ie. Lending interest rate, credit volume to economy and real effective exchange rate).

ΔX_{t-K}^{+} : Represents a vector of differentiated values of positive asymmetric effect of independent variables of monetary transmission channels with a lag of k (ie. Lending interest rate, credit volume to economy and real effective exchange rate).

ΔX_{t-K}^{-} : Represents a vector of differentiated values of negative asymmetric effect of independent variables of monetary transmission channels with a lag of k (ie. Lending interest rate, credit volume to economy and real effective exchange rate).

$\alpha 0$ represents the intercept coefficient, while εt denotes the error term.

To illustrate further, let's delve into the asymmetric terms. The positive asymmetric effect (ΔX_{t-k}^{+}) is defined as:

$$\Delta X_{t-k}^{+} = \begin{cases} \Delta X_{t-k}; & If\ \Delta X_{t-k} > 0 \\ 0; & Otherwise \end{cases}$$

Conversely, the negative asymmetric effect (ΔX_{t-k}^{-}) is expressed as:

$$\Delta X_{t-k}^{-} = \begin{cases} \Delta X_{t-k}; & If\ \Delta X_{t-k} < 0 \\ 0; & Otherwise \end{cases}$$

The second model will be constructed in the same way except that the dependant variable Y_t will stand for inflation.

After estimating the two models we will first test for variables stationarity, determinate optimal lags, assess the existence of long term cointegration, proceed to th F-statistic bound test as per method developed within ARDL framework (Pesaran et Al., 2001), test for models fitting quality, assess the asymmetric nature of the transmission

channels through the asymmetric dynamic multiplier curves and finally discuss the obtained results.

2.2 USED DATA.

To study the asymmetric effects of monetary transmission channels on Algerian real economy outcomes we have collected and compiled Quarterly data from various sources. The used data are as follow:

2.2.1 Monetary Policy Transmission Channels Data:

Real Commercial banks landing rates (RLR):

Quarterly data of nominal lending rates in Algeria ranging from Q1-1995 to Q4-2019 extracted from the International Financial Statistics database of the international monetary fund. The real interest rate was calculated by subtracting inflation rate from the nominal interest rates. We use of real interest rates instead of the nominal values since the transmission of monetary policy to the economy operates through the real interest rate as stated by the works of Taylor.J.B.(Taylor, 1993) and confirmed by Frederic S. Mishkin (Mishkin, 2011).

Total Volume of credits allocated to the Algerian economy (CV):

Quarterly data of Total Volume of credits allocated to the Algerian economy from Q3-2006 to Q3-2019 was extracted manually form the quarterly statistical Bulletins of the Bank of Algeria. We used Annual Data from 1999 to 2006 to interpolate Quarterly data for the corresponding period.

Real Effective Exchange Rate (REER):

Quarterly data of real effective exchange rates of the Algerian dinars ranging from Q1-1995 to Q4-2019 obtained from the IMF's International Financial statistics database.

The decision to choose the real effective exchange rate instead of the nominal exchange rate of Algerian Dinars is motivated by the fact that the main objective of the exchange rate policy in Algeria since 1990 is the stabilisation of the Real effective exchange rate as stated in the 2009 report on the monetary and economic evolution in Algeria (BA, 2010).

The REER is a synthetic index of global competitiveness of national economy, that take in account the commercial exchanges between Algeria and 15 of the main countries in terms of trade volume with Algeria (representing 88% of total trade volume in 1995) (Bank of Algeria , 2010).

2.2.2 Real Economy data:

Real Gross Domestic Product (RGDP):

Quarterly data of actual values of the gross domestic product ranging from Q1-1999 to Q4-2019 obtained from the National office statistics (ONS). The real gross domestic product was calculated.

Inflation Rate (INF):

Quarterly data of inflation rate (YoY percentage change of consumer price index) ranging from Q1-1995 to Q4-2019 was obtained from the IMF's International Financial Statistics database (International Monetary Fund, 2020)

The following table represent the main statistics of the used data:

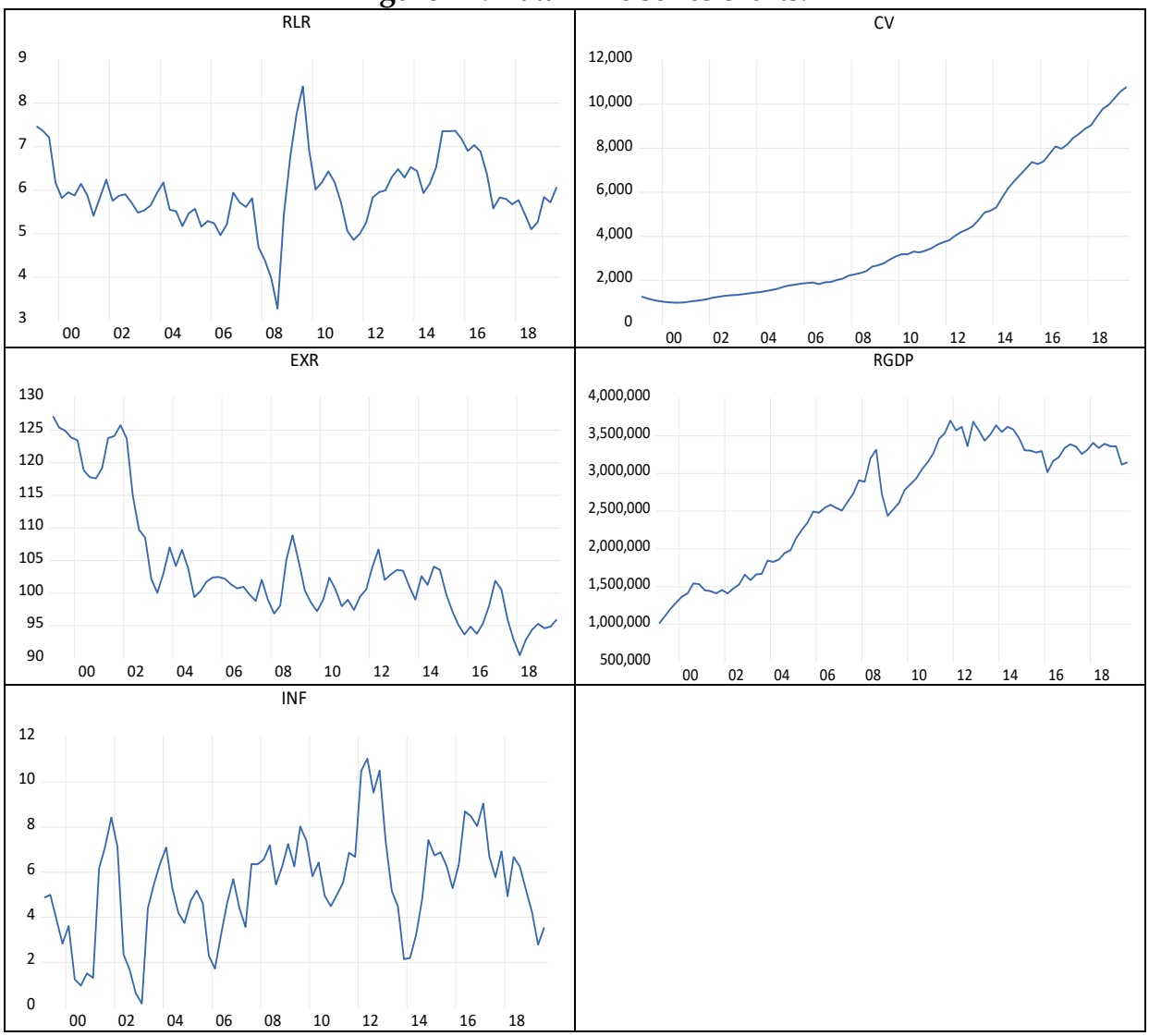
Table -1-: Main Statistics of used data

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Observations
RLR	5.93	5.83	8.38	3.27	0.82	0.12	4.27	83.00
CV	3902.56	2774.10	10780.30	980.99	2937.83	0.90	2.47	83.00
REER	103.93	101.34	127.13	90.49	9.19	1.24	3.54	83.00
RGDP	2654231	2890807	3701754	1013149	813844.80	-0.50	1.81	83.00
INF	2.40	5.63	37.43	-0.38	0.98	-0.13	3.04	83.00

Source: Compiled by author using Eviews12 output.

While the following graphics shows the trend of the studied time series (dependent variables and regressors):

Figure -1-: Data Time series charts.



Source: Compiled by author using Eviews12 output.

3. Results and discussion

3.1 Stationarity Tests: An essential facet of time series analysis involves the examination of stationarity, wherein the ARDL (Autoregressive Distributed Lag) methodology, and by extension, the NARDL (Nonlinear Autoregressive Distributed Lag) methodology, remain consistent regardless of whether the regressors exhibit integration of order zero (I(0)) or integration of order one (I(1)), as demonstrated by Pesaran et al. (2001), it is imperative to note that the inclusion of regressors with integration of order two (I(2))

renders the employment of the bound testing procedure infeasible that is the reason we still need to conduct stationarity tests. We conducted stationarity tests using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods, with the respective results presented in Tables 2 and 3 below.

Table -2- : Stationarity test of the studies time series

UNIT ROOT TEST TABLE (PP)						
At Levels						
		RLR	CV	EXR	RGDP	INF
With Intercept	t-Statistic	-10.13	7.002	-2.470	-2.041	-3.647
	Prob.	0.000	1.000	0.126	0.269	0.007
With intercept and trend	t-Statistic	-6.719	0.041	-2.673	-1.199	-3.910
	Prob.	0.000	0.996	0.251	0.904	0.016
None	t-Statistic	-2.588	11.978	-1.574	1.030	-1.783
	Prob.	0.010	1.000	0.108	0.919	0.071
UNIT ROOT TEST TABLE (ADF)						
At Levels						
		RLR	CV	EXR	RGDP	INF
With Intercept	t-Statistic	-9.337	8.139	-2.598	-2.040	-2.477
	Prob.	0.000	1.000	0.098	0.270	0.125
With intercept and trend	t-Statistic	-9.236	0.088	-3.246	-1.169	-3.641
	Prob.	0.000	0.997	0.083	0.910	0.033
None	t-Statistic	0.080	13.867	-1.284	1.101	-0.831
	Prob.	0.705	1.000	0.182	0.929	0.353

Source: Compiled by author using Eviews12 output.

The table –3- below summarizes the level of integration of the dependant variables and the monetary policy channels regressors used within our study.

Table -3- : Summary of the integration level of the studied variables.

Variable	of Degree integration
RLR	0
Cv	1
EXR	1
RGDP	1
INF	1

Source: Compiled by author using Eviews12 output.

According to the results obtained from the variables stationarity tests, especially the fact that all the variables are either I(0) or I(1), the NARDL method can be confidently used

to assess the relationship between these variables. Based on the results of stationarity tests that indicated that the variables in the two models we are trying to estimate are integrated at order (I0) or at order (I1), there is a possibility of a long-term equilibrium relationship between the explanatory variables related to monetary policy channels and the dependent variables, namely real GDP and inflation rate.

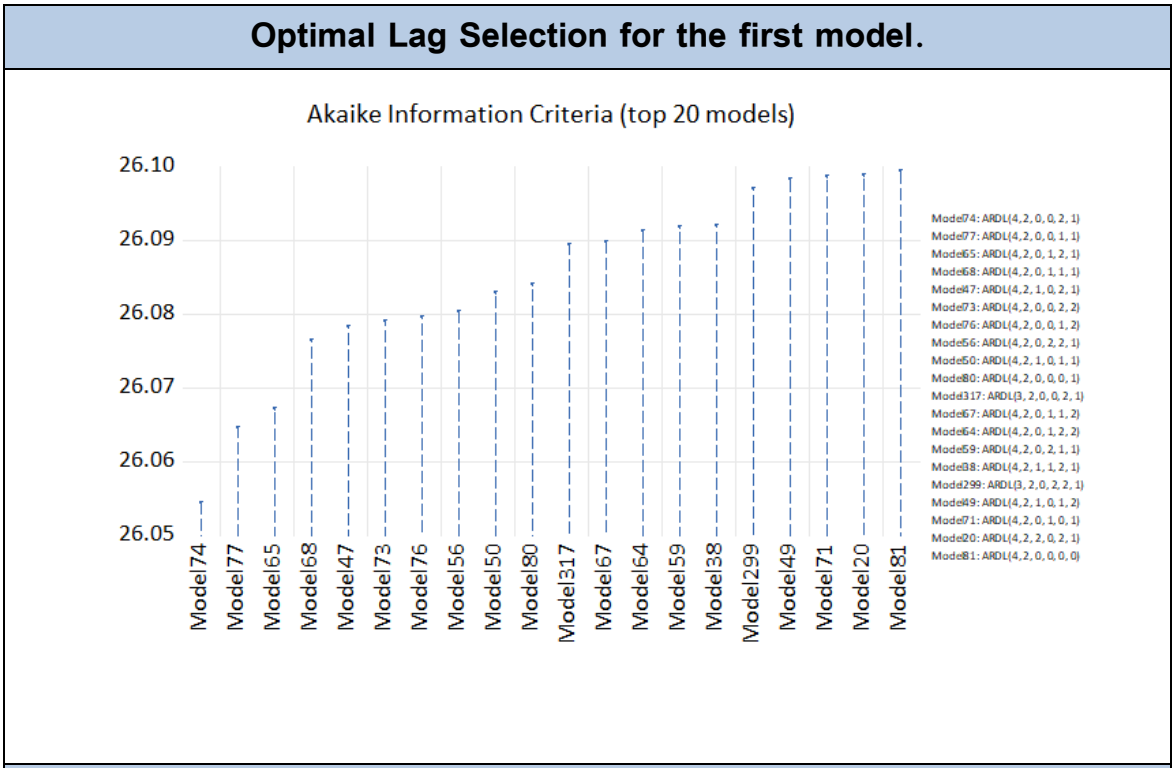
Next, the optimal lag order for the variables included in models will be determined as a first step to apply the bounds test (BOND TEST).

3.2 Optimal lags selection

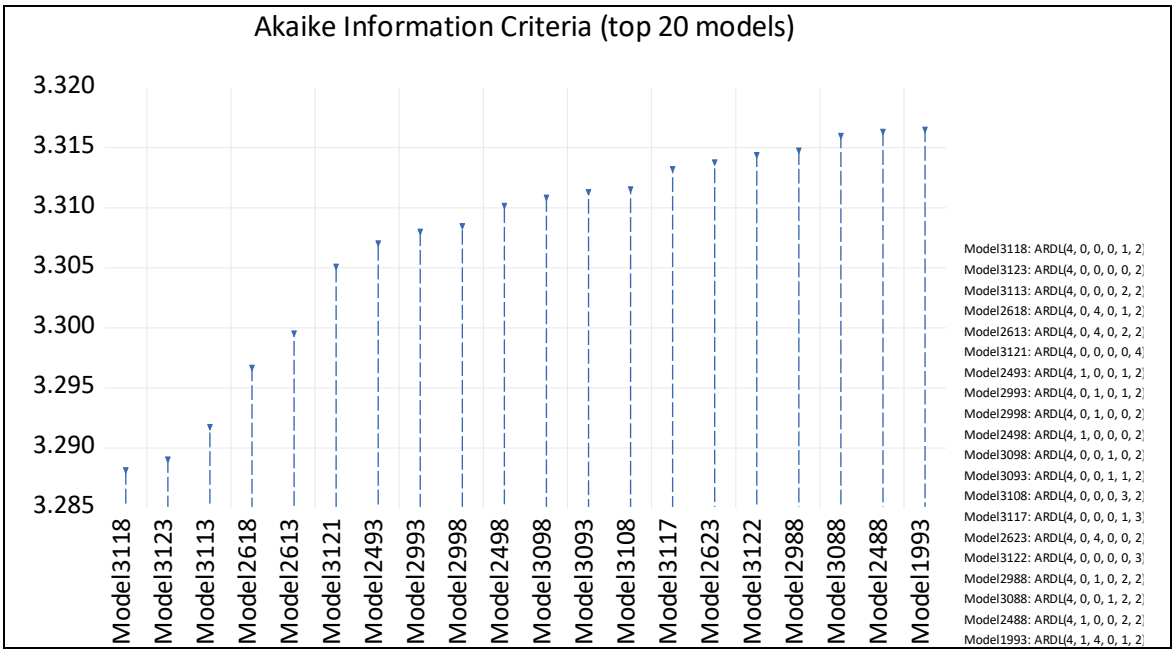
We will use the Akaike information criterion to select the most appropriate lag orders, the results of this procedure are shown in figure -2- Below, corresponding to the first and second model.

Figure -2-: Time Lag Selection.

Optimal Lag Selection for the first model.



Optimal Lag Selection for the second model.



Source: Compiled by author using Eviews12 output.

According to the above figure the lags that minimizes the AIK criterion for the first model are (1,2,0,0,4) which are the optimal lags orders for the model used to study the impact of monetary policy channels on the gross domestic product in Algeria. When the lags that minimizes the AIK criterion for the second model are (4,0,0,0,1,2) which are the optimal lags orders for the model used to study the impact of monetary policy channels on the inflation rate.

3.3 Long Term Cointegration.

The table -4- Below represents the results of the NARDL Long Term estimated models and the results of the bound tests.

Table -4- : NARDL MODELS ESTIMATION RESULTS

long term NARDL form					long term NARDL form				
First model : dependant variable d(RGDP)					second model : dependant variable d(INF)				
Selected Model: ARDL(4, 2, 0, 0, 2, 1)					Selected Model: ARDL(4, 0, 0, 0, 1, 2)				
Variable	Coef	Std, E	t-Stat	Prob,	Variable	Coef	Std, E	t-Stat	Prob,
C	601062,7	272268,2	2,21	0,03	INF(-1)*	-0,81	0,12	-6,97	0
RGDP(-1)*	-0,18	0,07	-2,59	0,01	RLR**	0,08	0,13	0,66	0,51
LR(-1)	-64468,89	27705,79	-2,33	0,02	CV_POS**	0	0	-3,55	0
CV_POS**	-83,61	24,86	-3,36	0	CV_NEG**	-0,01	0	-2,37	0,02
CV_NEG**	-208,42	400,81	-0,52	0,6	EXR_POS(-1)	0,13	0,05	2,77	0,01
EXR_POS(-1)	9900,07	6057,32	1,63	0,11	EXR_NEG(-1)	0,03	0,03	1,1	0,27
EXR_NEG(-1)	-3130,68	2382,45	-1,31	0,19	D(INF(-1))	0,52	0,11	4,77	0
D(RGDP(-1))	-0,33	0,12	-2,78	0,01	D(INF(-2))	0,36	0,1	3,46	0
D(RGDP(-2))	-0,28	0,12	-2,41	0,02	D(INF(-3))	0,42	0,1	4,1	0
D(RGDP(-3))	-0,22	0,11	-2	0,05	D(EXR_POS)	0,27	0,11	2,46	0,02
D(LR)	-162961,5	33151,78	-4,92	0	D(EXR_NEG)	0,14	0,1	1,48	0,14
D(LR(-1))	-73857,6	28814,9	-2,56	0,01	D(EXR_NEG(-1	-0,22	0,09	-2,4	0,02
D(EXR_POS)	-9693,44	9783,28	-0,99	0,33					
D(EXR_POS(-1	-15404,87	10129,55	-1,52	0,13					
D(EXR_NEG)	14696,12	8168,62	1,8	0,08					
Long term coefficients (conitegraion)					Long term coefficients (conitegraion)				
Variable	Coef	Std, E	t-Stat	Prob,	Variable	Coef	Std, E	t-Stat	Prob,
LR	-351567,7	159647,2	-2,2	0,03	RLR	0,1	0,16	0,66	0,51
CV_POS	-455,97	127,24	-3,58	0	CV_POS	0	0	-4,4	0
CV_NEG	-1136,6	2267,48	-0,5	0,62	CV_NEG	-0,01	0	-2,64	0,01
EXR_POS	53987,95	21217,4	2,54	0,01	EXR_POS	0,16	0,05	3,16	0
EXR_NEG	-17072,51	14943,71	-1,14	0,26	EXR_NEG	0,04	0,03	1,13	0,26
EC = RGDP - (-351567,7489*RLR -455,9670*CV_POS - 1136,5971*CV_NEG +53987,9546*EXR_POS -17072,5126*EXR_NEG)					EC = INF - (0,1042*RLR-0,0009*CV_POS -0,0096*CV_NEG + 0,1628*EXR_POS +0,0369*EXR_NEG)				
F-Bounds Test					F-Bounds Test				
Null Hypothesis: No levels relationship					Null Hypothesis: No levels relationship				
Test Statistic	Value	Signif,	I(0)	I(1)	Test Statistic	Value	Signif,	I(0)	I(1)
F-statistic	4,88	Finite Sample: n=80			F-statistic	8,56	Finite Sample: n=80		
k	5	10%	2,36	3,5	k	5	10%	1,81	2,93
Size	79	5%	2,79	4,02	Size	79	5%	2,14	3,34
		1%	3,73	5,16			1%	2,82	4,21

Source: Compiled by author using Eviews12 output.

From the obtained results, it is evident that error correction coefficients for the models are associated with a negative sign. Specifically, the error correction coefficient values for the first and second models are (-0.18) and (-0.81) respectively, with corresponding p-values of (0.03) and (0.00). These probability values are lower than the critical value (0.05), indicating that the statistical values of the student's t-test for error correction coefficients in these models are significantly greater than their corresponding tabulated values. This implies the acceptance of the alternative hypothesis, which suggests that the error correction coefficients for these models are statistically significant. Consequently, they

satisfy both the necessary and sufficient conditions assumed for error correction coefficients in Nonlinear Autoregressive Distributed Lag (NARDL) models.

These coefficients represent the speed of adjustment towards equilibrium from the short run to the long run among the variables. The time required for the error correction coefficient to correct short-run deviations and reach equilibrium in the long run for the first model is calculated as (1/0.18 = 5.55), approximately equivalent to 5 quarters and 50 days, or roughly 4 months and 20 days. Similarly, for the second model, the necessary time to correct short-run deviations and attain long-run equilibrium is calculated as (1/0.81 = 1.23), approximately equal to 1 quarter and 21 days.

3.4 F-Statistic Bound tests.

Next, we will proceed to the F-statistic bound tests according to the method described in Pesaran et al. Upon referring to the previous table, it becomes apparent that the statistical value (f-stat=4.88) for the boundary test of the first model exceeds the upper or critical value as tabulated by Pessaran & Shin (Pesaran&Shin, 2001), which stands at (4.02) with (k=5) degrees of freedom and a significance level of (5%). Hence, one may conclude the existence of a long-term equilibrium relationship in the first model concerning the channels of monetary policy transmission, specifically, the commercial loan interest rate (LR), total credit volume (CV), and exchange rate (EXR), along with the dependent variable in this model represented by the real Gross Domestic Product (RGDP).

As for the second model, the statistical value (f-stat=8.56) has also surpassed the upper tabulated critical value (3.35) at (k=5) degrees of freedom and a significance level of (5%). Consequently, the boundary test suggests the presence of a long-term equilibrium relationship in the fifth model, specifically pertaining to the commercial loan interest rate (LR), total credit volume (CV), and exchange rate (EXR), along with the dependent variable in this model represented by the inflation rate (INF).

Based on the results of the cointegration tests, which include the presence of statistically significant negative coefficients for error correction terms along with the fulfilment of

boundary test assumptions, it is reasonable to infer the existence of a long-term equilibrium relationship between the monetary policy transmission channel variables considered in the study and both the real Gross Domestic Product and the inflation rate. Therefore, the autoregressive distributed lag methodology for analyzing the non-symmetric transition of monetary policy transmission channels toward real economic variables can be confidently employed with a high degree of reliability.

3.5 Asymmetric Cumulative response curves:

The dynamic nonlinear cumulative multiplier can be exploited for following the pattern that the system under study adopts to accommodate positive and negative shocks, ultimately reaching a new equilibrium state in the long term. This will be done only for Volume of credit and exchange rate passthroughs as they exhibit non-asymmetric pattern.

One of the key characteristics of NARDL models used in this study is the ability to apply both positive and negative shocks to the independent variables and compare how they are transmitted to the dependent variable. This is illustrated in figures 1 to 4 (in Annexe) for shocks in each of them on production and inflation levels in Algeria.

It is clearly apparent from the exhibited results that the transmission of monetary policy stance through the channels of Credit offer and real effective exchange rate are of asymmetric Nature.

3.6 Models Quality assessment and econometric tests:

3.6.1 Models total fitting goodness and determination power:

The following table summarize the total fitting statistical values and determination power of the two models.

Table -5- : Fitting Goodness of the two models.

	First Model		Model Second	
	Velue	.Prob	Value	.Prob
R-squared	**0.98**		**0,78**	
F-statistic	**308,66**	**0.00**	**18,94**	**0.00**
Durbin-Watson stat	**2,07**		**1,72**	

Source: Compiled by author using Eviews12 output.

The statistical value of Fisher's test for Model 1 (f-stat=308.66) reached a probability value of (0.00), which is significantly lower than the critical value (0.05). In other words, the statistical value of Fisher's test for Model 1 is well below the absolute value of the corresponding tabulated value. Therefore, we can accept the alternative hypothesis for this test, indicating that Model 1 is statistically significant. On the other hand, for Model 2, the statistical value of Fisher's test (f-stat=18.94) yielded a probability value of (0.00), which is also significantly lower than the critical value (0.05). Thus, the alternative hypothesis can be accepted for Model 5 as well, signifying that Model 5 is also statistically significant.

The determination factor for the first model (R^2 =0.98) is very high, reflecting the strong explanatory power of the independent variables. The changes in the channels of monetary policy transmission variables included in the first model explain (98%) of the variations in real GDP, with the remaining (2%) accounting for unmodeled factors and measurement errors. It's worth noting that the value of (DW=2.07) is close to the value of 2, which refutes the possibility of autocorrelation issues in the first model. This will be confirmed through econometric tests adopted in this study.

The determination factor for the second model (R^2=0.78) is also high, reflecting the capacity of the variables related to the channels of monetary policy transmission in the second model to explain changes in the inflation rate. It explains (78%) of the variations, with the remaining (22%) being linked to other factors and unmodeled variables included in the error term. Similarly, the statistical value (DW=1.78) is close to the value of 2, indicating a low likelihood of autocorrelation among the remaining estimates.

3.6.2 Models Quality tests:

The aim of these tests is to ensure that there are no classical measurement problems in the study's two models (autocorrelation issues, heteroscedasticity, non-normal distribution of residuals). These problems can lead to biased and misleading estimates of model parameters. Additionally, two structural stability tests specific to NARDL models have been adopted, namely the Ramsey RESET test and the Cumulative Sum (CUSUM) test. The results of these tests are summarized in the following table and figure:

Table -6- : Models Quality tests.

Model	Type of test	Test	Value	Prob.
One	Error Auto-correlation	Breusch-Godfrey Serial Correlation LM Tes	1,05	0,35
	Heteroskedasticity	Heteroskedasticity Test : ARCH	0,38	0,53
	Natural distribution of errors test	Jacques-Berra Test	3,96	0,13
	regression specification error test	Ramsey RESET Test	2,43	0,12
Two	Error Auto-correlation	Breusch-Godfrey Serial Correlation LM Tes	3,69	0,2
	Heteroskedasticity	Heteroskedasticity Test: ARCH	0,81	0,36
	Natural distribution of errors test	Jacques-Berra Test	1,64	0,44
	regression specification error test	Ramsey RESET Test	1,006	0,32

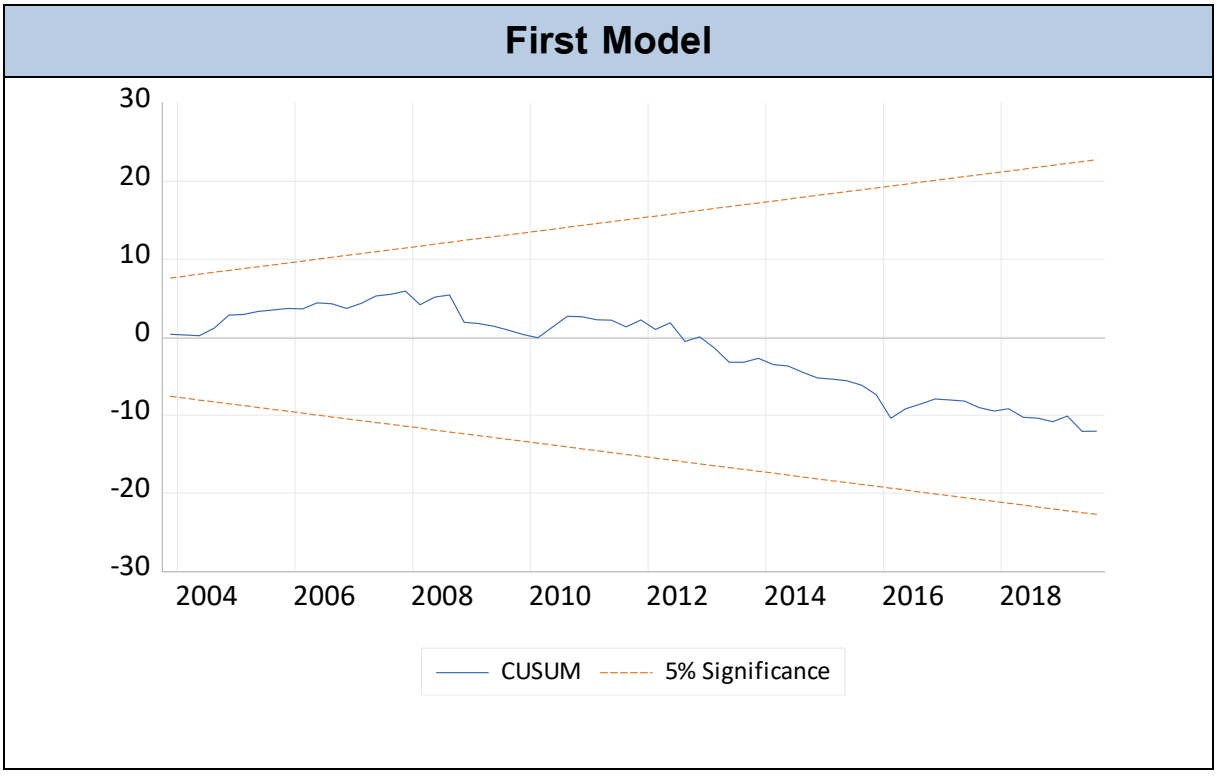
Source: By Author using Eviews 12.

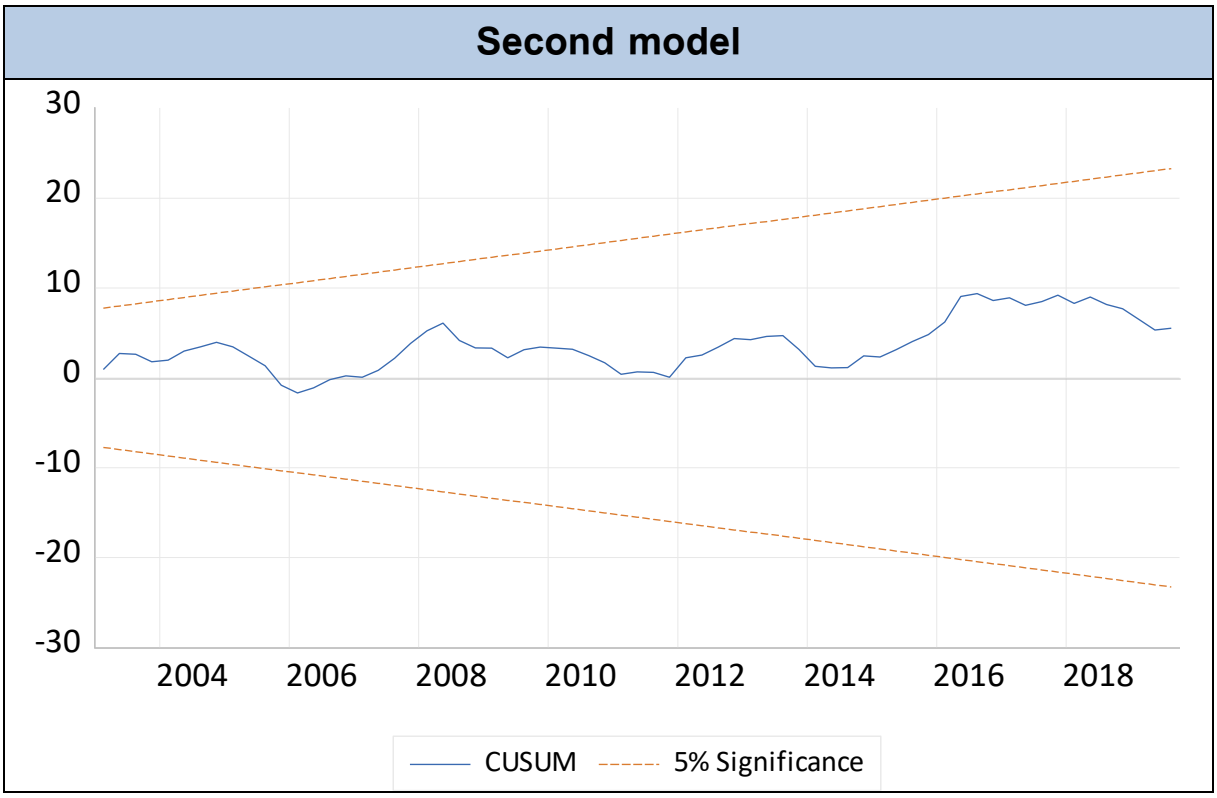
The tests presented in the table above are based on somewhat similar hypotheses, where the null hypothesis assumes the absence of measurement problems in the estimated models during the study period, while the alternative hypothesis assumes the opposite result. From table -6-, it is observed that the statistical values for the tests of heteroskedasticity (ARCH), normal distribution of residuals (Jarque-Bera), and serial correlation of errors (Breusch-Godfrey Serial Correlation LM Test) for the first model are (0.38, 3.96, 1.05) respectively. These values are lower than the corresponding critical

values because the probability values for the mentioned tests accompanying the statistical values are less than the critical value (0.05). Therefore, the null hypothesis can be accepted, indicating that the first model under study does not suffer from heteroskedasticity or serial correlation of errors, and the residuals of the fourth model follow a normal distribution. As for the Ramsey RESET Test, the statistical value is (2.43) with a probability value of (0.12), which is much lower than the critical value (0.00). This implies that the functional form adopted for the fourth model is suitable for the study's data. Regarding the second model, it appears that the probability values associated with the statistics related to the four measurement problems mentioned in the table above are all greater than the critical value (0.05). Thus, the model does not suffer from any measurement problems, whether related to serial correlation of errors, heteroskedasticity, normal distribution of residuals, or functional form suitability.

The following figure represents the Cumulative Sum (CUSUM) test for structural stability for the fourth and fifth models, respectively:

Figure -3- : CUSUM Tests results for the two models.





Source: Compiled by author using Eviews12 output.

Through the above figure, it is evident that the cumulative values (in blue) fall within the confidence intervals (in red lines). Consequently, the estimations of the study's model exhibit stability throughout the entire time period under consideration.

3.7 Results discussion.

Based on the previously presented results, it appears that the real gross domestic product (GDP) only responds to positive shocks in commercial loan interest rates. The negative sign associated with the short-term interest rates variable suggests its inverse impact on real GDP. A 1% increase in interest rates leads to a decrease in real GDP by a value of 162,961 Algerian Dinars. Similarly, a 1% increase with a one-quarter lag in interest rates results in a decrease in real GDP by a value of 73,857 Algerian Dinars. These high elasticities indicate the effectiveness of the impact on real GDP through interest rate increases. This effect aligns with economic theory, which posits that rising commercial interest rates negatively affect the investment capacity of institutions, leading to a decline in their productive capacity.

The estimated dynamic model does not show any short-term impact of changes in the volume of loans directed to the economy and the exchange rate, whether positive or negative, at a significance level of 5%. However, there is a positive effect of the lagged exchange rate at one period with an elasticity of 14,696.12 at a significance level of 10%.

Considering the long-term forward transactions related to Model Four, it is evident that the positively valued variable of commercial interest rates had a negative impact on real gross domestic product (GDP) in the long term. An increase in bank interest rates by 1% could lead to an increase in real GDP by a value of 351,567.7 Algerian Dinars. This high elasticity also reflects the significant effect of increasing interest rates in commercial banks on raising real GDP in the long term. This aligns with the expectations of economic theory.

Based on the estimation results presented earlier, it appears that the inflation rate is positively influenced by positive values in the real effective exchange rate. An increase in the real effective exchange rate by one unit leads to a 0.27% increase in the inflation rate, which contradicts economic theory. Furthermore, the estimation results indicate that the national income is inversely affected by negative shocks in the exchange rate, with a lag of one quarter and a elasticity coefficient of -0.22, with a significance level of 0.12. Based on the estimation results presented earlier, it appears that the inflation rate is positively influenced by positive values in the volume of loans directed to the economy. An increase in the volume of loans by one unit leads to a 0.1-point increase in the inflation rate. This result can be economically explained by the increase in the money supply resulting from the higher volume of loans, ultimately leading to a rise in the overall price level. The estimation results also indicate that the inflation rate responds inversely to negative shocks in the volume of loans directed to the economy. A decrease in the volume of loans can potentially raise the inflation rate, which contradicts economic theory.

Conclusion:

The aim of the present research work was to study the asymmetric effect of monetary policy stance on production and prices stability in Algeria using the NARDL framework. The study conclusions can be presented as follows:

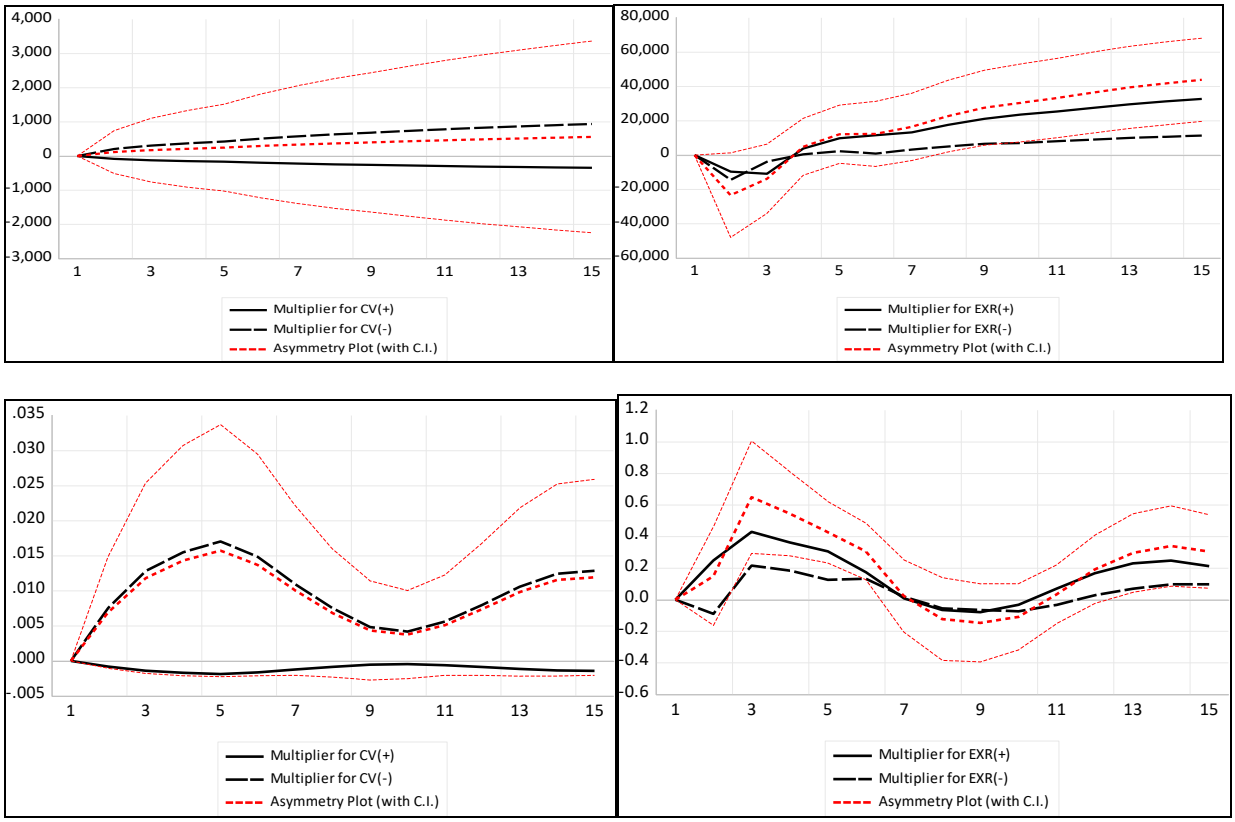
- The existence of a co-integration relationship between the channels of monetary policy transmission and real gross domestic product implies a return to long-term equilibrium. By monitoring the error correction equation coefficients in the estimated model, it is evident that when a monetary policy shock occurs, the GDP returns to equilibrium after a period of 16 months and 20 days. The estimation results also indicate that the short-term impact of monetary policy on the national output is only transmitted through the commercial loan interest rate channel. However, in the long term, in addition to the interest rate, an increase in the volume of loans directed to the economy and the real effective exchange rate have a significant impact, contradicting economic expectations.
- The existence of a co-integration relationship between the channels of monetary policy transmission and the inflation rate implies a long-term equilibrium. By monitoring the error correction equation coefficients in the estimated model, it is evident that when a shock occurs in the channels of monetary policy transmission, the output returns to equilibrium after a period of 111 days. The estimation results indicate that inflation responds to changes in the real effective exchange rate in the short term, with a decrease in the Algerian dinar exchange rate leading to an increase in the inflation rate. However, this effect becomes statistically insignificant at equilibrium (long term). An appreciation of the exchange rate in the short term has a statistically significant effect, but it contradicts economic theory. In the long term, an increase in the volume of loans directed to the economy has a statistically significant impact, in line with economic theory, while a decrease has a statistically significant impact contrary to economic expectations.

- Monetary policy transmission in Algeria during the studied period is characterized by a generally non-linear nature. The examination of the response

functions of the dynamic nonlinear cumulative multiplier shows that the transmission channels asymmetrically affect production and inflation levels. This applies to all channels except for the loan interest rate.

Appendices.

Figure (1 to 4): Dynamic response of GDP and inflation to credit volume and exchange rate*.



The source: By author using Eviews 12 outputs.

*: Top left : Credit volume effect on GDP, top right: Exchange rate effect on GDP, bottom left: Credit volume effect on Inflation, bottom right: Exchange rate effect on inflation

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