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The Symmetric and Asymmetric Nexus Between Monetary Policy Interest Rate and Core Inflation in Jordan

Ahmad Al-Majali*[1]**, ***Renad Jehad Al-Shamaileh [2]

[1]Economics, Department of Business & Finance, College of Business, Mutah University, Jordan, majalia@mutah.edu.jo

[2]Researcher, Mutah University, renadsh96@gmail.com

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Abstract

Objectives: This study investigates monetary policy's symmetric and asymmetric impacts on core inflation in Jordan. It employs linear and nonlinear autoregressive distributed lag (NARDL) models. The research also seeks to assess the relationship between the overnight deposit rate, money supply growth, and real GDP growth on core inflation and to explore potential linear or nonlinear effects.

Methods: The study applies ARDL and NARDL models to estimate the relationships above. It utilizes data from the first quarter of 1998 to the first quarter of 2023. Tests for Granger causality are conducted, and the Brock-Dechert-Scheinkman (BDS) test is employed to ascertain the presence of nonlinear paths within the study variable. Robustness checks are conducted to ensure parameter stability.

Results: The analysis provides compelling empirical evidence supporting a long-term relationship between the overnight deposit rate and core inflation. The Brock-Dechert-Scheinkman (BDS) test confirms the existence of nonlinear dynamics. The ARDL model reveals a linear relationship: a 1% interest rate increase leads to a 0.26% reduction in core inflation in the long run. In contrast, the Nonlinear Autoregressive Distributed Lag (NARDL) analysis unveils an asymmetric effect: a 1% increase in the overnight deposit rate decreases core inflation by 0.43%, while a 1% reduction increases it by 0.37%.

Conclusions: These findings have critical implications for monetary policymakers. They underscore the importance of judiciously considering interest rate adjustments to manage inflation dynamics, acknowledging the nonlinear and asymmetric effects inherent in the relationship between the overnight rate and core inflation. When crafting monetary policy strategies, policymakers must consider these nuanced dynamics to address inflation concerns effectively.

Keywords: Nonlinear, linear, Autoregressive Distributed Lag Model (ARDL), core inflation, monetary policy, asymmetric, symmetric.

العلاقة المتماثلة وغير المتماثلة بين أسعار فائدة السياسة النقدية والتضخم الأساسي في الأردن

أحمد المجالي[1] ، ريناد جهاد الشمايلة[2]

[1]قسم الأعمال والمالية، كلية الأعمال، جامعة مؤتة، الأردن.

[2]باحث في جامعة مؤتة.

ملخّص

الأهداف: تهدف هذه الدراسة إلى اختبار التأثير الخطي وغير الخطي للسياسة النقدية على التضخم الأساسي في الأردن، باستخدام نماذج الانحدار الموزع الذاتي الخطية وغير الخطية (NARDL)، كما تهدف إلى تقييم العلاقة بين سعر فائدة نافذة الإيداع لليلة واحدة، ونمو المعروض النقدي، ونمو الناتج المحلي الإجمالي الحقيقي، على التضخم الأساسي، واستكشاف إمكانية وجود تأثيرات خطية أو غير خطية.

الطرق الإحصائية: استخدام نموذج الانحدار الذاتي الموزع الخطي (ARDL) وغير الخطي (NARDL). باستخدام البيانات من عام 1998: الربع الأول إلى عام 2023: الربع الأول، فحص السببية بواسطة اختبار جرينجر، واستخدام اختبار بروك ديشيرت شينكمان للتحقق من وجود مسارات غير خطية داخل المتغيرات. إجراء فحوصات قوة النموذج لضمان استقرار المعاملات.

النتائج: تؤكد النتائج وجود علاقة سببية، كما وأظهر اختبار بروك ديشيرت شينكمان- BDS وجود مسارات غير خطية في متغير الدراسة. يُظهر نموذج الانحدار الذاتي الموزع الخطي أنّ زيادة 1% في معدل الفائدة يقلل التضخم الأساسي بنسبة 0.26% على المدى الطويل. فيما تشير نتائج نموذج الانحدار الذاتي الموزعة وغير الخطي أنّ زيادة 1% في معدل الفائدة على نافذة الإيداع لليلة واحدة تخفض التضخم الأساسي بنسبة 0.43%، في حين يزيد خفضها التضخم الأساسي بنسبة 0.37%. تؤكد اختبارات الاستقرار متانة المعلمات المقدرة على مدى فترة الدراسة، وعدم وجود مشكلة الارتباط الخطي المتعدد ومشكلة الارتباط الذاتي وعدم تجانس التباين.

الاستنتاجات: لهذه النتائج آثار هامة تخدم صناع السياسة النقدية، حيث تسلط الضوء على ضرورة النظر بعناية في تعديلات أسعار الفائدة لإدارة ديناميكية التضخم عند صياغة استراتيجيات السياسة النقدية، وضرورة الأخذ بعين الاعتبار التأثيرات غير الخطية وغير المتماثلة بين معدل الفائدة على نافذة الإيداع لليلة واحدة والتضخم الأساسي.

الكلمات الدالة: غير خطي، خطي، نموذج الانحدار الزمني الموزع (ARDL)، التضخم الأساسي، السياسة النقدية، غير متماثل، متماثل.

1. INTRODUCTION

Monetary policy has played a significant role in economic thought since the nineteenth century, becoming increasingly important in response to economic and monetary crises, particularly during the Great Depression of the late 1920s and early 1930s. The inability to find solutions to this crisis spurred the development of new ideas in the field, leading to the exploration of quantitative theories and mechanisms for transmitting the impact of monetary policy. Economist John Keynes proposed monetary ideas to address the depression and restore stability to the monetary system. Following these developments, modern trends in monetary policy management have emerged. These trends involve using price-based tools such as interest rates on monetary policy instruments like the overnight deposit window rate. Additionally, quantity-based tools such as issuing certificates of deposit have also gained importance. These tools have shown greater effectiveness in influencing inflation rates overall, including core inflation rates. Numerous studies have attempted to examine the relationship between these variables and the overall economy and Inflation by measuring the direct linear effects (symmetric). However, only a few studies have explored the nonlinear (asymmetric) effects (Apergis & Cooray, 2015)(Galindo & Steiner, 2022). This study aims to investigate the nonlinear and asymmetric relationship of Jordanian monetary policy compared to its linear effects.

Monetary policy and inflation are pivotal in shaping a country's overall economic conditions. In the case of Jordan, comprehending the nature of the relationship between monetary policy and core inflation holds immense importance for policymakers and researchers. The symmetry or asymmetry of this relationship, along with its effectiveness and directionality, can significantly impact the formulation of appropriate monetary policy measures to maintain price stability and foster sustainable economic growth. Hence, analyzing this relationship using advanced econometric techniques such as the Nonlinear Autoregressive Distributed Lag (NARDL) model is crucial. This model enables the capture of both short-term and long-term dynamics between monetary policy and core inflation while considering potential linearities (symmetries) or nonlinearities (asymmetries) within the relationship. By gaining insights into the nature and magnitude of this relationship, policymakers and researchers can make well-informed decisions regarding adjustments to monetary policy, aligning with their objectives of achieving price stability and promoting economic growth.

The main objectives of this study are to estimate the asymmetric effect of monetary policy on core inflation in Jordan. This objective is achieved by employing linear and nonlinear autoregressive distributed lag (NARDL) models. The analysis will use quarterly data for the Jordanian economy from 1998:Q1 to 2023:Q1. In this study, the dependent variable will be core inflation (COR), which is calculated by excluding energy and food prices. The independent variables considered will include the overnight deposit rate (R), the growth in money supply (M2), and the growth in real GDP (GDP). The hypothesis posits a significant relationship between these independent variables and core inflation and that this relationship may have linear effects (symmetric) or nonlinear (asymmetric) effects.

This study contributes to the existing literature by enhancing the understanding of the mechanisms through which the effects of monetary policy transmit in Jordan, providing strong empirical evidence of their interconnectedness. Moreover, the paper highlights asymmetric effects, indicating that changes in the overnight deposit rate have varying impacts on core inflation depending on whether there are increases or decreases. It does so by estimating the symmetric and asymmetric impact between the overnight deposit rate of the Central Bank of Jordan (CBJR) and inflation in Jordan using core inflation techniques, achieved by employing the ARDL model and NARDL models and comparing their results.

This insight into the nonlinear relationship between monetary policy interest rates and core inflation in Jordan is of significant importance to policymakers, as it underscores the need for careful consideration and fine-tuning of interest rate adjustments to manage inflation dynamics effectively in the country's economy. The study's comprehensive analysis and robust results contribute to the existing literature on monetary policy transmission mechanisms, offering valuable guidance for formulating effective inflation-targeting strategies and ensuring monetary stability in Jordan.

This research study consists of the following sections: the Introduction provides the background and research objectives, while the Literature Review presents a synthesis of related studies. Methodology details the research design and data collection methods. Results showcase the findings, followed by their interpretation in the Discussion. The Conclusion summarizes key points and suggests future research areas.

2. LITERATURE REVIEW AND EMPIRICAL STUDIES

2.1 Literature Review

In classical theory, Inflation is driven by the positive and direct relationship between money supply and Inflation (Boissay, Collard, Gali, & Manea, 2022). An increase in the money supply boosts demand for goods and services, resulting in higher prices and decreased purchasing power (Baltensperger, 2023). Fisher's rise in interest rates reduces the demand for money, increasing the cost of credit, which leads to a decline in aggregate demand and lower prices (Uribe, 2022). According to the traditional Keynesian interest rate channel, a tightening of monetary policy (increase in short-term nominal interest rate), represented by a shock to the Taylor rule, has various effects. Initially, it leads to a rise in longer-term nominal interest rates (Levrero, 2023). This process occurs when nominal prices adjust slowly due to costly or staggered price settings. Investors exploit differences in risk-adjusted expected returns on debt instruments of different maturities, as explained by the expectations hypothesis of the term structure (Galindo & Steiner, 2022). As a result, investors adjust their investment expenditures, reducing borrowing due to increased real costs over all horizons. Furthermore, the rise in the real interest rate prompts households to decrease spending, as demonstrated by the IS curve. Higher real borrowing costs cause households to scale back on purchases of homes, automobiles, and durable goods. Lastly, through the Phillips curve, the decline in output exerts downward pressure on Inflation (aggregate demand), which adjusts gradually following the shock (Apergis & Cooray, 2015).

Empirical studies have extensively examined this channel using linear models such as OLS, VAR, FOML, and ARDL ((Carvalho et al., 2021), (Nguyen et al., 2019), (Musa et al., 2019)). These studies have focused on assessing the effectiveness of interest rate pass-through and the speed of inflation adjustment to changes in monetary policy rates. Most studies have found a significant effect in this regard. Some empirical studies have also explored the structural effects of monetary policy using S-VAR models (Smirnov & Tlostanov, 2018). These models impose restrictions on variables that cannot be observed and contemporaneously reacted to by monetary policy. In large macroeconomic models, many exogenous variables are treated as exogenous by default, which presents an identification problem. Therefore, these models introduce identifying restrictions in the estimation process. These models capture the transmission mechanism of monetary effects (Caboverde & Romero, 2022).

However, nonlinear effects in the variables may exist, leading researchers to study the nonlinear impact of monetary policy. Moreover, studies have identified differences in the pass-through and adjustment speed of inflation to changes in monetary policy rates depending on the direction of the policy rate adjustment (De Bondt, 2005). They found that the adjustment of monetary policy rates is slower in response to a decrease in money market rates than an increase (Galindo & Steiner, 2022). This phenomenon can be attributed to reduced interest elasticity during economic downturns, resulting in upward interest rate rigidity (Gregor & Melecký, 2019). The nonlinear autoregressive distributed lag model (NARDL) has been utilized in many studies to estimate asymmetries within a single framework. These studies have found long-run asymmetric interest rate pass-through, providing policymakers with clear evidence of the expected effects of monetary actions based on the direction of interest rate changes (Galindo & Steiner, 2022).

Despite the strengths of these models, the definition of the variable responsive to monetary policy changes may yield misleading results, especially when using overall inflation as the definition. This is because inflation components, particularly food and energy items, are influenced by global and regional trends and effects beyond the control of domestic monetary policy (Stock & Watson, 2016). Consequently, many studies have employed a core inflation rate that excludes the impact of changes in food and energy prices. This core inflation rate offers a fair assessment of the impact of monetary policy on inflation.

Many studies have highlighted the significance of core inflation, emphasizing its role as a reliable indicator for monetary policymakers in forecasting inflationary patterns and determining the expected trajectory of the target inflation rate over a short time frame (Bullard, 2011). Additionally, they demonstrate the interconnection between core inflation and monetary policy, underscoring its value in guiding the implementation and administration of monetary policy (Al-Assaf, 2018). Core inflation offers a valuable analysis of present and future trends by excluding short-term price fluctuations (Hijazine & Al- Assaf, 2022).

2.2 Empirical Studies

Various studies have employed different methodologies to investigate the relationship between interest rates and Inflation in diverse economies. (Mirza & Rashidi, 2018) conducted a study using panel data to evaluate the causal relationship between interest rates and inflation rates. Their findings revealed a significant relationship between real interest rates and inflation rates. Additionally, (Lee and Yu, 2020), (Musa et al., 2019), and (Oumbé Honoré, 2018) employed the Autoregressive Distributed Lag (ARDL) model to examine the impact of monetary policy on inflation. These studies found a significant relationship between monetary policy and inflation. In the context of interest rate pass-through, (Galindo & Steiner, 2022), (Apergis & Cooray, 2015), and (MacDonald et al., 2011) utilized asymmetric methodologies (NARDL) to investigate the effects of changes in policy rates on lending rates, particularly consumer and ordinary corporate loans. Their findings suggested that lending rates were rigidly rising, with large retail lending rates responding more to policy rate decreases than hikes. This shows that financial intermediaries are more hesitant to boost interest rates after policy changes. These studies also indicated that the asymmetric pass-through phenomenon was still operating.

(Nagao & Nakazono, 2021), (Nguyen, Papyrakis, & Van Bergeijk, 2019), and (Khan, 2020) evaluated the economic effects of monetary policy on macroeconomic variables, including inflation, using the Vector Autoregression (VAR) model. Their findings suggested a short-term bidirectional causal relationship between interest rates and inflation. They also discovered that interest rates have a negative impact on inflation and that money supply has a positive impact on inflation. Similarly, (Tran, 2018) used the Vector Error Correction Model (VECM) to examine the effect of monetary policy transmission channels on the inflation rate and discovered that the money supply was the key determinant of inflation. In contrast, an increase in interest rates caused inflation to rise.. Also, (Stock & Watson, 2016), (Zaidi et al., 2017), and (Smirnov & Tlostanov, 2018), conducted studies using the Structural Vector Autoregression (SVAR) model to assess the impact of monetary policy on the inflation rate. Their findings consistently demonstrated a negative relationship between interest rates and Inflation, indicating that an increase in interest rates leads to a decrease in Inflation. Additionally, these studies found a positive impact of the money supply on Inflation, suggesting that an expansion in the money supply contributes to higher inflation levels.

3. DATA AND METHODOLOGY

3.1 Data

This study used quarterly data from 1998:Q1 to 2023:Q1 for the Jordanian economy available from the Central Bank of Jordan; study variables included the core inflation rate as a dependent variable, the overnight deposit rate, the growth of the money supply, and the real GDP growth. Core inflation was calculated by excluding energy and food prices from overall inflation. Also, the data were filtered for seasonal effects using the X-12-ARIMA quarterly seasonal adjustment method.

Figure 1 shows a strong correlation between Central Bank interest rates (overnight deposit rates) and the core inflation rate, reaching 74% at a significance level of 5%. The Central Bank implements a contractionary policy by raising interest rates when the inflation rate increases. This strategy aims to reduce liquidity levels and dampen aggregate demand, lowering inflation. Over the observed period, interest rates exhibited fluctuations, initially declining until 2010 due to the global financial crisis and expectations of an economic slowdown. During this period, interest rates aligned with the core inflation rate.

In 2015, interest rates reached their lowest point following decreased inflationary pressures and an uptick in economic activity. The Central Bank of Jordan has consistently adjusted interest rates based on economic developments and local indicators, such as a decline in the inflation rate and a slowdown in GDP growth. Additionally, the Central Bank significantly raised interest rates in 2022-2023 in response to global interest rate fluctuations and local inflationary pressures. The monetary policy of the Central Bank is linked to the US monetary policy due to pegging the Jordanian Dinar to the US Dollar.

As a result of significant inflationary pressures caused by the quantitative easing policy and substantial liquidity injections, as well as disruptions in supply chains due to the COVID-19 pandemic and the Russian-Ukrainian crisis, the US Federal Reserve raised interest rates. In response to the continuous interest rate hikes by the US Federal Reserve, the Jordanian Central Bank implemented multiple rates increases on its monetary policy instruments, seven times during 2022 and four times during 2023, to maintain an interest rate margin between the Dinar and the Dollar in favor of the Dinar.

Despite the absence of significant inflationary pressures in Jordan that would necessitate such interest rate hikes, given the economic downturn with low inflation rates and record-high unemployment, the priority of the Jordanian Central Bank remains to raise interest rates to ensure monetary stability in the Kingdom.

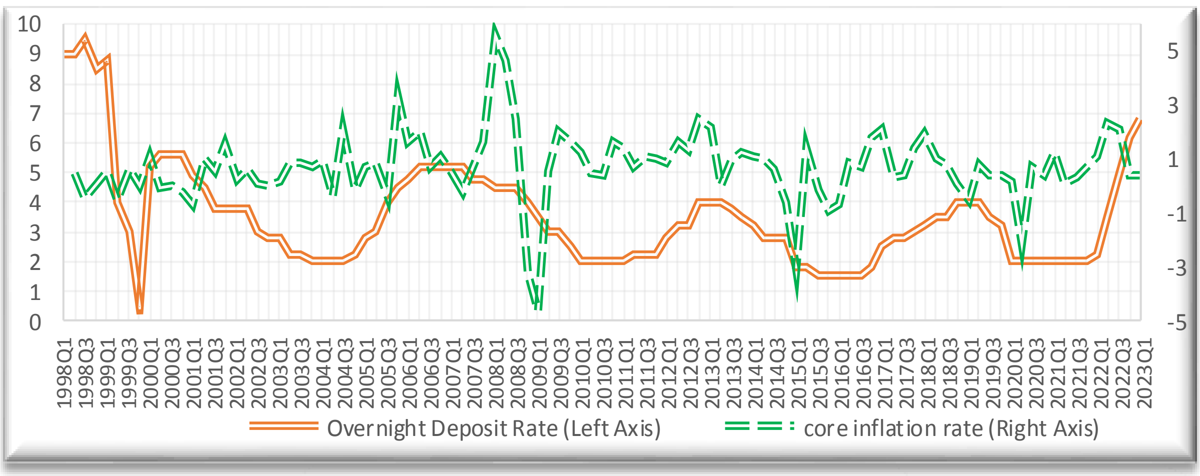


Figure 1: Overnight Deposit Rate, core inflation rate

Source: Central Bank of Jordan, Annual Statistical Bulletin, 2023 & CBJ database.

3.2 Methodology

The study employed linear and nonlinear models, utilizing the Autoregressive Distributed Lag (ARDL) and Nonlinear Autoregressive Distributed Lag (NARDL) Models, to assess the impact between variables. The general form of the ARDL is as follows:

$$cor_t = \alpha_0 + \alpha_1 EC_{t-1} + \alpha_2 R_{t-1} + \alpha_3 M2_{t-1} + \alpha_4 GDP_{t-1} + \sum_{t=1}^{p} \alpha_4 \Delta R_{t-i} + \sum_{t=1}^{p} \alpha_5 \Delta M2_{t-i} + \sum_{t=1}^{p} \alpha_6 \Delta GDP2_{t-i} + U_t \quad (1)$$

Where Nonlinear Autoregressive Distributed Lag (NARDL) Model is as follows:

$$cor_t = \alpha_\circ + \alpha_1 EC_{t-1} + \beta_1^+ R_{t-1}^+ + \beta_2^- R_{t-1}^- + \beta_3^+ M2_{t-1}^+ + \beta_4^- M2_{t-1}^- + \beta_5^+ GDP_{t-1}^+ + \beta_6^- GDP_{t-1}^-$$

$$+ \sum \theta_{1i}^{\pm} \Delta R_{t-i} + \sum \theta_{2i}^{\pm} \Delta M2_{t-i} + \sum \theta_{3i}^{\pm} \Delta GDP_{t-i} + Ut$$

Where: COR: Core inflation rate, R: Overnight deposit interest rates, M2: Growth rate in money supply, GDP: Growth rate in real GDP, α, β, θ: Estimation parameters, EC: Error correction term, U: Random error in the model, (-): Represents a negative effect, (+): Represents a positive effect.

The variables used in the model were selected based on a literature review and in line with Keynesian theory and the IS curve. The interest rate and output were chosen to represent the IS curve, while the money supply represented the LM curve. The use of the study variables is attributed to the inverse relationship between the output gap and inflation derived from the Phillips curve and several previous studies, such as (Catherine et al., 2017), (Khan, 2020), (Musa et al., 2019), (Tran, 2018).

These variables capture important aspects of the relationship under study. The core inflation rate was calculated by eliminating volatile components such as food and energy prices from the overall inflation rate. It provides a more realistic depiction of overall inflation and aids in identifying long-term inflation tendencies.

On the other hand, overnight deposit interest rates are a monetary policy tool used by the central bank to regulate borrowing costs and control the money supply. Changes in interest rates can have a major impact on various economic indicators, including inflation. By including this variable, the model captures the impact of monetary policy on inflation.

The rate of growth in the money supply, specifically M2 (a broad measure of money supply), is an important indicator of money availability in the economy, showing expansion or contraction in the money stock, and it influences inflation. Including this variable helps better explain inflation movements. Furthermore, the growth rate in real GDP measures the expansion or contraction of the economy. It assists in interpreting inflation within the model.

These variables were generally selected based on their relevance and importance in understanding the dynamics of inflation and its relationship with monetary policy.

4. THE EMPIRICAL RESULTS AND DISCUSSIONS

The study used the Phillips-Perron (P.P) test to assess the time series' stationarity, which corrects for autocorrelation in the residuals of the unit root test equation. This test employs a non-parametric technique to account for autocorrelation difficulties and capture the series' dynamic nature. The goal was to ensure that no unit root problems existed and to determine the amount of stationarity in the time series. The test is based on the null hypothesis of level non-stationarity.

The test results are presented in Table 1, showing the degrees of integration for the variables. The variables R, M2, and COR are stationary at the level, while GDP exhibits stationarity at the first difference. These findings are the starting point for implementing the ARDL and NARDL models and using variables at the level.

Table 1: Philip Perron Test Results (unit root test)

	At Level				
		M2	R	GDP	COR
With Constant	t-Statistic	-2.6866	-4.9749	-2.0183	-7.0284
	Prob.	**0.0801**	**0.0001**	**0.1366**	**0.0000**
		*	***	N0	***
With Constant & Trend	t-Statistic	-3.6580	-4.6981	-2.8399	-6.9905
	Prob.	**0.0302**	**0.0013**	**0.1184**	**0.0000**
		**	***	N0	***
Without Constant & Trend	t-Statistic	-0.9418	-2.0219	-1.7056	-5.5692
	Prob.	**0.3063**	**0.0419**	**0.0984**	**0.0000**
		N0	**	*	***
	At First Difference				
		d(GM2)	d(CBJ_R)	d(GRGDP)	d(COR_INF)
With Constant	t-Statistic	-6.3439	-5.0549	-9.5560	-9.8412
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		***	***	***	***
With Constant & Trend	t-Statistic	-6.3115	-5.3255	-9.5487	-9.7862
	Prob.	**0.0000**	**0.0001**	**0.0000**	**0.0000**
		***	***	***	***
Without Constant & Trend	t-Statistic	-6.3765	-5.0781	-9.6062	-9.8897
	Prob.	**0.0000**	**0.0000**	**0.0000**	**0.0000**
		***	***	***	***

Where COR is core inflation, R is the overnight deposit rate, M2 is growth in money supply, and GDP is growth in real GDP. The significance levels are as follows: *: significant at 10%, ** at 5%, *** at 1%, and NO: insignificant. The p-values based on Mackinnon (1996).

The study performed a test to determine the presence of cointegration, which is required for the ARDL and NARDL models. The Johansen and Juselius approach determined whether there was a long-term link between the variables. This method calculates the number of common integral vectors (r) and offers information about the long-term relationship. The integration test produced statistics such as the Trace statistic and Eigenvalue statistic.

The results in Table 2 indicate that the unrestricted cointegration rank test rejects the null hypothesis of no long-term relationships between the variables. The critical values from the Johansen Test show that the eigenvalue trace statistic surpasses the critical value at each level of cointegration, supporting the alternative hypothesis that long-term relationships exist among the selected variables.

Table No. 2: Unrestricted Cointegration Rank Test

Johansson Test				
critical values	**Eigenvalue**	**Trace statistic**	**Critical Value**	**Probability**
None	0.256496	53.29680	47.85613	0.0141
At most 1	0.179527	25.14054	29.79707	0.1565
At most 2	0.052549	6.342499	15.49471	0.6550
At most 3	0.012702	1.214438	3.841465	0.2705

The study also conducted the Bounds test using the Fisher F statistic (presented in Table 3). This test determines the presence of long-term relationships by comparing the F value with the upper critical values. If the F value exceeds these critical values, it indicates the existence of long-term relationships. In this case, the null hypothesis was rejected, suggesting the absence of long-term relationships. In contrast, the alternative hypothesis, indicating the presence of long-term relationships between the variables, is accepted.

Table No. 3: F-Bounds Test

Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
F-statistic	12.22670	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Nonlinearity Test

The Brock Dechert Scheinkman-BDS test examines the behavior of time series regarding serial dependence and linearity, including both linear and nonlinear dependencies. This test can detect nonlinear behavior in time series. Accordingly, it was applied to the main study variable to distinguish whether it exhibits linear or nonlinear behavior. Table 3 shows the rejection of the null hypothesis, indicating the presence of nonlinear paths in the study variable.

Table No. 3: Nonlinearity Test (BDS) Results

Lag time	COR		GDP		R		M2	
	BDS	**probability**	**BDS**	**probability**	**BDS**	**probability**	**BDS**	**probability**
2	0.09	0.000	0.13	0.000	0.14	0.000	0.01	0.094
3	0.15	0.000	0.20	0.000	0.22	0.000	0.04	0.009
4	0.17	0.000	0.23	0.000	0.28	0.000	0.04	0.034
5	0.2	0.000	0.27	0.000	0.31	0.000	0.04	0.014
6	0.21	0.000	0.29	0.000	0.33	0.000	0.05	0.006

The pairwise Granger causality tests (presented in Table No. 4) provide additional insights into the relationship between the variables. The results indicate that the null hypothesis, stating that overnights deposit rate does not Granger Cause core inflation, is rejected with an F-statistic of 2.59891 and a p-value of 0.0145. Similarly, the null hypothesis that core inflation does not Granger Cause overnights deposit rate was rejected with an F-statistic of 4.86602 and a p-value of 0.0007. These findings suggest a causal relationship between overnights deposit rate and core inflation.

Table No. 4: Pairwise Granger Causality Tests

Null Hypothesis:	**F-Statistic**	**Prob.**
overnight deposit rate does not Granger Cause core inflation	2.59891	0.0145
Core inflation does not Granger Cause overnight deposit rate	4.86602	0.0007

Table No. 5 indicates a significant impact of the overnight deposit interest rate on core inflation. An increase in the interest rate by one percentage point leads to a decrease in core inflation by 0.25933 percentage points in the long run. The error correction term coefficient indicates that the error correction term is less than one, which is both statistically significant and negatively signed. The result suggests a long-run cointegration relationship between the independent and dependent variables, with a correction period of 1.043 quarters. These findings are consistent with the theoretical framework and previous studies such as (Galindo & Steiner, 2022), (Apergis & Cooray, 2015), and (MacDonald, Mullineux, & Sensarma, 2011). The results also indicate that a 1% increase in the Gross Domestic Product (GDP) leads to a 0.1% increase in core inflation, while a 1% increase in money supply growth leads to a 0.51% increase in core inflation.

Table No. 5: Results of Estimating Long-Term Linear (Symmetries) Relationship (ARDL)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GRGDP	0.107821	0.062188	1.733797	0.0866
CBJ_R	-0.25933	0.083137	-3.11931	0.0019
GM2	0.50824	0.084424	6.020089	0.0000
C	0.418801	0.345171	1.213313	0.2284
CointEq(-1)*	-0.95834	0.119751	-8.00279	0.0000

When the Nonlinear Autoregressive Distributed Lag Model (NARDL) was estimated, as presented in Table No. 6, it revealed a long-term cointegration relationship. The coefficient of the error term was -0.54501, which is significant and negative, indicating a long-run cointegration relationship. The speed of adjustment was found to be 1.834 times (per quarter). The results in Table No. 6 also demonstrated asymmetric effects between the overnight deposit rate and core inflation. An increase in the overnight deposit rate by one percentage point decreased the core inflation rate by 0.42 percentage points. Conversely, a reduction in the overnight deposit rate by one percentage point led to an increase in the core inflation rate by 0.37 percentage points. These results confirm the significance of this relationship. These findings are consistent with the theoretical framework and previous studies such as (Galindo & Steiner, 2022), (Apergis & Cooray, 2015), and (MacDonald et al., 2011). Furthermore, the results demonstrate asymmetric effects of the Gross Domestic Product (GDP) variable, where a 1% decrease leads to a 0.14% decrease in core inflation, while a 1% increase results in a 0.99% increase in core inflation.

Table No. 6: Results of Estimating Long-Term Nonlinear (Asymmetries) Relationships (NARDL)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP_NEG	-0.14366	0.071735	-2.00261	0.0482
GDP_POS	0.99334	0.129778	7.654148	0.0020
M2_NEG	-0.34773	0.058251	-5.96951	0.0000
M2_POS	-0.72644	0.066607	-10.9064	0.0000
R_NEG	0.373536	0.127471	2.930361	0.0136
R_POS	-0.42513	0.174815	-2.43189	0.0212
C	0.95226	1.082441	0.879734	0.3814
CointEq(-1)*	-0.54501	0.250114	-2.17905	0.0320

Where: CORE: core inflation, GDP: growth in real GDP, R: overnight deposit rate, M2: growth in the money supply.

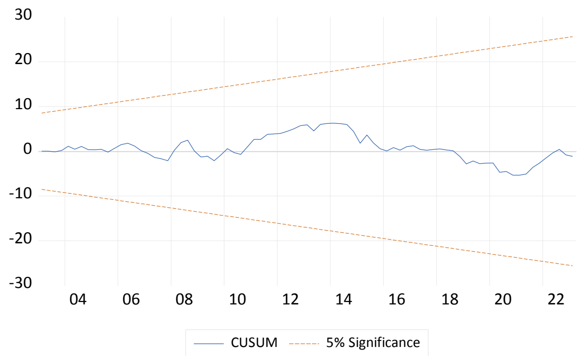
By comparing the estimation results between the ARDL and NARDL models, it was found that the responsiveness elasticity of core inflation to the overnight deposit rate was higher in the case of the nonlinear asymmetric NARDL model. Additionally, within the NARDL model, the responsiveness elasticity to interest rate hikes was higher than the responsiveness to interest rate cuts. These findings are consistent with previous studies in this field, such as the study by Galindo and Steiner (2022).

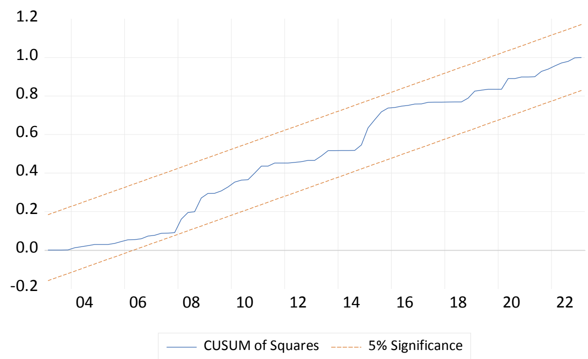
Robustness Tests

This study conducted a structural stability test to ensure that the model parameters remained stable over the study period. The cumulative sum of residuals (CUSUM) and CUSUMSQ statistics were utilized to assess the stability of the estimated parameters. The graph generated from the CUSUM test, depicted in Figure 2, demonstrates that it lies within the confidence limits at a significance level of 5%. This indicates that the estimated model parameters remain stable throughout the entire study period for ARDL and NARDL models. Similarly, the CUSUMSQ test, illustrated in Figure 2, confirms the structural stability of the study model. The test statistic line remains within the confidence limits at a significance level of 5% for the ARDL and NARDL models, suggesting the absence of structural deviations throughout the study period.

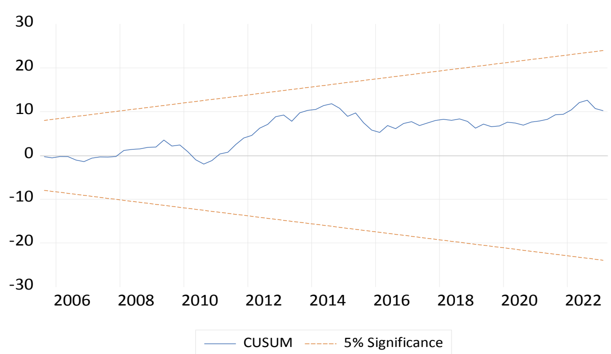
CUSUM **CUSUMSQ**

(Symmetries) Relationships (ARDL)





Nonlinearities (Asymmetries) Relationships (NARDL)



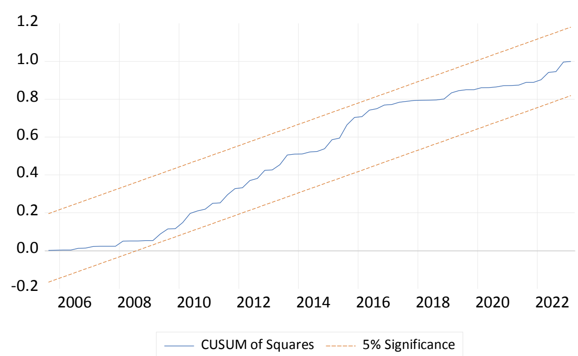


Figure No. 2: CUSUM & CUSUMSQ Test Result

The multicollinearity in the model was assessed using the variance inflation factor (VIF) test. The results presented in Table No. 7 demonstrate no significant multicollinearity issue within the model. The VIF values for all variables are below 10%, indicating the absence of excessive correlation between the independent variables.

Table No. 7: Variance Inflation Factors Test

	Coefficient	**Uncentered**	**Centered**
Variable	Variance	VIF	VIF
GDP	0.002858	3.745162	1.207494
M2	0.001209	3.019144	1.174575
R	0.006384	5.434706	1.030439
C	0.124868	7.171164	NA

Where: GDP: growth in real GDP, R: overnight deposit rate, M2: growth in the money supply.

The Breusch-Pagan-Godfrey test the variance heterogeneity in estimation errors until the Null-Hypotheses that there is a heteroscedasticity problem between variables the results in Table 8 indicate no heteroscedasticity problem.

Table No. 8: Breusch-Godfrey Serial Correlation LM Test

ARDL Model			
F-statistic	0.320502	Prob. F(2,82)	0.7267
Obs*R-squared	0.752378	Prob. Chi-Square(2)	0.6865
NARDL Model			
F-statistic	0.508736	Prob. F(2,69)	0.6035
Obs*R-squared	1.395041	Prob. Chi-Square(2)	0.4978

The serial correlation test was conducted to assess the presence of autocorrelation between variables. The null hypothesis is rejected when autocorrelation exists. In this study, the null hypothesis is rejected with a probability value of 0.1132 for the ARDL model and 0.6760 for the NARDL model, indicating the presence of autocorrelation.

Table No. 9: Heteroskedasticity Test: Breusch-Pagan-Godfrey

ARDL Model			
F-statistic	1.579909	Prob. F(12,84)	0.1132
Obs*R-squared	17.86163	Prob. Chi-Square(12)	0.1200
Scaled explained SS	16.64574	Prob. Chi-Square(12)	0.1634
NARDL Model			
F-statistic	0.839879	Prob. F(24,71)	0.6760
Obs*R-squared	21.22798	Prob. Chi-Square(24)	0.6252
Scaled explained SS	11.63481	Prob. Chi-Square(24)	0.9837

According to Wald Test Table No.10, there are asymmetrical relationships between variables since the probability value was less than 5%, which means rejecting the null hypothesis that the negative effect equals the positive impact.

Table No. 10: The Results of the Wald Test.

Null-Hypotheses	χ^2	Probability	Result
$ß_{M2\_pos} = ß_{M2\_NEG}$	41.3	0.000	There is asymmetry.
$ß_{R\_Pos} = ß_{R\_NEG}$	12.4	0.021	There is asymmetry
$ß_{GDP\_POS} = ß_{GDP\_NEG}$	38.3	0.000	There is asymmetry.

5. CONCLUSION

This study provides strong empirical evidence supporting a long-term relationship between the overnight deposit rate and core inflation. The findings show a causal relationship, confirmed by pairwise Granger causality tests. The Brock Dechert Scheinkman-BDS test indicates the presence of nonlinear paths in the study variable. The ARDL model suggests a linear relationship: a 1% increase in interest rates lowers core inflation by 0.26% in the long run. NARDL analysis reveals an asymmetric effect: a 1% increase in the overnight deposit rate decreases core inflation by 0.43%, while a 1% reduction increases it by 0.37%. The stability tests confirm the estimated parameters' stability throughout the study period, and the absence of significant issues related to multicollinearity or heteroscedasticity strengthens the reliability of the findings.

These results have important implications for monetary policymakers, emphasizing the need to consider interest rate adjustments to manage inflation dynamics effectively and carefully. Given the observed asymmetric effects between the overnight deposit rate and core inflation, policymakers should consider the different responses to interest rates. This indicates the need for a nuanced policy response that considers the specific circumstances and the potential impact on inflation. Policymakers should consider the nonlinear and asymmetric effects between the overnight deposit rate and core inflation when formulating monetary policy strategies.

Future studies could explore additional factors and variables that may influence the relationship between interest rates and inflation, such as fiscal policy measures, exchange rate dynamics, or external factors. Moreover, conducting similar analyses in different economic contexts and countries would provide a broader perspective on the relationship between interest rates and inflation.

Overall, this study contributes to understanding the complex relationship between the overnight deposit rate and core inflation, providing valuable insights for policymakers and researchers.

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