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# Impact of inflation and exchange rate on stock market returns in India: An ARDL approach

**H R TEJESH**
Vijayanagara Sri Krishnadevaraya University, India
hrtejesh@gmail.com

**Abstract.** *The study examines the impact of exchange rate and inflation on stock market (Nifty-50) returns in India using monthly data spanning from April 2013 to February 2024. The autoregressive distributed lag (ARDL) cointegration and error correction parameterization approach is applied to analyse this relationship. The findings reveal an insignificant long-run association between stock market returns and both inflation and the exchange rate. However, there is a significant short-run relationship between stock market returns and both inflation and the exchange rate.*

**Keywords:** ARDL cointegration, exchange rate, inflation, stock market returns, unit root test.

**JEL Classification:** C10, C40, E31.

## 1. Introduction

The stock market wields significant influence over the path of an economy, playing a crucial role in its growth or decline. The stock market is known for its volatility, marked by significant fluctuations that offer investors insights into potential positive or negative outcomes for stock market returns. Governments, industries, and central banks closely monitor stock market movements, recognizing their profound impact on economic dynamics (Chandra et al., 2014). In many developing nations, efforts to revitalize the stock market often involve collaboration with international institutions like the World Bank. Among the various macroeconomic factors influencing both the broader economy and the stock market specifically, inflation rates and exchange rates are particularly noteworthy. The relationship between inflation, exchange rate and stock market returns has garnered significant attention from academics, resulting in diverse findings and perspectives. High inflation rates diminish the real value of currency, leading to diminished purchasing power, profitability, and actual returns on investments. Understanding the association between stock market returns, exchange rates, and inflation holds significant importance for investors, as stocks are often considered a hedge against the impacts of inflation and exchange rate fluctuations. However, despite diverse theoretical frameworks offering differing conclusions regarding the interplay among inflation, exchange rates, and stock market returns, the relationship remains a subject of ongoing exploration and debate. Fama’s (1981) hypothesis, widely cited in literature, posits a negative correlation between inflation and stock prices. Inflation, characterized as the sustained, continual increase in the general level of prices, remains a pervasive concern for governments worldwide, as it serves as an indicator for assessing economic health. The proxy hypothesis posits a negative association between inflation rates and both stock market returns and stock prices (Hiraki, 1985), echoing the findings of Fama (1981). Conversely, the Fisher theory suggests that equity stocks represent ownership stakes in real business assets, potentially serving as a hedge against inflation (Osagie et al., 2016).

Numerous studies have investigated the impact of inflation and exchange rates on stock returns in both developed and developing economies worldwide. Mahmood (2014) explored the relationship between inflation and stock prices in Pakistan, revealing a negative influence of inflationary pressures on stock prices. Kwofie et al. (2018) investigated the impact of exchange rate and inflation on stock market returns in Ghana using monthly data. The findings revealed a significant long-term relationship between GSE market returns and inflation. Ibrahim et al., (2013) contend that despite governments' implementation of stringent policies and measures to stabilize inflation at a satisfactory single-digit figure, its path has become increasingly erratic. They further posit that factors such as income levels, elevated nominal wages, revenue fluctuations, and debt repayment significantly impact inflationary trends within an economy. Over the years, Indian economy has exhibited visible fluctuations in prices, leading to non-constant inflation rates. Meanwhile, Mahonye et al., (2014) delved into the long-term relationship between stock returns and various determinants in Zimbabwe, identifying inflation, real income, money supply, and exchange rates as key determinants of stock market returns. Khan et al. (2019) explored the impact of exchange rate on stock returns in the Shenzhen Stock Exchange using monthly data. They analyzed the long-run and short-run relationship between stock returns and exchange rates through the ARDL method. In Tanzania, research findings on the relationship between macroeconomic variables and DSE (Dar es Salaam Stock Exchange) returns have been inconsistent, as evidenced by studies conducted by Gwahula (2018) and Abdalla (2014). The variability in findings among different researchers regarding the association between macroeconomic variables and stock market returns highlights the necessity for further investigation. Uwubanmwen (2015), examined the influence of inflation rate on stock returns in the Nigerian Stock Market using the ARDL method. The findings suggested that the inflation rate had a negative impact on stock returns. Hence, an attempt has been made to determine the impact of Inflation and Exchange Rate on Stock Market Returns in India using the ARDL (Autoregressive Distributed Lag) model. In light of the ongoing fluctuations in the economic scene, it is crucial to undertake a new study to determine the present-day effects of exchange rates and inflation on stock market returns, specifically focusing on securities listed on the Nifty 50 Index. With macroeconomic variables like inflation and exchange rates constantly evolving, a fresh examination would offer updated perspectives on how these factors shape stock market dynamics. However, many studies have used models such as multiple regression analysis, panel data analysis, Granger causality, vector error correction model (VECM), and autoregressive fractionally integrated moving average (ARFIMA). Nonetheless, this study sticks with the ARDL model, considering the mixed stationarity data at level ($I_0$) and first difference ($I_1$).

The paper is structured as follows: section 2 depicts the data and methodology, followed by the results and discussion. Finally, the study is concluded with implications and the scope for future research.

## 2. Data and Methodology

### 2.1. Variables and Measurement

This study considers the exchange rate and inflation rate as independent variables, while the stock market return serves as the dependent variable. The adjusted closing prices of the Nifty 50 index served as a proxy for stock market returns. To measure the stock market returns, we applied the following formula:

$$R_m = \frac{(P_i - P_{i-1})}{P_{i-1}} \times 100$$

where $P_i$ is the stock price at time $i$ and $P_{i-1}$ is the stock price at time $i-1$. However, for inflation and exchange rate, we used the actual values.

## 2.2. Sources of Data

The study used secondary data acquired from April 2013 to February 2024, comprising 131 monthly observations for each variable. The adjusted closing prices of the Nifty 50 index are sourced from the official website of the National Stock Exchange (NSE). Inflation and exchange rate data are obtained from the website of the Reserve Bank of India (RBI).

## 2.3. Unit Root Test

In this study, the time series variables considered are stock market returns, exchange rate, and inflation. To apply the ARDL methodology, the unit root test is first conducted on the three time series variables to establish whether they are stationary or not. For this purpose, the Augmented Dickey-Fuller (ADF) unit root test is used in this study.

It is generally observed that macroeconomic time series variables are non-stationary (Kwofie et al., 2018). Numerous studies have indicated that many time series variables are nonstationary or integrated of order 1. Any dataset found to be non-stationary undertakes differencing using the formula:

$$\Delta Y_t = Y_t - Y_{t-1}$$

The ADF test is based on the Dickey-Fuller test, developed by David Dickey and Wayne Fuller (1979). The ADF test statistic is calculated as follows:

$$ADF = (Y_t - Y_{t-1}) - \lambda \times \Delta Y_{t-1}$$

where $Y_t$ represents the time series at time $t$, $Y_{t-1}$ denotes the time series at time $t-1$, $\Delta Y_{t-1}$, is the first difference of the time series at time $t-1$, and $\lambda$, indicates the coefficient.

## 2.4. Cointegration

The variables are considered to be cointegrated if there exists a linear combination among the variables that is stationary. If the variables under consideration exhibit unit roots of the same order, then the long-run cointegrating relationship between the variables can be examined. On the other hand, if there are variables with unequal orders of integration, then the ARDL approach is suitable. In this study, the ARDL methodology is employed due to the different orders of integration observed in the independent and dependent variables form Table 3.

## 2.5. ARDL Approach

The ARDL bounds testing technique, founded by Pesaran and Shin (1990), Pesaran et al. (1997) and Pesaran et al. (2001), is flexible, necessitating those variables in the model specification be integrated at order 0 or 1, denoted as ($I_0$) or ($I_1$). In order to estimate the ARDL model, the optimal lag length (p) is chosen based on Akaike Information Criterion (AIC), or Schwarz Bayesian Criterion (SBC). Once the appropriate lag length is determined, the ARDL model can be specified and estimated.

Below is the ARDL equation:

*a) ARDL Equation for short-run relationship:*

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, \Delta Y_{t-i} + \sum_{i=0}^{q} \beta_i \, \Delta X_{t-i} + \varepsilon_t$$

*b) ARDL Equation for long-run relationship:*

$$Y_t = \alpha + \sum_{i=1}^{p} \gamma_i \, \Delta Y_{t-i} + \sum_{i=0}^{q} \delta_i \, X_{t-i} + \varepsilon_t$$

where $Y_t$ and $X_t$ the dependent and independent variables at time *t*, Δ denotes the first difference operator, indicating the short-run relationship, *p* and *q* represent the lag lengths for the dependent and independent variables, $\alpha_0$ is the intercept term for the short-run equation, $\alpha$ is the intercept term for the long-run equation, $\alpha_i$, $\beta_i$, $\gamma_i$, and $\delta_i$ are coefficients associated with the lagged values of Y and X variables, and $\varepsilon_t$ represents the error term at time *t*.

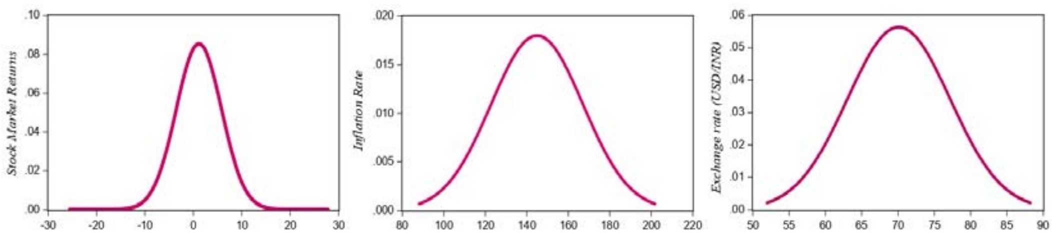
## 3. Results and Discussion

**Table 1.** *Summary statistics for the monthly rates of inflation, exchange rate, and stock market returns*

| | Stock market returns | Inflation rate | Exchange rate (USD/INR) |
|---|---|---|---|
| Mean | 1.156 | 144.982 | 70.110 |
| Std. Dev. | 4.672 | 22.160 | 7.074 |
| CAGR | -0.0051 | 0.0044 | 0.0033 |
| Skewness | -0.7830 | 0.335 | 0.294 |
| Kurtosis | 7.683 | 2.103 | 2.231 |
| Jarque-Bera | 133.107 | 6.850 | 5.113 |
| Prob. | 0.000 | 0.0326 | 0.078 |

**Source:** Author's Calculation.

**Figure 1.** *Distribution of Monthly returns, inflation and exchange rates*



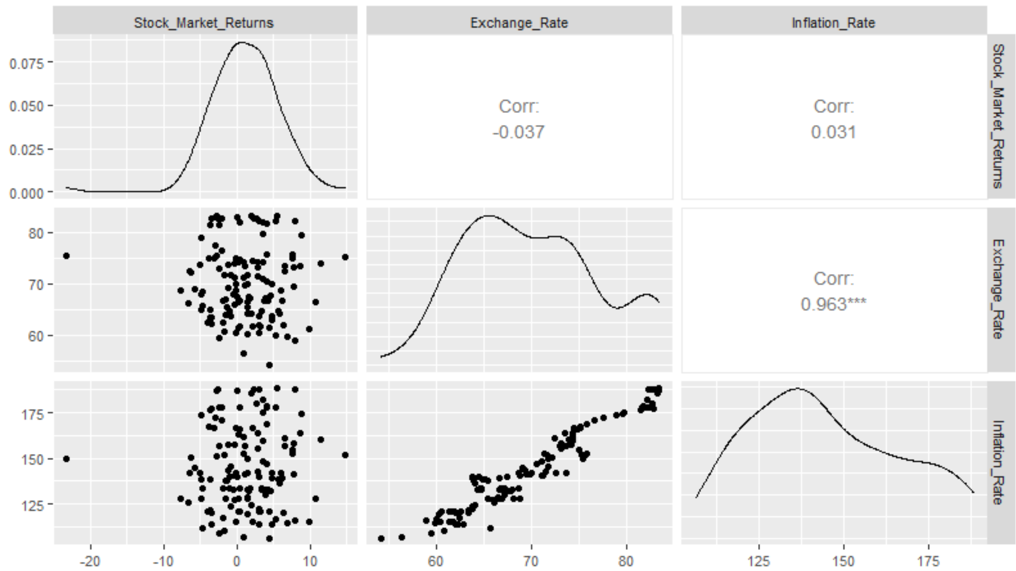

The inflation and exchange rates show positive Compound Annual Growth Rate (CAGR) values of 0.44 percent and 0.33 percent, respectively, while the stock market returns exhibit negative growth rate of -0.51 percent. Similarly, the distribution of stock market returns is left-skewed, with the majority of observations lying to the right side of the mean. In contrast, both inflation and exchange rates have right-skewed distributions. The leptokurtic nature in the distribution is noticed only in the case of stock market returns. With the exception of the exchange rate, almost all other variables do not follow a normal distribution.

**Table 2.** *Correlation Analysis*

| | Stock market returns | Inflation rate | Exchange rate (USD/INR) |
|---|---|---|---|
| Stock market returns | 1 | | |
| Exchange rate (USD/INR) | -0.037 | 1 | |
| Inflation rate | 0.031 | 0.963 | 1 |

**Source:** Author's Calculation.

**Figure 2.** *Correlation Matrix*




A weak positive association between stock market returns and inflation rate can be observed in Table 2. On the other hand, there is weak negative relationship between stock market returns and exchange rate, suggesting almost no linear relationship between them. However, the inflation rate is highly correlated with changes in the exchange rate.

**Table 3.** *Augmented Dickey-Fuller (ADF) unit root test at level ($I_0$)*

| Variable | Model type | t-statistic | P-value |
|---|---|---|---|
| Stock market returns | Constant | -11.936 | 0.000*** |
| | Constant + trend | -11.900 | 0.000*** |
| | None | -11.302 | 0.000*** |
| Exchange rate (USD/INR) | Constant | -1.439 | 0.561 |
| | Constant + trend | -3.464 | 0.058 |
| | None | 1.978 | 0.989 |
| Inflation rate | Constant | 0.477 | 0.985 |
| | Constant + trend | -1.742 | 0.727 |
| | None | 4.555 | 1.000 |

**Source:** Author's Calculation.

The time series plot of monthly stock market returns form Figure 2 indicates potential stationarity in return series. To validate this observation, the ADF test is conducted. The results of the ADF test for the return series reveal that they are stationary, representing lack of trend or long-term growth pattern across all three model types: constant, constant + trend, and none. This indicates that the returns are integrated with order zero ($I_0$), signifying that stock market returns are stationary without differencing.

**Figure 2.** *Time series plot of the monthly stock market (Nifty-50) returns*

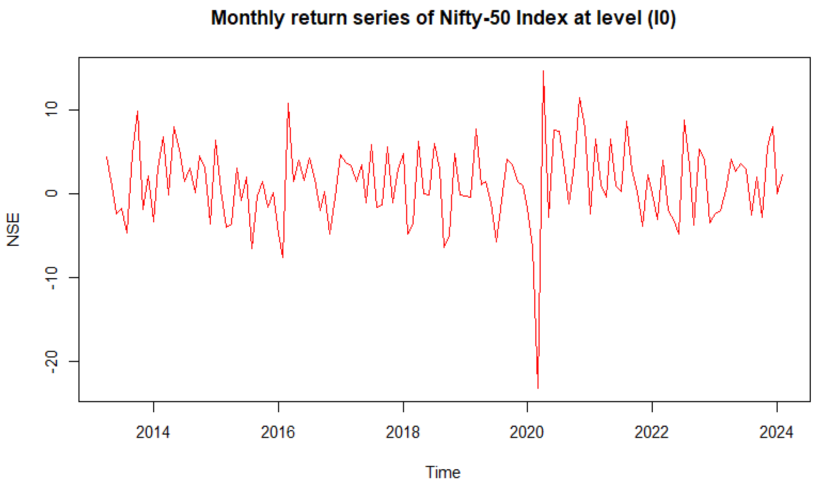



Table 3 also shows the results of the ADF test for inflation and exchange rates, revealing non-stationarity with p-values. This observation is further supported by Figure 3, where the plot of the level values of inflation and exchange rate demonstrates non-constant mean and variance over time. Accordingly, data transformation is deemed necessary to achieve stationarity. Both inflation and exchange rate values are then differenced, as depicted on the right side of Figure 3.

**Table 4.** *Augmented Dickey-Fuller (ADF) unit root test at level ($I_1$)*

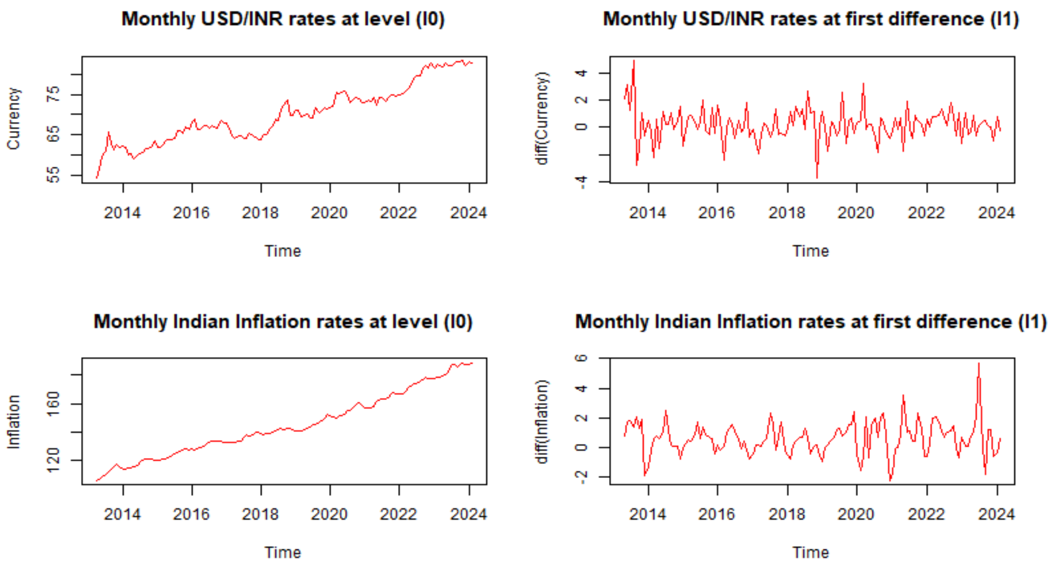
| Variable | Model type | t-statistic | P-value |
|---|---|---|---|
| Exchange rate (USD/INR) | Constant | -12.190 | 0.000*** |
| | Constant + trend | -12.143 | 0.000*** |
| | None | -11.851 | 0.000*** |
| Inflation rate | Constant | -8.086 | 0.000*** |
| | Constant + trend | -8.105 | 0.000*** |
| | None | -6.391 | 0.000*** |

**Source:** Author's Calculation.

The mean and variance of inflation and exchange rate series after first differencing appear to be constant over time, as evident from Figure 3. This observation is further supported by the ADF test of stationarity. The p-values from Table 4 are all less than the significance level (alpha), indicating that the variables are now stationary or integrated with order one

$(I_1)$. Therefore, it can be inferred that after first differencing, both inflation and exchange rate series became stationary.

**Figure 3.** *Time series plot of monthly inflation and exchange rate*




From Table 3, it is observed that the stock market returns show integration of order zero, $(I_0)$, while inflation and exchange rate show integration of order one, $(I_1)$, as indicated in Table 4. These results are consistent with the findings reported by Kwofie et al. (2018). Therefore, according to Pesaran et al. (2001), the ARDL test is the best feasible method for cointegration analysis irrespective of whether the regressors are purely $(I_0)$, purely $(I_1)$, or a mixture of $(I_0)$ and $(I_1)$. Hence, the ARDL model is applied in this scenario.

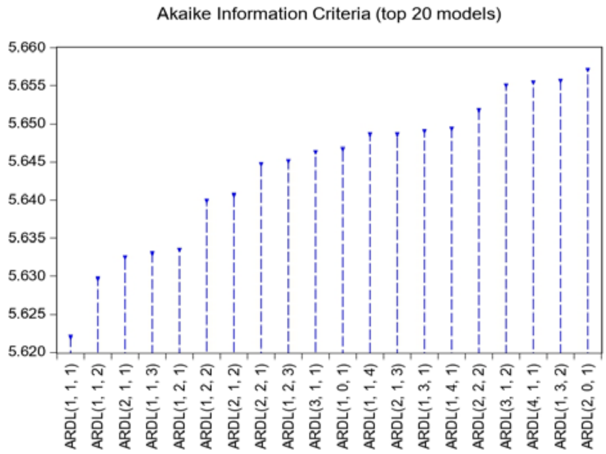
**Table 5.** *Estimated results of ARDL bound test for cointegration*

| Test statistic | Value | Significance | Lower bound value | Upper bound value |
|---|---|---|---|---|
| Computed F-statistic | 49.72420 | 10% | 3.17 | 4.14 |
| | | 5% | 3.79 | 4.85 |
| k | 2 | 2.5% | 4.41 | 5.52 |
| | | 1% | 5.15 | 6.36 |

**Source:** Author's Calculation.

The estimated results of the ARDL model, depicting the relationship between stock market returns, inflation, and exchange rate, are presented in Table 5. Both short- and long-run relationships and effects are investigated. Additionally, the ARDL bound test for cointegration among these variables is conducted. The calculated F-statistic from the table is 49.72, exceeding the upper bound critical value at all significance levels. This indicates that stock market returns are indeed cointegrated with inflation and exchange rate. These results supports the findings of Kwofie et al. (2018). Furthermore, the results suggest the existence of a long-run relationship among the variables.

**Figure 4.** *Akaike information criteria graph*




The results of the ARDL model presented in Table 6 and Table 7 are determined using the Akaike Information Criterion (AIC). Figures 4 show 20 computed ARDL models based on AIC, which serves as a measure to select the most suitable model among competing alternatives. In the figure, the model with the lowest AIC value is ARDL(1, 1, 1), hence it is considered to be the most appropriate based on the trade-off between model accuracy and complexity.

**Table 6.** *Estimated long-run coefficients of ARDL (1, 1, 1) model*

| Variable | Coefficient | Std. Error | t-Statistic | P-value |
|---|---|---|---|---|
| Inflation rate | 0.065361 | 0.058823 | 1.111152 | 0.2687 |
| Exchange rate | -0.208017 | 0.185387 | -1.122069 | 0.2640 |
| Intercept | 6.218050 | 5.239351 | 1.186798 | 0.2376 |

**Source:** Author's Calculation.

The results from the long-run relationship analysis among stock market returns, exchange rate, and inflation are shown in Table 6. The results indicate that the estimated coefficients of inflation and exchange rates are insignificant, irrespective of their signs. Hence, there is no significant long-run effect of inflation and exchange rate on stock market returns. These results againest the findings of Kwofie et al. (2018) & Mfugale et al. (2023).

**Table 7.** *Estimated results of Error Correction Model (ECM)*

| Variable | Coefficient | Std. Error | t-Statistic | P-value |
|---|---|---|---|---|
| *d* (inflation rate) | 0.841 | 0.311 | 2.707 | 0.002 |
| *d* (exchange rate) | -2.283 | 0.288 | -7.929 | 0.000 |
| ECM (- 1) | -1.046 | 0.074 | -14.213 | 0.000 |
| $R^2$ | 0.687 | Mean dependent var | | -0.016 |
| Adj. $R^2$ | 0.680 | S.D. dependent var | | 6.796 |
| Std. Error | 3.847 | Akaike info criterion | | 5.563 |
| Log likelihood | -357.563 | Schwarz criterion | | 5.651 |
| F-statistic | 92.232 | Hannan-Quinn criter. | | 5.598 |
| P-value | 0.000 | Durbin-Watson stat | | 2.114 |

**Source:** Author's Calculation.

The estimated coefficients for the first differences of inflation and the exchange rate exhibit significant short-term impacts on stock market returns, regardless of their signs. Hence, these results are consistent with the conclusion drawn by Mfugale et al. (2023), while certain aspects of the findings are in line with those stated by Kwofie et al. (2018). Additionally, the error correction coefficient is estimated to be -1.046, with a p-value below the significance level, indicating the presence of error correction in the model. This suggests a significant adjustment process towards long-run equilibrium. Finally, the model demonstrates moderate explanatory power and confirms that the model is good fit.

**Table 8.** *Residual Diagnostic test*

| Variable | F-statistic | P-value |
|---|---|---|
| White test for heteroskedasticity | 5.405752 | 0.0000 |
| Breusch-Godfrey test for serial correlation | 0.756661 | 0.4714 |

The results of the White test from Table 8 confirm the presence of heteroskedasticity in the residuals. Therefore, there is a need for healthy standard errors to address this issue. On the other hand, the results of the Breusch-Godfrey test indicate that there is no significant serial correlation present in the residuals, supporting the assumption of independent errors in the model.

**Figure 5.** *Histogram for Normality*

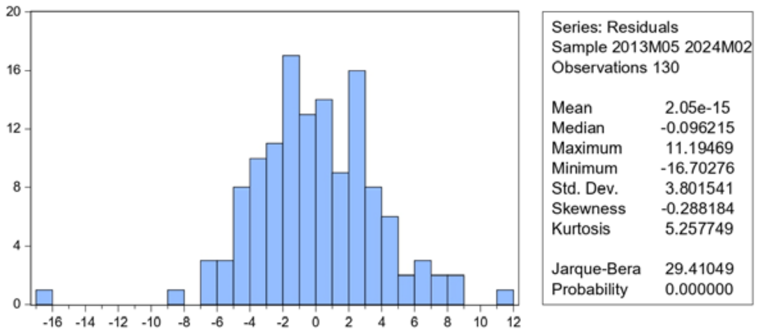
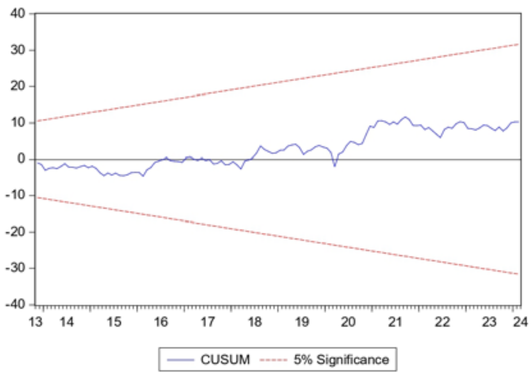



**Figure 6.** *CUSUM plot for stability of short- and long-run relationships in the model*



Results from Figure 5 indicate that the residuals are not normaly distribution in the model, as evidenced by the probability value being less than alpha. Hence, the null hypothesis based on the Jarque-Bera test is rejected.

The plot of cumulative sums of recursive residuals (CUSUM) demonstrates the stability of short- and long-run connections between variables. The graph, depicted in Figure 6, shows time series on the horizontal axis and residuals on the vertical axis. Notably, the CUSUM fall within the 5% critical line, indicating that the model is stable and there are no significant deviations. Thus, the accurate specification of this model supports the null hypothesis at the 5% significance level.

## 4. Conclusion

The purpose of this study is to examine the short- and long-run relationships between stock market (Nifty-50) returns, inflation, and exchange rates (USD/INR) in India. The application of the ARDL bound cointegration approach in this study is notable, especially considering its relatively limited exploration within the context of India in previous studies regarding this issue. The findings revealed no significant long-run relationship between stock market returns and inflation, as well as between stock market returns and exchange rate. However, both the long- and short-run relationships between stock market returns and inflation, and stock market returns and exchange rate (USD/INR) are found to be statistically significant. The error correction model estimated significant adjustment process towards long-run equilibrium for inflation and exchange rates regarding stock market returns, indicating their substantial influence on investment flows in India. Additionally, the study identified that the model is stable, with no significant deviations. The findings of this study add value to the existing literature and have important implications for regulatory authorities, investors and policymakers in making informed decisions regarding stock market cointegration. Although no significant long-run relationship is observed between stock market returns and both inflation and the exchange rate, the existence of short-run relationships between these variables suggests a nuanced understanding of their dynamic interactions. The major limitation of the study is its focus on only two macroeconomic variables. Future research could extend its focus by including other macroeconomic variables and non-macroeconomic variables to explore causality, volatility, and contagion effects, particularly during times of crisis. This would enhance our understanding of the intricate relationships among these variables.

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