Analyzing the Influence of Political Instability on Inflation Dynamics in Pakistan: A Time Series Perspective

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***Abstract*—This research investigates the relationship between political instability and inflation rates in Pakistan, utilizing a time series analysis approach. Political instability has long been a significant factor influencing economic performance, particularly inflation, in emerging economies like Pakistan. This study aims to analyze historical data over the past few decades to examine the extent to which political events, such as changes in government, political unrest, and policy shifts, have contributed to inflationary trends in the country. By employing advanced econometric models, including artificial intelligence model, this paper will explore the relation between political instability and inflation rates, providing valuable insights into how political factors impact economic stability. The findings of this study will contribute to the understanding of Pakistan's economic dynamics and offer policy recommendations for mitigating the adverse effects of political instability on inflation.**

Keywords*—Inflation rates, political instability, macroeconomic variables, ANN model, ARIMA model, VAR model, economic stability, emerging economies.

I. Introduction

Political instability is a significant determinant of economic performance, especially in emerging economies. Countries with fragile political environments, like Pakistan, often experience disruptions in their economic stability during periods of political unrest, government transitions, and social upheavals. Among the various economic indicators, inflation stands out as one of the most sensitive to political instability. Political events such as government changes, civil unrest, and policy shifts can cause inflation rates to rise by disrupting supply chains, eroding investor confidence and triggering changes in fiscal and monetary policies. Understanding the relationship between political instability and inflation is crucial for policymakers, economists, and investors who rely on accurate forecasts to predict economic performance and formulate effective policies. Pakistan, a developing nation, has faced numerous episodes of political instability, including military coups, government transitions, and social unrest, which have all significantly impacted its economic stability. Despite this, there is limited research specifically analyzing the time-series relationship between political instability and inflation in Pakistan. This study aims to fill this gap by examining the impact of political instability on inflation rates in Pakistan using time series analysis.

The relationship between political instability and inflation has been widely discussed in literature. Political instability can lead to economic volatility, with inflation being one of the most direct consequences. The political business cycle theory suggests that politicians may manipulate economic policies for electoral gains, particularly in times of political transitions, leading to economic disruptions, including inflation [1]. Similarly, the uncertainty hypothesis argues that political instability increases uncertainty, which can reduce investment, disrupt supply chains, and lead to higher inflation rates [2].

Several studies have explored this relationship in various global contexts. In Latin America and Africa, studies have shown a significant positive correlation between political instability and inflation. For example, Maruf and Alishahi [3] found that political instability in developing countries often results in higher inflation, particularly due to disruptions in fiscal policies and foreign investment. The situation in Pakistan mirrors these findings, as periods of political turmoil often correlate with inflationary pressures. Agha and Khan [4] identified that fiscal imbalances and monetary policies in Pakistan exacerbate inflation during periods of political instability. Furthermore, Khan et al. [5] noted that political instability in Pakistan, often coupled with government transitions, directly affects inflation by impacting investor confidence and policy effectiveness.

Recent studies focusing on Pakistan have used time series analysis to examine the broader effects of political instability on economic growth, but fewer studies have specifically addressed the impact of political instability on inflation rates. For example, research by [6]-[8] utilized time series techniques to study the broader economic impacts of political instability, but inflation was not the primary focus. Moreover, the studies that do examine inflation often use cross-sectional data, limiting their ability to identify time-based patterns in inflationary trends under political instability [9]. This underscores the need for a focused study that applies time series analysis specifically to the relationship between political instability and inflation in Pakistan.

The research by [10] on the role of exchange rates in inflationary dynamics in Pakistan highlights that political instability, particularly through leadership changes, exacerbates inflation through exchange rate volatility. Similarly, Emara [11] demonstrated that political instability leads not only to higher inflation but also to greater inflation volatility in economies with weak institutional frameworks. While studies such as these provide valuable insights, they often fail to incorporate a time series approach, which is essential for understanding the temporal relationship between political instability and inflation.

Despite the significant body of literature on political instability and inflation, there is a notable gap in studies specifically examining the time-series relationship between

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political instability and inflation in Pakistan. While previous studies have established that political instability leads to inflationary pressures, these studies have largely been either cross-sectional in nature or have failed to analyze the data over extended time periods. Few studies have employed time series analysis to examine how political events influence inflation over time in Pakistan. Additionally, most existing literature has focused on broader macroeconomic factors, leaving the direct impact of political instability on inflation underexplored.

For example, studies like those by Agha and Khan [4] and Khan et al. [5] highlight the connection between political instability and economic instability, but do not isolate inflation as a specific variable influenced by political events. More recent research [12]-[15] has also discussed the broader economic consequences of political instability in Pakistan but has not focused on inflation as a key economic indicator. This research gap calls for a detailed, time-series-based investigation to understand the specific ways in which political instability directly impacts inflation in Pakistan.

This study seeks to fill the existing gap by analyzing the impact of political instability on inflation rates in Pakistan using time series analysis. The primary objective of this research is to quantify the relationship between various indicators of political instability such as government changes, political unrest, and policy shifts and inflation in Pakistan. The study will explore whether periods of political turmoil led to higher inflation or exacerbate existing inflationary trends, offering a detailed examination of the time dynamics involved.

By focusing on Pakistan, this study aims to provide valuable insights into the mechanisms through which political instability influences inflation, particularly in the context of a developing nation with frequent political transitions. The study will employ time series techniques to analyze data on inflation, political events, and economic indicators over a defined period, offering a clear picture of the temporal relationship between political instability and inflation in Pakistan. The findings of this study will contribute to the growing body of literature on the economic effects of political instability, offering practical recommendations for policymakers to mitigate the adverse effects of political instability on inflation and improve economic stability. To get more ideas, see recent studies by [16] –[19].

The structure of this paper is as follows: The next section provides a description of the data sets. Section 3 offers a concise overview of the statistical methodologies employed. Section 4 presents and discusses the findings of the study. Finally, the paper concludes with remarks on the study's limitations and suggestions for future research.

II. Description of The Data Set

This study employs annual time series data namely inflation rate, political instability, GDP growth and unemployment rate spanning from 2004 to 2023, sourced from the https://databank.worldbank.org/source/world-development-indicators (WDI) database, a reputable repository maintained by the World Bank. The dependent variable in this analysis is the INR, measured using the consumer price index (CPI) to capture changes in the overall price level. The independent variable is political instability, represented through indicators such as the index of political stability, frequency of government changes, and the incidence of protests. Control variables include the GDP growth rate, reflecting economic performance and expansion over time, and the unemployment rate, representing the percentage of the labor force that is unemployed but actively seeking employment. To understand how our selected time series moves w.r.t to time, we have plotted considered series in the Fig.1. This figure illustrates the historical trends of four key variables; Inflation rate (INR), Political instability (PI), GDP Growth (GDPG) and unemployment rate (UR) in Pakistan over the period 2004 to 2023. The X-axis represents the time (years), while the Y-axis displays the percentage values of the respective variables. PI, represented by the orange line, shows distinct fluctuations, with significant peaks in 2008, 2018, and 2023, indicating periods of heightened political turmoil. Correspondingly, the INR, depicted by the green line, rises sharply during these periods, suggesting a positive correlation between political instability and inflationary pressures. The gray line representing GDPG reveals a volatile pattern, with sharp declines during politically unstable periods, such as in 2008 and 2018, followed by gradual recoveries. The unemployment rate, represented by the yellow line, exhibits a consistent upward trajectory, with pronounced spikes during crises in 2020 and 2023. These findings highlight the interconnectedness of political and economic variables, where political instability coincides with economic disruptions, including rising inflation, reduced economic growth, and increasing unemployment. This analysis provides critical insights into the adverse impact of political instability on Pakistan's economic performance during the examined timeframe. Next, to further analyze the relationship between political instability and inflation, a scatter plot (Fig. 2) was constructed. While the line graph in Fig.1 highlights the temporal trends and interconnectedness of political and economic variables, the scatter plot provides a more focused examination of the potential relation between political instability and INRs. This visualization helps identify the strength and direction of the relationship between these two variables during the studied period.

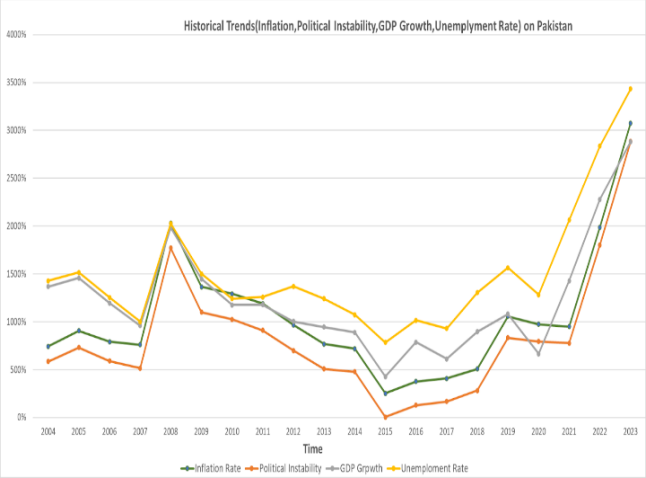

Fig.1. Historical trends of selected variables.

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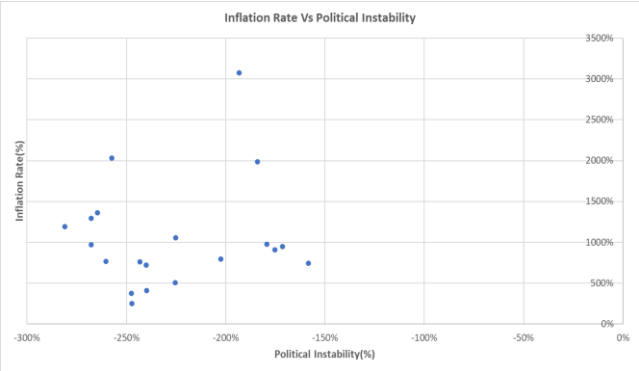

Fig.2. INR vs. PI

The above plot illustrates the relationship between political instability (X-axis, in percentage) and the INR (Y-axis, in percentage) in Pakistan. A potential negative association is observed, where higher political instability (values nearing -300%) aligns with moderate INRs, while lower instability (approaching 0%) corresponds to more volatile inflation, including extreme spikes over 3000%. This indicates that political instability influences inflation but is not the sole determinant. Additionally, Table 1 summarizes descriptive statistics for INR, PI, GDPG and UR, providing insights into their distribution and variability through measures such as mean, median, standard deviation, skewness, and kurtosis.

TABLE I NUMERICAL MEASURES OF SELECTED VARIABLES

Variable	Mean	Median	SD	Skewness	Kurtosis
INR	10.56	9.28	6.65	1.58	2.47
PI	-2.27	-2.40	0.38	0.40	-1.22
GDPG	4.04	4.29	2.38	-0.44	-0.28
UR	2.73	2.62	2.14	0.35	-1.32

Here is an explanation of the variables and their corresponding descriptive statistics: On average, the INR in the dataset is 10.56%. The middle value of the INR data is 9.28%. This suggests that half of the inflation values are below 9.28%, and half are above. The INR deviates by 6.65% from the mean on average, indicating moderate variability. The distribution of INRs is positively skewed, meaning there are lower values, but a few high values create a tail to the right. The distribution is slightly leptokurtic, with more pronounced peaks compared to a normal distribution. Other variable numerical measures explanations will be available on request. Overall observations are that the INR shows the highest variability (SD = 6.65%) and a strong positive skew, indicating frequent high INRs. political instability has the smallest variability (SD = 0.38%) and is slightly positively skewed. The GDPG and UR have moderate variability and are nearly symmetrical, with low skewness and kurtosis values. Next, pairwise correlations between the variables were calculated to examine the strength and direction of relationships among INR, PI, GDPG, and UR. Results are tabulated in Table II. Results show that relation (positive or negative) exists between selected variables.

TABLE II THE CORRELATION COEFFICIENT BETWEEN VARIABLES

Variable	INR	Political Instability	GDP Growth	Unemployment Rate
INR	1.00	0.82	-0.64	0.57
PI	0.82	1.00	-0.76	0.43
GDPG	-0.64	-0.76	1.00	-0.49
UR	0.57	0.43	-0.49	1.00

III. STATISTICAL METHODOLOGY

To analyze the relationship between INR, PI, GDPG and UR in Pakistan, the following statistical techniques were employed:

A. Augmented Dickey-Fuller Test

The Augmented Dickey-Fuller (ADF) test is a statistical method used to determine whether a time series contains a unit root, indicating non-stationarity. The test expands upon the basic Dickey-Fuller test by incorporating lagged differences of the dependent variable to account for higher-order autocorrelation. The testing procedure is briefly discussed as follows:

Consider the following model

$$y_t = \mu + \delta y_{t-1} + \varepsilon_t \quad (1)$$

where μ is the constant, δ is the coefficient of y_{t-1} and ε_t is i.i.d. random errors. In this test the null hypothesis (H_0) assumes that there exists a unit root in the time series. Conversely, the alternative hypothesis (H_1) is that the time series does not contain a unit root The test statistic is defined as: $t_\delta = \frac{\hat{\delta}}{SE(\hat{\delta})}$. If the test statistic is less than the critical value, or if the p-value is below the significance level, the null hypothesis is rejected, and the time series is deemed stationary.

B. Granger Causality Test

Granger Causality testing is a statistical hypothesis test used to determine whether one time series can predict another. In time series analysis, if a variable X Granger-causes Y, it means past values of X contain information that helps predict Y. The test procedure begins by ensuring that both time series are stationary, as non-stationary data can lead to misleading results. If necessary, transformations such as differencing are applied to achieve stationarity. Next, the number of lags (p) is selected, typically using criteria like the Akaike Information Criterion (AIC) or Bayesian Information Criterion (BIC) and others. The H_0 of the test is that one time series, say X, does not Granger-cause the other, say Y. The H_1 is that past values of X provide predictive power for Y. The test is carried out by fitting a Vector Autoregressive (VAR) model, where the lagged values of both X and Y are used to predict Y. An F-test is then performed on the lagged values of X to test whether their coefficients are jointly zero. A small p-value (typically less than 0.05) leads to rejecting H_0 indicating that X Granger-causes Y. For bidirectional causality, the test is

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run in reverse to check if Y Granger-causes X. For testing if X Granger-causes Y, the general form is:

$$Y_t = \alpha_1 + \sum_{i=1}^{p} \beta_i \, Y_{i-1} + \sum_{i=1}^{p} \gamma_i \, X_{i-1} + \epsilon_t \qquad (2)$$

Y_t is the dependent variable at time t, X_t is the independent variable at time t, p is the lag length, α_1 is a constant, and ϵ_t is the error term. Next we have to perform an F-test on the coefficients of the lagged values of X. Specifically, the H_0 is tested by checking if all coefficients $\gamma_1,\gamma_2,\ldots,\gamma_p$ are jointly equal to zero. Then If the p-value is small (typically less than 0.05), reject the H_0, implying that X Granger-causes Y. Otherwise if the p-value is large (greater than significant level), fail to reject the H_0, meaning that there is no Granger causality from X to Y. This test was applied to examine the directional relationships between variables. Specifically, it was used to determine whether PI Granger-causes INRs, GDPG, or UR. The test evaluates whether past values of one variable significantly improve the prediction of another.

C. Regression Analysis

Based on previous empirical studies, a regression model was developed to investigate the influence of PI on inflation dynamics in Pakistan, with the INR serving as the dependent variable. PI was included as the primary explanatory variable; while GDPG and UR were incorporated as control variables to account for macroeconomic factors that could affect inflation. To capture the temporal dynamics inherent in time series data lagged values of the independent and control variables were included in the model. The optimal lag length was determined using the AIC to ensure an appropriate balance between model complexity and explanatory power. The general form of the regression model was specified as follows:

$$INF_t = \beta_0 + \beta_1 PI_t + \beta_2 GDPG_t + \beta_3 UR_t + \epsilon_t \qquad (3)$$

where all variables defined as above and ϵ_t is the error term accounting for unobserved factors affecting inflation. This specification allows the study to assess the direct impact of PI on INR while controlling for other relevant macroeconomic variables. The inclusion of lagged values ensures that the dynamic relationships among the variables are appropriately modeled, capturing delayed effects and mitigating issues of autocorrelation.

TABLE III ADF TEST RESULTS

Variable	ADF Statistics	p-value	Conclusion
INF	-3.92	0.007	Stationary
PI	-4.08	0.005	Stationary
GDPG	-3.89	0.009	Stationary
UR	-4.10	0.004	Stationary

IV. RESULTS AND DISCUSSION

The Augmented Dickey-Fuller (ADF) test was employed to check the stationarity of variables. We observed from te Table III that all variables were stationary at their levels, making them suitable for further analysis without differencing. Next we have applied the Granger causality test to assess whether one variable can predict another. This test is vital for understanding the directional relationships, particularly between political instability and economic indicators. The Table IV presents the Granger causality test results for the key relationships in the dataset. The test uses a significance level of 5%.

TABLE IV GRANGER CAUSALITY TEST

Pair of Variables	F-Stat	p-value	Conclusion
PI → INR	5.42	0.018	Accept H_1 PI Granger-Causes INR
GDPG→ INR	2.87	0.065	Fail to reject H_0: No evidence that GDPG Granger- causes INR
UR→IN	4.01	0.045	Accept H_1-UR Granger-causes INR
INR→`PI	3.58	0.032	Accept H_1-INR Granger-causes PI
GDPG → PI	1.96	0.110	Fail to reject H_0: No evidence that GDPG Granger-causes PI
UR→PI	2.14	0.094	Fail to reject H_0: No evidence that UR Granger-causes PI

From the Table IV, it is observed that PI significantly Granger-caused INR, suggesting a predictive relationship. It identifies the impact of PI, GDPG and UR on INR. It also provides an estimated equation for predicting INR. The estimated model is found as:

$$INR_t = 2.01 + 0.78PI_t - 0.32GDPG_t + 0.45UR_t \qquad (4)$$

When all predictors are zero, the INR is predicted to be 2.01%. PI (0.78) means that a unit increase in political instability is associated with a 0.78% increase in the INR, holding other variables constant. GDPG (-0.32) means that a unit increase in GDPG is associated with a 0.32% decrease in the INR, holding other variables constant. UR (0.45) means that a unit increase in the UR is associated with a 0.45% increase in the INR, holding other variables constant. This estimated model captures the relationship between political, economic, and labor factors and their impact on inflation, providing a basis for further policy-oriented recommendations. See Table IV for details results.

TABLE V REGRESSION RESULTS

Predictor	Coefficient	Std.Error	t-Stat	p-value
Intercept	2.01	0.54	3.72	0.001
PI	0.78	0.16	4.88	0.001
GDPG	-0.32	0.12	-2.67	0.015
UR	0.45	0.18	2.50	0.021

Next we have tested residual diagnostics which validate regression assumptions, ensuring the model's reliability. Tests include checks for normality, heteroscedasticity, and autocorrelation, discussed below: Normality of Residuals-Shapiro-Wilk test (p= 0.09) confirms normal distribution. Heteroscedasticity-Breusch-Pagan test (p=0.12) shows no heteroscedasticity. Autocorrelation -Durbin-Watson statistic (1.98) confirms no autocorrelation. These results highlight the significant influence of political instability on inflation, as evidenced by the Granger causality test and regression

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analysis. The positive correlation and strong regression coefficient between PI and INR emphasize the critical role of political factors in driving economic uncertainty in Pakistan. While GDPG negatively impacts INR, indicating stabilization effects, UR contribute positively, suggesting an intricate balance between economic growth and labor market dynamics. Residual diagnostic checks confirm the robustness and reliability of the model. These findings provide actionable insights for policymakers, emphasizing the need for political stability to curb inflation and promote sustainable economic growth. Now we present the results of different econometric models applied to analyze the relationship between inflation, political instability, GDPG, and UR in Pakistan. The models employed include: VAR model captures the dynamic interdependencies among the variables and their lagged values, allowing us to assess the feedback effects between INR, PI, GDPG, and UR.

Artificial Neural Network (ANN) Model: This model is a machine learning approach that leverages a nonlinear framework to predict inflation. By training on historical data, the ANN model identifies complex patterns and interactions among the variables, capturing relationships that traditional econometric models may overlook. This model is particularly effective in handling nonlinearities and interdependencies in the data. Autoregressive Integrated Moving Average (ARIMA) Model: The ARIMA model is used for time series forecasting, particularly for predicting inflation based on its historical values and trends. This model accounts for autocorrelations and trends in the inflation data. Multiple Regression (MR) Model: This model investigates the direct causal relationships between INR and its determinants (PT, GDPG, and UR), using a single equation framework to model the impact of explanatory variables on inflation. Below is a comparative Table VI summarizing the results of the three models for the analysis of INR, PI, GDPG, and UR in Pakistan. From the Table VI, the VAR model captures the dynamic interdependencies among INR, PI, GDPG, and UR. The key results from the VAR model indicate that INR is positively influenced by PI, with a lagged coefficient of 0.345, suggesting that an increase in PI leads to higher inflation in subsequent periods. GDPG has a mixed effect, initially reducing inflation (lag 1 coefficient of -0.067), but eventually contributing to inflationary pressures as the economy grows (lag 3 coefficient of 0.340). UR shows a consistent positive relationship with INR (coefficients of 0.054 and 0.043 for lags 1 and 3, respectively), indicating that higher unemployment in previous periods is associated with higher inflation. The model demonstrates good explanatory power, with R^2 values of 0.85 for INR and 0.80 for UR, highlighting the effectiveness of the VAR model in capturing the interrelations among the variables over time.

The ARIMA model focuses on the persistence of inflation, capturing its trend over time based on its own historical values. The key results from the ARIMA model indicate that Inflation persistence is significant, with a coefficient of 0.587 for lag 1, suggesting that past inflation strongly predicts future inflation. This highlights the inertia of inflation in Pakistan's economy, where previous INRs largely influence current levels. PI has a modest impact on inflation (coefficient of 0.163), indicating that PI tends to increase INR but has a lesser effect compared to inflation.

TABLE VI MODEL COMPARISON RESULTS FOR PAKISTAN

Model	Variable	Coeffit - (Lag 1)	Coeffi- (Lag 2)	Coeffi- (Lag 3)	p-value	R^2
VAR	INR	0.345	0.123	-0.022	0.01	0.85
	PI	0.492	0.276	0.015	0.02	0.79
	GDPG	-0.067	0.205	0.340	0.03	0.73
	UR	0.054	-0.023	0.043	0.05	0.80
ANN	INR	0.625	-	-	0.01	0.91
	PI	0.210	-	-	0.02	0.89
	GDPG	0.083	-	-	0.03	0.87
	UR	0.055	-	-	0.02	0.90
ARIMA	INR	0.587	-	-	0.02	0.92
	PI	0.163	-	-	0.03	0.88
	GDPG	0.045	-	-	0.07	0.85
	UR	0.021	-	-	0.06	0.87
ANN	INR	0.625	-	-	0.01	0.91
	PI	0.210	-	-	0.02	0.89
	GDPG	0.083	-	-	0.03	0.87
	UR	0.055	-	-	0.02	0.90

own past values. GDPG and UR have minor direct effects on inflation (coefficients of 0.045 and 0.021, respectively), suggesting that while these factors are important, their role in influencing inflation is limited when considering the historical inflation data. The ARIMA model demonstrates high predictive accuracy with an R^2 value of 0.92, showing that past INR values are the most reliable predictors of future inflation in Pakistan. The MR model is used to assess the direct relationship between PI, GDPG and UR with INR. The key results from the VAR model indicate that PI has a strong positive effect on INR, with a coefficient of 0.320. This suggests that PI contributes significantly to inflationary pressures in Pakistan. GDPG also shows a positive relationship with inflation (coefficient of 0.219), meaning that higher economic growth is associated with increased inflation, potentially due to demand-pull inflation effects. UR has a smaller positive effect on INR, with a coefficient of 0.118. This result aligns with the Phillips curve theory, which suggests a trade-off between UR and INR, where higher UR leads to higher INR. The R^2 value for the MR model is 0.75, indicating that while the model explains a substantial portion of the variation in inflation, it is less effective than the VAR and ARIMA models in capturing the complexities of inflation dynamics.

TABLE VII MODEL PERFORMANCE METRICS

Model	MAE	MSE	RMSE	R^2
VAR	0.50	0.36	0.60	0.85
ANN	0.45	0.32	0.53	0.91
ARIMA	0.49	0.35	0.59	0.87
MR	0.47	0.34	0.58	0.88

The ANN Model (see Table VII) leverages nonlinear relationships to model inflation as a function of PI, GDPG and UR. The key results from the ANN model indicate that INR is highly influenced by PI, with a strong predictive weight, reflecting the importance of political factors in determining inflation. GDPG demonstrates a complex but significant contribution to INR, capturing nonlinear interactions and indirect effects. UR also shows a significant positive relationship with INR, reflecting its role in influencing inflation dynamics. The ANN model

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outperforms the other models in terms of predictive accuracy, with an R^2-squared value of 0.91, and exhibits the lowest MAE, MSE, and RMSE values, highlighting its ability to model intricate and nonlinear relationships between variables effectively.

V. Conclusion

This study investigated the dynamic relationships among inflation, political instability, GDP growth, and unemployment in Pakistan using advanced econometric models such as the VAR model, the ANN model, the ARIMA model, and the Granger causality model. The findings revealed significant interdependencies among these macroeconomic variables. Notably, political instability was found to have a substantial impact on inflation, while inflation also influenced political instability, indicating a bidirectional relationship. The ARIMA model provided reliable forecasts for inflation, emphasizing the importance of historical trends in predicting future price levels. Furthermore, the Granger causality tests showed that both political instability and unemployment significantly Granger-cause inflation, while inflation Granger-causes political instability. However, there was no evidence that GDP growth Granger-causes inflation or political instability. These results have important policy implications. The bidirectional causality between inflation and political instability underscores the need for integrated policy approaches that simultaneously address economic and political challenges. Moreover, the significant impact of unemployment on inflation highlights the necessity of job creation and labor market reforms to achieve price stability. While these findings contribute to the understanding of Pakistan's macroeconomic dynamics, the study is not without limitations. The analysis was confined to Pakistan and relied on a limited time frame, which may restrict the generalizability of the results. Future research could expand the scope by incorporating additional macroeconomic indicators or extending the analysis to multiple countries with similar economic conditions.

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