

A Nexus Between Economic Growth And Inflation: An Indian Experience

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Abstract

The study is an attempt towards examining the relationship between economic growth and inflation in India. Annual time series data collected from the Reserve Bank of India for the period 1971 – 2022 has been used to explain this relationship. Empirical evidence is obtained by employing the co-integration and vector error correction techniques. The findings reveal long-run relationship among GDP and inflation in India. However, short run relation among is ambiguous. Moreover, one-way causality runs from GDP towards inflation. These findings have important policy implications.

Keywords: *Inflation, GDP, Economic Growth, Macroeconomics, Co-integration, VECM*

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I. Introduction

One of the indispensable objectives of macroeconomic policies in India like other economies of the world, industrialized or emerging, is to maintain high economic growth along with the goal price stability. However, there has been a substantial debate on the nature as well as existence of this relationship. The contrast in the relationships among variables are widely dependent on global economic environment. According to (Friedman, 1973) the relationship between inflation and economic growth is ambiguous—historically, all possible combinations have occurred: inflation with and without development, no inflation with and without development.

There are various theories which suggest that macroeconomic stability, specifically defined in terms of low inflation is positively related to economic growth. Macroeconomists, central bankers and policymakers have often stressed on the costs associated with high and unstable inflation. Inflation can have negative impact on the economy when it interferes with country's efficiency. Several examples of such inefficiencies can be located at theoretical level. Inflation can lead to unpredictability about the future profitability of investment as well as fall in real income. This may lead to more stringent investment policies than it would have been otherwise. This eventually leads to lower levels of investment and economic growth.

With the beginning of rise of the Keynesian economics, countries have been liberal in implementing Keynesian policies. Rising aggregate demand not only increased production and its determinants but also general price level. 1970's saw inflation as having detrimental effect on economy. It became evident from the empirical study conducted by (Phillips, 1958) by employing time series data for almost 100 years for the United Kingdom. The concept of Phillips Curve showed positive relation between inflation and economic growth and a negative relation with unemployment. But this condition in the world economies lasted only until the 1970s (Snowdon & Vane, 2005). Surprisingly, during 1970's, countries which had high rates of inflation started to show lower rates of economic growth. Because of this reason the agreed notion that inflation is positively related to economic growth changed towards the fact that high level of inflation is negatively related to growth (Friedman, 1977).. The contradictory interpretations in the relationship of inflation and growth are not only in the theoretical works but also in empirical findings which are based on the macroeconomic and development condition of the countries under consideration. Therefore, the present study tries to examine cointegration and causality between inflation and GDP in India for the period 1971 – 2022. The study is divided into seven parts. It begins with discussion of literature review, then objectives of study are defined. Third, hypothesis of study are formed, fourth, the paper explains data and methodology used to evaluate these hypothesis which is then followed by empirical evidence and conclusion.

II. Literature Review

There exists a plethora of studies on inflation and economic growth which inspects theoretical and empirical aspects of relationship between inflation and economic growth.

(Fischer, 1993) uses both cross-sectional and panel data for both industrialized and developing economies to present a relevant contribution to the existing literature in exploring the possibility of a non-linear relationship

between inflation and economic growth in the long-run. In his study, he finds that inflation decreases growth by reducing investment and productivity growth. He also stated that while inflation is negatively related with growth and production function, it is not clear - especially in the panel regression that which way the causation runs. He also concluded that high inflation is incompatible with sustained economic growth.

(Barro, 1995) uses data for around 100 countries to analyze the effects of inflation on economy's performance over the sample period of 1960-1990. His study reached to a deduction that if some of the country characteristics are held constant, then the regression results shows that an increase in average inflation of 10 percent per annum reduces the growth rate of real GDP by 0.2 to 0.3 percent per annum and lowers the ratio of investment to GDP by 0.4 to 0.6 percent.

(Ghosh et al., 1998) claim that although this is certain that high inflation is bad for growth, there is less agreement about the effect of moderate inflation. Using panel data regression and nonlinearity specification, they reached to a conclusion that a statistically significant inverse relationship holds among inflation and economic growth at all levels but not when inflation rate is low. They further said that short-run costs of disinflation are only relevant when inflation rate goes beyond defined range.

(Abor & Quartey, 2010) explored the idea whether revenue maximizing rate of inflation is growth maximizing in Ghana. He uses Johansen co-integration model for this and finds that Ghana's economy performed higher under low inflation rather when inflation was high. He also verified the revenue maximizing rate of inflation using the Laffer curve approach. Moreover, from his findings, it can be established that the single digit inflation target set by the Central bank was not growth maximizing in Ghana.

Understanding the relationship between inflation and real growth has always been a crucial concern in macroeconomic research. According to (Rangarajan, 1998), generally economists presume beforehand a possible trade-off between price stability and growth either in the long or short run. The new endogenous growth theories inferred that inflation has an adverse impact on growth because of its harmful effects on productivity and efficiency.

Literature on papers in a Phillips-curve framework in India inspects the relation between inflation and the output gap. Taking a sample from 1950 to 2009 (Dholakia, 2011) discovers that a tradeoff does exist between inflation and unemployment in the short-run in the economy. "Our results indicate an upward sloping short-run aggregate supply curve that is responsive to market driven prices". He further emphasizes that the emergence of the tradeoff has come from the backdrop of the economy moving from inward looking and control oriented administration to the liberalized and trade oriented policies. He concludes that, "as the economy becomes more integrated to international trade with markets operating on the demand-supply forces, inflation is no longer driven only by domestic demand factors."

(Bhattacharya & Lodh, 1990) use Indian yearly data from 1950 to 1978 and observe a weak and negative relationship between inflation and output growth.

(Balakrishnan, 1991) works on a sample from 1950 to 1980 in the Indian manufacturing sector. By regressing inflation on the output gap or the activity variable, he finds a significant negative relation, which is clearly in contradiction with the Phillips curve for India.

In another study on a sample from 1955 to 1995, (Nachane & Lakshmi, 2002) infers a negative relation between inflation and the output gap. They also asserted that tenacious sign for the output gap that are obtained for both the annual and quarterly versions of the model in the Indian case are largely because of numerous problems such as, lag in data availability, lack of reliable series for potential GDP, difficulty of estimating quarterly estimates of actual and potential GDP, relatively poor forecasting performance of the output and price gap models.

(Rangarajan & Arif, 1990) inspects the interrelationship between output growth, inflation, and money growth in India using annual data over the period from 1961 to 1985. They concluded that the price level has no response to the changes in real output.

(Das, 2003) working with money, price, and output of India over the period from April 1992 to March 2000 using VARMA approach shows a negative relationship between price and output. Generally most papers using VAR model, especially papers that clearly focused on the Phillips curve, do not show that a Phillips curve exists for India, (Salian & Gopakumar, 2010). A few papers discuss supply shocks faced by India without effectively incorporating them in estimating inflation.

Objectives

1. To study the trend and pattern of GDP and inflation in India.
2. To examine the short run as well as long run relationship between the GDP and Inflation.

Hypothesis

1. H_0 : There is no short run relationship between GDP and Inflation
- H_1 : There is a short run relationship between GDP and Inflation.

2. H_0 : There is no long run relationship between GDP and Inflation.
 H_1 : There is a long run relationship between GDP and Inflation.

III. Data & Methodology

To examine the short-run and long-run relation between economic growth and inflation equations are estimated over the period 1971-72 to 2021-2022. The study uses annual time series data collected from Database on Indian Economy published by RBI, and database of CSO. Inflation (WPI) is measured from the average wholesale price index (WPI) and GDP measured in rupees crore is used as a proxy for economic growth is calculated at 2011-12 prices. For evaluation the GDP series has been converted into natural logs.

The study uses Augmented Dickey-Fuller (ADF) unit root test to examine the stationarity of the variables under consideration. For this we need to run a regression of the first difference of the series on the first lag of the series, subsequent lagged difference terms and optionally, a constant and a time trend. It can be expressed as:

$$\Delta Y_t = \beta_1 + \beta_2 t + \beta_3 Y_{t-1} + \sum_{j=1}^p \Delta Y_{t-j} + \mu_t$$

The additional lagged terms are included to ensure that the errors are uncorrelated. In this ADF test the null hypothesis $\beta_3 = 0$ against the alternative hypothesis that $\beta_3 \neq 0$. If β_3 is significantly different from zero, then the hypothesis that Y_t contains a unit root is rejected. Rejection of the null hypothesis implies series is stationary.

We use Johansen's Cointegration approach (Johansen, 1988, 1991) to test the presence of cointegration between GDP growth and inflation rate. To carry out the Johansen test, we first formulate the vector autoregression (VAR) of order p :

$$Y_t = c + \alpha_1 Y_{t-1} + \dots + \alpha_p Y_{t-p} + \mu_t$$

We can stack this equation and variables into a vector Y to obtain:

$$\Delta Y_t = c + \pi Y_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta Y_{t-i} + \mu_t \dots (i)$$

where,

$$\pi = \sum_{i=1}^p \alpha_i - I \text{ and } \phi_i = -\sum_{j=i+1}^p \alpha_j$$

πY_{t-1} represents the error correction term. Johansen's methodology rests on estimating the rank of π matrix. If the matrix π equals a matrix of zeroes, that is, $\pi = 0$ then the variables are not cointegrated and the relationship reduces to the vector autoregression in the first differences

$$\Delta Y_t = \sum_{i=1}^{p-1} \phi_i \Delta Y_{t-i} + \mu_t$$

If the rank (π) $\neq 0$ and in fact rank (π) = number of cointegrating vectors (n), then all variables are integrated of order 0.

If, $0 < \text{rank}(\pi) = r < n$, then there are r independent cointegration relationships.

IV. Empirical Analysis

At the outset, the Pearson's correlation coefficient (r) between economic growth (GDP) and Wholesale Price Index (WPI) is calculated over the sample period and its significance is tested by the t-test. The value of Pearson's correlation coefficient (r) between these two time series over the sample period turned out to be 0.98.

It shows that economic growth (GDP) and Wholesale Price Index (WPI) are positively related in India and that too a very high degree of correlation is evident between these two variables. To test whether this value of ' r ' shows a significant relationship between two time series, student's t-test has been used. The null hypothesis of the test is $r = 0$ against the alternative of $r \neq 0$. Since the t-statistic at 52 degrees of freedom is 35.42 and the critical value of ' t ' at 5% level of significance is less than that, the null hypothesis is rejected. So, it can be said that the correlation between economic growth (GDP) and Wholesale Price Index (WPI) is statistically significant. Correlation, however, does not give any picture about long-run relationship and thus, leaves unsettled the debate concerning the long-run relationship between economic growth (GDP) and Wholesale Price Index (WPI).

Before proceeding with the time series analysis, it is required to determine the order of integration for each of the two variables used in this analysis. The Augmented Dickey-Fuller unit root test has been used for this purpose, and the results of such test are reported in Table 1.

Table 1

Results of ADF test

Variables	ADF Statistic at level with trend and intercept	p-value	ADF Statistic at 1 st Difference and intercept	p-value
IGDP	-3.052	0.128	-7.742*	0.000

WPI	-0.339	0.989	-5.496*	0.000
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Source: Author's Estimation

Note: (*) denotes significance at 1% level

It is clear that the null hypothesis of no unit roots for both the time series are rejected at their first differences since the ADF test statistic values are less than the critical 1% levels of significances. Thus, the variables are stationary and integrated of same order, i.e., I(1).

In the next step, the cointegration between the stationary variables has been tested by the Johansen's Trace and Maximum Eigenvalue tests.(Johansen & Juselius, 1990) The results of these tests are shown in Table-2. The Trace test indicates existence of one cointegrating equation at 5% level of significance. And, the maximum eigenvalue test confirms this result. Thus, the two variables of the study have a long run relationship among them. Now, we need to verify whether movements from long run equilibrium are self-correcting or not. For this, Vector Error Correction Model is used to infer short-run dynamics between the variables.

Table 2

Results of Johansen's Cointegration Test

No. of Cointegrating Vector (r)	Eigenvalue	Trace Statistic	Critical Value at 5%(p-value)	Max-Eigen Statistic	Critical Value at 5%(p-value)
r=0	0.305	17.942	15.494(0.021)	17.874	14.264(0.012)
r≤1	0.001	0.067	3.841(0.794)	0.067	3.841(0.794)

Note(s) : Series :l(GDP), wpi

Probability is given in parentheses(), which are calculated by MacKinnon-Haug-Michelis (1999)

Trace statistic indicates there is cointegration at the 0.05 level; Max-eigenvalue test confirms this result..

Source: Author's Estimation

Table 3

Results of VECM Estimation

Independent Variable	$\Delta l g d p_t$	$\Delta w p i_t$
$E c_{t-1}$ [t-statistic](p-value)	0.0173 [1.013] (0.315)	4.367* [3.319] (0.001)
$\Delta l g d p_{t-1}$ [t-statistic](p-value)	-0.118[-0.808] (0.422)	-35.033* [-3.117] (0.003)
$\Delta w p i_{t-1}$ [t-statistic](p-value)	0.001[0.815] (0.419)	0.551* [4.387] (0.000)

Source: Authors' Estimation

Note: (*) denotes significance at 1% level

The estimation of a Vector Error Correction Model (VECM) requires the selection of an appropriate lag length. Since, the optimal number of lags chosen for Johansen's cointegration turned out to be two (see Appendix Table 1) we use one(p-1) lag for our VECM. Then an error correction model with the computed t-values of the regression coefficients is estimated and the results are reported in Table 4. The estimated coefficient of error-correction term when $\Delta l g d p_t$ is dependent variable is statistically insignificant but has a negative sign. However, the error-correction term when $\Delta w p i_t$ is dependent variable is statistically significant at 1 per cent level of significance but has a positive sign. It means that the deviations from long run equilibrium are not converging towards long run stability. Empirically it means that in short run relation between economic growth and inflation as measured by WPI is ambiguous in India for the study period 1971-2022.

The result of a Granger causality test as depicted in Table 4 shows that causality runs from GDP to inflation at 1% significance level.

Table 4

Results of Granger Causality Test

Null Hypothesis	Obs.	F-statistic	Prob.
WPI does not Granger Cause LGDP	50	0.496	0.612
LGDP does not Granger Cause WPI		4.793	0.013

Source: Author's Estimation

It means that lagged values of GDP has an incremental forecasting power when applied to equation of inflation in univariate autoregressive model. In contrast WPI does not Granger Cause LGDP at any traditional significance level. This means that inflation does not predict anything about the short run properties of the GDP in the country while the latter significantly suggest something about short run behavior of inflation in India during the study period of 1971 -2022.

V. Conclusion

The main objective of the study was to examine whether any relationship exists between economic growth and inflation, and, if so, its nature. For this Johansen's Cointegration test was applied to the model which indicated the existence of one cointegration relation between economic growth and inflation. The estimation results show that there indeed lies a long run relation among the variables under consideration. However, the short run dynamics among them seem ambiguous. Secondly, the sensitivity of inflation to changes in GDP rate is larger than that of GDP to changes in inflation rates. Further, Granger causality is found to be uni-directional running from economic growth to inflation rate. It means that economic growth is inflationary in India but inflation does not causes economic growth. It means that low inflation is not necessarily a factor leading to economic growth. The challenge for monetary authorities and policy makers is to devise such policy which keeps inflation sustainable for economic growth in the long run.

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