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Impact of Inflation on Economic Growth: Evidence from Tanzania

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Abstract

This empirical study investigates the impact of inflation on economic growth in Tanzania, aiming to provide insights for policymakers on maintaining macroeconomic stability. Utilizing a quantitative research design, the study analyzes secondary data spanning 32 years (1990-2021) through reduced-form regression and co-integration analysis techniques. The findings reveal a significant negative correlation between inflation and economic growth, indicating that higher inflation rates are associated with lower GDP growth. However, no long-term relationship or co-integration between inflation and economic growth is found. This study contributes to the existing literature by providing empirical evidence on the negative impact of inflation on economic growth in Tanzania, emphasizing the importance of price stability for sustainable economic growth. The findings underscore the need for policymakers to prioritize effective monetary policies while promoting investment and productivity to ensure sustained economic growth.

Keywords: inflation, economic growth, augmented dickey-fuller, Phillips perron, co-integration

1. Introduction

Inflation is a critical macroeconomic phenomenon that affects various aspects of an economy, including economic growth (Agarwal and Baron, 2023). This introductory section seeks to provide a foundation for understanding the complexities surrounding this relationship, elucidating both the problem at hand and its significance in the broader context of economic policymaking.

1.1 Introduce the Problem

The interaction between inflation and economic growth stands as a pivotal concern in macroeconomic analysis. Various studies have probed this relationship, yielding divergent findings and interpretations. Barro's seminal work in 1995 revealed a negative correlation between inflation and economic growth, suggesting that high and volatile inflation rates may impede long-term economic development. Subsequent research by Fischer (1993) and Bruno and Easterly (1998) expanded on this notion, proposing the existence of threshold effects wherein excessive inflation could significantly hinder economic growth beyond certain thresholds. However, Khan and Senhadji (2001) presented a contrasting viewpoint, positing a U-shaped relationship between inflation and economic growth, implying that moderate inflation levels could potentially stimulate investment and enhance price flexibility.

Moreover, studies specific to individual countries, such as those conducted by Iqbal and Nawaz (2009) in Pakistan and Jayathilake and Rathnayake (2013) in Sri Lanka, further highlight the nuanced nature of this relationship, suggesting that country-specific dynamics play a crucial role in shaping the inflation-growth nexus. Kasidi and Mwakanemela (2013) conducted a study to examine the impact of inflation on economic growth in Tanzania. The findings of the study indicated that inflation hurt economic growth in Tanzania. Furthermore, the analysis revealed the absence of co-integration between inflation and economic growth during the study period, suggesting the lack of a long-run relationship between these variables in Tanzania. The problem addressed in this study was to examine the impact of inflation on economic growth in Tanzania and determine whether a negative relationship exists between these variables. Specifically, the study aims to investigate whether higher inflation rates lead to lower GDP growth rates in the Tanzanian context.

1.2 Explore the Importance of the Problem

The significance of unraveling the intricacies of the inflation-economic growth relationship cannot be overstated. Inflation, as a macroeconomic phenomenon, exerts profound influences on various facets of economic activity. Distortions in price signals, erosion of purchasing power, and uncertainties in the investment climate are among the potential consequences of unchecked inflationary pressures, all of which can impede long-term economic growth trajectories. Policymakers, tasked with the formulation of effective macroeconomic policies, rely heavily on insights derived from empirical analyses of the inflation-growth nexus to devise strategies aimed at achieving optimal economic outcomes. Consequently, comprehending the dynamics underlying this relationship holds paramount importance for policymakers worldwide, as it equips them with the knowledge necessary to design and implement policies conducive to fostering sustainable economic growth while mitigating inflationary risks.

1.3 Describe Relevant Scholarship

Iqbal and Nawaz (2009) conducted a study with the dual objectives of examining the impact of the inflation rate on economic growth and investigating the nonlinear relationship between inflation and investment in Pakistan. Using annual data from 1961 to 2008, the researchers identified two threshold levels for inflation (6 percent and 11 percent) and observed a nonlinear relationship between inflation and economic growth. The findings revealed that inflation rates below the first threshold had a positive but insignificant impact on economic growth. Jayathilake and Rathnayake (2013) addressed the crucial debate on the connection between inflation and economic growth in economic literature. Their study focused on investigating the short-run and long-run relationship between economic growth and inflation in three Asian countries during the period 1980-2010.

The research employed cointegration and causality tests to analyze the relationship between these variables. Aydın et al. (2016) examines the impact of inflation on economic growth in five transition economies: Azerbaijan, Kazakhstan, Kyrgyzstan, Uzbekistan, and Turkmenistan. Employing dynamic panel data analysis with a threshold approach, the study finds a nonlinear relationship between inflation and growth rate. Kryeziu and Durguti (2019) aimed to investigate the impact of inflation rate on the growth rate of GDP in Eurozone countries. The study utilized panel data covering the period 1997-2017, with a total of 257 annual observations. The researchers employed a multiple linear regression model with the least squares regression method to analyze the data and obtain results.

These findings indicated a favorable relationship between inflation and economic growth in the region. Karahan and Çolak (2020) conducted a study aiming to contribute to the ongoing debate surrounding the relationship between inflation and economic growth. Different schools of economics hold contrasting views on this relationship, with Keynesian economists suggesting a positive link between inflation and economic growth, while Classical economists argue for a negative impact of inflation on economic growth. Mamo (2012) examined the relationship between inflation and economic growth in 13 Sub-Saharan African countries from 1969 to 2009. Using panel data analysis, the study finds a negative relationship between economic growth and inflation. Mallik and Chowdhury (2001) conducted a study analyzing the relationship between inflation and GDP growth in four South Asian countries: Bangladesh, India, Pakistan, and Sri Lanka.

The study utilizes cointegration and error correction models with annual data from the IMF International Financial Statistics. The findings reveal a long-run positive relationship between GDP growth rate and inflation in all four countries, as well as significant feedback effects between inflation and economic growth. Cili and Alkhaliq (2022) conducted a study to examine the relationship between economic growth and inflation in Indonesia during the period from 2010 to 2014. The research employed static data panel analysis, with economic growth as the dependent variable and inflation, investment, and population as the independent variables. The findings of the study revealed that inflation, investment, and population all had a positive relationship with economic growth. Ndoricimpa (2017) conducted a study on the inflation-growth nexus in Africa, utilizing a dynamic panel threshold regression to account for potential endogeneity bias.

The findings reveal the presence of nonlinearities in this relationship. Doguwa (2012) conducted a study on the inflation-growth relationship in Nigeria, employing three different approaches to estimate the inflation threshold. Rutayisire (2015) examined the relationship between inflation and economic growth in Rwanda and determined the presence of threshold effects. Using a quadratic regression model with data from 1968 to 2010, the study finds evidence of a non-linear relationship. It identifies a threshold level of inflation at 12.7% above which inflation negatively impacts economic growth. Özyilmaz (2022) examines the relationship between inflation and economic growth in 27 EU countries from 1996 to 2019.

The study also explores the causality between inflation and growth, finding a bidirectional causality relationship between inflation to growth and from growth to inflation using the Dumitrescu and Hurlin (2012) causality approach. Phiri (2013) investigated the threshold effects of inflation on economic growth in Zambia using quarterly data from 1998 to 2011. Through a threshold autoregressive (TAR) model and conditional least squares (CLS) estimation, the study identifies an inflation threshold level of 22.5%. This suggests that economic growth can still be stimulated in a moderately high inflation environment. Sayehmiri et al. (2021) conducted a meta-analysis to examine the impact of inflation on economic growth, aiming to resolve the disagreement surrounding this relationship. The findings provide insights into the significance of these variables in understanding the relationship between inflation and economic growth.

Ahmad (2022) re-evaluates the relationship between inflation and economic growth in Pakistan from 1985 to 2019. Shitundu and Luvanda (2000) delved into the ongoing debate within macroeconomics concerning the impact of inflation on economic growth. The empirical findings obtained from the study indicated that inflation hurt economic growth in Tanzania. These results provided evidence supporting the notion that inflation has adverse effects on economic growth within the Tanzanian context. Shitundu and Luvanda's (2000) research tackled the contentious issue of the relationship between inflation and economic growth. Their study focused on Tanzania and employed the LTS method to robustly examine this relationship. The findings demonstrated that inflation had a detrimental effect on economic growth in Tanzania, aligning with the viewpoint put forth by scholars in the monetarist tradition.

Kasidi and Mwakanemela (2013) conducted a study to examine the impact of inflation on economic growth in Tanzania. The findings of the study indicated that inflation hurt economic growth in Tanzania. Furthermore, the analysis revealed the absence of co-integration between inflation and economic growth during the study period, suggesting the lack of a long-run relationship between these variables in Tanzania. Ekinci et al. (2020) investigated the relationship between price stability and economic growth in countries adopting inflation targeting. These findings highlight the nonlinear nature of the inflation-economic growth relationship. Shibanda (2020) examines the impact of inflation on economic growth in Tanzania from 1995 to 2017. The study finds that inflation significantly affects economic growth, as indicated by various statistical tests.

1.4 State Hypotheses and Their Correspondence to Research Design

The research design employed in this study is a quantitative research design utilizing statistical tests and regression models, while the method of data analysis includes the utilization of reduced-form regression equation and co-integration analysis.

Hypothesis Testing:

- Reduced-Form Regression Equation (ILS):
  - Hypotheses Correspondence: The reduced-form regression equation helped test the relationship between inflation (INFL) and economic growth (GDP).
  - H_0: The coefficient β_1 of the inflation variable is equal to zero, indicating no significant effect on economic growth.
  - H_1: The coefficient β_1 of the inflation variable is not equal to zero, indicating a significant effect on economic growth.
- Co-integration Test:
  - Hypotheses Correspondence: The co-integration test will examine whether there is a long-term relationship between inflation and economic growth.
  - H_0: There is no cointegration between inflation and economic growth, suggesting no long-term relationship.
  - H_1: There is a cointegration between inflation and economic growth, suggesting a long-term relationship.

Unit Root Test for Stationary Data:

- Hypotheses Correspondence: The unit root tests (ADF and PP) will assess the stationarity of the data.
- H_0: The variable exhibits a unit root, indicating non-stationarity.
- H_1: The variable is stationary, indicating no unit root.

Johansen Test for Co-integration:

- Hypotheses Correspondence: The Johansen test will determine the presence of co-integration between inflation and economic growth.
- H_0: There is no cointegration between inflation and economic growth, indicating no long-term relationship.
- H_1: There is cointegration between inflation and economic growth, indicating a long-term relationship.

2. Method

2.1 Research Design

This study employed a quantitative research design to investigate the effects of inflation on economic growth in Tanzania. The research design incorporates a variety of statistical tests and regression models to thoroughly analyze the collected data.

2.2 Data Source, Attribution, and Considerations

The GDP and inflation data utilized in this analysis were sourced from the World Bank website, renowned for its extensive repository of global economic metrics. The process began with the identification of relevant indicators, including GDP and inflation, followed by retrieval and download of precise data spanning from 1990 to 2021 via the World Bank's Data Portal. Rigorous validation methods were then applied to ensure data accuracy and reliability, including comprehensive tests for consistency and integrity. The attribution of data by the World Bank underscores its credibility, reflecting the institution's commitment to data transparency and quality assurance. While the World Bank dataset provides valuable insights, it's crucial to acknowledge potential limitations such as variations in data availability across nations and the possibility of reporting errors. Nonetheless, leveraging the World Bank's dataset bolsters the strength and trustworthiness of our analysis, facilitating well-informed decision-making and insightful interpretations of global economic trends. The dataset covers a 32-year period, enabling the calculation of economic growth (EG) through the analysis of percentage changes in Gross Domestic Product (Current US dollar) retrieved from the World Bank database.

2.3 Methods of Data Analysis

To accomplish the two objectives of this study, the researcher employed two distinct analysis techniques, each serving a specific objective.

The first objective of investigating the impact of inflation on Economic Growth was addressed by employing the reduced form regression equation (ILS). This technique enabled the study to examine the relationship between inflation and Economic Growth. For the second objective, which aimed to assess the long-term movement of the two variables, namely inflation and Economic Growth, a co-integration technique was utilized. This technique provided a measure of whether these variables move together over an extended period of time.

2.4 Reduced-form Regression Equation

The reduced-form regression equation (ILS) is considered a statistical model that expresses an endogenous variable as a function of exogenous variables without explicitly specifying the underlying causal or structural relationships. In the context of this study and the point of view in econometrics, the ILS is applied with a focus on estimating the overall effect of INFL on GDP rather than understanding the specific mechanisms or causal pathways through which the relationship operates.

Hence the reduced-form regression equation (ILS), expressed GDP as a linear combination of the INFL, along with an error term to capture unobserved factors and measurement errors.

The equation can be represented as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \epsilon, \tag{1}$$

where:

Y is the endogenous variable (GDP).

$X_1, X_2, \ldots, X_n$ are the exogenous variables (*INFL*).

$\beta_0, \beta_1, \beta_2, \ldots, \beta_n$ are the coefficients representing the effects of the *INFL*

on the GDP.

ϵ is the error term.

2.5 Modified Reduced form Regression Equation

Based on the title and objectives, the modified reduced form regression equation is as follows:

Dependent variable: Economic Growth (GDP).

the overall growth rate of the economy and will serve as the dependent variable.

Independent variable: Inflation Rate (*INFL*).

The Inflation, GDP deflator (annual %) or "Inflation, consumer prices (annual %)" as the inflation rate variable. This captures the rate of inflation in the economy and will serve as the independent variable.

The modified reduced form regression equation:

$$GDP = \beta_0 + \beta_1 * INFL + \epsilon, \tag{2}$$

where:

GDP represents Economic Growth (the dependent variable).

$INFL$ represents the Inflation Rate (the independent variable).

β_0 represents the intercept or constant term in the equation.

β_1 represents the coefficient or the effect of inflation on economic growth.

ϵ represents the error term capturing the unexplained variation in economic growth.

This equation aims to explore the relationship between inflation and the growth rate, estimating the coefficient β_1. A positive and statistically significant coefficient is interpreted as indicating a positive relationship between inflation and economic growth, suggesting that higher inflation rates are associated with higher growth rates. Conversely, a negative and statistically significant coefficient would imply a negative relationship. The study adopts the reduced form regression equation to estimate the impact of inflation on Economic Growth (EG) without explicitly modeling the underlying causal relationships.

2.6 Unit Root Test for Stationary Data

The analysis of data stationarity involved conducting two commonly used unit root tests: The Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. Both tests were employed to examine the presence of a unit root in the time series data, which indicates non-stationarity. The coefficients estimated in these tests were compared to critical values to determine the stationarity status of the variable.

2.6.1 The ADF Test Equation

Consider the ADF test Equation:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \gamma \Delta Y_{t-1} + \delta_1 \Delta Y_{t-2} + \cdots + \delta_p \Delta Y_{t-p} + \epsilon t, \tag{3}$$

where:

ΔY_t represents the differenced time series variable, which is the variable of interest transformed by taking the first difference.

Y_{t-1} represents the lagged level of the variable.

$\Delta Y_{t-1}, \Delta Y_{t-2}, \ldots, \Delta Y_{t-p}$ represents lagged differences of the variable.

$\alpha, \beta, \gamma, \delta_1, \delta_p$ are coefficients to be estimated.

ϵt represents the error term in statistical analysis.

The null hypothesis of the ADF test is that the variable has a unit root, indicating non-stationarity (δ = 0), while the alternative hypothesis is that the variable is stationary (δ ≠ 0).

2.6.2 Phillips-Perron Test Equation

The Phillips-Perron (PP) test equation is similar to the ADF equation, with the addition of a deterministic trend term:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \gamma \Delta Y_{t-1} + \delta_1 \Delta Y_{t-2} + \cdots + \delta_p \Delta Y_{t-p} + nt + \epsilon t, \quad (4)$$

where:

nt represents the deterministic trend term.

The PP test allows for the presence of a deterministic trend in the data. Both the ADF and PP tests aim to compare the estimated coefficients to critical values to determine whether the variable is stationary or exhibits a unit root. Therefore, the general form of the Dickey-Fuller (DF) test equation is similar to the augmented Dickey-Fuller (ADF) test equation, but it does not include the augmented terms. The equation can be expressed as follows:

$$\Delta Y_t = \alpha + \beta Y_{t-1} + \epsilon t, \quad (5)$$

In the DF test, only the lagged level of the variable is included in Equation (5).

2.7 Co-Integration Test

The co-integration test, a statistical technique, was utilized to investigate the existence of a long-term relationship between two non-stationary time series variables (Gujarati, 2004). This approach was deemed appropriate for studying inflation and economic data, where a stable relationship is expected over time. In this study, the Johansen test was adopted, to estimate the number of cointegrating vectors (relationships) between the variables GDP and *INFL*, and to tests the null hypothesis of no cointegration against the alternative hypothesis of cointegration. The test considers both the trace statistic and the maximum eigenvalue statistic to determine the presence of cointegration. The general equation for co-integration is represented as follows:

$$Y(t) = \beta_0 + \beta_1 X_1(t) + \beta_2 X_2(t) + \cdots + \beta_n X_n(t) + \epsilon t, \quad (6)$$

where:

$Y(t)$ is the dependent variable (i.e., economic growth)

$X_1(t), X_2(t), \ldots, X_n(t)$ are the independent variables (i.e., inflation)

$\beta_0, \beta_1, \beta_2, \ldots, \beta_n$ are the coefficients of the independent variables.

ϵt is the error term.

In co-integration analysis, the primary focus lies in testing the null hypothesis of no cointegration, which suggests that all the coefficients $\beta_0, \beta_1, \beta_2, \ldots, \beta_n$ are equal to zero. If the null hypothesis is rejected, it indicates the presence of cointegration, indicating a long-term relationship between the variables. The equation used to examine this relationship can be represented as:

$$GDP(t) = \beta_0 + \beta_1 * INFL(t) + \epsilon t, \tag{7}$$

where:

$GDP(t)$ represents the economic growth variable at time t.

$INFL(t)$ represents the inflation variable at time t.

β_0 and β_1 are the coefficients that measure the relationship between EG and *INFL*.

ϵt is the error term.

In the co-integration test, the study estimates the coefficients β_0 and β_1, tests their statistical significance. The test is conducted to determine whether there is a long-term relationship or co-integration between *GDP* and *INFL*. The presence of co-integration suggests that changes in inflation have a significant impact on economic growth in the long run.

2.8 The Johansen Tests

The Johansen test is a commonly used method for testing co-integration. It involves estimating a vector autoregressive (VAR) model and examining the eigenvalues of the resulting matrix:

$$\Delta Y_t = \prod Y_{t-1} + \sum(\alpha_i \Delta Y_{t-i}) + \epsilon t, \tag{8}$$

where:

ΔY_t is the differenced vector of the variables under consideration.

Y_{t-1} is the lagged level of the variables.

Π is the matrix of coefficients for the lagged levels

$\sum(\alpha_i \Delta Y_{t-i})$ represents the lagged differences of the variables.

ϵt is the error term.

The Johansen test equation specifically for the case of testing co-integration between the economic growth (GDP) and inflation (*INFL*) variables can be written as:

$$\Delta GDP(t) = \prod\nolimits_1 GDP(t-1) + \prod\nolimits_2 GDP\,(t-2) + \sum(\alpha_i\, \Delta GDP(t-i)) + \sum(\beta_i\, \Delta INFL(t-i)) + \epsilon t, \quad (9)$$

where:

$\Delta GDP(t)$ is the different economic growth variable at time t.

$\Delta INFL(t)$ is the differenced inflation variable at time t.

GDP_{t-1} and $INFL_{t-1}$ are the lagged levels of the economic growth and inflation variables.

Π_1 and Π_2 are the matrices of coefficients for the lagged levels.

$\Sigma(\alpha_i\, \Delta GDP(t-i))$ and $\sum(\beta_i\, \Delta INFL(t-i))$

represent the lagged differences in the economic growth and inflation variables.

3. Results

3.1 Information for GDP

In Figure 1, the interquartile range (IQR) of 2.64 indicates the spread of the middle 50% of GDP values. It measures the variability in the growth rates of the economy during a specific time. The median value of 5.74 represents the central value in the GDP data, providing an estimate of the typical growth rate. In contrast, the mean value of 5.18 represents the average GDP growth rate over the given time, reflecting the overall performance of the economy in terms of growth. Furthermore, the minimum value of 0.58 and maximum value of 7.67 represent the lowest and highest observed GDP growth rates, respectively, illustrating the range of economic performance observed during the period.

Legends of GDP Box Plot

The diagram is a box plot that displays the distribution of Gross Domestic Product (GDP) from 1990 to 2021. The interquartile range (IQR) of GDP numbers is represented by each box, with a horizontal line inside indicating the median. The whiskers span from the lower value within 1.5 times the IQR below the first quartile to the upper value within 1.5 times the IQR above the third quartile. Individual data points reflect any values that fall outside of this range, which are considered outliers. The x-axis represents the years, ranging from 1990 to 2021, while the y-axis shows the GDP figures in their corresponding units. This representation offers a valuable understanding of the variations and patterns noticed in the GDP data during the selected period (Figure 1).

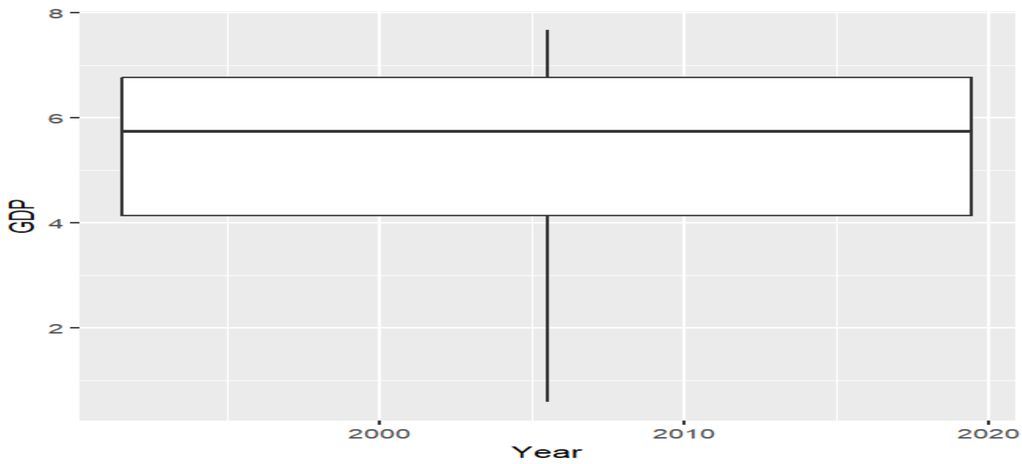

Figure 1. Boxplot of GDP over the Years

GDP: Median=5.74, Mean=5.18, Min=0.58, Max=7.67: IQR=Interquartile Range

Therefore, the GDP growth rates (GDP) exhibited relatively smaller variability compared to inflation, with values ranging from 0.58 to 7.67. The small range of 7.09 suggests a more stable and consistent pattern of economic expansion or contraction. Higher GDP growth rates typically indicate a growing economy, increased production, and improved standards of living. Conversely, lower GDP growth rates may signal an economic slowdown, decreased investment, and reduced employment opportunities.

3.2 Information for INFL

The IQR of 13.33 indicates that the middle 50% of the INFL values are spread over a range of 13.33. This implies that there is significant variability in the inflation rates observed during the given time. The median value of 9.07 represents the middle value of the INFL data when arranged in ascending order. This indicates that half of the observed inflation rates are below 9.07, and the other half are above it. Also, the mean value of 13.56 represents the average inflation rate over the given time. It provides an estimate of the central tendency of the data followed by the minimum value of 0.34 and maximum value of 67.199 representing the lowest and highest observed inflation rates respectively, during the time. This shows the range within which the inflation rates fluctuated (Figure 2).

Legends of INFL Box Plot

The box plot depicts the distribution of inflation (INFL) statistics from 1990 to 2021. The plot consists of boxes that indicate the interquartile range (IQR) of INFL values. The median is shown as a horizontal line inside each box. The whiskers span from the first quartile minus 1.5 times the IQR to the third quartile plus 1.5 times the IQR. Any data points that fall outside of this range are displayed as outliers. The x-axis represents the period from 1990 to 2021, while the y-axis represents the equivalent INFL values. This visualization provides a clear understanding of the fluctuations and patterns found in INFL rates within the given time frame.

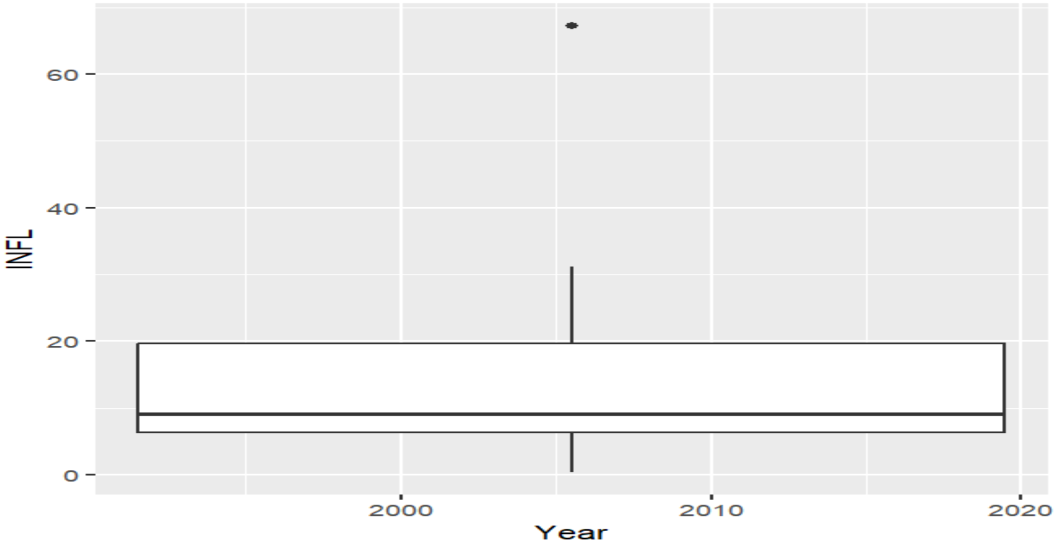

Figure 2. Boxplot of INFL over the Years

GDP: Median=9.07, Mean=13.56, Min=0.34, Max=67.19: IQR=Interquartile Range

The inflation rates (INFL) experienced considerable variability, ranging from as low as 0.34 to as high as 67.199. This suggests that the economy has been exposed to fluctuations in prices and purchasing power during the given time (66.85 range). Higher inflation rates can erode the value of money, increase production costs, and affect consumer purchasing power. On the other hand, lower inflation rates may indicate relatively stable prices and a more controlled economic environment.

3.3 Identification Using a Time Series Line

This step aims to assess the stationarity of the INFL and GDP data and determine the orders of the autoregressive (AR) and moving average (MA) components. Figures 3 and 4 indicate that the data do not exhibit a consistent fluctuation around the mean and lack a constant amplitude. This observation suggests that the data are non-stationary.

The stationarity of the GDP

Before performing the analysis, an assessment was made to determine whether the Gross Domestic Product (GDP) data exhibited stationarity, which is a prerequisite for conducting time series analysis (Figure 3). Stationarity is an essential requirement in time series modeling, suggesting that the statistical properties of the data remain unchanged throughout time. The Augmented Dickey-Fuller (ADF) test, a frequently used technique for evaluating stationarity, was adopted for this objective.

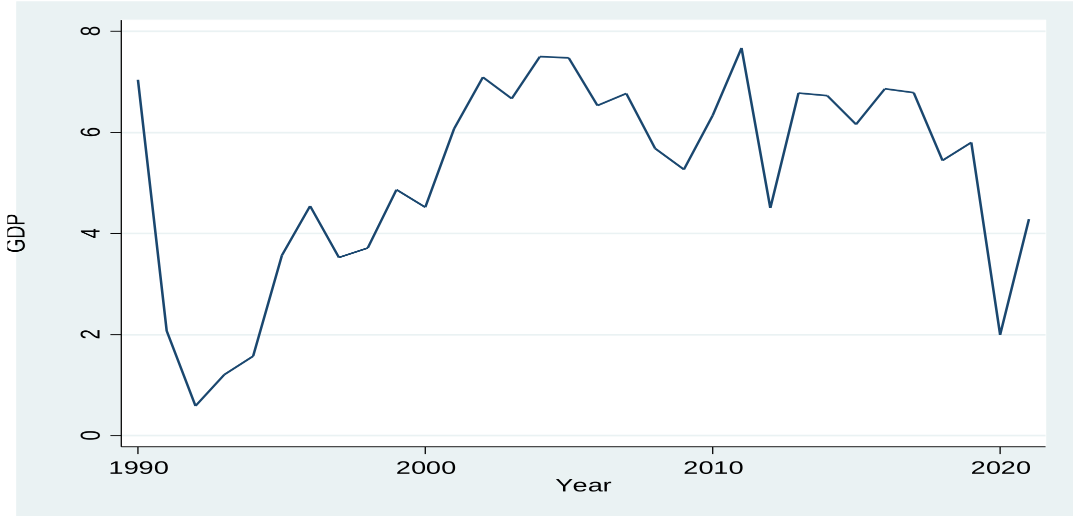

Figure 3. Checking for stationarity of GDP

The stationarity of the INFL

Before doing the analysis, the stationarity of the inflation (INFL) data was evaluated to confirm its appropriateness for time series analysis as Figure 4. Stationarity is a crucial assumption in time series modeling, signifying that the statistical characteristics of the data remain consistent throughout time. The Augmented Dickey-Fuller (ADF) test was used to determine if the data was stationary. The null hypothesis assumes that the data is non-stationary.

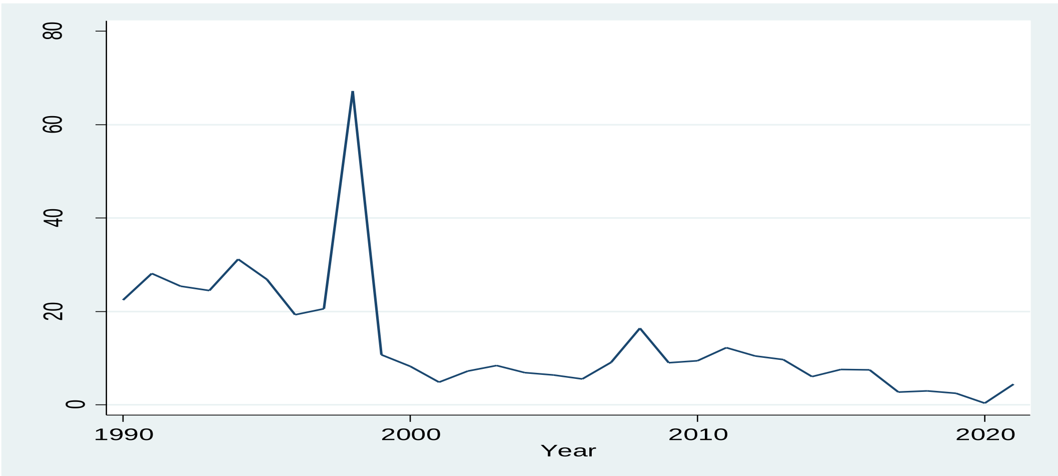

Figure 4. Checking for stationarity of INFL

3.4 Correlogram

The autocorrelation function graph indicates that the lags for INFL decline rapidly compared to GDP, suggesting that the data may be stationary. This is supported by the fact that most of the lags fall within the 95% confidence bands (Figures 5 and 6).

Correlogram for GDP

The autocorrelation function (ACF) of the Gross Domestic Product (GDP) data was examined to gain awareness of any temporal dependencies that exist within the dataset, in addition to assessing stationarity. The ACF plot provides a visual representation of the correlation between the GDP series and its lagged values, allowing for the identification of any underlying patterns or trends that exist over time. The x-axis in the legend indicates the lag values, and the y-axis shows the autocorrelation coefficients (Figure 5).

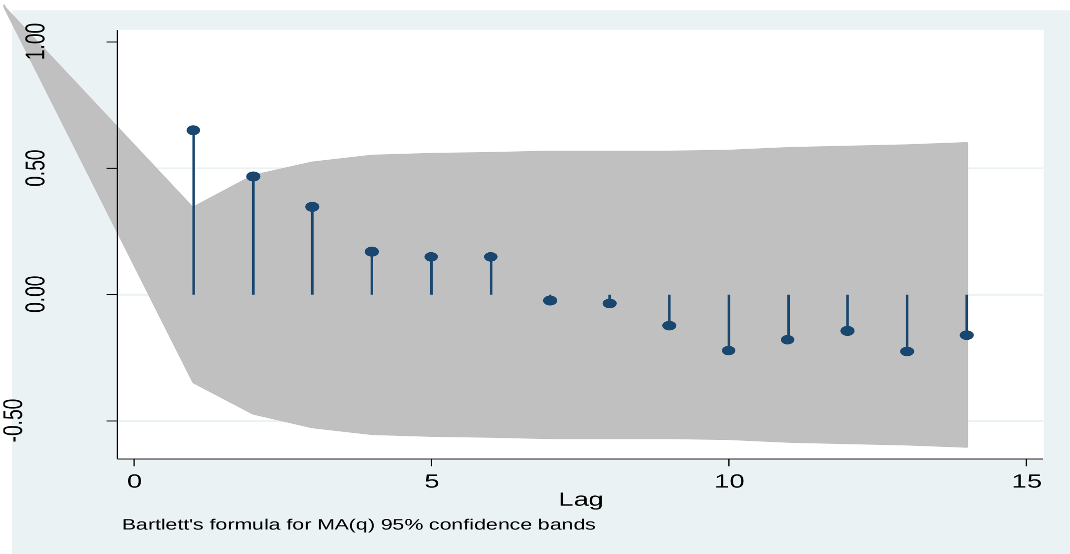

Figure 5. Checking for stationarity of GDP

Correlogram for INFL

Furthermore, the autocorrelation function (ACF) of the inflation (INFL) data was analysed to establish its appropriateness for time series analysis, in addition to evaluating its stationarity. The ACF plot graphically represents the correlation between a series and its lagged values, offering an understanding of patterns within the data. The x-axis in the legend indicates the lag values, while the y-axis represents the autocorrelation coefficients (Figure 6).

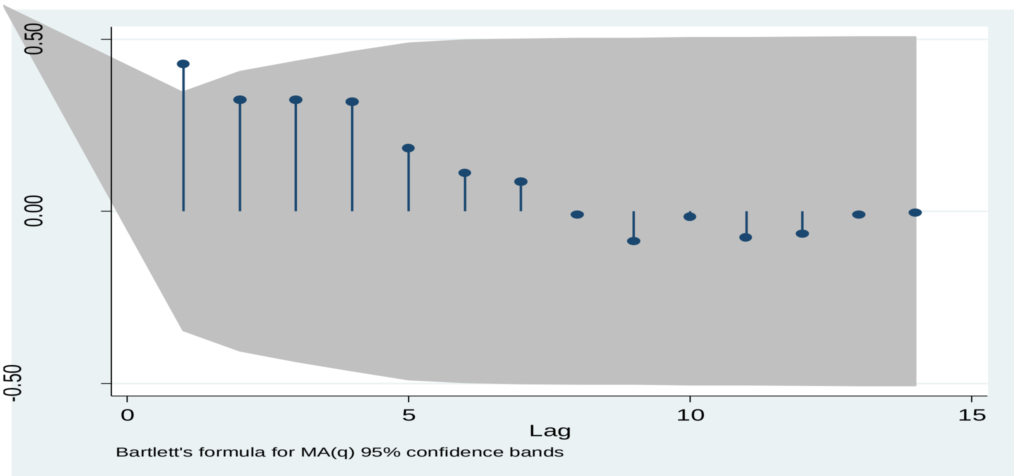

Figure 6. Checking for stationarity of INFL

3.5 Unit Root Test

- ADF unit root for GDP and INFL
- Phillips-Perron (PP) test for GDP and INFL

The unit root test hypothesis declares that.

H_o: There is no serial correlation or non-stationary

H_1: There is a serial correlation. The H_o is rejected when the p-value is <0.05.

From Table 1, ADF and PP for GDP observed that the p-value is >0.05 so not enough evidence to reject Ho, while the INFL p-value for ADF and PP is <0.05 hence we reject H_O and conclude that INFL data are stationary but not for GDP.

Table 1. Unit root test

Variable	Augmented Dickey-Fuller (ADF)		ρ - value	Phillips-Perron test (PP)		ρ - value
	Test statistic	5% Critical Value		Test statistic	5% Critical Value	
GDP	-3.020	-3.576	0.1267	-3.383	-3.576	0.0538
INFL	-4.977	-3.576	0.0002	-4.968	-3.576	0.0002

Given that the time series variable INFL is stationary while GDP is non-stationary, the study opts to apply the first difference order. This transformation ensures that both variables fall into the same category, enabling the investigation of cointegration.

3.5.1 Unit Root Test (1st Difference)

The unit root test and the MacKinnon Approximate computation method are both important in assessing the stationarity of time series data and ensuring the reliability of subsequent analysis.

The Augmented Dickey-Fuller (ADF) test, a commonly used test for determining the presence of a unit root, was utilized. The ADF test assesses the null hypothesis of non-stationarity in a time series. The MacKinnon Approximation approach was used to compute critical values for the ADF test statistic. This technique accounts for the existence of serial correlation and heteroskedasticity, hence improving the precision of the test outcomes.

ADF and PP

Considering the same null hypothesis, the p-value for both ADF and PP for INFL and GDP were respectively stationary. This concludes that the variables are stationary at 1st difference (Table 2).

Table 2. Unit root test (1st difference)

Variable	Augmented Dickey-Fuller (ADF)		ρ - value	Phillips-Perron test (PP)		ρ - value
	Test statistic	5% Critical Value		Test statistic	5% Critical Value	
GDP	-7.293	-3.580	<0.001	-8.509	-3.580	<0.001
INFL	-8.358	-3.580	<0.001	-10.938	-3.580	<0.001

MacKinnon Approximate ρ – value for z(t) = 0.0000

H_0: There is no serial correlation or non-stationary

H_1: There is a serial correlation.

3.6 Cointegration

After conducting the stationarity test using the first difference, the next step is to determine the optimal lag before proceeding to the Johansen Cointegration test. The results indicate that the optimal lag chosen is 1, as determined by the AIC criteria for the lag list (Table 3).

Table 3. Determining the lag to select in the Johansen test.

Selection-order criteria
Sample: 1994 - 2021 Number of obs = 28

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-160.632				380.266	11.6166	11.6457	11.7117
1	-150.826	19.611*	4	0.001	251.582*	11.2019*	11.2891*	11.4873*
2	-149.497	2.6588	4	0.616	306.315	11.3926	11.5381	11.8684
3	-148.11	2.773	4	0.597	374.355	11.5793	11.7829	12.2454
4	-145.672	4.8764	4	0.300	429.385	11.6909	11.9527	12.5473

Endogenous: GDP INFL
Exogenous: _cons

3.6.1 Johansen Test

Table 4. Determining the lag to select in the Johansen test.

Johansen tests for cointegration
Trend: constant Number of obs = 30
Sample: 1992 - 2021 Lags = 2

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	6	-168.94366	.	13.8103*	15.41
1	9	-164.03711	0.27899	3.9973	3.76
2	10	-162.03848	0.12475		

maximum rank	parms	LL	eigenvalue	max statistic	5% critical value
0	6	-168.94366	.	9.8131	14.07
1	9	-164.03711	0.27899	3.9973	3.76
2	10	-162.03848	0.12475		

The Johansen test is utilized in this case to determine the presence of cointegration between GDP and INFL, indicating a long-term relationship between the variables. The test estimates the cointegrating vectors (Π1 and Π2) and evaluates their statistical significance. In the Johansen study, a maximum or optimal lag is selected based on the decision criteria to determine the presence or absence of cointegration. The trace statistics versus the 5% critical value and the maximum eigenvalues versus the 5% critical value are considered, with the null hypothesis (Ho) stating no cointegration and the alternative hypothesis (Hi) suggesting the presence of cointegration.

According to the results in Table 4, both the trace statistic for the maximum rank of 0 and the maximum rank of 1 are above the 5% critical value. This indicates that there is no evidence of cointegration. As a result, the study can only estimate the short-run relationship and does not consider the Vector Error Correction Model (VECM) equation to capture the dynamics between economic growth (GDP) and inflation (INFL) while accounting for both short-term and long-run effects.

Table 5. Johansen test for Cointegration

Trend: Constant				Number of Obs = 30	
Sample 1992 - 2021					Lags = 2
Max rank	Parms	LL	Eigenvalue	Trace statistic	5% Critical value
0	6	-168.9437	-	13.8103*	15.41
1	9	-164.0371	0.2790	3.9973	3.76
2	10	-162.0385	0.1248		

3.7 Examining the Impact of Inflation on Economic Growth

The Impact of Inflation on Economic Growth (GDP and INFL) is examined. The R-squared value of 0.2422 suggests that approximately 24.22% of the variation in GDP can be explained by changes in INFL. Furthermore, the p-value of 0.0042 indicates that the relationship between inflation and economic growth is statistically significant at a conventional significance level (e.g., $\alpha = 0.05$).

The intercept (constant term) of 6.2111 represents the estimated value of GDP when INFL is zero. Additionally, the coefficient of the INFL variable (-0.0763) indicates that holding other factors constant, a 1 unit increase in inflation is associated with a decrease of 0.0763 units in economic growth (GDP). Thus, the results suggest that inflation has a statistically significant negative impact on economic growth. As inflation increases, economic growth tends to decrease accordingly (Table 6).

Table 6. The impact of Inflation on Economic growth

Source	SS	df	MS			
				Number of obs	=	32
				F(1, 30)	=	9.59
Model	30.1028921	1	30.1028921	Prob > F	=	0.0042
Residual	94.1784082	30	3.13928027	R-squared	=	0.2422
				Adj R-squared	=	0.2170
Total	124.2813	31	4.0090742	Root MSE	=	1.7718

GDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
INFL	-.0763135	.0246441	-3.10	0.004	-.1266434	-.0259836
_cons	6.211134	.4580473	13.56	0.000	5.275677	7.146592

Regression of GDP and INFL:

Table 7. The impact of Inflation on Economic growth

GDP	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
INFL	-.0763135	.0246441	-3.10	0.004	-.1266434	-.0259836
_cons	6.211134	.4580473	13.56	0.000	5.275677	7.146592

The model is: $GDP(t) = 6.2111 - 0.0763 * INFL(t).$

3.8 Relationship between Inflation and GDP Growth

Examining the Relationship between Inflation and GDP Growth Rate (INFL and GDP), the R-squared value of 0.2422 indicates that approximately 24.22% of the variation in the GDP growth rate can be explained by changes in inflation. Moreover, the p-value of 0.0042 indicates that the relationship between inflation and the GDP growth rate is statistically significant.

The constant term of 29.9909 represents the estimated value of the GDP growth rate when inflation is zero. Additionally, the coefficient of the GDP variable (-3.1739) indicates that assuming other factors remain constant, a 1 unit increase in the GDP growth rate is associated with a decrease of 3.1739 units in inflation. Consequently, the results suggest a statistically significant negative relationship between the GDP growth rate and inflation. Higher GDP growth rates are associated with lower levels of inflation.

Table 8. Relationship between Inflation and GDP Growth Rate

Source	SS	df	MS			
				Number of obs	=	32
				F(1, 30)	=	9.59
Model	1252.01012	1	1252.01012	Prob > F	=	0.0042
Residual	3916.97648	30	130.565883	R-squared	=	0.2422
				Adj R-squared	=	0.2170
Total	5168.9866	31	166.741503	Root MSE	=	11.427

INFL	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDP	-3.173957	1.024972	-3.10	0.004	-5.267229	-1.080685
_cons	29.99094	5.676951	5.28	0.000	18.39706	41.58482

Regression of INFL and GDP

Table 9. Relationship between Inflation and GDP Growth Rate

INFL	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDP	-3.173957	1.024972	-3.10	0.004	-5.267229	-1.080685
_cons	29.99094	5.676951	5.28	0.000	18.39706	41.58482

The models for GDP and Inflation are presented as follows, respectively:

$$GDP(t) = 6.2111 - 0.0763 * INFL(t).$$

$$INFL(t) = 29.9909 - 3.1739 * GDP(t).$$

4. Discussion

The key findings of the analysis are summarized as follows:

4.1 GDP Growth

The interquartile range (IQR) of 2.64 reflects the spread of GDP values within the middle 50%, indicating the variability in economic growth rates. The median value of 5.74 represents the typical growth rate, while the mean value of 5.18 represents the average growth rate over the given period. The range of economic performance is illustrated by the minimum value of 0.58 and the maximum value of 7.67. Higher GDP growth rates suggest a growing economy, increased production, and improved standards of living, while lower growth rates may indicate an economic slowdown.

4.2 Inflation

The IQR of 13.33 indicates significant variability in inflation rates observed during the given period. The median value of 9.07 represents the middle value of the inflation data, while the mean value of 13.56 represents the average inflation rate. The range of inflation rates is shown by the minimum value of 0.34 and the maximum value of 67.199. Higher inflation rates can erode the value of money, increase production costs, and affect consumer purchasing power.

4.3 Stationarity

The analysis suggests that the GDP data are non-stationary, while the inflation data are stationary. Differencing the data is necessary to achieve stationarity for further analysis.

4.4 Cointegration

The Johansen Cointegration test does not provide evidence of a long-term relationship or cointegration between GDP growth and inflation. Therefore, the study focuses on estimating the short-run relationship between the variables.

4.5 Impact of Inflation on GDP Growth

The regression analysis reveals that approximately 24.22% of the variation in GDP growth can be explained by changes in inflation. The statistically significant negative coefficient (-0.0763) suggests that higher inflation is associated with a decrease in economic growth. The results indicate that inflation has a detrimental impact on GDP growth, with higher inflation rates leading to lower economic growth rates.

4.6 Relationship between Inflation and GDP Growth Rate

The analysis also examines the relationship between inflation and the GDP growth rate. The results show a statistically significant negative relationship, indicating that higher GDP growth rates are associated with lower levels of inflation.

In summary, the analysis highlights that higher inflation rates have a negative impact on GDP growth, while lower inflation rates are associated with higher GDP growth rates. These findings emphasize the importance of maintaining price stability and controlling inflation to promote sustainable economic growth.

5. Conclusion

Inflation has a negative impact on economic growth. Higher inflation rates tend to be associated with lower economic growth. Also, there is a reciprocal relationship between inflation and the GDP growth rate. Higher GDP growth rates are linked to lower inflation levels. Therefore, it is important for policymakers to carefully manage inflation to ensure sustainable economic growth.

It is essential to consider that GDP growth rates alone do not provide a comprehensive picture of economic well-being. Factors such as income distribution, inequality, and quality of life indicators need to be considered to assess the overall impact on society. Furthermore, the relationship between inflation and GDP growth rates can be complex, as high inflation can hinder economic growth while moderate inflation can stimulate economic activity.

However, it is important to note that high inflation can also stimulate economic growth by encouraging spending and investment, while low inflation can be associated with sluggish economic activity. Therefore, the impact of inflation on the economy is complex to understand its full implications.

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