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Effectiveness of Monetary Policy in Controlling Inflation during Normal and Crisis Periods: An ARDL Analysis for Pakistan

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ABSTRACT

This paper examines how well monetary policy has worked to limit inflation in Pakistan between 2000 and 2024, considering the COVID-19 epidemic and the global financial crisis of 2008. The autoregressive distributed lag (ARDL) framework is used to evaluate the dynamics in the short and long term. The findings highlight the monetary policy rate's function as a key policy tool by showing that it significantly reduces inflation over the long term. Both the currency rate and the policy rate have a major impact on inflation in the short term, with the latter having long-lasting consequences due to its delayed term. The error correction term corrects 77% of the disequilibrium per year, indicating a quick rate of adjustment. Stability tests verify parameter constancy during times of crisis, while diagnostic tests verify the lack of heteroscedasticity, autocorrelation, and non-normality. The main goals of policy recommendations are to improve the efficiency of money supply mechanisms, control exchange rate volatility, and strengthen interest rate transmission.

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1. Introduction

A primary goal of macroeconomic policy is price stability since persistent inflation restricts growth, reduces purchasing power, and affects the distribution of resources. Domestic demand pressures, exchange rate volatility, structural supply constraints, and price fluctuation globally all influence the dynamics of inflation in rising economies like Pakistan. The major weapon for controlling inflation is still monetary policy, which is carried out by the State Bank of Pakistan (SBP) and includes tools such as reserve requirements, open market operations, and the policy rate. However, given fiscal supremacy, institutional limitations, and the frequency of cost-push inflation, the usefulness of these measures is regularly contested (Hussain, 2009). According to the traditional theory, which is captured by the Quantity Theory of Money (MV = PY), when the money supply grows faster than real output growth, the level of prices rises proportionately, which lowers the buying power of money. Similarly, by reducing aggregate demand, monetary tightening through higher policy rates should reduce inflation. However, empirical data for Pakistan has frequently been conflicting, with research indicating both robust and feeble transmission channels based on the macroeconomic environment, the financial system's structure and the effects of external shocks (Onodugo, Anowo, & Ofoegbu, 2018).

The years 2000–2024 present a special opportunity to reevaluate Pakistan's monetary policy's effectiveness. This includes periods of severe inflation in the middle of the 2000s, periods of relative stability in the middle of the 2010s, and the global finical crises along with COVID-19 pandemic (2020–2022), which caused unheard-of disruptions. Particularly during the pandemic, monetary authorities faced unprecedented difficulties as a result of fast monetary expansion to support economic activity, global supply chain disruptions, rising commodity prices, and currency depreciation. These changes raise doubts about monetary policy's ability to effectively regulate inflation in both regular and emergency scenarios (Chaudhry et al., 2015; Qayyum, 2008). This study uses the Autoregressive Distributed Lag (ARDL) bounds testing approach to empirically investigate the short- and long-term relationships among inflation and the three key monetary policy factors: the policy rate, exchange rate, and broad money supply (M2). This approach captures both short-term policy impacts and long-term equilibrium dynamics, allowing for the integration of variables at I(0) and I(1). The paper adds to the continuing discussion about the function, constraints, and conditional efficacy of monetary policy in controlling inflation by encompassing a 25-year period and specifically mentioning the global finical crises along with COVID-19 years. This study has been divided into five major sections to ensure a logical flow of analysis and discussion. Section 2 discusses the literature on monetary policy's effectiveness and inflation. The data, variables, and methodological framework are described in Section 3. The empirical findings, along with stability diagnostics and estimations for the short and long terms, are presented in Section 4. The results are discussed in the context of theory and macroeconomic developments under normal and crisis periods as well in section 4. Policy implications for improving Pakistan's monetary policy's efficacy and conclusion are discussed in Section 5.

2. Literature Review

Both theoretical and empirical contributions have influenced the discussion surrounding the efficacy of monetary policy, which has long been seen as an essential tool for attaining macroeconomic stability, especially in containing inflation. One of the first comprehensive analyses was provided by Smith (1956) who claimed that the response of aggregate demand to changes in the money supply and policy rates affects the impact of monetary policy. Subsequently, Woodford (2004) promoted inflation targeting as a sound and progressive policy framework, contending that anchoring expectations is essential to price stabilization. This link was also examined during financial crises by Mishkin (2009), who pointed out that when market disturbances hinders transmission mechanisms, even vigorous policy interventions may have limited effects. The results of empirical research conducted in various national contexts vary. Using an error correction model, Akarara and Azebi (2018) found that monetary policy has a significant long-term effect on inflation in Nigeria, but short-term effects are still minimal because of structural rigidities and policy lags. Similar results were documented by Gbadebo and Mohammed (2015), who emphasized that supply-side restrictions, exchange rate volatility, and fiscal dominance all reduce the effectiveness of monetary policy. While Ezeanyeji et al. (2021) emphasized institutional flaws and external shocks as enduring obstacles to efficient inflation control, Onodugo, Anowo and Ofoegbu (2018) pointed out that in emerging African economies, inefficient transmission channels frequently prevent monetary policy from attaining desired inflationary outcomes. Issa et al. (2018) examined inflation targeting and concluded that while it provides a logical framework for policy, central bank independence, policy transparency, and supportive fiscal discipline are critical to its effectiveness(Ahmed, Azhar, & Mohammad, 2024; Mohammad & Ahmed, 2017).

Qayyum (2008) revealed that monetary policy plays a crucial role in controlling inflation within Pakistan, especially changes to the money supply and policy rates that serves as essential tools for price stabilization. Waliullah and Rabbi (2011) demonstrated the existence of a long-term relationship between monetary policy variables and inflation using bound testing, while they acknowledged that short-term consequences are sometimes weakened due to lagged responses. In his historical analysis of Pakistan's monetary policy experience, Hanif (2014) made the case that political interference and fiscal constraints still threaten policy autonomy in spite of institutional improvements. Chaudhry et al. (2015) looked at how monetary expansion affects inflation and emphasized how crucial it is to match monetary growth to real output in order to prevent persistent price pressures. Hussain (2009) investigated policy transmission channels and discovered the policy rate & credit channels have significant effects on both inflation and GDP; however, their strength fluctuates over time. Ahmed and Malik (2011) investigated the structure of monetary policy regulations in Pakistan as well as recommended that responce functions be adjusted to the nation's structural constraints. When considered collectively, the literature shows a consistent pattern across various economies: monetary policy tends to have more long-term effects on controlling inflation than short-term ones. This phenomenon is primarily explained by structural bottlenecks, fiscal-monetary coordination issues, and policy implementation lags (Akarara & Azebi, 2018; Waliullah & Rabbi, 2011). Even with the extensive research, there are still gaps in our understanding of the asymmetric effects of monetary shocks, regional differences in policy effectiveness, and the interaction between domestic policy and international financial developments. This suggests that future studies should focus on more complex and context-specific analyses(Ragmoun & Alwehabie, 2020; Wided & Abdulaziz, 2024).

3. Methodology

3.1. Data and Variables

This current study uses annual time series data for Pakistan during 2000 to 2024. The data was compiled from three main sources: The World Bank's World Development Indicators (WDI), Trading Economics, and the State Bank of Pakistan (SBP). The sample period was selected depending on the availability of data and the requirement to record significant macroeconomic phenomena such as (2008) the global financial crisis and the COVID-19 pandemic of 2020-2022. The following variables are included in the dataset:

- Rate of inflation: expressed as the Consumer Price Index (CPI) annual percentage change. Data came from Trading Economics and WDI.
- Interest rate on policy: The annual percentage representing the SBP's policy (discount) rate. Data came from Trading Economics and SBP papers.
- The nominal rate of exchange: defined as the average annual Pakistani rupee value in relation to the US dollar; a rise indicates a decline in the rupee's value. Data on exchange rates was gathered from WDI and SBP.
- Broad money supply (M2): Money in circulation plus demand and time deposits held by the general public. SBP and WDI provided the M2 statistics.

3.2. Specification of the Model

The model's functional form;

$$INFt = f\ (M2t, PRt, EXRt) \quad (1)$$

Equation expressed in form of ARDL;

$$\Delta INFt = \alpha 0 + \sum_{i=1}^{p} \beta i\, \Delta INFt - i + \sum_{j=0}^{q1} \gamma j\, \Delta PRt - j + \sum_{k=0}^{q2} \delta k \Delta EXRt - k + \sum_{1=0}^{q3} \phi l \Delta M2t - l + \lambda 1 INFt - 1 + \lambda 2 PRt - 1 + \lambda 3 EXRt - 1 + \lambda 4 M2t - 1 + \varepsilon t \quad (2)$$

Where:

INFt = Inflation rate	PRt = Policy interest rate
EXRt = Nominal exchange rate	M2t = Broad money supply
Δ = first-difference	p,q1,q2,q3 = optimal lag lengths
α0 = constant term	βi,γj,δk,ϕl = short-run dynamic coefficients
λ1,λ2,λ3,λ4 = long-run coefficients	εt = white-noise error term

3.3 Stationarity testing (Unit Root Test)

No variable of order 2 or above must be integrated such as (I(2)) according to ARDL. It is necessary to look for unit roots in each series. The Augmented Dickey-Fuller test (ADF) is used for this purpose. Dickey and Fuller (1979, 1981) established this test, and the stationarity characteristics of the variables were examined. For a variable X_t, the general ADF regression is defined as follows:

$$\Delta X_t = \alpha + \beta_t + \gamma X_{t-1} + \sum_{i=1}^{P} \phi i\, \Delta Xt - i + \varepsilon t \quad (3)$$

where Δ shows the first-difference, t is the time trend, εt is the white-noise error term and p is the number of lag differences added to account for autocorrelation. The alternative and null hypotheses are defined as follows:

H0: $\gamma=0$(unit root, non-stationary)
H1: $\gamma<0$(stationary)

Based on the visual examination of the series and the underlying economic theory, the constant term (α) and time trend (βt) were included. The optimal lag length (p) was determined using the Akaike Information Criterion (AIC) and the Schwarz Bayesian Information Criterion (BIC) to ensure that there was no serial correlation in the residuals. By comparing the test statistic with the crucial values provided by MacKinnon (1996), the order of integration for each variable was determined.

3.4 ARDL (Bounds Test)

If the variables are a combination of I(0) and I(1), cointegration is investigated using the ARDL bounds testing approach (Pesaran, Shin, & Smith, 2001). The alternative and null hypotheses for the bounds test are as follows:

H0: $\lambda1=\lambda2=\lambda3=\lambda4=0$ (No long-run relationship)
H1: $\lambda1\neq0,\lambda2\neq0,\lambda3\neq0,\lambda4\neq0$ (Long-run relationship exists)

The calculated F-statistic is contrasted with the critical value bounds proposed by Pesaran, Shin and Smith (2001):

- If F > Upper bound (cointegration exists)
- If F < Lower bound (no cointegration)
- If F is between bounds (inconclusive)

3.5 The Model's Stability

Brown, Durbin and Evans (1975) The computed coefficients' stability assessed using the CUSUM and CUSUM of Squares (CUSUMSQ) tests.

CUSUM statistic

$$\text{Wt} = \frac{\sum_{i=k+1}^{t} \mathbf{u\hat{}i}}{\boldsymbol{\sigma}\hat{}} \tag{4}$$

CUSUMSQ statistic:

$$\text{Ct} = \frac{\sum_{i=k+1}^{t} \mathbf{w2t}}{\sum_{t=p+1}^{k} \boldsymbol{w2t}} \tag{5}$$

The plots of CUSUM and CUSUMSQ are compared using the 5% significant bounds. If the plots stay inside the crucial bounds, stability is verified.

3.6 Tests for Diagnosis

The following tests are used to make sure the results are robust:

- For serial correlation, use the Breusch-Godfrey LM test.
- Heteroscedasticity is measured using the Breusch-Pagan-Godfrey test.
- The normality test by Jarque-Bera.

4. Results and Discussion

4.1. Descriptive Statistics

For a 25-year period, Table 1 displays the descriptive data for the money supply (M2), inflation, exchange rate, and monetary policy rate.

Table 1: Descriptive Statistics

Statistics	Inflation	Exchange	M2	Policy
Mean	9.506400	114.8652	14.3904	10.60000
Median	7.920000	96.50000	14.2000	9.750000
Maximum	30.77000	281.0000	19.6200	22.00000
Minimum	2.530000	51.90000	8.95000	5.750000
Std. Dev.	6.520303	66.46951	3.10403	3.627872
Sum	237.6600	2871.630	359.760	265.0000
Observations	25	25	25	25

Source: Author calculation using EViews 10

For most of the time, inflation was in the single digits, reaching a top of 30.77% and a minimum of 2.53%, with an average rate of 9.51% and a median of 7.92%. The cumulative sum of inflation over the time was 237.66, while the standard deviation of 6.52 indicates moderate variations. With a median of 96.50 and an average of 114.87 PKR/USD, over time, the exchange rate demonstrated a consistent deprecation. The large standard deviation of 66.47 further demonstrates the significant variation, with the highest reported rate being 281.00 and the lowest being 51.90. The sum of the exchange rates throughout that time was 2,871.63. The money supply (M2) as a proportion of GDP showed relatively low fluctuations, with a mean of

14.39% and a median of 14.20%, a maximum of 19.62%, and a minimum of 8.95%. The overall sum for the period was 359.76, and the standard deviation of 3.10 indicates little unpredictability. With a median of 9.75% and an average of 10.60%, the monetary policy rate peaked at 22.00% and fell as low as 5.75%. The total value for the period was 265.00, and the standard deviation of 3.63 indicates moderate volatility.

4.2. Stationary Results

The Augmented Dickey–Fuller (ADF) tests were used to assess each variable's order of integration. According to table 2's indication of order I(1) integration, the exchange rate series (EXR) was non-stationary at levels (ADF statistic = 0.01, p = 0.9491 > 0.05) but became stationary at the first difference (ADF = −5.79, p < 0.01). At first difference, both the broad money supply (M2) and inflation (INF) were stationary (ADF statistics = −5.07 and −4.88, p < 0.01, respectively). The ARDL bounds testing approach, which can handle both I(0) and I(1) variables, was justified by the variety of integration orders.

Table 2: Unit Root Test's Results

Variables	At Level		At 1st Difference		Results
	Test Statistic	Probability	Test Statistic	Probability	
INF	-2.483896	0.1316	-4.882535	0.0008	Stationary
M2	-3.236245	0.0301	-5.072562	0.0005	Stationary
PR	-2.147588	0.2292	-3.901187	0.0072	Stationary
EXR	0.011079	0.9491	-5.790719	0.0001	Stationary

Source: Author calculation using EViews 10

4.3. Estimation of ARDL Model (Bounds Test)

A long-term cointegrating link between inflation, the policy rate, the exchange rate, and M2 was confirmed by the ARDL bounds test as indicated in table 3, which resulted in an F-statistic = 6.498, above the upper bound critical value at the 5% level (upper bound= 3.67).

Table3: Autoregressive distributed lag bounds test

Statistics	Value	K
F-Statistic	6.958406	3
Critical Value Bounds		
Significance	Lower Bound	Upper Bound
10%	2.37	3.2
5%	2.79	3.67
1%	3.65	4.66

Source: Author calculation using EViews 10

4.4. The autoregressive distributed lag model's long-run coefficient

The model's estimated long-run coefficients, which consider the possible impact of significant economic disruptions like the COVID-19 pandemic and the global financial crisis of 2008, are shown in Table 4. In the long run, a 1 percentage point increase in the monetary policy rate is linked to an approximate 0.90 percentage point increase in the inflation, according to the statistically significant positive coefficient of the policy rate (0.9033, p < 0.01). This implies that the policy rate had a significant and long-lasting effect on the economy during times of economic instability, such as when monetary policy was tightened following the 2008 financial crisis to reduce inflationary pressures and during COVID-19 to control currency depreciation.

Table 4: Long Run Coefficient of ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
POLICY	0.903329	0.202564	4.459481	0.0005
M2	0.287736	0.255466	1.126318	0.0279
EXCHANGE	0.02951	0.022626	1.30442	0.2131
C	-3.50151	4.021272	-0.87075	0.3986

Source: Author calculation using EViews 10

The money supply (M2) coefficient (0.2877) indicates that increases in broad money had no consistent long-term effects during the data period, despite being positive and statistically significant (p = 0.02790). This might be the result of systemic flaws in monetary transmission, which were most evident during the COVID-19 liquidity injections and the 2008 credit crisis, when increases in M2 failed to result in corresponding economic growth. Although statistically insignificant (p = 0.2131), the exchange rate and the inflation have a positive long-term connection (0.0295). This suggests that currency depreciation have positive long-term effects, these effects were weak and erratic, most likely as a result of external aid flows and policy changes that lessened the effect of the exchange rate during the 2008 and COVID-19 shocks. Additionally, the constant term (−3.5015) is statistically insignificant, indicating that long-term structural factors that are not directly captured by the variables included, such as global commodity price fluctuations, supply chain disruptions, and trade imbalances, may have contributed to the crisis periods. Overall, the findings imply that, despite significant external shocks, monetary policy continued to be the primary long-term driver, but the channels of the money supply and exchange rate were somewhat weaker and less stable during the 2008 and COVID-19 turmoil.

4.5. The autoregressive distributed lag model's short-run coefficient

The short-run error correction model results are shown in table 6. These results capture the immediate effects of monetary and exchange rate modifications during the sample period, which spans two significant global economic disruptions: the COVID-19 pandemic and the global financial crisis of 2008. Short-term effects of the monetary policy rate change (D(POLICY)) on the dependent variable are extremely significant and positive (1.3737, $p < 0.01$). This implies that the central bank's use of interest rate modifications as a quick reaction tool is reflected in the immediate impact that a rise in the policy rate has on the economic indicator. In the COVID-19 era, policy measures were focused on promoting liquidity while limiting exchange rate pressures, whereas during the 2008 crisis, tighter policy was implemented to stabilize inflation and currency volatility.

Table 5: Long Run Coefficient of ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(POLICY)	1.373662	0.201934	6.802517	0.0000
D(M2)	0.020195	0.113764	0.177515	0.8616
D(EXCHANGE)	0.09086	0.042288	2.148621	0.0496
D(EXCHANGE(1))	0.15893	0.051516	3.085047	0.0081
CointEq(-1)*	-0.77113	0.115296	-6.68824	0.0000

R^2=0.943694, Adj. R^2= 0.931181, DW=2.152502

It is implied that liquidity injections, whether during the global financial crisis or the pandemic, did not have rapid, quantifiable effects on the inflation because changes in the broad money supply (D(M2)) are statistically insignificant (0.0202, p = 0.8616). This could be a result of structural constraints in the financial sector, delayed transmission effects, or a preference for prudent savings during times of crisis. The exchange rate change (D(EXCHANGE)) has a positive and significant coefficient (0.0909, $p < 0.05$), suggesting that an increase in the inflation is linked to short-term currency depreciation. When its one-period lag is taken into consideration, the effect becomes bigger (D (EXCHANGE (-1)) = 0.1589, $p < 0.01$), indicating a persistence effect in which changes in the exchange rate have an ongoing effect on the economy beyond the initial shock. Both crises demonstrated this tenacity: in 2008, currency depreciation increased import prices over several quarters, and in 2020, supply chain disruptions brought on by COVID-19 prolonged the inflationary effect of exchange rate shocks. The existence of a considerable rate of adjustment toward long-run equilibrium is confirmed by the negative and highly significant error correction term (CointEq(-1) = -0.7711, $p < 0.01$). In particular, within a single period, over 77% of any variation from the long-run path is corrected. Even in the wake of major shocks, the economy is reverting pretty quickly, as evidenced by this high adjustment speed. The Durbin-Watson statistic (2.15) indicates that residuals are not correlated to each other, and the model's goodness of fit (R^2 = 0.9437, Adjusted R^2 = 0.9312), suggesting a well-specified short-run model. Overall, these results show that while changes to the money supply have delayed or lessened effects, monetary policy rate changes and exchange rate fluctuations are the main short-run transmission channels in crisis situations. Despite significant shocks like those in 2008 and 2020, the economy tends to settle rather fast, as seen by the high error correction speed.

4.6. Results of tests for Diagnosis

a) Heteroscedasticity Test: Breusch-Pagan-Godfrey

The null hypothesis of homoscedastic residuals cannot be rejected, according to the results of the Breusch–Pagan–Godfrey heteroscedasticity test (F = 0.5838, p = 0.7755). This indicates that the estimated standard errors are reliable and that inference based on t-statistics is still acceptable since it validates that the model is not heteroscedastic**.**

b) Breusch–Godfrey Serial Correlation LM test

The null hypothesis that there is no serial correlation in the residuals up to the specified lag order is also not rejected by the Breusch–Godfrey Serial Correlation LM test (F = 1.3044, p = 0.3072) This implies that the residuals are not autocorrelated.

Table 6: Test for Diagnosis

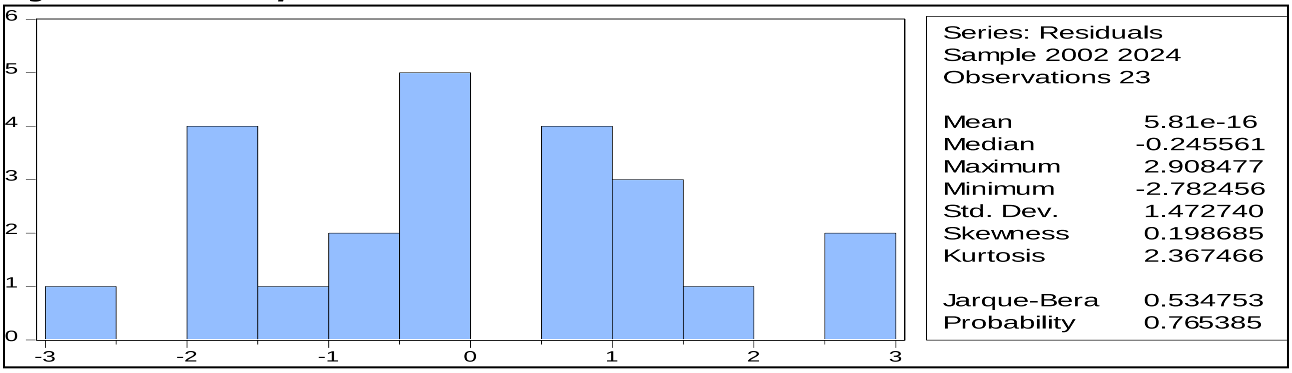
Tests	F-Statistic	Degree of freedom	Prob.
Breusch-Pagan-Godfrey	0.583833	F (8,14)	0.7755
Breusch–Godfrey	1.304389	F (2,12)	0.3072

Source: Author calculation using EViews 10

c) Normality Test-Histogram

The Jarque–Bera (JB) test was used to determine if the residuals were distributed normally. With an associated probability of 0.7654 and an estimated JB statistic of 0.5348, the results are significantly higher than the typical significance limits of 1%, 5%, and 10%. Therefore, it is not possible to reject the null hypothesis that the residuals are normally distributed. This result supports the validity of the model's statistical inference and satisfies one of the fundamental conditions of classical linear regression by confirming that the residuals show approximate normality.

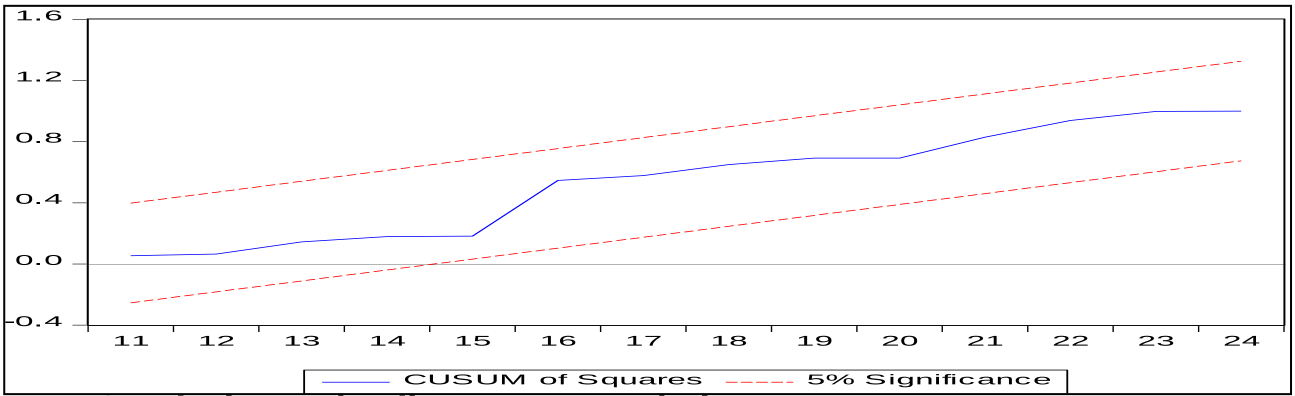
Figure 1: Normality Test



4.7. Stability of The Model

The CUSUM of Squares (CUSUMSQ) test was used to assess the stability of the predicted ARDL model. The blue lines show the 5% significance bounds, and the red line is the plotted CUSUMSQ statistic. The findings demonstrate that there is no structural instability because the red line stays completely inside the blue boundary lines during the sample period. This result implies that even during times of big economic shocks like the COVID-19 epidemic and the global financial crisis of 2008, the model's parameters remained constant throughout time and did not significantly change. The model's short- and long-term estimations are more resilient when the coefficients are stable.

Figure 2: CUSUMSQ Test



5. Conclusion and Policy Recommendation

According to the study's findings, monetary policy rate has a long-term, positive effect on the inflation, highlighting its function as Pakistan's main outlet for macroeconomic changes. The exchange rate on the other hand, have statistically negligible long-term impacts, indicating that their impact is either sporadic or mediated through other mechanisms. Both the exchange rate (including its lagged effect) and the policy rate have a considerable short-term impact on the dependent variable, suggesting that short-term macroeconomic dynamics are mostly determined by immediate policy changes and currency fluctuations. M2's minimal short-term effect points to delayed transmission, which could be brought on by structural barriers to financial intermediation and crisis-related precautionary saving. Even after major economic shocks, a strong and quick adjustment toward long-run equilibrium is confirmed by the negative and significant error correction period. The model's statistical validity is confirmed by diagnostic tests, which show no signs of non-normality, serial correlation, or heteroscedasticity. Additionally, the model's parameters held steady during the sample period, including the COVID-19 and 2008 crises, according to the CUSUM of Squares stability test. This robustness boosts trust in the conclusions' applicability to policy. Following policies are suggested;

- The central bank should continue to have a transparent and credible interest rate policy framework, especially in times of increased uncertainty, because the policy rate plays a major role in the short and long run.
- In order to reduce imported inflation and external balance pressures, exchange rate stabilization measures are necessary, particularly during crisis episodes, as evidenced by the notable short-run impact of exchange rate movements.
- To increase the pass-through of broad money expansion to the real economy and lessen the lag in its efficacy, structural improvements in the banking and financial sectors are required.
- Using a combination of interest rate changes and targeted liquidity support, policy interventions should strike a balance between growth support and inflation control during significant shocks like the global financial crisis or pandemics.
- Monitoring structural stability continuously is necessary to make sure that unexpected domestic or international shocks do not compromise the prediction accuracy of the model, especially because stability was preserved during previous crises.

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