

THE ASYMMETRIC EFFECT OF MONETARY POLICY ON CORE INFLATION IN JORDAN: NARDL MODEL

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Abstract. *This study aimed to estimate the asymmetric impact of monetary policy on core inflation rates in Jordan during the period 2000-2020 using the Nonlinear Autoregressive Distributed Lag Model (NARDL) Based on quarterly data. The unit root tests showed the different degrees of integration by applying the Augmented Dickey-Fuller Test (ADF) and Philip Perron (P.P). and have a cointegration relationship using Johansson's test, and the Bound test. Also, there is a nonlinear relationship in the time series using the waled test. The study used Core Inflation (CORINF) as a dependent variable (calculated based on excluding energy and food prices method) and the overnight deposit rate (CBJR), the loan and advances interest rate (LR), the growth in money supply (GM2), and the growth in real GDP (GRGDP) used as independent variables. The results indicated that there are asymmetric effects of both CBJR and GM2 on core inflation, as a 1% increase in GM2 leads to an increase in the CORINF by 1.3%, while its decrease by 1% leads to a decrease in the CORINF by 1.2%, in contrast, an increase in the LR by 1% leads to a decrease in the CORINF by 0.15% and a decrease by 1% leads to a rise in the CORINF by 0.44%, and the study also found that a rise in LR by 1% lead to a decrease in the CORINF by 0.43%, while its decrease by 1% leads to a rise in the CORINF by 0.44%.*

Keywords: Nonlinear Autoregressive Distributed Lag Model (NARDL), core inflation, monetary policy, asymmetric effect.

JEL Codes: C32, E31, F31

1. INTRODUCTION

The role of monetary policy in economic thought has emerged since the nineteenth century, then its role increased after the occurrence of economic and monetary crises, especially during the Great Depression from the end of the twenties until the beginning of the thirties after the classic inability to find solutions to this crisis, until the economic and its balance and the development of thought in this field until quantitative theories and mechanisms of impact transmission the economist John Keynes came up with monetary ideas to confront this depression and try to return monetary stability to modern trends, which borrowed the use of price captive monetary tools such as overnight deposit window rate and interbank lending and the quantity such as the deposit window and certificates of deposit and repurchase agreement.

Many studies have proven that there is a typical transitional effect from the monetary sector to the real sector and an influential role in maintaining the stability of inflation rates by controlling monetary tools (Smets, 2018). It is reflected positively on the rate of Inflation, and therefore lower interest rates contribute to an increase in purchasing power and aggregate demand, which leads to an increase in the growth rate of GDP. Monetary policy is one of the most important economic policies that countries follow to confront economic problems by influencing economic variables, which prompted researchers to study the relationships between monetary policy indicators and economic variables to measure the effects that may be unclear due to the neutrality of money, as stated in the classical theory, however, that there are short-term and long-term relationships, and these relationships may have an asymmetric effect. Therefore, the

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importance of the study is manifested in the statement of the asymmetric effects of monetary policy on core inflation rates by estimating the Nonlinear Autoregressive Distributed Lag Model (NARDL) on Jordan's economy. The importance of the study comes from the importance of estimating nonlinear relationships, as it considers all the effects that may not be visible in linear relationships. Accordingly, the problem is not knowing the nonlinear effect between interest rates and the introductory inflation rate in Jordan. Accordingly, this study aims to estimate the effects using different variables compared to the previous study. It also employs the Nonlinear Autoregressive Distributed Lag Model (NARDL) on quarterly data for the Jordanian economy and estimates the monetary effect on core inflation, as it is characterized by giving more accurate results in the analysis of relationships rather than headline inflation.

2. LITERATURE REVIEW

Economic literature confirmed that Inflation is one of the reasons for the sustainability of economic activity, and it must be within a specific range consistent with the economic situation (Fakhri, 2011), as well as has pointed out the different theories in determining the sources of Inflation, in the classical theory is based on the money supply there is a positive and direct effect between money supply and Inflation as the increase in the money supply leads to increase of demand for goods and services this leads to a rise in the level of prices (decrease in purchasing power) (Anwar, 2021). Also, Fisher's rise in interest rates leads to a decrease in the demand for money (increasing the cost of credit), which leads to a decline in aggregate demand and lower prices (Mahdi, 2011). From the viewpoint of Keynesians, Inflation occurs as a result of a rise in aggregate demand for consumption, investment, and government spending, which is called demand-pull Inflation; the inflationary gap appears whenever aggregate demand increases at a rate higher than aggregate supply at the level of full employment so Inflation increases with this increase the gap, and he also emphasized the effective role of monetary and fiscal policy in reducing this Inflation by increasing taxes and controlling the money supply (Al-Zoubi et al., 2013). The Keynesian theory assumes another factor for Inflation that results from the rise in the cost of production causes a rise in commodity prices. Therefore, he called it cost-push Inflation and referred to the reason for cost-push Inflation as the result of the monopolistic companies raising the prices of goods to cover production costs and achieve profits which was also called profit-paying Inflation (Totonchi, 2011).

The monetary theory came in opposition to the ideas of Keynes and supported the classical theory in an edition of the positive impact of money supply and negative interest rates on the rate of Inflation, but this is in the long term as for the short term, it saw that there are non-monetary factors associated with financial procedures and the effects of cost payment and lack of supply, especially in the field of food and energy, which leads to higher prices, which may be associated with an excessive increase in the money supply the monetary point of view is summarized by what Friedman said that Inflation is a monetary phenomenon directly related to money supply and has nothing to do with employment costs or aggregate demand (Frimpong, 2021).

When analyzing individual consumption, we find that many elements in the consumer basket are affected by non-monetary factors that lead to remarkably high fluctuations in price levels in the short term; it is one of the problems that are difficult to control from the monetary authority of applying monetary policy these fluctuations are often linked to supply shocks, which constitute an obstacle to economic decision-makers in implementing monetary policy so that many studies such as (Amstad et al., 2014) and (Lao & Steyn, 2019) suggested ways to exclude the monetary policy unstable elements usually include food prices associated with weather fluctuations and seasonal fluctuations and energy prices that are determined globally and are linked to many global factors, including political turmoil in some countries.

Accordingly, the process of rebalancing the components of Inflation is carried out to derive core inflation. Hence the importance of core inflation emerged as an essential tool in making appropriate decisions to achieve stability in the general level of prices as a target for monetary policy as well as creating forecasts of inflation rates with high accuracy (Alassaf & Alawin, 2018).

The importance of core inflation has emerged in many studies, as Mankikar& Paisley (2002) referred to the role of core inflation for monetary policymakers as a good indicator for predicting inflationary trends and determining the expected course of the target inflation rate within a short period. (Cockerell,1999) He also showed the relationship between core inflation and monetary policy, as he referred to the role of core inflation in the conduct and management of monetary policy, as it provides a valuable analysis of current and future trends after excluding short-term price fluctuations.

Some studies presented opposing views to the ideas presented previously, such as the study (Bollard, 2011) which downplayed the importance of core inflation and focused on the headline inflation rate, arguing that monetary policy measures can be developed effectively to suit Fluctuations in prices without the need for measures of core inflation, as well as (Labonte, 2008) indicated that core inflation did not do any good in affecting the side of wages, wealth, returns, as well as social security payments. Therefore, family income is adjusted based on general Inflation, which represents the most significant part of the consumer basket and excludes core inflation.

Studies and research indicated that there is a linear relationship between monetary policy tools and Inflation, but the difference between them is like the impact, whether it is positive or negative. Additionally, few studies dealt with asymmetric effects, especially on the core inflation rate. The study (Lee & Yu, 2021) analyzed the impact of money supply on Inflation and economic growth in China during the period (1980-2018) using the ARDL model, and the study concluded that there is a positive impact of money supply on the inflation rate in the short and long term.

The study (Nagao & et al.,2021) examined the economic effects of monetary policy on macroeconomic variables in Japan based on the VAR model where the study concluded that higher interest rates lead to a significant decrease in Inflation and production rates and a decrease in the money supply leads to a decrease Inflation and production rates.

The study (Khan, 2020) estimated the causal relationship between the interest rate and Inflation in the United Kingdom during the period (1988-2017) using the VAR model, and the results of the study indicated that each variable causes the other in the short term while in the long term the interest rate it does not cause Inflation.

The study (Shokr& et al.,2019) aimed to study the effects of monetary policy and external shocks on production, Inflation, and the exchange rate in the Egyptian economy using the SVAR model based on quarterly data during the period (1991-2011), and the results indicated in the aspect of the impact on Inflation that there is a negative impact of interest rates on Inflation, as well as a positive impact of the money supply on Inflation.

In Russia, a study (Smirnov & Tlostanov, 2019) evaluated the impact of monetary policy on the inflation rate using the SVAR model where the study concluded that there is a positive impact of money supply on the rate of Inflation there are also indications of a positive effect of the interbank lending rate on the inflation rate.

The study (Nguyen & et al., 2019) an analysis of the impact of monetary policy on Inflation in the Vietnamese economy during the period 2000-2016 using the VAR model; the study found the rate of

Inflation that there is a negative impact on interest rates on the inflation rate in addition to a positive effect on the money supply on the rate of Inflation.

In Vietnam, the study (Tran, 2018) aimed to analyze the impact of monetary policy transmission channels on the inflation rate during the period (2001-2015) using the VECM model, and the results showed that the money supply is the primary determinant of the rise in the rate of Inflation while the rise in interest rates leads to a rise in the rate of Inflation which is inconsistent with the previous study.

The study (Honore, 2018) also examined the impact of monetary policy on Inflation and analyzed the nature of the relationship between money supply and Inflation in the Cameroon economy, and the study estimated the ARDL model on the data during the period (1980-2016), and the results of the study revealed that there is a long positive parallel relationship between money supply and Inflation, and a one-way causal relationship from money supply to Inflation.

3. Research Elaboration

This study used quarterly data during the period (2000-2020) for the Jordanian economy available in the Central Bank of Jordan study variables included the core inflation rate as a dependent variable, the overnight deposit rate, the interest rate on loans and advances, as well as the money supply (M2), and the GDP growth. Core inflation was calculated based on the method of excluding energy and food prices from overall Inflation. Also, Data is filtered from seasonal effects using X-12-ARIMA quarterly seasonal adjustment Method.

The study applied a standard nonlinear model represented in the Nonlinear Autoregressive Distributed Lag Model (NARDL) to achieve the study's goal of measuring the effect between variables. The model took the following form for the equation:

$$cor_{inf_t} = \alpha_0 + \alpha_1 EC_{t-1} + \beta_1^+ CBJ_{R_{t-1}} + \beta_2^- CBJ_{R_{t-1}} + \beta_3^+ LR_{t-1} + \beta_4^- LR_{t-1} + \beta_5^+ GM2_{t-1} + \beta_6^- GM2_{t-1} + \beta_7 GRGDP_{t-1} +$$

$$\sum_{i=1}^p \theta_{1i}^+ \Delta CBJ_{R_{t-i}} + \sum_{i=1}^p \theta_{2i}^+ \Delta LR_{t-i} + \sum_{i=1}^p \theta_{3i}^+ \Delta GM2_{t-i} + \sum_{i=1}^p \theta_{4i}^+ \Delta GRGDP_{t-i} + Ut \dots \dots 1$$

Where: COR INF: Core inflation rate, which was calculated by excluding the food and energy group from overall Inflation and performing a rebalancing of the relative importance of the remaining items. CBJR: overnight deposit interest rates, LR: The interest rate on lending, GM2: Growth rate in money supply (M2), GRGDP: Growth rate in real GDP, $\alpha \beta \theta$: Estimation parameters, EC: Error correction, U: Random error in the model, - Negative effect, + Positive effect.

To find sound economic decisions and appropriate measures aimed at maintaining price stability, a distinction must be made between transient and continuous changes included in total Inflation by recalculating Inflation based on core inflation measures to exclude the most affected elements in seasonal effects and demand shocks and temporary display especially since food and energy components in Jordan are the most vulnerable to changes in their prices in response to fluctuations in the prices of imports and oil prices globally. Therefore, this must be considered in the formulation of decisions. Figure No. (1) shows the trends of the consumer price index in Jordan during the period 2006-2020; after applying the measures of excluding food and energy prices, it is noted that there is a convergence in the trends of the three gauges in most years and stability in other years, so there are no significant deviations between the values which indicate to assist decision-makers in setting practical measures to create a monetary policy aimed at stabilizing Inflation within limited rates and predicting future inflation trends.

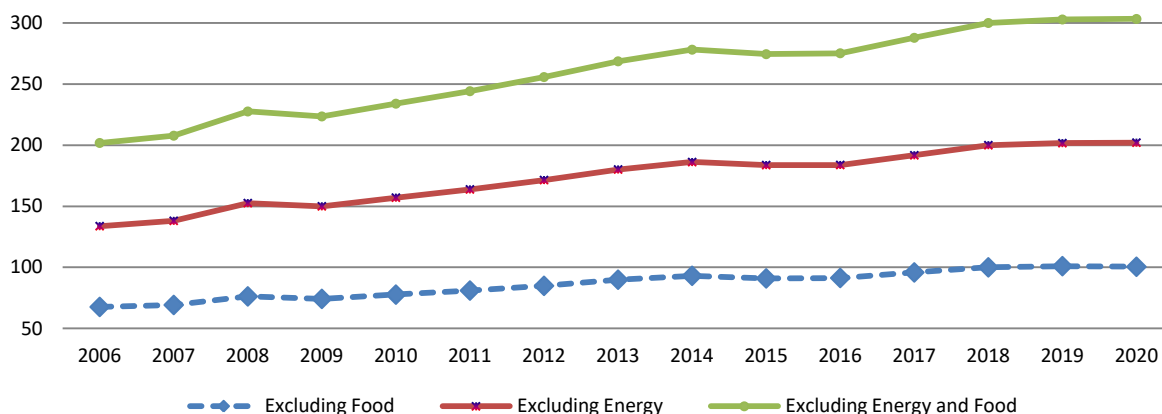


Figure (1): consumer price index in Jordan
 (Source: Central Bank Annual Statistical Bulletin, 2022)

It is noted in Figure (2) that the movements of Central Bank interest rates (overnight deposit rates) are in line with the core inflation rate. When the inflation rate rises, the Central Bank seeks a direct deflationary policy by increasing interest rates to reduce the volume of liquidity and lower aggregate demand and thus lower Inflation. We noticed the fluctuations of interest rates as they decreased at the beginning of the period until 2010 because of Jordan's impact on the repercussions of the global financial crisis and expectations of a slowdown in economic activity to keep interest rates in line with the core inflation rate. Interest rates witnessed the lowest rate in 2015 after the decline in inflationary pressures and the increase in economic activity as interest rates are in line with economic developments and local indicators such as the decline in the inflation rate and the slowdown in the growth of output with the GDP. By tracing the path of core inflation and the extent to which it is in line with interest rate movements, we find that there is a compatibility of the movements for each of the interest rates on the overnight deposit rate, as in Figure 2 or the interest rate for loans and advances as in figure (3), which gives a clear vision of the extent of interdependence and the impact of these prices on core inflation which excludes fluctuations resulting from supply shocks, especially those related to the prices of oil derivatives and short-term fluctuations in food prices which are partly due to seasonal effects, therefore, it is considered worth analyzing this path through a standardized impact assessment.

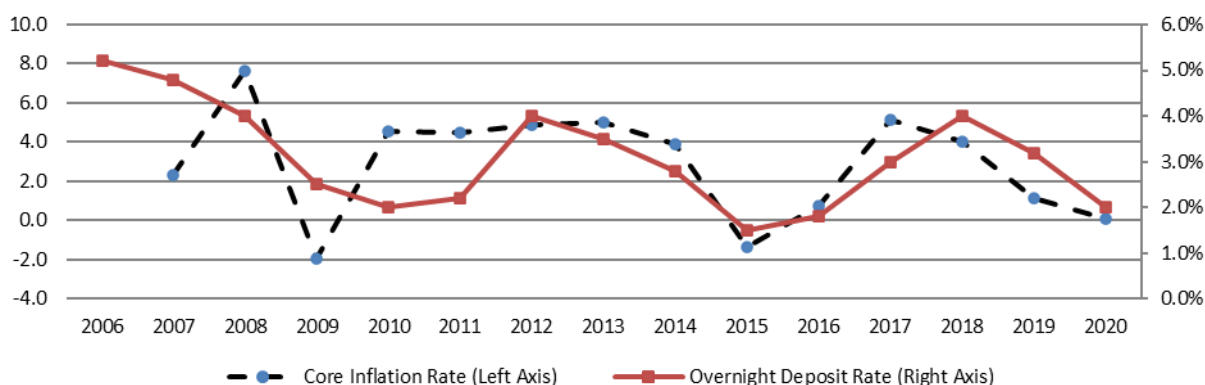


Figure 2: Overnight Deposit Rate, core inflation rate
 (Source: Central Bank Annual Statistical Bulletin, 2022)

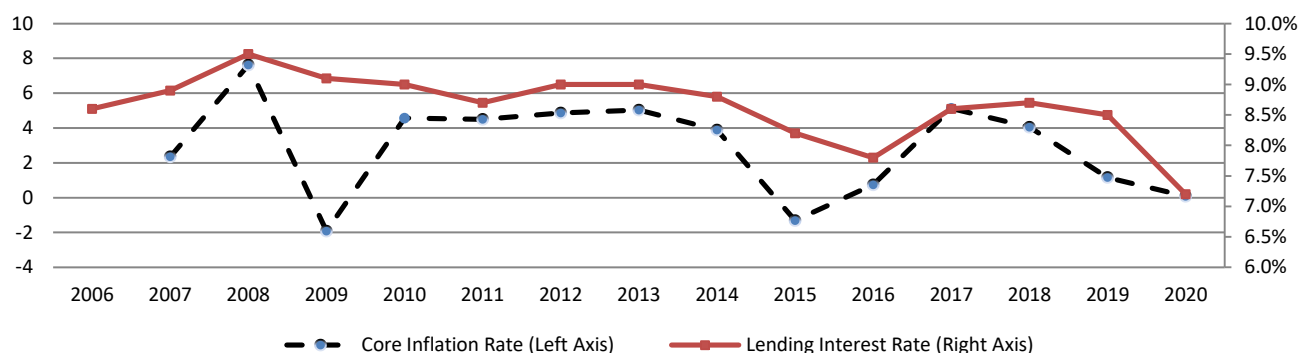


Figure 3: Lending Interest Rate and core inflation rate
 (Source: Central Bank Annual Statistical Bulletin, 2022.)

4. The Empirical Results and Discussions

To determine the stationary of the time series, the unit root test using the Phillips-Perron (P.P) test was applied, which is based on correcting the Autocorrelation in the residuals of the root test equation the unit using a non-parametric method of model variance to take into account the existence of the autocorrelation problem and reflect the dynamic nature in the series to make sure that there is no unit root problem by determining the degree of stationarity of the time series, and the test depends on the null hypothesis represented by the non-stationarity of the variable at the level. It is noted in Table no. (1) the different degrees of integration of the variables after applying the test, which is the initial condition for applying the NARDL model.

Table No 1: Results of the Philip Perron test

			CORE_INF	GRGDP	CBJ_R	GM2	LR
At level I(0)	With constant	T value	-3.46	-1.05	-4.34	-8.15	-2.25
		probability	0.012	0.731	0.001	0.000	0.192
		Result	**	No	***	***	No
	With a constant and trend	T value	-3.17	-2.46	-4.44	-9.3	-2.22
		Probability	0.097	0.349	0.003	0.000	0.473
		Result	*	No	***	***	No
At first difference I(1)	Without a constant and trend	T value	-2.08	-0.88	-2.12	-3.6	-2.03
		Probability	0.369	-0.88	-2.12	-3.6	0.041
		Result	**	No	No	***	**
	With constant	T value	-7.06	-8.17	-10.98	-35.83	-8.17
		Probability	0.000	0.000	0.000	0.000	0.000
		Result	***	***	***	***	***
	With a constant and trend	T value	-7.12	-8.72	-10.92	-35.2	-8.1
		Probability	0.000	0.000	0.000	0.000	0.000
		Result	***	***	***	***	***
	Without a constant and trend	T value	-7.13	-8.17	-11.05	-35.73	-7.88
		Probability	0.000	0.000	0.000	0.000	0.000
		Result	***	***	***	***	***

Where: CORE_INF: core inflation, GRGDP: growth in real GDP, CBJ_R: overnight deposit rate, GM2: growth in money supply, LR: the interest rate on loans and advances. (*): significant over 10%. (**): significant over 5%, (***): significant over 1%, (no): not significant. P value based on Mackinno (1996.)

The existence of cointegration - which is the second condition of the NARDL model - was tested, and the existence of a long-term relationship between the variables was evaluated by applying the Johansson and Juselius technique to determine the number of common integral vectors (r). The integration test results in a (Trace) and) Eigenvalue) statistic, as shown in Table no. (2), indicates that there are two cointegration relationships for monetary policy variables selected in the study on the core inflation rate. Also, The Bounds test was applied within the ARDL model, which is based on the Fisher F statistic, where the existence of long-term relationships is indicated when the value of F is higher than the upper limits of critical values, and here the null hypothesis indicating the absence of long-term relationships is rejected. Furthermore, accept the alternative hypothesis that indicates the existence of long-term relationships between the variables.

Table No 2: Co-integration test results

Johansson Test				
critical values	Eigenvalue	Trace statistic	Critical Value	Probability
None	0.459	100.062	69.819	0.000
At most 1	0.296	50.35	47.856	0.029
At most 2	0.164	21.919	29.797	0.303
At most 3	0.085	7.424	15.495	0.529
At most 4	0.003	0.213	3.841	0.645
Bound test				
F	critical values	%10	%5	%1
326.7	Minimum	2.03	2.32	2.96
	Maximum	2.93	3.21	4.26

The results of the estimation of the Nonlinear Autoregressive Distributed Lag Model (NARDL) showed that there is a long-term cointegration relationship, where the coefficient of the error term is negative and less than one, which is -0.496, significant, and the speed of adjustment is 2.13 time (a quarter). The results shown in Table (3) indicate that there are asymmetric effects, as the increase in the growth in the money supply by one percentage point leads to a rise in the core inflation rate by 1.3%. The results also indicated the significance of this effect. This result is consistent with the economic theories in this field, as the increase in the money supply leads to a rise in the aggregate demand for goods and services, and as a result, the general level of prices rises, and this result was supported by many previous studies (Nguyen & et al., 2019), (Ogunmuyiwu et al., 2018), (Honore, 2018). On the other hand, a decrease in growth in the money supply by one percentage point leads to a decrease in the core inflation rate by 1.2 percent. This effect is significant, as shown in the Table below, where the probability was less than 5%. It is also noted in Table No. (3) that there is a disproportionately negative impact of interest rates on the core inflation rate, as an increase in the overnight deposit rate by one percentage point leads to a decrease in the core inflation rate by 0.15 percent, and the results indicated the significance of this relationship. While the decrease in the overnight deposit rate by one percentage point leads to a rise in the core inflation rate by 0.44%, this result is not significant, as the probability is 0.12, which is higher than the level of significance of 5%.

Table No 3: Results of estimating long-term relationships

variable	Coefficient	Error value	Value t	Probability
GM2_POS	1.26	0.067	18.75	0.000
GM2_NEG	-1.22	0.081	-15.08	0.000
GRGDP	-48.5	5.231	-9.28	0.000
CBJ_R_POS	-0.15	0.094	-1.57	0.122
CBJ_R_NEG	0.44	0.1	4.37	0.000
LR_POS	-0.43	0.508	-0.85	0.396
LR_NEG	0.44	0.158	2.78	0.007
error coefficient	-0.469	0.014	-33.322	0.000

Where: *CORE_INF*: core inflation, *GRGDP*: growth in real GDP, *CBJ_R*: overnight deposit rate, *GM2*: growth in money supply, *LR*: the interest rate on loans and advances.

The results also indicated in the field of interest rate on loans and advances that there is an asymmetric effect on the core inflation rate, as the increase in the interest rate on loans and advances leads to a decrease in the inflation rate by 0.43% and the probability is 0.39, which is an insignificant result. The decrease in the interest rate on loans and advances leads to a rise in the core inflation rate by 0.44 %, and the results indicated the significance of this relationship. This result was supported by a study (Ahiabor, 2013). The growth in Real Gross Domestic Product (GDP) showed a negative impact on the core inflation rate, as the increase in output growth by 1% led to a decrease in the core inflation rate by 48.5%. This finding is consistent with economic theories and previous studies.

Four robustness Tests

The structural stability test of the model was analyzed in this study, which aims to ensure that the model parameters enjoy high stability over the time on which the study is based, depending on the cumulative sum of residuals (CUSUM) and CUSUMSQ statistics and to achieve the stability of the estimated parameters. The graph must lie between the two confidence limits (the upper bound and the lower bound) at the 5% significance level and not exceed that. It is clear from Figure (4) in the CUSUM test that the graph is confined within the confidence limits at a significant level of 5%, which indicates that the parameters estimated in the model are stable throughout the study period. The (CUSUMSQ) test indicated, as shown in Figure (5), the structural stability of the study model and the absence of deviations that affected structurally during the study period, as the test statistic line fell within the confidence limits at the 5% level of significance.

Figure No 5 : CUSUMSQ. Test Results

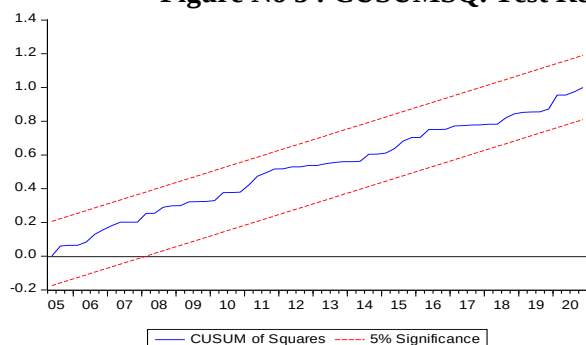
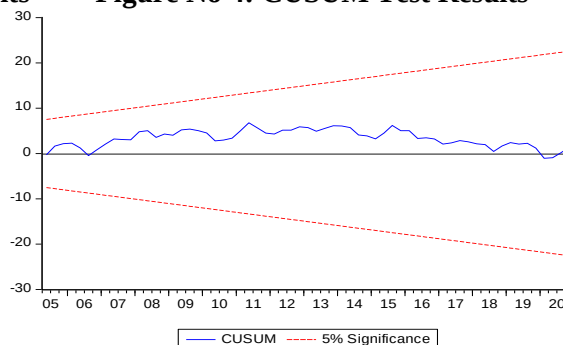


Figure No 4: CUSUM Test Results



To test the multicollinearity problem in the model, the variance inflation factor (VIF) test was used, as Table No. (4) shows the absence of the problem, as the statistical value is less than 10%.

Table No 4: VIF Test Results

Variable	Variance	VIF value
GM2	0.0379	1.339
GRGDP	134.44	1.595
CBJ_R	0.078	1.608
LR	0.0918	1.307

Where: CORE_INF: core inflation, GRGDP: growth in real GDP, CBJ_R: overnight deposit rate, GM2: growth in money supply, LR: the interest rate on loans and advances.

The Breusch-Pagan-Godfrey test has been applied to test the heterogeneity of the variance in estimation errors until the Null-Hypotheses that there is a heteroscedasticity problem between variables the results in Table (5) indicate that there is no heteroscedasticity problem. It also applies to the (Serial Correlation) test, where the Null-Hypotheses are rejected in the presence of Autocorrelation between variables. Here the Null-Hypotheses is rejected, with a probability value of 0.072.

Table No 5: Results of the Heterogeneity Test and the Autocorrelation Test

	Statistical Value	Probability
Variation Heteroskedasticity test*	0.833	0.649
Autocorrelation Test**	2.746	0.072

*Test F adopted in "Breusch-Pagan-Godfrey."

** Test chi-square adopted in "LM-Test."

According to Wald Test Table No. (6) there are asymmetrical relationships between variables since the probability value was less than 5% which means rejecting the null hypothesis that the negative effect is equal to the positive effect.

Table No 6: The Results of the Wald Test

Null-Hypotheses	χ^2	Probability	Result
$\beta_{GM2_pos} = \beta_{GM2_NEG}$	102.5	0.000	There is asymmetry.
$\beta_{cbj_R_Pos} = \beta_{cbj_R_NEG}$	14.47	0.041	There is asymmetry.
$\beta_{LR_POS} = \beta_{LR_NEG}$	270.0	0.000	There is asymmetry.

5. Conclusion

The diagnostic tests indicated that the variables are stationary at different levels between level I(0) and the first difference I(1). the Johansen Test (Cointegration Johansen Test) and the Bounds Test, indicating there is a cointegration relationship, in addition to the results of the Wald Test indicating there is a nonlinear relationship between variables, leading to the possible estimated of the (NARDL) model, the results of the analysis showed asymmetrical effects between the variables and the core inflation rate. Higher growth in the money supply by one percentage point leads to a rise in the core inflation rate of 1.3%, an increase in the core inflation rate. Based on this result, the central bank must pay attention to the asymmetry of the effects of

monetary policy variables when targeting the impact on core inflation rates. In monetary policy, the result found that there was an asymmetric negative impact of the overnight deposit rate on the core inflation, as an increase in the overnight deposit rate by one percentage point led to a 0.15% reduction in the core inflation rate. At the same time, the reduction of the overnight deposit interest rate by one percentage point leads to an increase in the core inflation rate by 0.44%. Based on this finding, the study recommends that monetary policy be focused on the overnight deposit interest rate if the core inflation rate is raised.

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