Feedback effects of inflation and economic growth in India: An econometric analysis

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Abstract

In the recent years, developing countries including India are achieving growth at higher rate which is accompanied by high inflation. Several quality researches have been made in the past on the impact of rising prices on the economic growth. However, very little or no attention has been paid to study the dynamics of mutual relationship between inflation and economic growth. Clear understanding on the cause and effect relationship between the two variables is essential to frame effective policies. In an attempt to fill the vacuum, the present study empirically examines the feedback effects of the inflation and economic growth in India during post reform period i.e. 1991 to 2014 for 23 annual observations by employing econometric tools. Consumer Price Index (CPI) and Gross Domestic Product (GDP) are taken as proxy variables for inflation and growth respectively. From the Johansen's cointegration method, it has been noted that CPI and GDP are not cointegrated. The Granger Causality test has indicated that in the short run there exists a bidirectional causality between inflation and growth. Vector Auto Regression (VAR) model has been estimated and results

showed the presence of feedback effects between inflation and economic growth. It is found that lagged values of inflation negatively affect the economic growth and the lagged values of growth positively induce the inflation rate. The Variance Decomposition Index and Impulse Response Function strengthened the causality and VAR results and concluded that inflation shocks affect the future growth and growth shocks positively explain the future inflation. The results have significant monetary and fiscal policy implications in sustaining the growth and stabilising the price level.

Keywords: *Growth, inflation, GDP, CPI, Granger Causality, Cointegration, Variance decomposition, impulse response, feedback effects, India*

Introduction

The nexus between inflation and growth is still debated. Macroeconomic theorists have developed several theoretical models on the impact of inflation on economic growth. No consensus has emerged over the nature of the relationship between the two. Mundell (1963) was the first to conceptualise a model to show that expected inflation has a real economic effect using the IS-LM curves. The model advocates that when prices are expected to increase, the money rate of interest rises by less than the rate of inflation giving impetus to an investment boom and an acceleration of growth and vice versa. The theoretical model proposed by Sidrauski (1967) predicts a neutral relationship, which asserts that inflation would have no impact on the economic growth. This contradicts with the

theoretical framework of Tobin (1965) which estimates that inflation has a positive effect on long-run growth. The cash-in-advance model of Stockman (1981) strongly forwarded negative effect of inflation on long-run growth. Theoretical models constructed by the new class modern economists predict the negative effect of inflation on long-run growth, but only if the inflation rate exceeds certain threshold level. The finite-horizon utility- maximization model of Drazen (1981) supports the conclusion of the Mundell and Tobin. The model predicts that increased rate of inflation will increase the demand for capital and aggregate capital-labor ratio.

Following Friedman's Nobel Lecture of 1977, the macroeconomic thoughts on the relationship between inflation and growth have broadly segregated in to two schools. The first school examines the impact of inflation on growth with reference to the uncertainty in them. The theorists, using Phillips curve argue that growth is positively related to inflation. While the second school constructs inflation-growth framework without considering their uncertainties. This school applies Real Business Cycle theories to assert that inflation has negative long run impact on economic growth.

The new endogenous growth theories arrived at the inference that inflation negatively affects growth predicting the harmful effects of inflation on productivity and efficiency. For instance, the model of Manuelli and Jones (1995) argues that as inflation rate rises, the discounted value of depreciation tax credits decreases, and

therefore the effective tax on capital income gets higher and consequently lower after-tax return on capital. Hence, people slow their rate of capital accumulation. This decreases the rate of economic growth. Echoing similarly, Haslag's (1995) model states that an increase in inflation rate decreases the return on bank deposits because return on deposit is an average of return on money and capital. If saving goes down due to less return on deposits, there is less amount of capital accumulation which in turn impedes economic growth. Choi, Smith and Boyd (1996) argued that inflation, in the presence of information asymmetry can harm growth by accentuating financial markets frictions and thereby adversely affecting the provision and allocation of investment. Similarly, Rangarajan (1998) presumes a possible trade-off between price stability and growth either in the long or short run. According to him, under flexible markets, repeated monetary shocks meant to facilitate growth could only lead to ever increasing levels of inflation in the long run. Gillman, Harris and Matyas (2001) using an endogenous growth model strengthens such arguments of negative relation between inflation and economic growth.

The debate is unresolved and no unanimity has emerged among the theorists. In this context the present study makes an attempt in re-visiting the nexus between inflation and economic growth of India without considering the uncertainties of price volatilities and growth instabilities. Hence, the study is built up on the arguments of the second school of thought.

Review of literature

Several studies, mostly empirical, were conducted post mid-1970s to investigate the nature of response of the growth for price shocks using different theoretical models and methodologies. Studies of Dornbusch and Reynoso (1989), Levine and Renelt (1992) and Levine and Zervos (1993) derived enough empirical evidences to conclude that the economic growth was affected in the countries which had either very high or very low inflation rates. Similar conclusion was deduced from study by Fisher (1993). Fisher has investigated the link between inflation and growth in time-series, cross section and panel data sets for a large number of countries. The results indicate that inflation hampers the efficient allocation of resources and leaves negative impact on the growth.

Bruno and Easterly (1995) investigated on the growth performances of the country during inflation crisis and after crisis. Inflation rate exceeding 40 percent was kept as yardstick for crisis period. The results established a negative relationship between inflation and economic growth at higher level of inflation. Researchers believed that economy will recover with reduction in inflation post crisis, though result was ambiguous, at low and moderate inflation. A comprehensive study of 87 countries including India by Sarel (1995) strengthens the views of endogenous growth theories. It was found that inflation rate beyond 8 percent demonstrates negative and significant effect on economic growth. Inflation below 8 percent appeared having either insignificant or even little positive effect on the growth of the economies chosen for the study.

Using regression model Barro (1996) analyses the effect of inflation on economic growth in different countries for the time series data of 30 years. The estimate considers inflation as explanatory variable and the result indicates that there is a negative relationship between inflation and growth with a coefficient of -0.024. Even the study done by Andres and Hernando (1997) obtained a significant negative but relationship between inflation and economic growth during long periods. The results disseminate that inflation reduces the level of investment as well as the factor efficiency, which in turn has a negative temporary impact on long term growth leading to permanent fall in per capita income. The study concludes that the long run cost of inflation on economic growth is large.

Paul, Kearney and Chowdhury (1997) has done a cross country study involving 70 countries for the period between1960 and 1989 and the results appeared varied for different countries. In about 40 percent of the countries involved in the study, no causal relationship between inflation and economic growth could be established. Results reported bidirectional causality in about 20 percent of countries and a unidirectional (either inflation to growth or vice versa) relationship in the rest 40 percent. In some cases, the relationship was found to be even positive.

Bruno and Easterly (1998) investigated the relation between inflation and economic growth specifically during the cases of discrete high-inflation which was defined as 40 percent and above. It was found from the result that growth falls

sharply during high-inflation crises, then recovers rapidly and strongly after inflation falls. It supports the results of Bruno and Easterly (1995) and Sarel (1995). The cost-benefit analysis of inflation in the context of South Africa made by Nell (2000) finds out nonlinear relationship between inflation and economic growth and concludes that Africa's growth is benefited by single digit inflation, while it costs in terms of slower growth at higher level. The results of Khan and Senhadji (2001) are not dissimilar to these studies. They analyzed the threshold effect between inflation and economic growth of 140 countries for a period of 1960-1998. The empirical results obtained through conditional least squares estimation method affirms the negative impact of the inflation beyond the threshold on growth. Inflation levels below the threshold levels of inflation have no or little positive effect on growth.

The conclusion of Mallik and Chowdhury (2001) contradicts with the results of earlier studies. They examined the relationship between inflation and GDP growth for four South Asian countries (Bangladesh, India, Pakistan and Sri Lanka) by employing the cointegration and error correction models. The authors find evidence of a long-run positive relationship between GDP growth rate and inflation for all four countries. There are also significant feedbacks between inflation and economic growth. The study infers that moderate inflation is helpful to growth, but faster economic growth feeds back into inflation. Though many studies concluded that even low inflation would mar the growth prospects with poor investment sentiments, Sweidan (2004) finds out that low inflation would

accelerate growth. Sweidan examines the relationship between inflation and economic growth for the Jordanian economy from the period between 1970 and 2003. He finds that this relation tends to be positive and significant below an inflation rate of 2-percent and beyond this threshold level inflation affects economic growth negatively.

Ahmed and Mortaza (2005) studied the long term and short term dynamics of the relationship between inflation and growth for four south Asian countries; Bangladesh, India, Pakistan and Sri Lanka and established a long term positive relationship between inflation and economic growth. In contrary, Saaed (2007) found a strong long term inverse relationship between CPI and GDP for Kuwait from the data of 20 years. Whereas a study on inflation and growth relationship in Turkey for time series data of over 20 years was conducted by Erbaykal and Okuyan (2008) and it found a negative short term relationship between the variables. Very interestingly, Chimobi (2010**)** found no long run relationship between inflation and economic growth in Nigeria from the data for the period 1970-2005.

An empirical study of Bhushna and Silpakar (2011) with reference to Nepal for the period 1975-2010 estimated that inflation rate above or below 6 percent would jeopardized the economic growth of Nepal. Leshero (2012) used the regression method to identify the impact of inflation on growth in Africa. The results revealed that at inflation level below 4 percent inflation has positive impact on economic growth unlike the results of Bhushna and Silpakar (2011). But at inflation level above 4 percent the relationship is negative.

Enu et.al (2013) examined the impact of inflation on GDP in Ghana for the period 1980 to 2012. By employing Ordinary Least Squares method, the study established a strong and significant negative linear relationship between GDP growth rate and inflation rate. Similar results are obtained by Yabu and Kessy (2015). They studied the possible impact of inflation on growth in three East African Countries- Kenya, Tanzania and Uganda using panel data for 1970-2013. The regression results of the random effect model establish that the average rate of inflation beyond 8.46 percent has negative and significant impact on growth.

Several studies on the inflation- growth relation in India were conducted since the roll out of economic reforms in early 1990s. Rapid economic progress and sharp rise in price levels simultaneously during the post reform period caught the attention of the researchers and the policy makers. Dholakia (1990) and Rangarajan and Arif (1990) investigated the relation between the two variables for pre-reform era and found that inflation and growth were not related. Dholakia (1990) studied the impact of inflation in India for the years from 1950 to 1985, asserts that no tradeoffs between growth and inflation seems to exist even in the short run. Rangarajan and Arif (1990) used annual data over the period from 1961 to 1985 and concluded that the price level has no response to the changes in real output.

Singh and Kalirajan (2003) using the annual data from India for the period of 1971–1998 analysed nexus between inflation and economic growth. The findings suggest that the increase in inflation from any level has negative effect

on economic growth and substantial gains can be obtained by focusing the monetary policy towards maintaining price stability. Das conducted a study in 2003 on the same issue for the post reform period ranging from 1992 to 2000 and strengthens the results of Singh and Kalirajan (2003).

Veni and Choudhury (2007) examined the relationship between inflation and growth of the Indian economy during 1981-2004. Contradicting with results of other studies (for instance Das, 2003), Veni and Choudhury could not establish any causal relation between the two and further, it was found that inflation and growth were not co-integrated. Tanwar (2014) also examined the data for 1981-2004, and arrived at the same conclusion as Veni and Choudhury (2007) that the two variables inflation and growth are not co integrated.

An investigation on the relation between inflation and GDP growth in the context of India was undertaken by Kaur (2014) has sufficient empirical evidences to reach to the conclusion that inflation has a negative long run impact on the economic growth. Even Mohaddes and Raissi (2014) traced a negative long-run relationship between inflation and economic growth in India**.** The study was based on the data collected from a sample of 14 Indian states over the period 1989–2013 using the cross-sectionally augmented distributed lag (CSDL) approach.

The empirical findings across the time and geography are different. Hence the issue of nexus between the inflation and economic growth is inconclusive. Furthermore,

most of the studies attempted to investigate the possible impact of inflation on the domestic economic growth but ignored the possible impact of growth on inflation. In the recent years, developing countries including India are achieving growth at higher rate which is coupled with high inflation. What is not addressed is whether rise in inflation is owing to high growth. Thus the present study makes an attempt in filling the vacuum and investigate the feedback effects of inflation and growth in India.

Study objective

The major objective of the present study is to examine the dynamics of the relationship between inflation and economic growth and empirically test the feedback effects of the inflation and economic growth of India during post reform period.

Research methodology

Variables and data

Since the study examines the impact of the shocks of growth and price instability on each other, economic growth and inflation form two variables of the study. Gross Domestic Product (GDP) and Consumer Price Index (CPI) are the proxies for growth and inflation respectively. The study is conducted for post economic reform period of India from 1991-92 to 2013-14 with 23 annual observations. The motivation to select this study period was erratic growth of GDP and inflation during the reform era. The

necessary data for the sample period are obtained from the secondary sources. The variables are converted into log transformation before being processed by applying econometric tools and techniques for facilitating further analysis through E-views.

Econometric specification

The study has employed certain econometric tools and techniques for analysing the relationship between the variables. The study consists of the following steps:

- Test the stationarity of data
- Test the co-integration between the variables
- Test the causal relationship between the variables
- Fitting an error correction model, if co-integration is established, otherwise, estimate a vector autoregressive model.
- Applying variance de-composition method
- Examining the impulse response of the one variable to the shocks of other variable

Test of stationarity- unit root test

Empirical work based on time series data assumes that the underlying time series is stationary. Broadly speaking a data series is said to be stationary if its mean and variance are constant overtime and the value of covariance between two time periods depends only on the distance or lag between

the two time periods and not on the actual time at which the covariance is computed (Gujarati and Sangeetha, 2007). The present study investigates whether GDP and CPI series are stationary by applying Unit Root Test.

The stationarity condition has been tested using the Augmented Dickey Fuller (ADF) method. ADF test is the modified version of Dickey-Fuller (DF) test. The ADF makes a parametric correction in the original DF test for higher order correlation by adding lagged difference terms of the dependent variable to the right hand side of the regression. The ADF test, in the present study, consists of estimating the following regression.

$$\dot{Y}t = bo + \beta \Delta Yt_{-1} + \mu_1 \Delta Yt_{-1} + \mu_2 \Delta Yt_{-2} + \sum_{i=1}^{m} \mu i \, \Delta Yt_{-1} + et \quad \text{---- (1)}$$

Yt represents the series to be tested, bo is the intercept term, β is the coefficient of intercept in the unit root test, $\mu 1$ is the parameter of the augmented lagged first difference of the dependent variable, Yt represents the ith order autoregressive process, et is the white noise error term. The number of lagged difference terms to include is determined empirically, the idea being to include enough terms so that the error term is serially uncorrelated (Gujarathi and Sangeetha, 2007).

The stationary condition under ADF test requires that: p value is less than 1 (Ipl <1). Another way of stating the same is that the computed t value should be more negative than the critical t value (t statistic < critical value). The computed t statistic will have a negative sign and large negative t value is generally an indication of stationarity (Gujarathi and Sangeetha, 2007).

Johansen's Co-integration test

If ADF test results exhibit the stationarity of the time series data and all the data sets are integrated at the same order, then we have to examine whether or not there exists a long run relationship between GDP and CPI. To investigate the co-integration between GDP and CPI, Johansen's Co-integration method is administered and it is as given in equation -2.

$$Xt = a + \sum_{j=1}^{p} \beta j \, Xt - j + et \qquad \text{.....(2)}$$

where, Xt is an n×1 vector of non-stationary I(1) variables, a is an n×1 vector of constants, p is the maximum lag length, βj is an n×n matrix of coefficient and et is a n×1 vector of white noise terms. The coefficient value (β) indicates the degree of co-integration or relationship, while the sign preceding to the coefficient indicates whether the longrun relationship between the variables is positive or negative.

Vector Error Correction Model (VECM)

Johansen's co-integration test reflects only the long term balanced relations between CPI and GDP. Of course, in the short run there may be disequilibrium. In order to cover the shortage, correcting mechanism of short term deviation from long term balance could be adopted. Therefore, under the circumstances of long term causality, short term causalities should be further tested (Ray, 2012). Hence, the Vector Error Correction Model (VECM) is used to analyse whether error correction mechanism takes place if some disturbance comes in the equilibrium relationship. In other words,

it is to measure the speed of convergence to the long run steady state of equilibrium. Thus the Johansen co-integration equation (2) has to be turned into a vector error correction equation as follows.

$$\Delta Xt = a + \sum_{j=1}^{p-1} \Gamma j\, \Delta Xt - j + \Pi Xt - p + et \quad \text{.....(3)}$$

Where Δis the first difference operator, Γj is $-\sum_{j=1+1}^{p} \beta j$ and Π is equal to $-1 + \sum_{j=1+1}^{p} \beta j$ is an identity metrics.

Vector Auto Regression (VAR) Model

In the event of absence of cointegration between the variables, the long-run dynamics of the relationship between the model variables concerned will be estimated through Vector Auto-regression Model (VAR). This model does not make any priory assumption of which variable is endogenous and which is exogenous. In addition, a VAR model allows us to study the Impulse Response Function and Variance Decomposition for the variables.

$$Yt = b_{10} - b_{12}\mathrm{X}t + \Upsilon_{11}\mathrm{Y}t\__1 + \Upsilon_{12}\mathrm{X}t\__1 + \varepsilon\mathrm{y}t \quad \text{.....(4)}$$

$$Xt = b_{20} - b_{21}Yt + \Upsilon_{21}\mathrm{Y}t\__1 + \Upsilon_{22}\mathrm{X}t\__1 + \varepsilon\mathrm{x}t \quad \text{.....(5)}$$

Where *b* is the unknown coefficient, εyt and εxt are the error terms, $t\__1$ is the lag term, Y and X are the variables of the study- CPI and GDP.

Granger causality test

Upon testing for co-integration, study will proceed towards testing the presence of short run causal relationship between CPI and GDP by administering the Granger

causality test. Causality is a kind of statistical feedback concept which is widely used in the building of forecasting models (Ray, 2012). The Granger causality Test (1969, 1988) seeks to determine whether past values of a variable help to predict changes in another variable. The Granger causality technique measures the information given by one variable in explaining the latest value of another variable. In addition, it also says that variable is Granger caused by variable if variable assists in predicting the value of variable If this is the case, it means that the lagged values of variable are statistically significant in explaining the variable (Ray, 2012).

GDP and CPI are interlinked and co-related. However, co-integration test provides no theoretical or empirical evidence that could conclusively indicate sequencing from either direction. For this reason, in the present study, Granger causality test was carried out on GDP and CPI. The causality test will see the reaction between GDP and CPI such as, if variable CPI has Granger cause to GDP and GDP also has Granger cause to CPI, it means that the value after GDP can help us to expect the value for the next period of CPI and also the value after CPI can help us to expect the value for the next period of GDP respectively. The Granger method involves the estimation of the regression equations. In this study of two-way variables (CPI & GDP) the following two equations are the formula for Granger causality regression test.

If the causality runs from CPI to GDP, then the Granger causality regression equation is;

$$GDPt = n + \sum_{a11} GDPt - 1 + \sum_{\beta 11} CPIt - 1 + \varepsilon_1 t \quad \text{.....(6)}$$

If the causality runs from GDP to CPI, then the Granger causality regression equation is;

$$CPI = n + \sum_{a12} CPIt - 1 + \sum_{\beta 12} GDPt - 1 + \varepsilon_2 t \quad \text{.....(7)}$$

From the equation (6), CPI_{t-1} Granger causes GDPt if the coefficient of the lagged values of CPI as a group β11 is significantly different from the zero based on F-test. Similarly, from equation (7), GDP_{t-1} Granger causes CPI if β_{12} is statistically significant.

Variance decomposition

Although the Granger Causality test and VAR model show the presence of a causal relationship between the variables involved in the short run and long run respectively, they do not sufficiently answer on what is the extent of causality and impact of one variable on the other. Variance decomposition helps to determine the percentage of the total variance in the volatility of one variable explained by innovations or shocks in the volatility of the other variable.

Impulse response function

Impulse response function verifies the results of variance decomposition. The impulse response explains the responsiveness of the endogenous variable in the system to shocks to each of the other endogenous variables. For each endogenous variable in the system, a unit shock is applied to the error, and the effects over time are noted.

Trend analysis

Table 1 : Trends in Growth & Inflation in India

Year	GDP	CPI
1991-92	6738.75	26
1992-93	7745.45	29.1
1993-94	8913.55	31
1994-95	10455.9	34.1
1995-96	12267.25	37.6
1996-97	14192.77	41
1997-98	15723.94	43.9
1998-99	18033.78	49.7
1999-00	20231.3	52.1
2000-01	21774.13	54.2
2001-02	23558.45	56.2
2002-03	25363.27	58.6
2003-04	28415.03	60.9
2004-05	32422.09	63.1
2005-06	36933.69	65.8
2006-07	42947.06	69.9
2007-08	49870.9	74.3
2008-09	56300.63	80.5
2009-10	64778.27	89.3
2010-11	77841.15	100
2011-12	90097.22	108.9
2012-13	101132.8	119
2013-14	113550.7	132
2014-15	123839.1	140.4

Source: World Development Indicators (WDI), June 2016

*GDP@MP in billion Rs. *CPI is for 2010=11 base year prices.

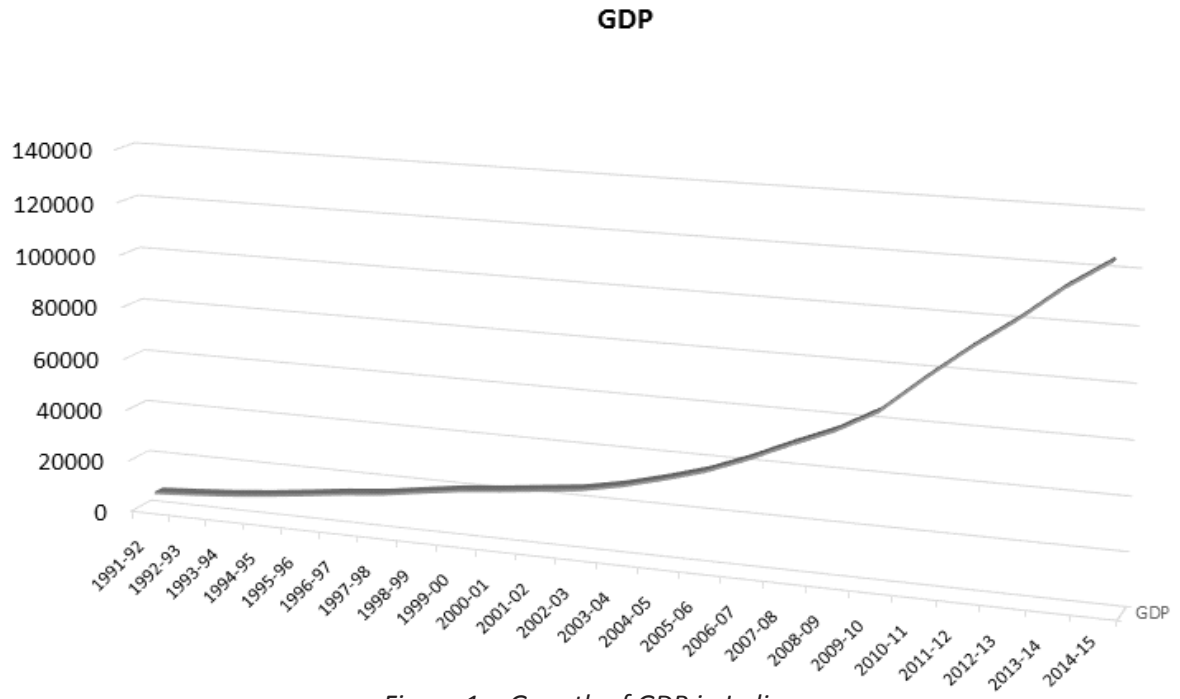
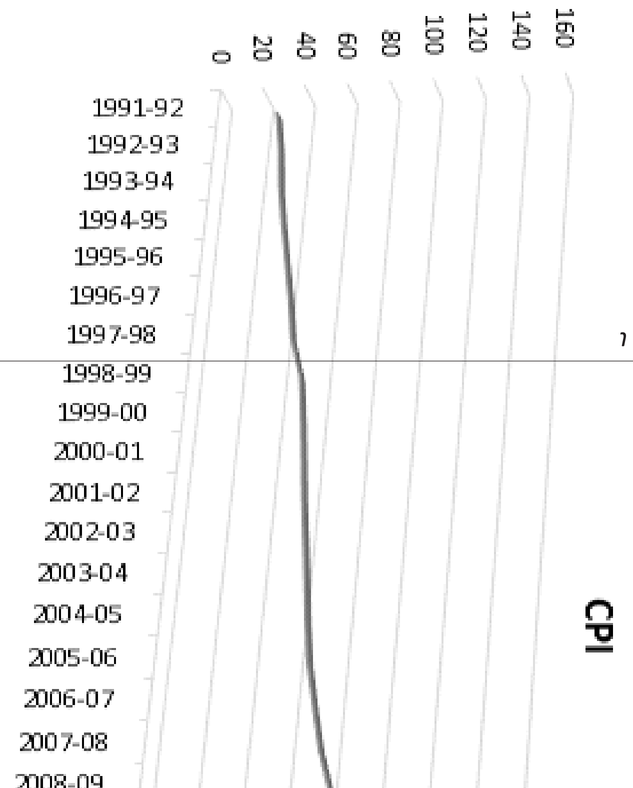


Figure 1 : Growth of GDP in India.



ı Inflation of India.

Table-1 and the Figure 1 & 2 exhibit that since the inception of economic reforms, the growth of Indian economy was positive. It is interesting to observe that since 2001-02 the GDP growth was faster than the previous decade. Simultaneously, inflation has also picked up at faster rate. In 2004-05 and thereafter, the pace of GDP growth got further acceleration and similar trends can be observed from the CPI movements as well. The trends only provide the status that both GDP and CPI are rising over the years. Trends justify the research question of this study whether high growth of GDP has fuelled inflation or vice versa. To arrive at conclusive inference on the feedback effects between GDP and CPI, further study has been conducted.

Results and analysis

In order to test the dynamics of relationship between GDP and CPI using time series data from 1991-92 to 2013-14, econometric tools are applied. As per the pre-condition, time series data pertaining to both the variables need to be stationary and should not encounter unit root problem. For this purpose ADF unit root test is administered and the results are presented in Table-2.

Table 2 : ADF Unit Root Test for CPI and GDP

Particulars	CPI				
	t-statistic	Critical Value		P- value	t-statisti
At level I(0)	0.783232	1%	-3.788030	0.9911	-0.06059
		5%	-3.012363		
		10%	-2.646119		
At 2nd difference I(2)	-6.808475	1%	-3.808546	0.0000	-4.24946
		5%	-3.020686		
		10%	-2.650413		

The results of ADF Unit Root Test show that both variables under study, namely GDP and CPI are non-stationary 'at level' (I (0)). However, only after second differencing (I(2)) both the variables become stationary. The results indicate that the null hypotheses- CPI has a unit root; and GDP has a unit root - can be rejected as the t-statistic value is smaller than the ADF critical value at first difference (I(2)) at 1% level of significance. This confirms that time series data of the two variables do not have any unit root problem and hence, they can be taken up for testing the presence of co-integration.

After ensuring the stationarity of the time series data of CPI and GDP, a co-integration test is carried out by using Johansen method to identify whether there exists any long run equilibrium relationship between the variables. The results are presented in Table-3.

Table 3 : Results of Johansen Co-integration test.

Cointegration Test	Level	Max.Eigen Value	t-statistic
Trace Test	H_0: r=0 (none)*	0.430042	12.87210
	H_1: r<=1 (at most 1)	0.049498	1.066056
Max.Eigen	H_0: r=0 (none)*	0.430042	11.80604
	H_1: r<=1 (at most 1)	0.049498	1.066056

Trace test indicates no cointegration at the 0.05 level

* denotes acceptance of the hypothesis at the 0.05 level

The results of Johansen co-integration test as presented in Table-3 exhibit that the trace statistic for the calculated Max-Eigen value (0.430042) is less than its critical value (15.49471) indicating the absence of co-integration between the variables. Even the Max-Eigen test confirms the non-existence of long run co-integration between the two variables.

The results of Johansen co-integration test denote the acceptance of the hypothesis that there is no co-integration between the CPI and GDP.

As the Johansen co-integration test exhibits only the presence of long run equilibrium relationship between CPI and GDP, pairwise Granger causality test is applied to capture the degree and direction of relationship between the two variables in the short run. The results of Granger causality test are presented in Table-4.

Table 4 : Results of Granger Causality Test

Null Hypotheses	Observations	F-statistic	Prob.	Decision
GDP does not Granger Cause CPI	20	8.67443	0.0020	Reject
CPI does not Granger Cause GDP	20	3.94341	0.0334	Reject

From the result it appears that there exists causality between CPI and GDP. The test explores a bidirectional causality between the two variables. The causality runs from CPI to GDP and GDP to CPI as well. It signifies that the value after GDP can help us to expect the value for the next period of CPI. Hence, GDP Granger cause CPI. It is also noteworthy that the value after CPI help us to expect the value for next period of GDP. From this it could be derived that CPI Granger cause GDP. The result leads to the rejection of null hypotheses. Thus, economic growth and inflation are correlated and there exists a strong feedback relationship between the two variables of the study.

Since the Johansen test for cointegration reveals the absence of long run cointegrating relationship, to examine

the short run and long run interaction of the underlying variables Vector Auto Regression (VAR) has been estimated based on Johansen co-integration methodology. The results of VAR regression are presented in Table-5.

Table 5 : Vector Autoregression Estimates (VAR)

Regressor	L(CPI)	L(GDP)
LCPI(-1)	0.601509 (0.13511) [4.45198]	-0.468032 (0.11988) [-3.90428]*
LGDP(-1)	0.212534 (0.07173) [2.96309]*	1.247415 (0.06364) [19.6011]
C	-0.480420 (0.19409) [-2.47523]	-0.500177 (0.17221) [-2.90451]

From the results of the VAR Estimates presented in the Table-5, it could be inferred that GDP will converge towards its long run equilibrium after the change in CPI at lag 1. From the results it could be predicted that the next year's GDP is influenced to a higher degree by the current year's inflation and this prediction appears to be accurate by 95 percent and statistically significant at 5 percent level. The coefficient term has negative sign signifying that next year's GDP is adversely affected by the shocks of rising CPI in the current year and vice versa. The result is in conformity with theoretical frameworks which advocate that rise in prices hampers the demand and investment sentiments causing a slide in economic growth.

It also appears from the VAR results that lag values of GDP also plays statistically significant role in predicting the CPI. The relation appears positive indicating that rapid economic growth at the given year predicts higher inflation in the following year. The result is again in line with the theoretical predictions. Thus, the lagged values of GDP and CPI have long term impact on each other in the Indian economy.

Although the Granger Causality test and VAR model show the presence of a causal relationship between the variables involved in the short run and long run respectively, they do not sufficiently answer on what is the extent of causality and impact of one variable on the other. Variance Decomposition helps to determine the percentage of the total variance in the volatility of one variable explained by innovations or shocks in the volatility of the other variable. Table – 6 shows the variance decomposition of the variables.

Table 6 : Variance Decomposition Index for GDP and CPI of India

Period	Variance Decomposition of CPI		Variance Decomposition of GDP	
	CPI	GDP	CPI	GDP
1	100.0000	0.000000	39.95589	60.04411
2	87.64328	12.35672	35.14751	64.85249
3	87.12657	12.87343	25.81018	74.18982
4	86.11159	13.88841	16.68300	83.31700
5	69.23761	30.76239	10.44773	89.55227
6	47.85833	52.14167	8.277397	91.72260
7	32.15457	67.84543	9.036298	90.96370
8	24.26855	75.73145	10.66326	89.33674
9	21.69789	78.30211	11.83386	88.16614
10	21.88930	78.11070	12.51699	87.48301

The results of the variance decomposition are depicted in the Table-6. This analysis supplements the Granger Causality test and VAR results. These results show how much an economic growth's own shock is explained by movements in its own variance and the other variable i.e. inflation. It also shows how much inflation's own shock is explained by movements in its own variance and the economic growth. It appears from the results that more than 12 percent variability of GDP is accounted by CPI shocks over the time horizon. Similarly, 78 percent variability of CPI is due to GDP shocks/innovations over the time period. Thus, the forecasting error in economic growth is mainly explained by the lagged values of inflation and the forecasting error of inflation is explained by the lagged values of economic growth.

Inorder to verify the results of variance decomposition, impulse response function has been estimated. The impulse response explains the responsiveness of the endogenous variable in the system to shocks to each of the other endogenous variables. So, for each endogenous variable in the system, a unit shock is applied to the error, and the effects over time are noted. In Figure-3, the pair wise impulse response relations between GDP and CPI of India are presented.

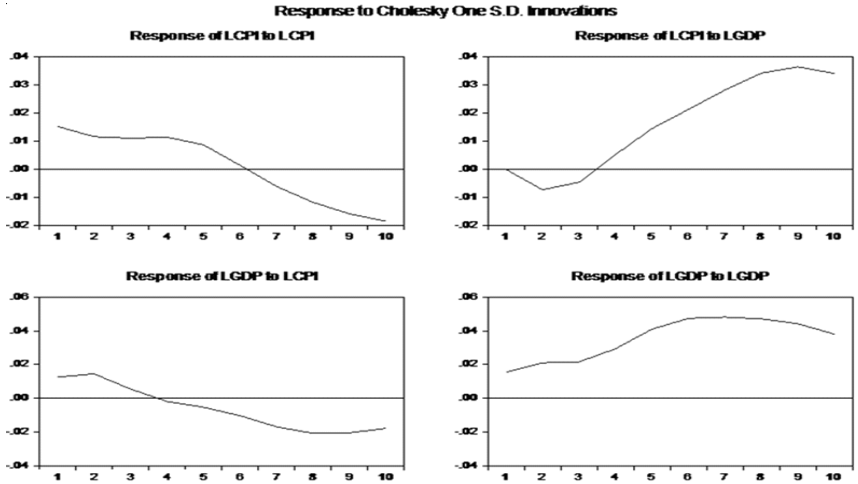


Figure 3 : Impulse Response Function

This is evident from the results that future values of CPI respond significantly and positively to the shocks of GDP. Impulse response function also exhibits that for inflation shocks future values of GDP respond sharply and significantly but negatively as year progresses. The inverse response of the GDP to the CPI is evident from the steep downward flow in the curve over the period. The results of impulse response function support the granger causality results of the presence of bi-directional causality between inflation and GDP in India. Thus, variations and shocks of both GDP and CPI are powerful enough to influence each other. The results confirm the feedback effects of inflation and economic growth.

Conclusion, policy implications and direction for future study

The main motivation for the present study was contradiction and inconclusiveness in the earlier empirical findings on the relationship between inflation and economic growth. Further, most of the studies considered growth as depended variable on inflation. During post reform period both growth and inflation have risen. Hence a study was necessitated to examine whether growth is explained by inflation and inflation is explained by growth and if relationship is established, examine accurately the percentage of impact of one variable on the other. Study results reveal that inflation and economic growth in India affect each other both in the short run and long run. It signifies that an increase in the inflation from the previous period negatively affects the growth of the country. It

corroborates the results obtained by many of the past studies (Das, 2003; Singh and Kalirajan, 2003; Kaur, 2014) and strengthens the arguments of the Real Business Cycle theories of endogenous growth school. Significantly, increased economic growth is found fuelling inflation. The direction and the nature of the relationship between inflation and economic growth of India for the period 1991 to 2014 supports the theoretical framework. The results have significant policy implications. As inflation affects growth, effective handling of monetary policy by the monetary authority is very essential. Similarly, the government should frame economically sound and sustainable fiscal policies to curb the impact of growth on inflation. To maintain high growth and stable price level the government may emphasise on ensuring transparent corporate financial reporting, efficient subsidy policy and control over black economy. Both monetary and fiscal policies will be effective in achieving sustainable growth if we could identify at what level of inflation growth is affected and at what rate of GDP inflation is fuelled. Further research could be pursued in identifying the threshold limit in supplementing the stabilization policies. The study may also be extended to examine whether the current inflation targeting of 2 to 6 percent is accurate. It is also pertinent to study the degree of impact on growth if the inflation moves from the band.

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Annexure-1

Log Values of GDP and CPI for India- 1991-92 to 2013-14

Year	LGDP	LCPI
1991-92	8.8156	3.2581
1992-93	8.9549	3.3707
1993-94	9.0953	3.4340
1994-95	9.2549	3.5293
1995-96	9.4147	3.6270
1996-97	9.5605	3.7136
1997-98	9.6629	3.7819
1998-99	9.8000	3.9060
1999-00	9.9150	3.9532
2000-01	9.9885	3.9927
2001-02	10.0672	4.0289
2002-03	10.1411	4.0707
2003-04	10.2547	4.1092
2004-05	10.3866	4.1447
2005-06	10.5169	4.1866
2006-07	10.6677	4.2471
2007-08	10.8172	4.3081
2008-09	10.9385	4.3883
2009-10	11.0787	4.4920
2010-11	11.2624	4.6052
2011-12	11.4086	4.6904
2012-13	11.5242	4.7791
2013-14	11.6400	4.8828

Source: Original data: World Development Indicators (WDI)Log values: Author's calculation