Macroeconomic Dynamics in India: Exploring the Interplay between Growth, Inflation and Unemployment

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Abstract

This study explores the intricate relationships among economic growth, inflation, and unemployment in the Indian economy using time series data from 1993 to 2021, sourced from the Reserve Bank of India and the World Bank. Employing econometric techniques such as cointegration analysis, Vector Error Correction Models (VECM), and Vector Autoregression (VAR), the paper investigates both long-run and short-run causal linkages. The results reveal a statistically significant long-run relationship between unemployment and inflation, where declining unemployment tends to increase inflation, consistent with the Phillips Curve framework. However, no short-run causality is observed between these variables. The study also finds a long-run inverse relationship between unemployment and GDP growth, in support of Okun's Law, while short-run effects remain statistically insignificant. In contrast, there is no evidence of either a short-run or long-run relationship between inflation and GDP growth, challenging the conventional notion of an inflation–growth trade-off. These empirical insights provide a nuanced understanding of India's macroeconomic dynamics and offer relevant policy implications for sustaining growth while managing inflation and employment in an emerging economy.

Keywords: Inflation, Unemployment, Economic Growth, Phillips Curve, Okun's Law, Indian Economy,

1. Introduction

1.1 Basic Concepts and the Significance of This Study

The complex interplay among economic growth, inflation, and unemployment has long been a subject of deep interest for economists and policymakers alike. This nexus holds particular relevance for developing countries, where the interaction of these macroeconomic variables often presents unique and evolving challenges. Among these, unemployment and inflation stand out as key indicators that significantly shape a nation's economic trajectory.

The intellectual foundation of this study is rooted in two seminal contributions to macroeconomic theory. In 1958, A.W. Phillips introduced the concept of an inverse

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relationship between inflation and unemployment, now widely known as the Phillips Curve. A few years later, Arthur Okun (1962) empirically established a link between unemployment and Gross Domestic Product (GDP), known as Okun's Law. Since then, a vast body of empirical and theoretical research has emerged, examining how these variables interact across different economies and time periods.

For instance, in Sri Lanka, Shiyalini and Bhavan (2021) reported a strong negative correlation between unemployment and GDP growth, along with a positive long-term relationship between inflation and GDP growth. Singh and Verma (2016), analyzing the Indian context, identified a significant short-run impact of unemployment on inflation, though its influence on real GDP was comparatively modest. In Jordan, Jaradat (2013) found that a 1% increase in GDP led to a 0.906% rise in inflation and a 0.607% decline in unemployment, indicating an intertwined relationship among the three variables.

Similarly, Abdul-Khaliq et al. (2014), through a cross-country study of Arab economies, revealed that a 1% increase in economic growth corresponded with a 0.16% reduction in unemployment—emphasizing the importance of output expansion in labor market improvements. Such findings illustrate the diversity and complexity of macroeconomic relationships across different national contexts.

Against this backdrop, the present study aims to analyze the dynamics of unemployment, inflation, and GDP within the Indian economy—a context characterized by rapid structural transformation and emerging macroeconomic complexities. By employing trend analysis and advanced time series econometric techniques on data spanning from 1993 to 2021, this research seeks to unravel the nature and direction of these relationships over time. The ultimate objective is to enhance our understanding of the underlying economic forces at work in one of the world's most dynamic and influential emerging economies.

1.2 Review of Literature

In the Indian context, the unique structure of the labor market and macroeconomic environment has drawn significant scholarly attention to the interrelations among unemployment, inflation, and economic growth. Ghose and Kumar (2021) examined India's employment conditions during periods of rapid economic growth, highlighting a mismatch between technological progress and the demand for skilled labor, which contributed to deteriorating employment conditions. Das (2015) investigated the productivity-growth-employment nexus and found that higher labor productivity growth often coincided with stagnant or declining employment, raising concerns about jobless growth. Sinha (2017) reported a long-run unidirectional causality from unemployment to inflation, confirming a Phillips Curve relationship, although no short-run linkage was observed. In contrast, Xia (2021) found a general but statistically insignificant relationship between inflation and unemployment in India. Kaur (2014) identified a significant negative effect of inflation and exchange rate fluctuations on unemployment, reinforcing the presence of a trade-off between inflation and unemployment. Sa'idu and Muhammad (2015) discovered a significant positive relationship between inflation and GDP, with a unidirectional causal flow from inflation to output, suggesting inflation might play a stimulative role in India's growth process. Patnaik (2011), however, questioned the assumption that output growth under capitalism necessarily leads to declining unemployment, pointing to structural issues within the labor market.

Internationally, several studies have also explored the tripartite relationship among inflation, unemployment, and economic growth, yielding diverse and often country-specific findings. Li and Liu (2012), analyzing China, found a stable long-run equilibrium among the variables. While they reported a short-run positive association between economic growth and unemployment, they also found a negative relationship between inflation and unemployment, supporting the Phillips Curve hypothesis. Shiyalini and Bhavan (2021) reported that in Sri

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Lanka, inflation and GDP growth were positively associated, while higher unemployment negatively affected growth, with evidence of long-run cointegration among all three variables. In Nigeria, Ademola and Badiru (2016) observed that both inflation and unemployment had a positive effect on economic growth—an unusual finding that contrasts with standard macroeconomic expectations. Orji et al. (2015) also revealed a positive link between unemployment and inflation, suggesting that joblessness could be inflationary. In Iran, Mohseni and Jouzaryan (2016) reported that both inflation and unemployment exerted a significant long-run negative impact on GDP growth, acting as major constraints on economic performance. Similar findings were observed in Pakistan by Shahid (2014), who found a long-run cointegrating relationship where unemployment negatively influenced GDP, though inflation's impact was statistically insignificant. At a global level, Barro (2013) analyzed over 100 countries and found that higher inflation was associated with slower GDP per capita growth and lower investment rates, emphasizing inflation's long-term drag on economic development.

Several other empirical studies deepen the understanding of these macroeconomic dynamics. Jacobson, Vredin, and Warne (1998) challenged the robustness of the real wage–unemployment relationship and advocated for more nuanced models like cointegrated VARs. Ahmed and Nasser (2023) identified threshold effects in the U.S. labor market, where reductions in unemployment had varying effects on the current account balance. In Malaysia, Noor et al. (2007) confirmed the existence of Okun's Law, suggesting output expansion could lower unemployment. Meyer (2017) found a cointegrating relationship between employment and economic growth in South Africa, influenced by monetary policy variables like the repo rate. Abdul-Khaliq et al. (2014) found that a 1% rise in GDP in Arab countries led to a 0.16% reduction in unemployment, reinforcing the employment benefits of growth.

Notably, not all findings align with the Okun's Law hypothesis. Akram et al. (2012) found it inapplicable to Pakistan, while Mosikari (2014) reported no significant long-run relationship between unemployment and GDP in South Africa. Quy (2016), studying Vietnam, emphasized the role of investment and trade in shaping unemployment outcomes. Hjazeen et al. (2021) highlighted the influence of structural factors such as education, urbanization, and female labor force participation in shaping unemployment trends in Jordan. Bhar and Hamori (2004) explored the relationship between inflation and inflation uncertainty in G7 nations. Their findings indicated that the impact of inflation uncertainty varied based on whether inflationary shocks were permanent or transitory, underscoring the complexity of inflation dynamics, particularly in advanced economies where expectations play a central role.

1.3 Motivation of the Study

While the existing body of literature provides valuable insights into the complex interplay among unemployment, inflation, and economic growth across various national contexts, several limitations persist. Many studies are predominantly country-specific, concentrating on developed or smaller emerging economies. While this approach helps in understanding localized macroeconomic dynamics, it often limits the broader applicability and generalizability of their findings. Moreover, the empirical evidence remains fragmented and inconsistent, with differing results regarding the direction, strength, and significance of these relationships depending on the country, time period, and methodology employed.

This inconsistency highlights the need for more context-specific and methodologically rigorous studies, especially for large, structurally diverse economies like India. Despite its rapid economic transformation and emergence as the world's fifth-largest economy, India lacks a comprehensive empirical study that simultaneously examines the triadic relationship among unemployment, inflation, and economic growth using modern time series techniques. Given India's rising global economic significance, an in-depth and updated analysis of these

macroeconomic linkages is not only timely but essential. Such a study can generate policy-relevant insights that aid in the formulation of effective macroeconomic strategies and also enrich the broader academic discourse on emerging market dynamics.

1.4. Objectives and Innovativeness of the Paper

Against this backdrop, the present paper seeks to undertake a systematic analysis of the interrelationships among unemployment, inflation, and economic growth within the Indian economy. The study aims to empirically test the validity of macroeconomic theories such as the Phillips Curve and Okun's Law by analyzing both short-run and long-run dynamics using nearly three decades of time series data from 1993 to 2021. By employing rigorous econometric techniques—including unit root tests, Johansen cointegration, Vector Error Correction Models (VECM), and Vector Autoregression (VAR)—the study endeavors to identify the direction and magnitude of causal relationships among these variables. It further attempts to contextualize India's experience by reflecting on international findings, thereby offering a broader comparative perspective.

What lends distinctiveness to this research is its integration of theoretical frameworks with robust empirical techniques tailored to the Indian macroeconomic landscape. In doing so, the study aims to fill a critical gap in the literature by providing nuanced, data-driven insights that are not only academically relevant but also highly pertinent for policymakers seeking to address issues of employment generation, inflation control, and sustainable economic growth.

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2. Data and Methodology

The present study relies on secondary data collected from the World Bank. Our objective is to explore the relationship between inflation and unemployment while also testing Okun's law in the Indian context. In this section, we provide an overview of the theoretical underpinnings of the Philips Curve and Okun's Law.

2.1 Philips Curve

The Phillips Curve, introduced by A.W. Phillips in 1958, postulates an inverse relationship between the rate of unemployment and the rate of change in money wages. Based on historical data from the United Kingdom (1861–1957), Phillips observed that periods of low unemployment were associated with higher rates of wage inflation. This implied a potential trade-off for policymakers: lower unemployment could be achieved at the expense of higher inflation, and vice versa.

Phillips, along with subsequent elaborations by Lipsey, attributed rising money wages to excess demand in the labor market. The functional form of the relationship was expressed as:

$$\frac{\dot{w}}{w} = f\left(\frac{L^D - L^S}{L^S}\right)$$

Where, $\frac{\dot{w}}{w}$= (1/w)(dw/dt) is the rate of change of the money wage rate, L^D is the demand for labour and L^S is the supply of labour.

Although the original Phillips Curve did not explicitly link inflation to unemployment, later economists such as Samuelson, Solow, Friedman, and Phelps expanded the framework. During the 1960s, the curve gained popularity as a policy tool for managing the trade-off between inflation and unemployment. However, the experience of stagflation in the 1970s—when many economies experienced both high inflation and high unemployment—challenged its empirical validity.

Milton Friedman responded with the expectations-augmented Phillips Curve, arguing that the original relationship was only valid in the short run. According to this revised view, workers adjust wage expectations based on past inflation, and in the long run, the economy returns to a

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natural rate of unemployment where the Phillips Curve becomes vertical. This marked an important evolution in macroeconomic theory, shifting the focus toward the role of expectations in wage and price dynamics.

2.2 Okun's Law

Okun's Law, developed by Arthur M. Okun in 1962, represents an empirical relationship between changes in a country's GDP and its unemployment rate. It suggests that a 1% decrease in the unemployment rate is typically associated with an approximate 2% increase in GDP. Conversely, a fall in GDP is expected to lead to a rise in unemployment. This relationship, while not derived from theoretical foundations, has proven to be a useful rule of thumb in macroeconomic analysis and policy evaluation.

The validity of Okun's Law, however, is not uniform across countries or time periods. The relationship can be influenced by various structural and cyclical factors such as labor market flexibility, productivity changes, and variations in capacity utilization or hours worked. A 2007 study by the Federal Reserve Bank of Kansas City confirmed that Okun's Law generally holds over time, but also identified periods where the unemployment–GDP relationship deviated significantly from expectations.

Despite these variations, Okun's Law remains an important empirical tool for assessing the growth-employment nexus, particularly in emerging economies like India, where jobless growth has been a recurrent concern. Testing this law in the Indian context provides important insights into the responsiveness of employment to output fluctuations.

2.3 Time Series Analysis

To examine the dynamic relationships among GDP growth, unemployment, and inflation in the Indian context, the study employs a suite of time series econometric techniques. The first step involves testing for the presence of unit roots in the data using standard tests such as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) procedures. These tests help determine the stationarity properties of each variable. A variable is considered stationary if its first difference is statistically significant, indicating that it does not exhibit persistent trends over time.

Once the stationarity of the variables is established, cointegration tests are employed to investigate the presence of a long-run equilibrium relationship among the variables. The Johansen cointegration test is used to determine whether two or more non-stationary time series are linked in the long term, thereby justifying the use of a Vector Error Correction Model (VECM). If cointegration is confirmed, the VECM framework allows for the analysis of both short-run and long-run causal relationships while incorporating the error correction term that captures deviations from long-run equilibrium.

In cases where no cointegration is found, the analysis resorts to the Vector Autoregression (VAR) model, which captures the short-run interdependencies among the variables without imposing any long-run structure. The VAR model estimates the mutual influence of lagged values of each variable on the others, making it suitable for analyzing short-run dynamics in the absence of a long-run cointegrating relationship.

2.4. Post-Estimation Tests

To ensure the robustness and reliability of the estimated models, several post-estimation diagnostic tests are conducted. The Jarque-Bera test is applied to examine whether the residuals from the models follow a normal distribution. This test assesses the skewness and kurtosis of the residuals, and a statistically significant result would imply a deviation from normality—potentially affecting inference.

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Additionally, the Lagrange Multiplier (LM) test is employed to detect the presence of serial correlation in the residuals. This test is crucial for verifying whether the model suffers from autocorrelation, which could bias standard errors and invalidate test statistics. The absence of residual autocorrelation and the confirmation of multivariate normality together reinforce the validity of the estimated models.

These time series methods and diagnostic checks form the empirical foundation of the study, enabling a nuanced investigation of the interrelationships among inflation, unemployment, and economic growth in the Indian macroeconomic context.

3. Results and Analysis

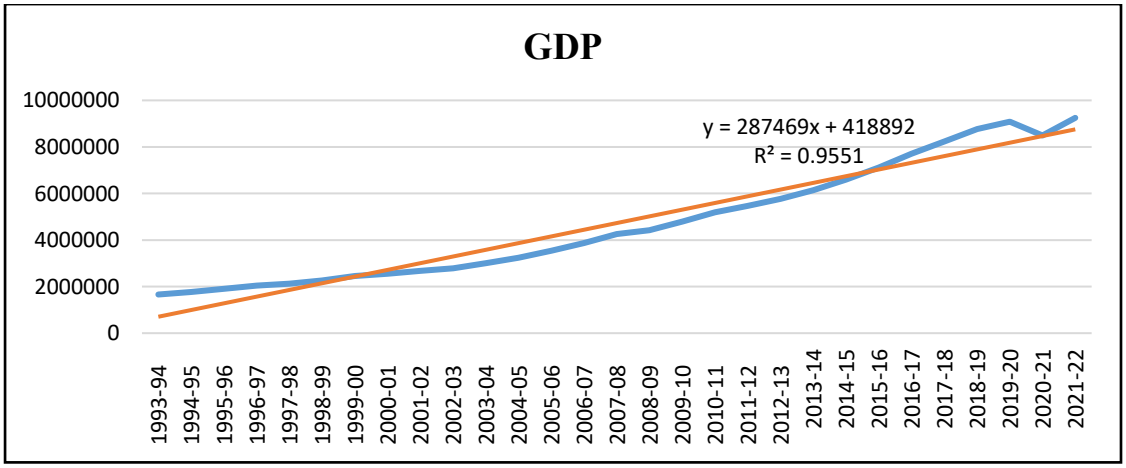
This section presents the empirical findings of the study, aimed at understanding the dynamic relationships among inflation, unemployment, and economic growth in the Indian context over the period 1993 to 2021. The analysis begins with a descriptive overview of trends in GDP, inflation, and unemployment to provide contextual background. This is followed by formal time series tests, including unit root and cointegration analyses, which guide the selection of appropriate econometric models. Subsequently, results from the VECM and VAR are discussed to assess both short-run and long-run causality. The section concludes with a summary of the causal dynamics among the three macroeconomic variables under investigation.

3.1 Trends of GDP, Unemployment Rate and Inflation Rate in India

This subsection presents an overview of the historical trends in India's key macroeconomic indicators—Gross Domestic Product (GDP), GDP growth rate, inflation rate (measured by the Consumer Price Index), and unemployment rate—over the period 1993 to 2021. A trend analysis offers a preliminary understanding of the evolving macroeconomic environment and serves as a contextual backdrop for the econometric analysis that follows.

Figure 1 presents the level of India's GDP from 1993 to 2021. The data exhibit a consistent upward trajectory over the entire period, reflecting sustained economic expansion. There is little evidence of significant cyclical downturns, suggesting a relatively stable growth process, particularly in the post-liberalization period. A trend line fitted using the method of least squares closely follows the actual GDP values, confirming the robustness of India's long-term growth momentum.

Figure 1: Trends of GDP in India, 1993 to 2021



Source: Reserve Bank of India (www.rbi.org.in)

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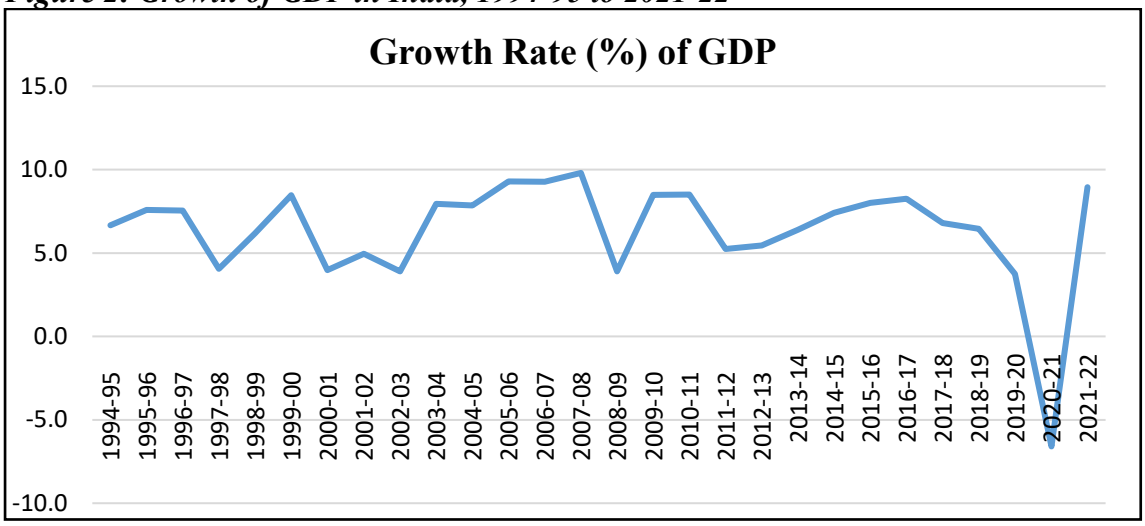
Figure 2: Growth of GDP in India, 1994-95 to 2021-22

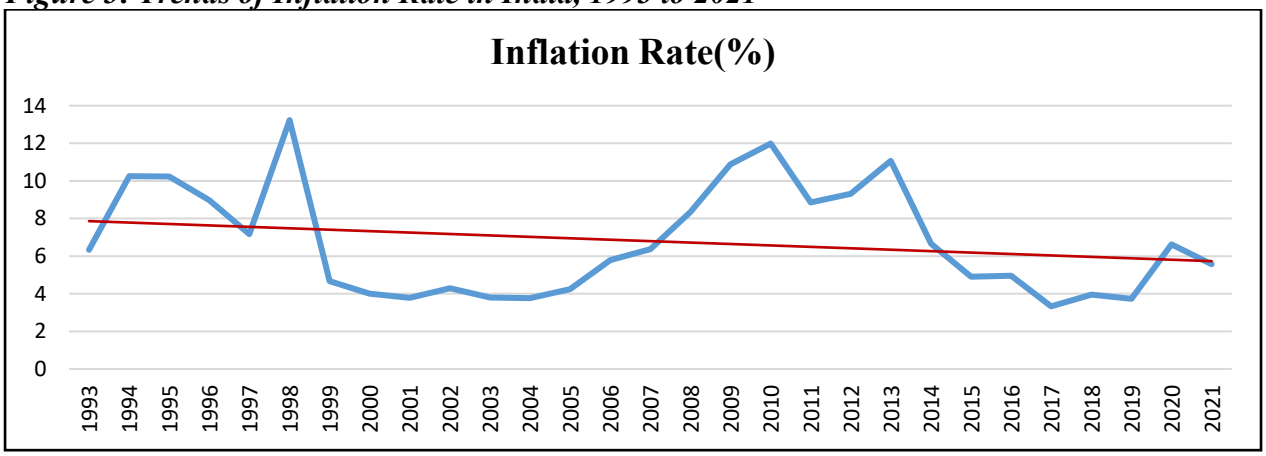


Source: Reserve Bank of India (www.rbi.org.in)

To understand year-on-year fluctuations, Figure 2 illustrates India's annual GDP growth rate. The series reveals significant variation over time, capturing the impact of both domestic policy shifts and global economic shocks. A particularly sharp contraction is observed in 2020–21, when the GDP growth rate turned negative due to the COVID-19 pandemic and its widespread economic disruptions. Nevertheless, the economy rebounded strongly in 2021–22 with a growth rate of 8.9 percent, reflecting recovery-led growth and the effect of fiscal and monetary interventions aimed at stabilizing the economy.

Inflation trends, measured through the Consumer Price Index (CPI), are displayed in Figure 3. Over the period 1993 to 2021, the inflation rate demonstrated substantial variation. From 1999 to 2005, inflation remained relatively stable, ranging between 3.8 percent and 4.7 percent—indicative of effective inflation control during this phase. However, the years 1998, 2010, and 2013 witnessed notable spikes in inflation, with the rate peaking at 13.2 percent, 12.0 percent, and 11.1 percent respectively. These inflationary surges were likely driven by a combination of supply shocks, global commodity price volatility, and domestic economic factors. The onset of the COVID-19 pandemic in 2020 led to another notable spike, with inflation increasing from 3.72 percent in 2019 to 6.62 percent in 2020, mainly due to supply chain disruptions. By 2021, inflation declined to 5.56 percent, signaling the effectiveness of policy measures undertaken by the Government and the Reserve Bank of India to restore price stability.

Figure 3: Trends of Inflation Rate in India, 1993 to 2021



Source: Reserve Bank of India (www.rbi.org.in)

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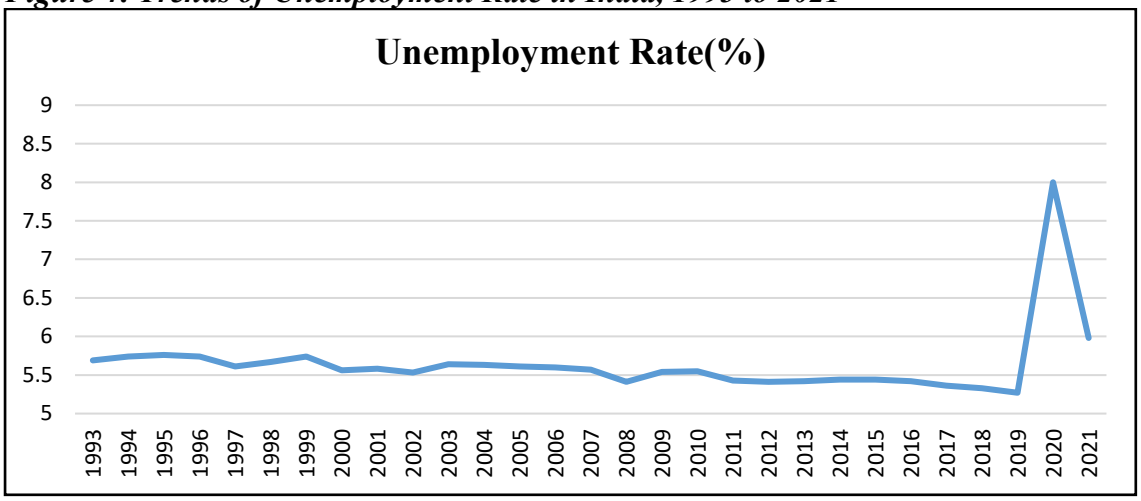
Figure 4: Trends of Unemployment Rate in India, 1993 to 2021



Source: World Bank (www.worldbank.org)

Unemployment trends are depicted in Figure 4, showing that India's unemployment rate remained relatively stable between 1993 and 2019, fluctuating within a narrow band of 5.27 to 5.69 percent. This long period of stability suggests a relatively balanced labor market despite significant structural changes in the economy. However, the COVID-19 pandemic in 2020 caused a sharp increase in the unemployment rate, which surged to 8 percent due to lockdowns and disruptions in business operations. In 2021, the unemployment rate declined to 5.98 percent, reflecting the impact of economic reopening and government stimulus measures aimed at restoring employment.

Together, these trends in GDP, inflation, and unemployment provide a valuable backdrop for understanding India's macroeconomic evolution over the past three decades. They also set the empirical foundation for exploring the dynamic interrelationships among these variables using time series econometric methods in the subsequent sections.

3.2 Stationarity Test:

To ensure the appropriateness of time series models, it is essential to examine the stationarity properties of the variables under study. Accordingly, both the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test were employed to assess whether the time series for the unemployment rate, inflation (measured by the Consumer Price Index), and GDP growth rate are stationary over the sample period from 1993 to 2021.

The results, presented in Table 1, reveal that the unemployment rate and GDP growth are stationary at levels as well as at their first differences under both the ADF and PP frameworks. This suggests that these two variables exhibit stable statistical properties over time, satisfying the conditions for inclusion in models that assume stationarity.

In contrast, the inflation rate is found to be non-stationary at level, but becomes stationary after first differencing, indicating that it follows an integrated process of order one, I(1). The consistency of findings across both unit root tests enhances the robustness of the analysis.

These results provide a critical basis for subsequent cointegration analysis. Since at least two of the variables—GDP and unemployment—are integrated of the same order, the possibility of a long-run equilibrium relationship among them can be meaningfully tested using cointegration techniques. Inflation, being I(1), also qualifies for inclusion in such models once appropriately differenced.

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Table 1: Estimated results of Augmented Dickey Fuller and Phillips-Perron

Variable	Level		1st Difference	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept
Augmented Dickey Fuller				
Unemployment	0.0009	0.0051	0.000	0.000
Inflation	0.1227	0.2706	0.000	0.000
GDP	0.0008	0.0037	0.000	0.000
Phillips-Perron				
Unemployment	0.0010	0.0051	0.000	0.000
Inflation	0.1224	0.2565	0.000	0.000
GDP	0.0008	0.0037	0.000	0.000

Source: Authors' Estimation

3.3 Cointegration Analysis

Following the confirmation of unit roots in the time series variables, the Johansen cointegration test was applied to investigate the presence of long-run equilibrium relationships among the key macroeconomic indicators—unemployment, inflation, and GDP growth.

The first set of tests, focusing on the unemployment and inflation relationship, reveals a statistically significant cointegrating equation at the 5 percent level. Although the trace statistic for the null hypothesis of no cointegration is not significant, the test for "at most one" cointegrating vector is statistically significant. This indicates the existence of a stable long-term relationship between unemployment and inflation, as shown in Table 2. A similar outcome emerges when testing for a long-run association between GDP growth and the unemployment rate (Table 3). This suggests that GDP and unemployment are linked in a long-run equilibrium relationship, supporting the theoretical foundation of Okun's Law.

Table 2 Cointegration test of unemployment and inflation

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.185	9.43	15.49	0.327
At most 1 *	0.134	3.89	3.84	0.048

Source: Authors' Estimation

Table 3 Cointegration test between GDP and unemployment

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.385	16.102	15.494	0.040
At most 1	0.103	2.956	3.841	0.085

Source: Authors' Estimation

In contrast, the cointegration test between inflation and GDP does not yield statistically significant results. Both the null hypotheses of no cointegration and of at most one cointegrating equation fail to be rejected, as indicated by the p-values above conventional significance thresholds (Table 4). This implies the absence of a long-run equilibrium relationship between inflation and GDP in the Indian context over the study period.

These findings suggest that while unemployment is closely linked in the long run to both inflation and economic growth, inflation and GDP do not share a stable long-run association.

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This distinction provides a foundation for the selection of appropriate models in the next stage of analysis, particularly in the application of VECM and VAR frameworks.

Table 4 Cointegration test between inflation and growth of GDP

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.279	10.883	15.49	0.218
At most 1	0.072	2.032	3.84	0.154

Source: Authors' Estimation

3.4 VECM Analysis

Inflation-Unemployment Relationship

The VECMs to investigate both the short-run and long-run causal relationships between the unemployment rate (UR) and inflation (INF) are specified as follows:
For UR:
D(UR) *= C(1)*[UR(-1) + 0.0815*INF(-1) – 6.171] + C(2)*D(UR(-1)) + C(3)*D(UR(-2)) + C(4)*D(INF(-1)) + C(5)*D(INF(-2)) + C(6)*

For INF:
D(INF) *= C(7)*(UR(-1) + 0.0815*INF(-1) – 6.171) + C(8)*D(UR(-1)) + C(9)*D(UR(-2)) + C(10)*D(INF(-1)) + C(11)*D(INF(-2)) + C(12)*

Here, D(UR) and D(INF) represent the first difference of the unemployment rate and inflation, respectively, while C() denotes the coefficients.

The results (Table 7) indicate that the coefficient C(1) is negative and statistically significant at the 10% level. This suggests the existence of a **long-run causal relationship from inflation to unemployment**, meaning that over time, changes in inflation have a significant impact on unemployment. In contrast, the coefficient C(7), which would indicate a reverse long-run causality from unemployment to inflation, is not statistically significant, implying that such a relationship does not exist. Additionally, the diagnostic statistics confirm the robustness of the model. The residuals show no signs of autocorrelation and conform to multivariate normality, affirming the validity of the VECM estimation.

Table 7: Estimation of the level of significance of different coefficients of VECM model

	Coefficient	Std. Error	t-Statistic	Prob.	
C(1)	***-0.87***	***0.44***	***-1.97***	***0.06***	
C(2)	-0.08	0.43	-0.18	0.86	Determinant residual
C(3)	-0.08	1.66	-0.05	0.96	covariance: 1.128
C(4)	0.06	0.06	1.10	0.28	Observations: 26
C(5)	0.05	0.05	1.05	0.30	R-squared: 0.492
C(6)	0.03	0.11	0.24	0.81	Adjusted R-squared: 0.365
C(7)	***-3.07***	***2.07***	***-1.48***	***0.15***	S.E. of regression : 0.545
C(8)	2.18	2.00	1.09	0.28	Durbin-Watson stat : 2.043
C(9)	-3.60	7.80	-0.46	0.65	Mean dependent var: 0.008
C(10)	-0.22	0.26	-0.86	0.40	S.D. dependent var: 0.683
C(11)	0.03	0.22	0.14	0.89	Sum squared residual: 5.933
C(12)	-0.47	0.54	-0.88	0.39	

Source: Authors' Estimation

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Table 8: Wald Chi square test for the joint effect for INF(-1) and INF(-2)

Test Statistic	Value	df	Probability
Chi-square	1.657	2	**0.436**

Source: Authors' Estimation

Table 9: Wald Chi square test for the joint effect for UR(-1) and UR(-2)

Test Statistic	Value	df	Probability
Chi-square	1.675	2	**0.432**

Source: Authors' Estimation

To explore into the short-run causality, particularly the causality running from inflation to unemployment, we conducted a Wald chi-square test considering the joint effect of INF(-1) and INF(-2), as detailed in Table 8. Under this test, the null hypothesis posits that both C(4) and C(5) are equal to zero, while the alternative hypothesis suggests that they differ from zero. The outcome of the Wald Chi-square test indicates a lack of statistical significance. Consequently, this implies the absence of short-run causality running from inflation to unemployment. Similarly, to explore short-run causality running from unemployment to inflation, we conducted a Wald chi-square test focusing on UR(-1) and UR(-2), as described in Table 9. In this context, the null hypothesis assumes that both C(8) and C(9) are equal to zero, while the alternative hypothesis suggests they differ from zero. The statistically insignificant result of the Wald Chi-square test implies that there is no short-run causality running from unemployment to inflation.

The VECM analysis reveals a significant long-run causal relationship from inflation to the unemployment rate, suggesting that inflation can influence unemployment over an extended period. However, the reverse causal relationship is not supported. Additionally, there is no short-run causality observed between these variables in either direction. These findings contribute to a nuanced understanding of the dynamic interplay between unemployment and inflation in the context of the studied data. That is, in the long term, changes in inflation appear to influence the unemployment rate, but this relationship is not observed in the short term. Policymakers may need to consider inflation targeting strategies to manage unemployment in the long run.

GDP-Unemployment Relationship

Continuing our examination of the VECM results, we now turn to the analysis of both short-run and long-run causality between the unemployment rate (UR) and the growth of GDP (GGDP). The model is specified as follows:

For UR:

$$D(UR) = C(1)(UR(-1) + 0.197GGDP(-1) - 6.856) + C(2)*D(UR(-1)) + C(3)*D(UR(-2)) + C(4) *D(GGDP(-1)) + C(5)*D(GGDP(-2)) + C(6)$$

For GGDP:

$$D(GGDP) = C(7)(UR(-1) + 0.197GGDP(-1) - 6.857) + C(8)*D(UR(-1)) + C(9)*D(UR(-2)) + C(10) *D(GGDP(-1)) + C(11)*D(GGDP(-2)) + C(12)$$

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Table 10: Estimation of the level of significance of different coefficients of VECM model

	Coefficient	Std. Error	t-Statistic	Prob.	
C(1)	-0.914	0.429	-2.129	0.040	Determinant residual covariance: 0.917167
C(2)	-0.467	0.353	-1.324	0.193	Observations: 26
C(3)	0.390	5.114	0.076	0.940	R-squared: 0.521
C(4)	0.084	0.074	1.130	0.265	Adjusted R-squared: 0.402
C(5)	0.028	0.168	0.168	0.867	S.E. of regression: 0.529
C(6)	0.101	0.128	0.791	0.434	Durbin-Watson stat: 1.986
C(7)	-0.216	2.773	-0.078	0.938	Mean dependent var: 0.008
C(8)	4.617	2.279	2.026	0.050	S.D. dependent var: 0.683
C(9)	-11.174	33.017	-0.338	0.737	Sum squared resid: 5.587
C(10)	-0.322	0.477	-0.675	0.504	
C(11)	0.188	1.082	0.174	0.863	
C(12)	-0.672	0.826	-0.814	0.421	

Source: Authors' Estimation

The estimation results, presented in Table 10, show that the coefficient C(1) is negative and statistically significant. This indicates the presence of a **long-run causal relationship running from GDP growth to the unemployment rate**, implying that changes in GDP significantly influence unemployment over time. In contrast, the coefficient C(7), representing the reverse long-run causality from unemployment to GDP growth, is negative but statistically insignificant. This suggests that **no long-run causal relationship** exists in that direction. Post-estimation diagnostic results further confirm the robustness of the model, indicating no residual autocorrelation and confirming multivariate normality of the residuals.

Table 11: Wald Chi square test for the joint effect for GGDP(-1) and GGDP(-2)

Test Statistic	Value	df	Probability
Chi-square	1.297	2	0.522

Source: Authors' Estimation

Table 12: Wald Chi square test for the joint effect for UR(-1) and UR(-2)

Test Statistic	Value	df	Probability
Chi-square	4.117	2	0.127

Source: Authors' Estimation

To investigate short-run dynamics, Wald chi-square tests were conducted. Table 11 reports the test results for the joint significance of GGDP(−1) and GGDP(−2) in the unemployment equation. The test fails to reject the null hypothesis that both coefficients are zero, implying **no short-run causality from GDP to unemployment**. Similarly, Table 12 presents the Wald test for the joint effect of UR(−1) and UR(−2) in the GDP equation. The test results are statistically insignificant, indicating **no short-run causality from unemployment to GDP** either.

The VECM analysis yields valuable insights into the dynamics between GDP and unemployment. It suggests a significant long-run causal relationship from GDP to unemployment, indicating that changes in GDP can impact unemployment over an extended period. However, similar to the inflation-unemployment relationship, there is no evidence of short-run causality in either direction. These results contribute to a more comprehensive understanding of the intricate relationship between economic growth and unemployment within the context of the data examined. It implies that GDP has a long-term impact on unemployment, but this relationship is not immediate. Policymakers should focus on sustained economic growth to mitigate long-term unemployment.

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3.5 Vector Autoregression (VAR) Analysis for Inflation and GDP Relationship

Since the Johansen cointegration test did not reveal any statistically significant long-run relationship between inflation (INF) and the growth rate of GDP (GGDP), a VAR model was employed to examine their short-run causal dynamics. This approach is appropriate when variables are integrated of the same order but not cointegrated, as is the case here, with both series found stationary at first difference. The VAR model is specified with each variable expressed as a function of its own lagged values and those of the other variable as given below:

INF = *C(1)*INF(-1) + C(2)*INF(-2) + C(3)*GGDP(-1) + C(4)*GGDP(-2) + C(5)*

GGDP = *C(6)*INF(-1) + C(7)*INF(-2) + C(8)*GGDP(-1) + C(9)*GGDP(-2) + C(10)*

Table 13: Estimation of the level of significance of different coefficients of VAR model

	Coefficient	Std. Error	t-Statistic	Prob.	
C(1)	0.595	0.194	3.074	0.004	Determinant residual covariance: 37.09
C(2)	0.097	0.197	0.493	0.624	Observations: 27
C(3)	-0.128	0.155	-0.825	0.414	R-squared: 0.474
C(4)	0.464	0.265	1.754	0.087	Adjusted R-squared: 0.378
C(5)	-0.422	2.141	-0.197	0.845	S.E. of regression: 2.284
C(6)	0.410	0.280	1.464	0.150	Durbin-Watson stat: 2.378
C(7)	-0.291	0.284	-1.025	0.311	Mean dependent var: 6.638
C(8)	0.124	0.225	0.551	0.584	S.D. dependent var: 2.897
C(9)	-0.048	0.382	-0.126	0.900	Sum squared resid: 114.83
C(10)	5.097	3.094	1.647	0.107	

Source: Authors' Estimation

The estimated coefficients from the VAR model are presented in Table 13. Among these, only the first lag of inflation (C(1)) is statistically significant at the 1% level, indicating some autoregressive persistence in inflation itself. However, the coefficients for the lagged values of GDP growth in the inflation equation, as well as those of inflation in the GDP growth equation, are not statistically significant, suggesting limited interdependence between the two variables in the short run.

To assess short-run causality more formally, Wald Chi-square tests were conducted. The test for the joint significance of GGDP(-1) and GGDP(-2) in predicting inflation yielded an insignificant result ($p = 0.208$), implying no short-run causality from GDP growth to inflation (Table 14). Similarly, the Wald test for the joint significance of INF(-1) and INF(-2) in predicting GDP growth was also statistically insignificant ($p = 0.338$), indicating that inflation does not exert any short-term influence on GDP growth (Table 15).

These findings imply that changes in GDP do not lead to immediate fluctuations in inflation and vice-versa. The residual diagnostics further strengthen the reliability of these results, with no evidence of autocorrelation and multivariate normality of residuals confirmed. Therefore, the VAR analysis provides clear evidence of the absence of short-run causal links between inflation and economic growth during the study period. Policymakers should thus be cautious in expecting immediate output responses to inflation-targeting measures or vice versa, and consider that these two macroeconomic variables may operate independently in the short term.

Table 14: Wald Chi square test for the joint effect for GGDP(-1) and GGDP(-2)

Test Statistic	Value	df	Probability
Chi-square	3.145	2	0.207

Source: Authors' Estimation

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Table 15: Wald Chi square test for the joint effect for INF(-1) and INF(-2)

Test Statistic	Value	df	Probability
Chi-square	2.170	2	0.337

Source: Authors' Estimation

4. Discussion

This study analysed the interrelationship among three key macroeconomic variables—unemployment, inflation, and GDP growth—in the Indian context during the post-reform period from 1993 to 2021. The trends show that India's GDP growth has been consistently positive but volatile, unemployment has remained persistently high in certain phases, and inflation has exhibited fluctuations due to both domestic and global factors. Understanding the dynamic links among these variables is essential for policy formulation, especially in the context of job creation, price stability, and inclusive growth. The empirical results derived from VECM and VAR models offer valuable insights, which are discussed below in light of relevant economic theories and previous research.

4.1 Unemployment and Inflation: Revisiting the Phillips Curve

The empirical findings support a statistically significant long-run inverse relationship between unemployment and inflation, validating the Phillips Curve hypothesis in the Indian economy. This suggests that a reduction in unemployment tends to exert upward pressure on inflation in the long run, consistent with the idea that increased employment boosts aggregate demand and consequently prices.

These findings are in line with previous empirical studies across different countries. For instance, Li and Liu (2012), using VAR and Error Correction Models, found a similar long-run negative relationship between unemployment and inflation in the Chinese economy. Furuoka et al. (2013) and King & Watson (1994) also confirmed this negative relationship, reinforcing the notion that the Phillips curve holds under certain macroeconomic conditions. Omran and Bilan (2021) further emphasized that the direction and strength of this relationship may depend on the nature of economic shocks and lagged responses.

However, not all studies agree. Wulandari et al. (2019) found no significant causal relationship between unemployment and inflation in either the short or long run. Similarly, Anthony et al. (2015) challenged the Phillips Curve by identifying a positive relationship between these variables. Despite these divergent findings, our results confirm the relevance of the Phillips Curve in the Indian macroeconomic environment, particularly over the long term.

4.2 Unemployment and Economic Growth: Evidence for Okun's Law

The VECM results reveal a statistically significant long-run inverse relationship between unemployment and GDP growth, lending empirical support to Okun's Law in the Indian context. This implies that sustained economic growth can lead to lower unemployment rates over time, reinforcing the idea that output expansion drives labor market improvements.

These findings are consistent with those of Hjazeen et al. (2021), who used an ARDL model to establish a long-run negative linkage between unemployment and economic growth. Similarly, Ola David and Oluwatobi (2012) concluded that while the long-run trade-off is evident, the slope coefficient of Okun's relationship may vary across economies and over time. Lubbock et al. (2022), using the Johansen cointegration test, also confirmed the existence of a long-run relationship between these two variables.

In contrast, Sa'idu and Muhammad (2015) found a positive but statistically insignificant relationship between unemployment and GDP using OLS, though their Granger causality test suggested a unidirectional causality running from inflation to GDP. These varied results

indicate that while the core proposition of Okun's Law remains broadly applicable, its strength and significance may be context-specific and time-dependent. Nonetheless, our findings emphasize the importance of promoting inclusive and sustained economic growth to reduce unemployment over the long term.

4.3 Inflation and GDP Growth: No Significant Link in Indian Context

Unlike the previous two pairs, our analysis does not find any significant long-run or short-run causal relationship between inflation and GDP growth in India during the study period. The Johansen cointegration test reveals the absence of a long-run equilibrium relationship, and the VAR estimates confirm no statistically significant short-run causality in either direction. These results suggest that inflation, within the observed range and macroeconomic conditions, did not play a decisive role in influencing GDP growth, nor was it significantly impacted by output changes.

This finding resonates with the results of Ahmed (2010), who also did not detect any statistically significant long-run relationship between inflation and economic growth using an ARDL model. However, he identified a negative short-run effect. Bruno and Easterly (1998) similarly concluded that the trade-off between inflation and growth is not evident unless inflation crosses a certain high threshold. Sarel (1997) further emphasized that inflation's impact on growth becomes significant only after breaching specific threshold levels.

On the other hand, Omran and Bilan (2021) and Lubbock et al. (2022) reported a positive long-run relationship between inflation and GDP, while Sa'idu and Muhammad (2015) found both a positive association and one-way causality running from inflation to output. These mixed findings underscore the complex and context-specific nature of the inflation-growth nexus. In the Indian context, our results indicate that moderate inflation during the study period did not hinder economic growth nor was it significantly driven by it.

5. Conclusions and Policy Implications

The empirical analysis of this study offers significant insights into the macroeconomic dynamics of the Indian economy, particularly regarding the interrelationships among inflation, unemployment, and GDP growth over the post-reform period. The results confirm the presence of a long-run inverse relationship between unemployment and inflation, consistent with the Phillips Curve, suggesting that as unemployment declines, inflation tends to rise due to demand-side pressures. However, this linkage is not evident in the short run. Additionally, the study finds strong support for Okun's Law in the long term: lower unemployment is associated with higher economic growth, although no short-run relationship is observed. These findings reinforce the importance of long-term employment generation as a catalyst for sustained economic growth.

In contrast, the relationship between inflation and GDP growth appears to be statistically insignificant in both the short and long run, indicating no direct causal linkage under the observed macroeconomic conditions. This aligns with earlier research that argued the inflation-growth nexus becomes relevant only beyond certain threshold levels of inflation. Taken together, these results highlight the asymmetry in macroeconomic relationships across different time horizons and underscore the need for nuanced policy interventions.

From a policy perspective, maintaining inflation within a stable and moderate range remains essential to prevent potential adverse spillovers on employment and economic stability. This supports the continuation of inflation-targeting frameworks by monetary authorities. At the same time, the clear long-run gains from reducing unemployment call for greater investment in employment-oriented strategies, such as skill development, labor market reforms, and inclusive education. Recognizing the time-dependent nature of these economic relationships, policymakers should integrate short-term flexibility with long-term vision, particularly in

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macroeconomic planning. Furthermore, the lack of a significant inflation-growth trade-off should not lead to complacency, as high inflation could still pose risks if allowed to breach critical thresholds. Therefore, inflation monitoring, coupled with proactive fiscal polciy and monetary policy coordination, remains vital. Overall, the study provides an evidence-based foundation for designing balanced and future-oriented macroeconomic policies aimed at fostering sustainable growth, job creation, and price stability in the Indian economy.

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