A Non-Linear Relationship Between Inflation and Growth in India

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Abstract

This paper studies the question of the presence of threshold effects in the relationship between inflation rate, based on consumer price index (CPI) for industrial workers (CPI-IW) and rural labourers (CPI-RL), and real gross domestic product at factor cost (GDP_{FC}) growth in India using Sarel methodology. The study is based on empirical analysis and uses data for the period of Q1:2000-01 to Q4:2017-18 in order to capture the most recent picture of the inflation growth nexus. Empirical results suggest that there exists statistically significant relation between inflation and growth. At 3.5 per cent level of inflation there is positive impact of inflation on growth, while at 6.5 per cent level of inflation there is a negative impact of inflation on growth. Controlling inflation is a necessary condition for promoting economic growth. The policy implication derived from this study is that it is desirable to keep an inflation rate below the threshold level in India, as it may help a sustainable growth. In order to maintain price stability while keeping in mind the objective of growth, Reserve Bank of India (RBI) needs to keep 3.5 per cent inflation as the target.

Keywords: Inflation; Economic growth; Threshold inflation; Non-Linear relationship.

Introduction

Inflation incites a more influential and fervent response than almost any other concept in economics (Donovan, 2015). The vast majority of the general population specify inflation as the top national concern as it mutilates their way of life (Shiller, 1996). According to Zou et al. (2011), "inflation is a major factor that leads to social and economic instability". During 1918, there were riots over the price of rice in Japan (Trentmann, 2012). Social order disintegrated in Germany during the hyperinflation of 1923, with the state of Bavaria effectively seceding from the country (Donovan, 2015). Further, the feminist of the 1970's also noted the Anti-price rise agitation in Mumbai, Gujarat and the Bihar region of India (Kumar, 1997). Margaret Thatcher, a British leader, declared in 1975 that, rampant inflation, if unchecked, could destroy the whole fabric of their society (Jackson & Saunders, 2012). Clearly, inflation was taken seriously as a threat to the stability of the realm.

According to Singh (2011), inflation is something which needs to be handled carefully. Since last decade, inflation has arisen as a principal concern of India's economic policymakers and citizens. Moreover, worries grew as the inflation rate (measured as the twelve-month change in the consumer price index) rose from 3.7 per cent to 12 per cent during the period between 2001-2010. Further, the rate of inflation had tumbled to 5 per cent in early 2015 and continues to drop till 2017, leading to a discussion, whether it will sustain or rise again (Ball et al., 2016). Various authors suggested that the monetary and fiscal provocations, following the economic crisis led to an increase in inflation rate, whereas other authors cite supply side constrictions arising from policy holdups (Economic Survey, 2013). Many, together with RBI Governor Rajan, fear that greater inflation rate may turn out to be rooted in the expectations of price setters, generating a self-sustaining "inflationary spiral" (Rajan, 2014). The character of monetary policy is controversial, with media and experts discussing the part of interest-rate upsurges in elucidating the current fall in rate of inflation, and more commonly the RBI's capability to regulate rate of inflation and its effects on the economy (Bhalla, 2014).

Whether inflation encourages or discourages welfare of citizens has been a subject of controversy since many years. The huge investigation laid by the debate has been ineffective in resolving it and the debate still continues. The Phillips curve representing the Keynesian tradition and the Mundell-Tobin hypothesis claimed positive growth effects of inflation in works by Phillips (1958), Tobin (1965), Mundell (1963) and Fischer (1977). Lucas (1973) expanded the elucidations of the relationship between growth and inflation. Sidrauski (1967) presented the neutral growth effects of inflation. Many empirical evidences support the contretemps of an inverse association between inflation and economic events such as the capital accumulation and growth (Kormendi & Meguire, 1985; Grier & Tullock, 1989; Barro, 1991; Grimes, 1991; De Gregorio, 1992; Karras, 1993 and Burdekin et al. 1994). However, these results are sensitive to the regression specification (Levine & Renelt, 1992).

It appears to be a general consent among economists that lofty inflation is unfavourable to growth. Moreover, the growth effects of little or modest inflation are not obvious. Recently numerous scholars reported a nonlinear relationship between inflation and economic activity (Fischer, 1993; Barro, 1995; Bruno & Easterly, 1995 and Clark, 1997). The effects of variation in the rate of inflation on the growth are not the same over different inflation ranges, which depend much on the selected threshold value of the inflation rate.

In contrast, the purpose of this study is to analyze the impact of inflation on growth, when inflation reaches certain threshold levels, by using Sarel methodology. In order to capture the more recent picture of inflation growth nexus, the empirical analysis uses data for the period of Q1:2000-01 to Q4:2017-18. A specific question addressed in this paper was, "Does inflation in India have to reach some minimum threshold before the growth effects turn adverse"? To the best of my knowledge, no previous study has tried to explore the inflation growth nexus in India for the period of Q1:2000-01 to Q4:2017-18 using Sarel methodology.

The rest of the article is organized as follows. The second section provides a brief review of the theoretical and empirical literature on inflation growth nexus. The third section presents the econometric methodology and data sources. A descriptive analysis of inflation and growth in India is given in fourth section. The econometric model estimation results are presented in fifth section. The sixth and last section provides concluding remarks.

Literature Review

Inflation stood at 3.6 per cent in the year 2017-18 (Economic survey, 2018). Historical data on CPI inflation shows that during the period 2010-2017 the recorded average inflation was 7.15 per cent; it was around

5.9 per cent during 2000-2009[1]. Given this historical trend, one can contend that the current level of inflation is not so disturbing. Nevertheless, an important question that needs to be addressed for overall macroeconomic stability is the issue of threshold level of inflation in the country. The Chakravarty committee had presumed the threshold inflation level at 4 per cent, which was supposed to be an "acceptable rise in prices purported to reflect changes in relative prices necessary to attract resources to growth sector" (Kalirajan & Sanker, 2003). Below is the list of some more threshold inflation level in India (Table 1).

Table 1: Threshold Inflation from Past Empirical Studies in India.

S. No.	Study	Period	Threshold Inflation (per cent)
1.	Rangarajan (1998) *		6
2.	Kannan and Joshi (1998)	1981-96	6-7
3.	Vasudevan, Bhoi and Dhal (1998)	1961-98	5-7
4.	Samantaraya and Prasad (2001)	1970-99	6.5
5.	Report on Currency and Finance (2001)	1970-2000	5
6.	Singh and Kalirajan (2003)	1971-98	No Threshold
7.	Bhanumurthy and Alex (2010) **	1975-2005	5 - 5.5
8.	Singh, Prakash (2010)	1970-2009	6
9	RBI Annual Report	2010-11	4-6

Source: RBI working papers

* Rangarajan (1996) viewed that the objective of policy should be to keep inflation rate around 6 per cent.

**In the monthly data over January 2000 to April 2007, they suggested 4 to 4.5 per cent as the threshold.

So, what is the concept of threshold level of inflation? The relation between inflation and growth has been a long-drawn debate in macroeconomic management, but the precise definition regarding the acceptable or threshold level has been quite ambiguous. Threshold level of inflation can be described as that inflexion point beyond which the output growth is not optimal. Empirical studies have shown that at inflation rates higher than threshold level, the output growth has retarded. Below are some other empirical evidences on inflation growth nexus.

Khan & Senhadji (2001), for instance, evaluate the threshold effect in the relationship between inflation and economic growth for 140 industrialized and developing countries for the period 1960 to 1998. They used five variables namely growth rate of GDP, CPI index, gross domestic investment, population growth and terms of trade. By using non-linear least square method (NLLS), they found, inflation threshold of 1 to 3 per cent for industrialized countries and 7 to 11 per cent for developing countries. Per centages higher than the above mentioned had a negative impact on economic growth and below the above-mentioned per centages had no impact on economic growth. Sarel (1996), used 87 countries annual data from 1970 to 1990 and found that when the inflation threshold level is less than 8 per cent then the effect of inflation on

[1] Computed from Labour Bureau data.

growth is negligible (or slightly positive), however, if this threshold level is above 8 per cent there is a significant, enormously influential and robust negative effect on economic growth.

A famous paper by Gylfason & Herbertsson (2001), who evaluated the threshold effect in the relationship between inflation and economic growth for 170 industrialized and developing countries for the period 1960-1992. They used seven variables namely GDP growth, GDP per capita, inflation (GDP deflator), openness, gross domestic fixed investment, primary exports and secondary education. By using panel regression, they found that an inflation rate of 10-20 per cent had a negative effect on economic growth. Similarly, Mubarik & Riazuddin (2005), examine the inflation growth trade-off for Pakistan for the year 1973-2000. They have used four variables namely real GDP, population growth, CPI and investment growth rate. By using threshold analysis, they concluded that an inflation rate of above 9 per cent had a negative impact on economic growth.

Moreover, Munir & Mansur (2009), examined the inflation and growth nexus for Malaysia for the period 1970-2005. They have used four variables real GDP growth, gross fixed investment, FDI, growth rate of export of goods and services. By using Endogenous threshold autoregressive (TAR) model they found that an inflation rate of above 3.89 per cent had a negative impact on economic growth; however, an inflation rate below this had a positive impact on growth. Fakhri (2011), examined the inflation and growth nexus for Azerbaijan (as a transition economy) for the period between 2000-2009. He used three variables namely real GDP per capita, CPI, gross fixed capital formation. By using threshold model, he concluded that an inflation rate above 13 per cent had a negative impact on growth, while a rate below this threshold had a positive effect on economic growth.

Tung & Thanh (2015), examined the inflation threshold and growth nexus for Vietnam (as a transition economy) for the period between 1986-2013. They have used six quantitative variables and one dummy variable if inflation is higher than the threshold per centage. The six quantitative variables are GDP per capita, CPI, trade openness, terms of trade, gross domestic investment and population growth. By using Two stage least square (2 SLS) and generalized method of moments (GMM) they concluded that an inflation rate of above 7 per cent had a negative impact on economic growth.

Vinayagathasan (2013), examined the inflation and growth nexus for 32 Asian economies for the period 1980-2009. He used seven variables namely GDP per capita, GDP growth rate, inflation (CPI), trade openness, terms of trade, population growth rate, investment ratio. By using Dynamic panel threshold model, he concluded that the inflation rate above 5.43 per cent had a negative impact on growth, while a rate below this threshold had no significant effect on growth. Barro (1995), investigated the inflation and growth nexus for 100 countries for the period 1960-1990. He used inflation as an explanatory variable and other determinants of growth are kept constant. By using Neo classical growth model, he founded that Inflation had a negative significant effect on growth and investment.

Bruno & Easterly (1998), investigated the impact of inflation on long term growth for 26 countries for the period 1961-1992. They have used four variables namely inflation rate, GDP per capital growth per worker, investment per GDP. By using threshold model, they concluded that higher inflation rate retards growth, and lower inflation costs an economy less. A country is in a high inflation crisis when its inflation is above the threshold level of 40 per cent.

Abbott & De Vita (2011), investigated the impact of inflation on growth under different exchange rate regimes for 125 countries for the period 1980-2004. They have used six quantitative variables namely GDP, inflation, fixed exchange rate, investment, intermediate exchange rate, hyperinflation and civil unrest as dummy variable. By using panel analysis, they concluded that developing countries that adopted flexible exchange rate regimes experienced lower growth than countries that adopted fixed or intermediate exchange rates. Malla (1997), investigated the impact of inflation on growth for 11 OECD and Asian countries. They have used six variables namely GDP per capita, GDP growth rate, inflation (CPI), trade openness, terms of trade, population growth rate. By using panel analysis, they concluded that for OECD countries, there was no relationship between inflation and growth, contrary to theories on inflation and growth. For Asian countries, there was a significant negative relationship between inflation and growth.

Dotsey & Sarte (2000), analysed inflation uncertainty and growth in a cash in advance economy. This was a theoretical paper and the summary and findings of this paper is that higher average inflation had a negative impact on steady state growth in the neo classical growth model, due to the higher cost of transactions in higher inflation. However, inflation had a positive impact in the short term, through precautionary savings.

Ozdemir (2010), investigated the dynamic linkages between inflation uncertainty, inflation and output growth for UK for the period 1957Q2– 2006Q4. He used two variables namely GDP growth and CPI rate. By using Vector auto regressive fractionally integrated moving average (VARFIMA) he concluded that inflation uncertainty had a positive impact on the inflation rate and growth when the whole sample is used, but no relationship was found for the sub period analysis. Therefore, inflation uncertainty is one of the most crucial determinants of economic growth.

Gillman & Harris (2010), analysed the effect of inflation on economic growth for 13 countries under transition for the period 1990-2003. The used 3 equations i.e. growth, inflation, and money demand equations. By using Maximum likelihood estimation technique, they have concluded that there was a strong negative relationship between inflation and growth. The recommended inflation targeting to be the main focal point of monetary policies, coupled with fiscal policies to keep budget deficits at bay.

Econometric methodology and data sources

It is rightly acknowledged in the literature that inflation has a non-linear impact on growth. While below a threshold level, inflation has a positive effect; it will have an adverse effect on growth once it crosses the threshold. Prima facie, such a non-linear relationship exists for Indian data (Figure 1).

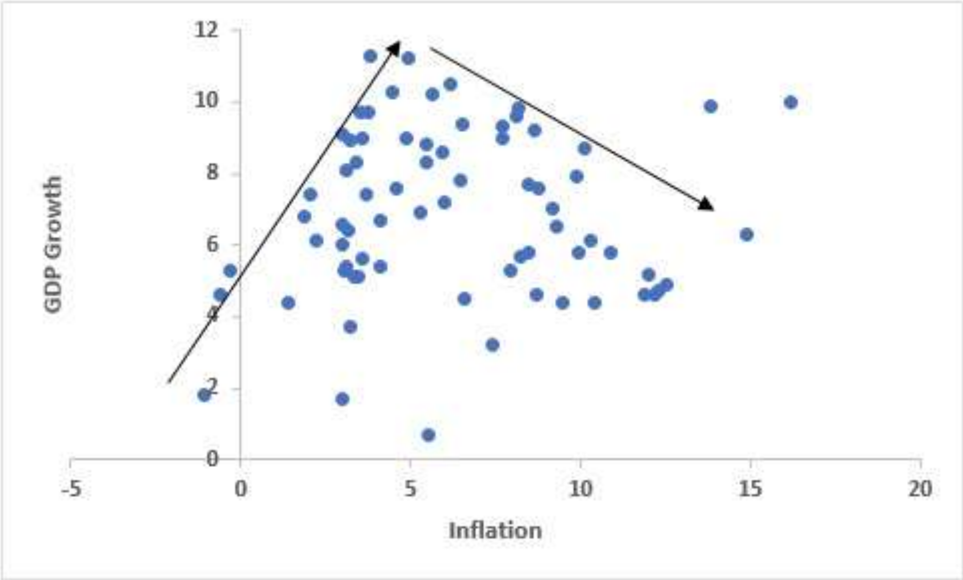

Figure. 1: Non-linear relationship between inflation and GDP growth in India.

Source: Author's calculation based on data collected from MOSPI and Labour Bureau of India.

Inflation threshold methodology

The researcher's perspective regarding the inflation thresholds is associated to the subject of whether inflation has moved to higher plateaus, as it tries to determine whether inflation beyond a certain threshold level has more destructive effects on growth. There are various methodologies that are used to identify the inflation threshold, in this study the researcher has used the Sarel methodology.

Sarel (1996) methodology for identifying inflation threshold is based on a spline regression. First, a dummy variable is defined (D = 1 if $\pi_t > \pi_t^*$ and zero otherwise, where π_t is inflation and π_t^* is the posited threshold). Then a reduced-form regression relating growth to inflation, the threshold dummy, and other controls is estimated. Because π_t^* is unknown, the reduced form is estimated for different levels of π_t^*. The threshold is identified at the level at which the adjusted R^2 attains its maximum over a grid of π_t^*s. The coefficient on the threshold dummy yields the difference between the effect of inflation on growth above and below the threshold, and the sum of coefficients on πt and D also changes sign at π_t^*.

The basic equation for estimation is specified as;

$$GDP_t = \alpha_0 + \beta_1(\pi_t)_t + \beta_2(\pi_t - \pi_t^*)_t + \beta_3(OECD\ GDP)_t + \beta_4(LagGDP)_t + \varepsilon_t \qquad 1$$

where,

GDP_t = quarterly growth rates in India,

π_t = quarterly inflation rates in India,

π_t^*= posited inflation threshold,

$(\pi_t - \pi_t^*)_t$ = a dummy variable which takes value 1 if $\pi_t > \pi_t^*$ and 0 otherwise,

$(OECD\ GDP)_t$ = quarterly growth rates of OECD countries,

$(LagGDP)_t$ = quarterly lagged growth rates in India.

Apart from inflation and lagged values of domestic GDP growth, we also used a control variable world GDP growth to examine the significance of external developments on domestic inflation growth nexus. However, in absence of quarterly World GDP data, Organisation for Economic Co-operation and Development (OECD) countries GDP growth is used as proxy. We assume that the impact of domestic factors is controlled using the GDP lags. Thus, effectively we have used lagged values of GDP growth as an instrumental variable. This also helps to overcome the problem of endogeneity, which is a possibility because of the use of contemporary endogenous variables.

Data Sources and Variable Construction

We collected the inflation statistics from Labour Bureau which undertakes compilation and maintenance of Consumer Price Index (CPI) numbers for industrial, agricultural and rural workers. This agency works under Ministry of Labour and is involved in the collection and compilation of Labour Statistics mainly in the organised sector. The State Governments compile such statistics at the State level; the Bureau in turn consolidates them for the country as a whole covering all States and sectors of the economy and brings out periodical reports.

The primary source of India's Gross Domestic Product (GDP) is Ministry of Statistics and Programme Implementation (MOSPI), which came into existence as an Independent Ministry after the merger of the Department of Statistics and the Department of Programme Implementation.

The OECD countries GDP growth data is collected from OECD, which is known as statistical agency, as it publishes comparable statistics on a wide number of subjects.

Variable Construction

1. Inflation

The inflation rate is defined as, when we subtract last year's CPI from the current CPI and divide the result by last year's CPI, and finally multiply the result by 100 (see equation 2)

$$\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} * 100 \qquad 2$$

where CPI_t refers to current CPI, CPI_{t-1} is the previous year's CPI.

In this paper, inflation variable is constructed by combining CPI for Industrial Workers (CPI-IW) & CPI for Rural Labourers (CPI-RL). Both the series, i.e. CPI-IW & CPI-RL are derived by splicing the all available series into a common series with base year 1999-2000.

2. GDP

The GDP growth rate is defined as, when we subtract last year GDP from the current GDP and divide the result by last year's GDP, and finally multiply the result by 100 (see equation 3)

$$\frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} * 100 \qquad 3$$

where GDP_t refers to current GDP, GDP_{t-1} is the previous year's GDP.

In order to capture the effect of inflation on three-sector model of India, GDP at factor cost (constant prices) is used. The series is derived by rebasing GDP with different base year into common base year 1999-2000.

Descriptive analysis: GDP and Inflation

The descriptive statistics for GDP and inflation are based on quarterly growth and inflation rates. For brevity, the entire period is subdivided as follows: Period I (2000-2005), Period II (2006-2010), Period III (2011-2015) and Period IV (2016-2017). The first period was marked by moderate inflation rates and high GDP growth rates. The second period covers the soaring inflation rates and tumbling of GDP growth rates. The third period was marked by further slowing down of GDP growth rates and a small fall in inflation rates. The fourth and final period is characterized by falling of inflation rates and rising GDP growth rates (Figure 2)

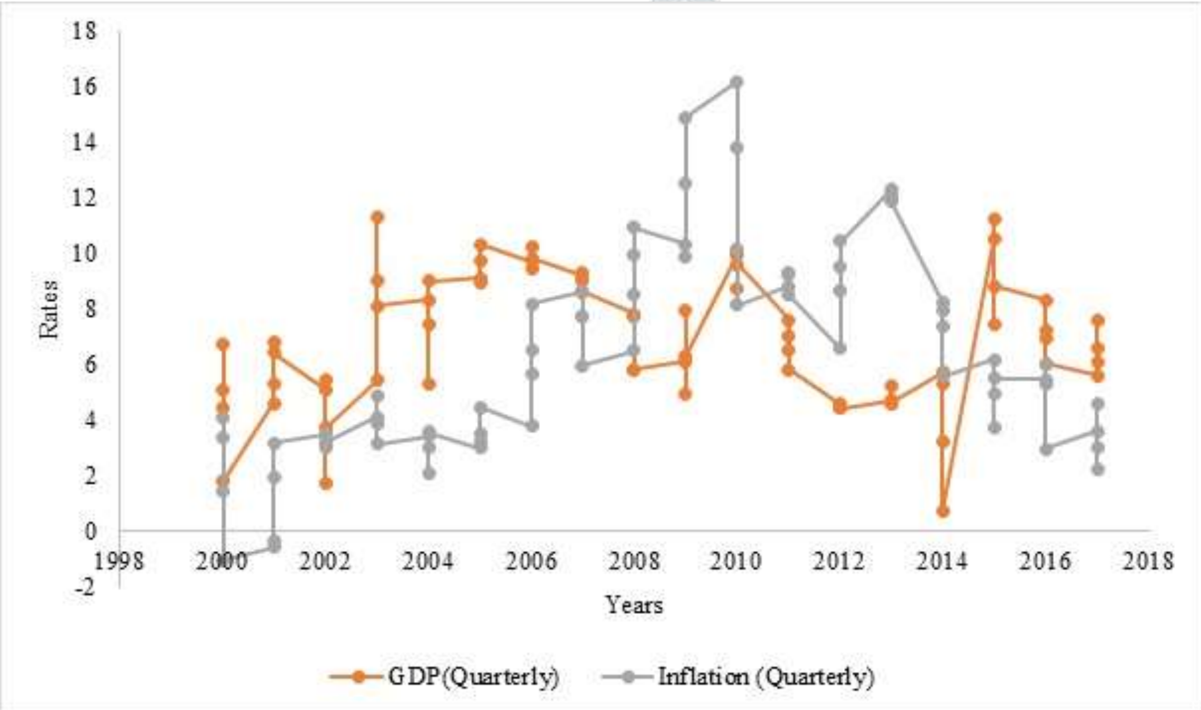

Figure 2: Trends in GDP growth rates and Inflation rates.

Source: Author's calculation based on data collected from MOSPI and Labour Bureau of India.

Table 2 provides the GDP_{FC} growth rates at constant (1999-2000) prices at sectoral level namely, primary sector which comprises of agriculture, forestry, fishing, mining and quarrying, secondary sector which comprises of manufacturing, electricity, gas, water supply, and construction, tertiary sector which comprises of trade, hotels, transport, communication, services related to broadcasting, financing, insurance, real estate, professional services, public administration, defence, and other services. For the entire period, the average growth rate of agriculture, forestry & fishing is 3.64 per cent, while mining & quarrying grew at 5.34 per cent. Moreover, manufacturing inked a growth rate of 7.89 per cent, while electricity, gas & water supply grew at 6.46 per cent and construction touched 7.11 per cent mark. Further, Trade, hotels, transport, communication and services related to broadcasting; Financing, insurance, real estate & professional services; & public administration, defence, and other services showed a growth rate of 9.11 per cent, 9.25 per cent and 7.44 per cent respectively.

The average growth of industries during 2000-2005 (I period) is 6.52 per cent, which further grew to 7.9 per cent during 2006-2010 (period II). However, the rising growth rates did not persist for long as all sectors witnessed sharp deceleration during 2011-2015 period (III). Thereafter, the final period, i.e., period (IV), registered the growth rate of 7.57 per cent during 2016-2017.

Table 2: Estimates of GDP_{FC} growth rates at constant (1999-2000) prices.

S.No	Industry	2000-2005	2006-2010	2011-2015	2016-2017	2000-2017
1	Agriculture, forestry & fishing	2.52	3.86	2.66	5.55	3.64
2	Mining & Quarrying	4.87	5.17	4.01	7.31	5.34
3	Manufacturing	6.9	9.91	7.82	6.94	7.89
4	Electricity, gas & water supply	4.39	6.72	5.44	9.29	6.46
	Construction	10.45	7.79	4.35	5.86	7.11
5	Trade, hotels, transport, communication and services related to broadcasting	10.09	10.57	8.03	7.77	9.11
6	Financing, insurance, real estate & Professional services	7.49	11.54	10.72	7.28	9.25
7	Public administration, defence, and other services	5.51	7.7	5.99	10.59	7.44
8	Average growth (Industries)	6.52	7.9	6.12	7.57	6.97

Source: Author's calculation based on data collected from MOSPI.

Inflation and Growth

Estimation Results

To study the inflation-growth nexus, we use Sarel Methodology as outlined in 'Econometric Methodology' section. Moreover, we ensure that the variables used in the regressions (GDP, π_t, $\pi_t - \pi_t^*$, OECD GDP, LagGDP) are not subject to a spurious correlation. In fact, we refer to Augmented Dickey-Fuller test (ADF, 1981) and Kwiatkowski–Phillips–Schmidt–Shin test (KPSS, 1992) to investigate the stationary status of each variable. The results are presented in tables 3 to 9.

The output shows that trend is not significant because prob. value is more than 5 per cent (85.18 per cent). Therefore, it means there is no deterministic trend. According to the ADF test statistic prob. value the series is stationary as the prob. value is less than 5 per cent i.e. (1.88 per cent). Further, with respect to the absolute ADF test statistics and absolute test critical values, the series is stationary. This is because 't-statistic' is more than critical value at 5 per cent level of significance i.e. 3.86 > 3.16 (Table 3).

Table 3: ADF test output for GDP quarterly data over the period 2000-2017.

S.No.	Test type	Augmented Dickey-Fuller
1	Order of integration	Level
2	Test equation	Trend and intercept
3	Maximum lags	11 (Automatically selected by E-views 9)
4	Test critical value (1 per cent)	-4.092547
5	Test critical value (5 per cent)	-3.474363
6	Test critical value (10 per cent)	-3.164499
7	ADF test statistic (t-statistic)	-3.863557
8	ADF test statistic (prob.)	0.0188
9	Trend (prob.)	0.8518

In table 4, according to prob. value i.e. 0.0035 (0.35 per cent), the series is stationary at 5 per cent level of significance. Also, the absolute test critical value is lesser than absolute t-statistic value at 5 per cent level of significance i.e. 2.9 < 3.88. So, according to t-statistic and test critical value, we can say that the series is stationary.

Table 4: ADF test output for GDP quarterly data over the period 2000-2017.

S.No.	Test type	Augmented Dickey-Fuller
1	Order of integration	Level
2	Test equation	Intercept
3	Maximum lags	11 (Automatically selected by E-views 9)
4	Test critical value (1 per cent)	-3.525618
5	Test critical value (5 per cent)	-2.902953
6	Test critical value (10 per cent)	-2.588902
7	ADF test statistic (t-statistic)	-3.888244
8	ADF test statistic (prob)	0.0035

In table 5, the output shows that trend is not significant because prob. value is more than 5 per cent (78.61 per cent). Therefore, it means there is no deterministic trend. According to the ADF test statistic prob. value the series is stationary as the prob. value is less than 5 per cent i.e. (0.42 per cent). Further, with respect to the absolute ADF test statistics and absolute test critical values, the series is stationary. This is because 't-statistic' is more than critical value at 5 per cent level of significance i.e. 4.38 > 3.47.

In table 6, according to prob. value i.e. 0.0006 (0.06 per cent), the series is stationary at 5 per cent level of significance. Also, the absolute test critical value is lesser than absolute t-statistic value at 5 per cent level of significance i.e. 2.9 < 4.43. So, according to t-statistic and test critical value, we can say that the series is stationary.

Table 5: ADF Test output for OECD countries GDP quarterly data over the period 2000-2017.

S.No.	Test type	Augmented Dickey-fuller
1	Order of integration	Level
2	Test equation	trend and intercept
3	Maximum lags	11 (Automatically selected by E-views 9)
4	Test critical value (1 per cent)	-4.094550
5	Test critical value (5 per cent)	-3.475305
6	Test critical value (10 per cent)	-3.165046
7	ADF test statistic (t-statistic)	-4.388461
8	ADF test statistic (prob)	0.0042
9	Trend (prob)	0.7861

Table 6: ADF test output for OECD countries GDP quarterly data over the period 2000-17.

S.No.	Test type	Augmented Dickey-Fuller
1	Order of integration	Level
2	Test equation	Intercept
3	Maximum lags	11 (Automatically selected by E-views 9)
4	Test critical value (1 per cent)	-3.527045
5	Test critical value (5 per cent)	-2.903566
6	Test critical value (10 per cent)	-2.589227
7	ADF test statistic (t-statistic)	-4.438852
8	ADF test statistic (prob)	0.0006

In table 7, the output shows that trend is not significant because prob. value is more than 5 per cent (79.67 per cent). Therefore, it means there is no deterministic trend. According to the ADF test statistic prob. value the series is non-stationary as the prob. value is more than 5per cent i.e. (75.03 per cent). Further, with respect to the absolute ADF test statistics and absolute test critical values, the series is non-stationary. This is because 't-statistic' is less than critical value at 5 per cent level of significance i.e. 1.67 < 3.47.

Table 7: ADF Test output for inflation quarterly data over the period 2000-2017.

S.No.	Test type	Augmented Dickey-Fuller
1	Order of integration	level
2	Test equation	trend and intercept
3	Maximum lags	11 (Automatically selected by E-views 9)
4	Test critical value (1 per cent)	-4.103198
5	Test critical value (5 per cent)	-3.479367

6	Test critical value (10 per cent)	-3.167404
7	ADF test statistic (t-statistic)	-1.677405
8	ADF test statistic (prob)	0.7503
9	Trend (prob.)	0.7967

In table 8, according to prob. value i.e. 0.2039 (20.39 per cent), the series is non-stationary at 5 per cent level of significance. Also, the absolute test critical value is more than absolute t-statistic value at 5 per cent level of significance i.e. 2.90> 2.21. So, according to t-statistic and test critical value, we can say that the series is non-stationary. Now, we are going to test the stationarity of the series inflation with KPSS method.

Table 8: ADF test output for inflation quarterly data over the period 2000-2017.

S.No.	Test type	Augmented Dickey-Fuller
1	Order of integration	level
2	Test equation	Intercept
3	Maximum lags	11 (Automatically selected by E-views 9)
4	Test critical value (1 per cent)	-3.533204
5	Test critical value (5 per cent)	-2.906210
6	Test critical value (10 per cent)	-2.590628
7	ADF test statistic (t-statistic)	-2.212532
8	ADF test statistic (prob)	0.2039

While in ADF test, the null hypothesis is of "non-stationary time series", in KPSS test, the null hypothesis is of "stationary time series". From table 9, at level the KPSS test shows that at 5 per cent level of significance the series is stationary as KPSS test statistic 0.44 is lesser than asymptotic critical value 0.46 at 5 per cent level of significance.

Table 9: KPSS test output for inflation quarterly data over the period 2000-2017.

S.No.	Test type	KPSS
1	Order of integration	level
2	Test equation	Intercept
3	Maximum lags	N/A
4	Asymptotic critical values (1 per cent)	0.739000
5	Asymptotic critical values (5 per cent)	0.463000
6	Asymptotic critical values (10 per cent)	0.347000
7	KSPSS test statistic	0.446443
8	KPSS test statistic (prob)	N/A

After looking at the pattern of the regression equations (Adjusted R^2) it is interpreted that the adjusted R square has reached its maximum twice, at 3.5 per cent and at 6.5 per cent. At 3.5 per cent level of inflation, the grease effect of inflation is positively significant at 5 per cent level of significance. While at 6.5 per cent level of inflation the grease effect of inflation is negatively significant at 5 per cent level of inflation. In between 1 – 4.5 per cent range, the coefficient is positive while, after 5 per cent till 9 per cent range it is having a negative sign on it (Table 10).

Table 10: Estimation output of inflation and growth using Sarel methodology.

Threshold level		**Intercept**	**Inflation (CPI)**	**Threshold**	**OECD GDP**	**Lag GDP**	**Adjusted R^2**	**Durbin Watson test**	**Harvey test**
1	Coefficient	1.59	0.02	0.84	0.51	0.59	0.41	1.84	No heteroskedasticity
	P value	0.15	0.69	0.49	0.22	0.00			
1.5	Coefficient	1.28	0.00	1.42	0.48	0.58	0.41	1.83	No heteroskedasticity
	P value	0.19	0.93	0.18	0.24	0.00			
2	Coefficient	1.71	0.01	0.8	0.48	0.59	0.41	1.85	No heteroskedasticity
	P value	0.06	0.79	0.41	0.25	0.00			
2.5	Coefficient	1.83	0.01	0.67	0.50	0.60	0.41	1.87	No heteroskedasticity
	P value	0.03	0.81	0.43	0.23	0.00			
3	Coefficient	1.78	-0.01	1.14	0.51	0.58	0.42	1.85	No heteroskedasticity
	P value	0.02	0.80	0.11	0.22	0.00			
3.5	Coefficient	2.04	-0.07	1.49	0.54	0.57	0.44	1.86	No heteroskedasticity
	P value	0.00	0.33	0.02	0.18	0.00			
4	Coefficient	2.08	-0.03	0.85	0.58	0.61	0.41	1.86	No heteroskedasticity
	P value	0.00	0.66	0.20	0.16	0.00			
4.5	Coefficient	2.15	-0.007	0.51	0.59	0.61	0.40	1.84	No heteroskedasticity
	P value	0.00	0.93	0.46	0.17	0.00			
5	Coefficient	2.09	0.08	-0.42	0.49	0.62	0.40	1.9	

	P value	0.00	0.36	0.55	0.25	0.00			No heteroskedasticity
5.5	Coefficient	2.05	0.12	-0.76	0.47	0.61	0.40	1.89	No heteroskedasticity
	P value	0.00	0.20	0.30	0.26	0.00			
6	Coefficient	2.09	0.07	-0.27	0.51	0.61	0.40	1.89	No heteroskedasticity
	P value	0.00	0.48	0.72	0.23	0.00			
6.5	Coefficient	1.74	0.23	-1.7	0.33	0.62	0.44	1.98	No heteroskedasticity
	P value	0.02	0.02	0.02	0.42	0.00			
7	Coefficient	1.8	0.21	-1.57	0.38	0.61	0.43	1.99	No heteroskedasticity
	P value	0.02	0.04	0.05	0.36	0.00			
7.5	Coefficient	1.90	0.14	-0.95	0.42	0.61	0.41	1.91	No heteroskedasticity
	P value	0.01	0.17	0.25	0.33	0.00			
8	Coefficient	1.92	0.15	-1.05	0.4	0.60	0.41	1.90	No heteroskedasticity
	P value	0.01	0.14	0.20	0.35	0.00			
8.5	Coefficient	1.90	0.18	-1.47	0.34	0.59	0.42	1.81	No heteroskedasticity
	P value	0.01	0.05	0.07	0.42	0.00			
9	Coefficient	2.06	0.14	-1.21	0.39	0.59	0.41	1.8	No heteroskedasticity
	P value	0.01	0.11	0.14	0.36	0.00			

Source: Prepared by Research Scholar using E-views 9.

Concluding Remarks

Empirical results based on the full sample Q1:2000-2001 to Q4: 2017-18 show that there exists statistically significant relation between growth and inflation at 3.5 per cent and 6.5 per cent. At 3.5 per cent there is positive impact of inflation on growth, while at 6.5 per cent there is a negative impact of inflation on growth. Moreover, empirical evidence emphasizes that the inflation-growth relationship depends on the level of inflation at some low levels, inflation escalates growth, while at some higher level's inflation is likely to be harmful to growth.

Controlling inflation is a necessary condition for promoting economic growth. The policy implication derived from this study is that it is desirable to keep an inflation rate below the threshold level in India, as it may help a sustainable growth. In order to maintain price stability while keeping in mind the objective of growth, RBI needs to keep 3.5 per cent inflation as the target.

Acknowledgment

The author is thankful to Aligarh Muslim University, Aligarh, India, for being pioneers in providing all the research facilities. The corresponding author (Dr. Khurram Khowaja) is also thankful to Dr. Mohd. Javed Naim for his help and for being a constant source of inspiration and laying emphasis on the quality research.

Conflict of Interest

The author declares no conflict of interest.

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