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What Lowered Inflation in India: Monetary policy or commodity prices?

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What lowered inflation in India: Monetary policy or commodity prices?

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Abstract

India has seen lower inflation by historical standards, for the past five years. This has been attributed by some observers to the adoption of inflation targeting by the country's central bank, the Reserve Bank of India. In particular, it has been asserted that the taming of inflation reflects the anchoring of expectations of it through inflation targeting. We evaluate these claims. Our estimates indicate that there is no basis to the claim that inflation has been lowered due to the anchoring of expectations. On the other hand, we are able to fully account for the trajectory of inflation in India in terms of an explanation of inflation other than the one on which inflation targeting is premised.

JEL Codes: E31, E52, E58

Keywords: Inflation targeting, Inflation models, Monetary policy, India, Structuralist macroeconomics

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In 2015 India's parliament amended the Reserve Bank of India (RBI) Act of 1933 to make inflation control the sole objective of monetary policy. The amendment mandated RBI to target inflation, measured in terms of the Consumer Price Index (CPI), of 4 percent, with ±2 tolerance band for the period from August 5, 2016 to March 31, 2021. With that the RBI made the transition to an inflation targeting (IT) central bank. In the five years since inflation has mostly remained within the target range. As per the original terms of agreement between the India's government and its central bank, the policy of inflation targeting was reviewed after five years and the mandate given to the latter was renewed. Prior to the official verdict academic evaluations had appeared. These had concluded that inflation targeting in India had succeeded and that this had been achieved by anchoring inflation expectations by the RBI. We investigate this claim. Our view is that for the claim that inflation targeting has succeeded it is necessary to first establish that the central bank has actually controlled inflation. This would require demonstrating that the inflation model on which the policy of inflation targeting is based is empirically valid. Next, it would be necessary to show that the instrument that the central bank uses has had traction in the way that it is expected to. Evaluations claiming the success of inflation targeting in India have not been accompanied by either of these exercises. In their absence there would be no basis for the claim that it is inflation targeting that is responsible for the observed path of inflation in India since 2016. In this paper, apart from investigating the claimed effectiveness of inflation targeting in India, we also provide an explanation for the observed trajectory of inflation during the IT regime.

1. Background: Anti-inflation policy before inflation targeting

Inflation targeting is one of a set of imagined inflation control policies. Thus, scepticism about the efficacy of inflation targeting does not imply rejection of inflation control as a legitimate objective of economic policy. This is not well understood. Well before

inflation targeting was advanced, Friedman had brought inflation control to the centre of macroeconomics through his prophecy of the dangers of inflation, implying therefore the need to control it. As a monetarist, Friedman had prescribed money supply-targeting as the means to control inflation. On the other hand, under inflation targeting the use of the interest rate to target inflation is prescribed. So what is new about inflation targeting is only the instrument chosen, not the goal itself. There is, however, the implicit suggestion that inflation targeting is more effective than the erstwhile monetarist approach, as the instrument – the policy interest rate – is directly under the control of the central bank in a way that the money supply is not. However, what has mostly remained hidden in the public discourse is the economic model that underlies inflation targeting. Given our objective in this paper, it is worth repeating that it cannot simply be assumed that this model is a valid representation of the inflationary process. This must be demonstrated.

2. Recent inflation in India

In order to identify the role played by inflation targeting in lowering inflation in India, we start by first studying its recent history. In Figure 1 may be seen the trajectory of inflation from the year 2000, including the period from the first quarter of the financial year 2016. When interpreting the data it would be useful to bear in mind that inflation targeting was adopted in 2016. Five observations may be made on the basis of this history. First, it may be asserted that inflation has been lowered very significantly in India. From a high of close to 15 percent in 2009, quarterly inflation hit a low of 2 percent in 2017. Secondly, since 2016 the quarterly inflation rate has remained within the prescribed band for a significant period. Thirdly, it begins to rise about three years into the experiment, in September 2019. It may be noted that this is before the lockdown in response to the COVID-19 pandemic, so the increase cannot be put down to an extraordinary event. Fourthly, even if it is said that inflation has remained within the

band for much of the time since inflation targeting was adopted, it entered the prescribed band some 7 quarters before 2016, having been on a downward trend for at least a year before entering the band. This should alert us to the possibility that factors other than inflation targeting may have been responsible for taming inflation in India. At least, it would be premature to claim a role for inflation targeting without investigating the matter as we do. Finally, inflation has remained within the band of 4±2 percent, and for a longer period, even in the distant past, in early 2000s, again suggesting a role for other factors in its determination.

Figure 1. The trajectory of inflation In India

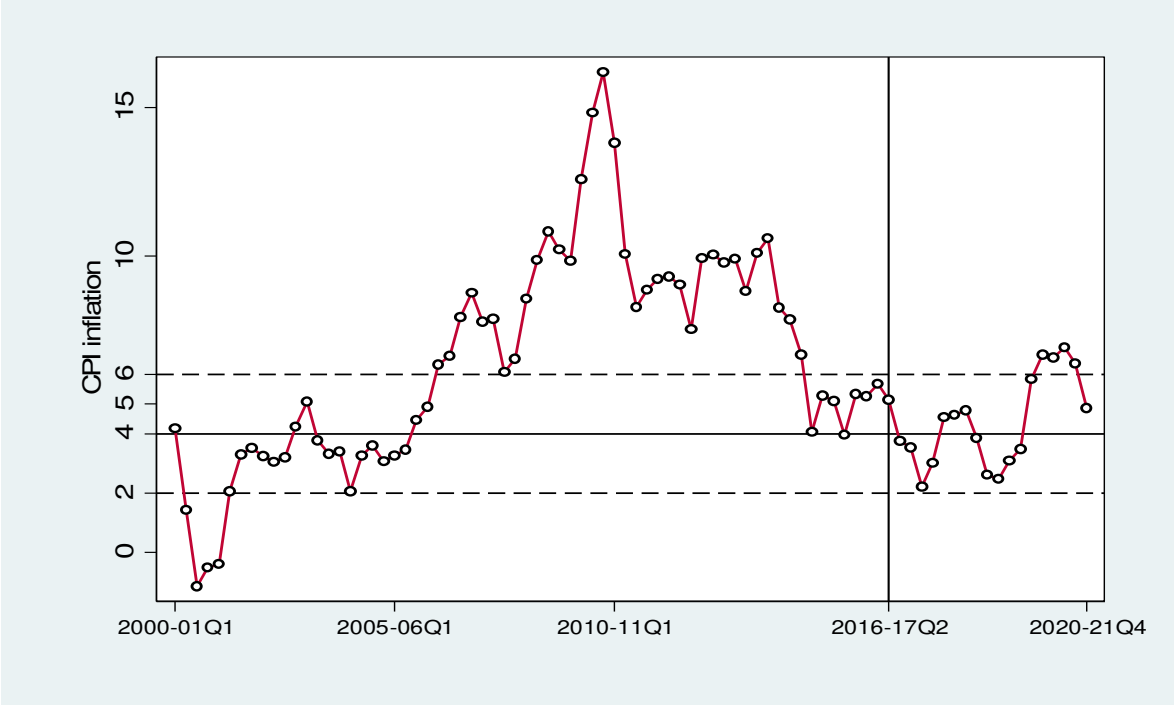


Table 1. Inflation by components of the consumer price index

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Consumer Price Index	10.2	9.5	5.8	4.9	4.5	3.6	3.4	4.8	6.2
Food and beverages	11.9	11.1	6.5	5.1	4.4	2.2	0.7	6	7.3
Core Inflation	8.7	8.1	5.4	4.6	4.8	4.6	5.8	4	5.5

Source: Reserve Bank of India; https://www.rbi.org.

In a preliminary attempt to understand the determinants of inflation we study movements in the principal components of the price level. From the data in Table 1 we can see the steady decline in food-price inflation since 2012-13. In fact, this decline is greater than the decline in the inflation rate, implying a decline in the relative price of food. It gives reason to believe that declining food price inflation has had a role in the decline in inflation. The behaviour of 'core' inflation, measured as inflation excluding Food and Fuel price movements, also declining in this period though not as sharply, suggests that it may not be autonomous of the behaviour of food prices. In fact, it may have been driven by it. If that is so, the case for targeting core instead of headline inflation, a proposition always on the agenda of international policy entrepreneurs and repeated by India's government economists, weakens. The data in Table 1 establish that inflation in India was trending downward well before 2016 and had settled into the band, or stabilised, a full two years before IT was adopted.

2. The theoretical basis of inflation targeting

The theoretical backing for 'inflation targeting', now adopted by most of the leading central banks of the world including the RBI, has come in the form of the New Keynesian Phillips Curve (NKPC). To the proponents of the NKPC, inflation reflects a level of output higher than the potential or 'natural' level, a gap that may be eliminated by appropriate movement of the interest rate, itself controlled by the central bank. For this reason it would not be inappropriate to term this the 'output gap' model of inflation, as we do here.

Fuhrer et al (2009) refer to the following as "the now-canonical version of the NKPC":

$$\Delta p_t = \beta E_t \Delta p_{t+1} + c_0 + \gamma y_t \qquad (1)$$

where Δp_t stands for the inflation rate, $E_t \Delta p_{t+1}$ is the expectation at time t of inflation in the next period, y is the output gap, and β and Υ are positive constants.

The output gap itself is the deviation of actual output from its 'natural' level, the level associated with the natural rate of unemployment. Note the centrality of the natural level of output to this explanation of inflation. It is particularly relevant when it comes to empirical validation of this view of inflation that the natural level of output is unobservable, can be estimated only by making assumptions and, in theory, can change. Methods have been proposed for the measurement of the output gap.

Gali and Gertler (1999) have presented a 'micro-founded' NKPC that is amenable to econometric estimation. They work with a market of monopolistically competitive firms that set prices as a fixed mark-up over marginal cost. The notable features of their model are price rigidity and rational expectations. Each period only a random fraction 'θ' of the firms reset their price while (1-θ) of the firms keep their prices unchanged. Now, the aggregate price level evolves as follows:

$$p_t = (1-\theta)p_{t-1} + \theta p_t^* \qquad (2)$$

where the aggregate price level p is a convex combination of the lagged price level and the optimal reset price p_t^*. Here, all variables are expressed as a deviation from a zero-inflation steady state.

Gali and Gertler derive the following equation for inflation

$$\pi_t = \lambda mc_t + \beta E\{\pi_{t+1}\} \qquad (3)$$

where *mc* is the real marginal cost.

Estimating the model would require a measure of the real marginal cost but it is not observable. The authors suggest two possible routes. In the first, specifying $mc_t = kx_t$, where x is the 'output gap' and k is the output elasticity of real marginal cost, the relation can be re-written as:

$$\pi_t = \lambda kx_t + \beta E\{\pi_{t+1}\} \qquad (4)$$

In a sense, taking this route only postpones the difficulty, as the output gap is not observable and needs to be estimated prior to estimating the model. G-G find this approach "ad hoc" but estimate such a model nevertheless, presumably because it is routinely done.

Note that in the original model derived by G-G, expectations are forward-looking. Thus, there is no 'intrinsic' inertia to inflation. However, motivated by the discovery of inertia in practice, they augment the NKPC by allowing for a sub-set of firms to use "a backward-looking rule of thumb to set prices".

The resulting model, specified as follows

$$\Delta p_t = \beta^a E_t \Delta p_{t+1} + \beta^b \Delta p_{t-1} + c_0 + \gamma x_t \quad (5)$$

is termed by them "the hybrid New Keynesian Phillips Curve". We find this classification of firms into two categories according to their expectation formation mechanism to be *ad hoc*.

The second route to the estimation proposed by G-G is to assume Cobb-Douglas production technology which would imply that real marginal cost is the ratio of the share of labour in output to the elasticity of output with respect to labour. Now, replacing the expression for marginal cost in Equation (3), the NKPC may be written as

$$\pi_t = \lambda s_t + \beta E\{\pi_{t+1}\} \quad (6)$$

where s is labour's share in value added.

Note that in (6) the elasticity of output with respect to labour is assumed to be constant, and hence ignored for our purposes. An attraction of this formulation is that the share of labour can be computed from national income data, no longer requiring an estimate of the output gap.

2.1 Does the output gap model describe inflation in India? An econometric investigation

In our estimation of the output gap model, with a view to testing how well it describes inflation in India, we pursue both the routes proposed by Gali and Gertler, allowing for hybridity in the formation of expectations. We estimate the output gap model using quarterly data for the period 1996-97 Q1 to 2016-17 Q1 using the rate of change of the Consumer Price Index (CPI) as the measure of inflation.[2] The details of the data and its sources are given in the Appendix A1. We shall use the data during the pre-inflation targeting period to estimate the model. If found empirically valid, the model will be used for forecasting inflation during the inflation targeting regime to know the extent to which it can trace the actual trajectory of inflation in the IT regime.

The variables were tested for stationarity and seasonal stability, and were found to be stationary and seasonally stable. The test results are given in the Appendix A2. When estimating the model, we work with two measures of the output gap. The first was arrived at through the use of the Hodrick-Prescott (H-P) filter. As the H-P filter has been subjected to criticism, the output gap was also calculated as the deviation of the log of actual output from its trend value (henceforth D-T) when a linear trend with breaks is fitted to the series[3]. As the output gap and expected inflation are potentially endogenous, we use both OLS and GMM-IV methods for estimation. The instruments used are the 2nd, 4th and 6th lags of the output gap, as these lags were found to be highly correlated with the current value of the output gap.[4] We also estimate the model with and without the change in the oil price. The results are presented in Tables 2 and 3,

[2] The inflation rate upto the third quarter of 2011-12 is computed using a constructed CPI, which combined the separately given CPI for 'agricultural labour' and 'industrial workers' with weights of 0.7 and 0.3, respectively. For the period from the fourth quarter of 2011-12 onwards, the new consumer price index with base 2012 = 100 (combined for rural and urban India) is used.

[3] Break points in the trend regression were estimated using the Bai and Perron (1998) methodology.

[4] The correlation coefficient of these lags are -0.839, 0.947, and -0.856 respectively.

respectively[5]. Note that the output gap is not statistically significant in the regressions, whichever way it is measured. Interestingly, both forward and lagged inflation terms are significant, suggesting that expectations matter. However, in our view, this finding cannot be interpreted in terms of the NKPC when the output gap itself is not a significant determinant of inflation.

Table 2. NKPC (CPI Inflation): OLS Estimates
(Quarterly data from 1996-97 Q1 to 2016-17 Q1)

	(1)	(2)	(3)	(4)
Lagged Inflation	0.270	0.286	0.267	0.282
	(1.90)	(1.97)	(1.90)	(1.98)
Forward Inflation	0.292	0.297	0.286	0.293
	(1.95)	(1.96)	(1.91)	(1.91)
Output Gap (H-P)	0.0547	0.0384		
	(0.92)	(0.61)		
Output Gap (D-T)			0.0532	0.0387
			(0.98)	(0.66)
Oil price (growth rate)		0.0191		0.0178
		(1.11)		(1.01)
q1	0.0176**	0.0158*	0.0137*	0.0131*
	(2.96)	(2.44)	(2.58)	(2.40)
q2	0.0355**	0.0328**	0.0301**	0.0291**
	(6.05)	(4.97)	(7.32)	(6.78)
q3	0.0183**	0.0174**	0.0179**	0.0172**
	(3.35)	(3.13)	(3.19)	(3.04)
Constant	-0.0109**	-0.0102*	-0.00833	-0.00836
	(-2.77)	(-2.51)	(-1.87)	(-1.86)
Observations	78	78	78	78
Adjusted R^2	0.468	0.465	0.469	0.466

Note: (1) t statistics in parentheses, (2) ** and * indicate significance at the 1 and 5 percent level, respectively, (3) q1 … q3 are quarterly dummies

[5] These results are for CPI inflation. Estimates using the change in the GDP deflator as the measure of inflation, and for alternative sample periods, may be found in Balakrishnan and Parameswaran (2021). The results remained unchanged.

Table 3: NKPC (CPI Inflation): GMM-IV Estimates
(Quarterly data from 1996-97 Q1 to 2016-17 Q1)

	(1)	(2)	(3)	(4)
Lagged Inflation	0.192**	0.238**	0.205**	0.253**
	(6.34)	(8.69)	(5.90)	(10.04)
Forward Inflation	0.751**	0.653**	0.589**	0.459*
	(3.06)	(3.19)	(2.68)	(2.00)
Output Gap (H-P)	0.00290	-0.0349		
	(0.16)	(-1.31)		
Output Gap (D-T)			0.0165	-0.0154
			(0.84)	(-0.58)
Oil price (growth rate)		0.0356**		0.0282**
		(3.49)		(2.83)
q1	0.00727	0.00533	0.00904*	0.0108*
	(1.58)	(1.07)	(2.01)	(2.17)
q2	0.0293**	0.0239**	0.0297**	0.0287**
	(9.90)	(5.71)	(18.51)	(14.39)
q3	0.0269**	0.0233**	0.0240**	0.0205**
	(7.15)	(8.12)	(5.82)	(5.76)
Constant	-0.0151**	-0.0121**	-0.0124**	-0.0108**
	(-3.98)	(-4.54)	(-3.84)	(-3.16)
Observations	74	74	74	74
Adjusted R^2	0.320	0.370	0.404	0.442
Hansen's J (χ^2)	1.023	1.484	0.0702	0.0790
p-value	0.312	0.223	0.791	0.779

Note: (1) t statistics in parentheses, (2) ** and * indicate significance at the 1 and 5 percent level, respectively, (3) q1 … q3 are quarterly dummies

We next estimate the output gap model following the second route to the estimation of the NKPC proposed by Gali and Gertler, indeed their preferred one. In this, the output gap is replaced by the labour share. The results are in Table 4. Before we turn to the results it may be noted that the data frequency is annual and not quarterly as the National Accounts Statistics, from which the labour share is derived, reports data on an annual basis. To ensure a reasonable sample size, the period is different from that of the estimates of the output gap model presented in Tables 2 and 3. Also, note that the measure of inflation used here is the rate of change of the GDP deflator. We consider

these differences as coming with an advantage, for now the output gap model would have been estimated using data at different frequencies and alternative measures of inflation. The results of this exercise mirror those obtained using the output gap in that the labour share is not statistically significant in the regression.

The estimates of the output gap model point conclusively to the NKPC being a poor descriptor of inflation in India. Our finding of the lack of validity of the output gap model for Indian data is in line with the findings of other researchers, see Paul (2009) and Hatekar, Sharma and Kulkarni (2011). Before it may be assumed that this finding reflects some developing-economy pathology, it may be noted that the output gap model is not always validated for the United States economy[6].

Table 4.The NKPC with labour share
(Annual data from 1980-81 to 2015-16; GDP deflator)

	OLS (1)	OLS (2)	GMM-IV (3)	GMM-IV (4)
Labour Share	0.0453	0.0484	-0.111	-0.105
	(0.34)	(0.37)	(-0.31)	(-0.32)
Lagged inflation	0.380**	0.366**	0.0898	0.104
	(3.10)	(2.93)	(0.23)	(0.26)
Forward inflation	0.393**	0.402**	0.828	0.814
	(3.14)	(3.22)	(1.58)	(1.50)
Oil Price (growth rate)		0.0242		0.0345
		(0.76)		(0.70)
Constant	-0.000975	-0.00397	0.0487	0.0436
	(-0.02)	(-0.08)	(0.39)	(0.39)
Observations	35	35	30	30
Hansen's J (χ^2)			1.58	1.62
p-value			(0.66)	(0.65)
Adjusted R^2	0.537	0.530		

Note: (1) t statistics in parentheses, (2) ** and * indicates significance at 1 and 5 percent level, respectively.

[6] See Rudd and Whelan (2007).

We have used headline inflation as our measure. The output gap model has been validated for India using core inflation as the measure (see Ball and Mishra, 2013). Two comments would be in order here. First, India's central bank targets headline inflation, so it is headline inflation that needs to be addressed when evaluating the record of IT in the country. Secondly, in a separate investigation we have found that core inflation is related to agricultural-price inflation, which are part of headline inflation. This association has two implications. First, core inflation has no autonomous status. Secondly, the RBI's cannot control core inflation without first stabilizing agricultural-price inflation.

Evaluations of inflation targeting in India have mostly proceeded without a test of the output gap model which underlies it. However, unless it is demonstrated that the output gap model is a good description of inflation in India it cannot be claimed that inflation has been stabilized due to inflation targeting. This has simply been assumed.

Does the finding that the output gap model is without statistical validity when confronted with Indian data leave us without an explanation of inflation in India? We now turn to this issue.

3. **Inflation in structuralist macroeconomics**

An explanation of inflation outside the monetarist and New Keynesian approaches have existed for long. Though developed some decades prior to the emergence of inflation targeting, it did not receive attention in the mainstream, perhaps because the framework within which it was embedded was developed as an alternative to that used to analyse developed economies[7]. Specifically, this explanation of inflation was intended for Latin America but has relevance for much of the developing world. This structuralist model of inflation is embedded within a larger model of the economy. It

[7] See Taylor (1984).

models both output and inflation, and is able to generate outcomes that are observed in India which cannot be explained by the Phillips Curve. These outcomes are disinflationary expansions and inflationary recessions. They stem from the presence of an agricultural sector in the model, as demonstrated in Balakrishnan and Parameswaran (2021).

In structuralist macroeconomics, the economy is modelled as having two sectors, agriculture and industry, with price and output determination mechanisms varying between the two. The agricultural price clears the market in each period, i.e., it is determined by supply and demand, while the industrial price is cost determined, with a fixed mark-up. The output of agriculture is considered exogenous, as it is driven by weather, while industrial output is demand determined. Industrial costs are made up of labour and material costs (notably the price of imported oil). The price of oil is determined in the global market while the wage is related to the general price level, though with a lag. We show[8] that in this model, inflation (π) is positively related to the relative price of the agricultural good (θ), industrial costs ($\gamma W_t + \tau e P_{m,t}$) and lagged inflation as follows

$$\pi_t = [\left(\frac{1}{P_{t-1}}\right)(1+r)\{\alpha\theta_t + (1-\alpha)\}(\gamma W_t + \tau e P_{m,t})] - 1 \qquad (7)$$

Further, we demonstrate through comparative statics that, in this model, a rise in the inflation rate can occur from either an expansion of industry or a decline in agricultural output. This feature has the implication that we can make no definite judgment about the level of activity, in particular, whether actual output exceeds the natural level, by observing the change in the inflation rate. Surely, inflation due to a negative agricultural shock cannot reasonably be interpreted as a case of the economy 'over-heating' due to output expansion.

[8] See Balakrishnan and Parameswaran (2021). In (7) W *and* P_m are the wage and the price of imported material, respectively, γ and τ the respective input coefficients and e *is* the exchange rate.

3.1 Estimates of the structuralist model of inflation for India

We estimated the structuralist inflation model for India using quarterly data and over the same sample period as in the case of the output gap model. As the relative price was found to be non-stationary, its log difference (growth rate) was used[9]. As the growth rate of relative price can be potentially endogenous in the econometric model, the model has been estimated using both OLS and GMM-IV. The instruments used are the 2nd to 6th lags of this variable, each of which were found to be correlated with its current value. The results are presented in Table 5. As the OLS and GMM-IV estimates are, mostly, very close to one another we make no distinction between them when discussing the results. First, the coefficient on the relative price of agricultural goods is statistically significant and quite high. As in the theoretical model, the price of oil matters for inflation, though the coefficient is far lower than that for the relative price. Lagged inflation matters for current inflation, implying inertia. Inflation inertia has the implication that inflation cannot be ended merely through central bank announcements termed "communication". Finally, the explanatory power of the model is high. These results add up to the conclusion that structuralist macroeconomics provides a valid description of the inflationary process in India, in particular that the growth of the relative price of agricultural goods is the principal driver of inflation.[10]

[9] It may be noted that Canavese (1984) presents a structuralist model of inflation in which the rate of inflation is a function of the *growth rate* of the relative price of the agricultural good.

[10] It is of interest that this has been established for a period earlier than the one studied here, before inflation targeting was adopted, when, globally, inflation control was guided by monetarism. See Balakrishnan (1994).

Table 5. The structuralist model of inflation
(Quarterly data from 1996-97 Q1 to 2016-17 Q1)

	OLS (1)	GMM-IV (2)
Relative price (growth rate)	0.336**	0.403**
	(5.68)	(6.09)
Oil price (growth rate)	0.0491**	0.0512**
	(3.79)	(11.56)
Lagged inflation	0.377**	0.371**
	(5.20)	(15.25)
q1	0.0121**	0.0120**
	(2.85)	(4.73)
q2	0.0197**	0.0182**
	(4.61)	(10.92)
q3	0.00770*	0.00661**
	(2.22)	(7.74)
Constant	-0.00218	-0.00110
	(-0.71)	(-0.96)
Observations	79	74
Adjusted R^2	0.624	0.637
Hansen's J (χ^2)		1.437
p-value		(0.838)

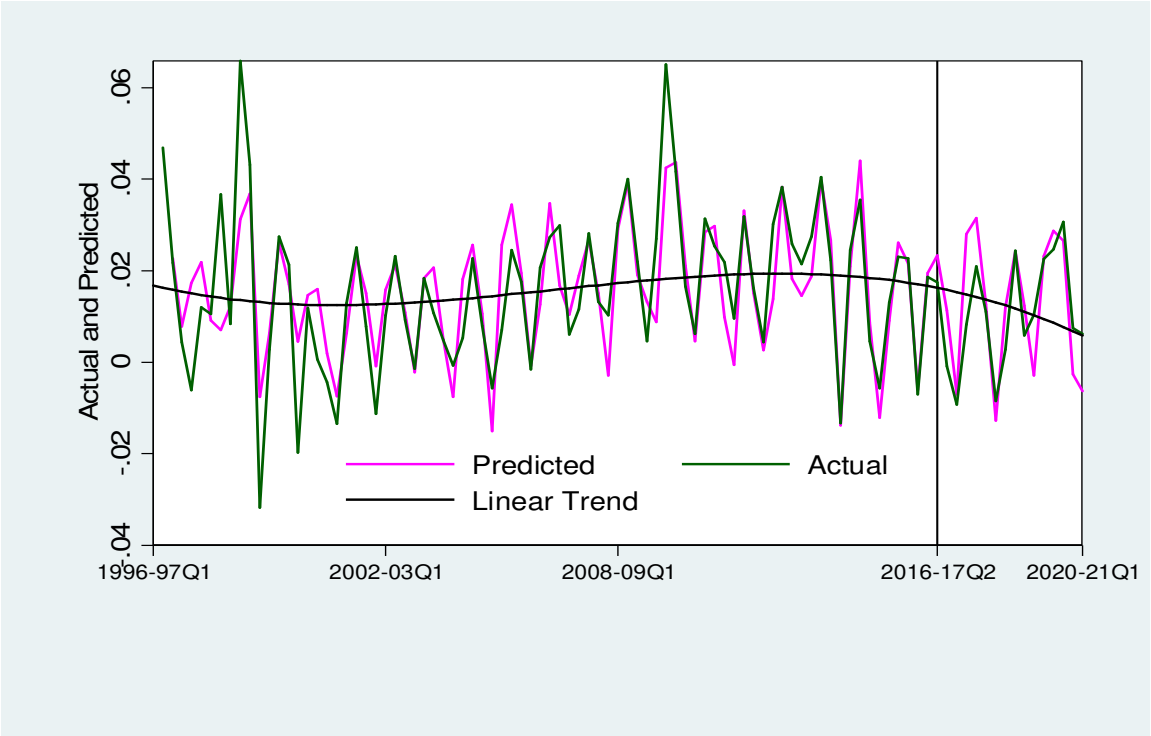
Note: (1) t statistics in parentheses, (2) ** and * indicate significance at the 1 and 5 percent level, respectively, (3) q1 … q3 are quarterly dummies

4. Interpreting lower inflation in India since 2016

On the basis of the econometric evidence for the two models of Inflation in the Indian context it may be surmised that the stable inflation since the adoption of inflation targeting in 2016 owes to the behavior of relative prices and the price of imported oil. This is confirmed by the following exercise. We use the OLS estimate of the structuralist inflation model estimated for the period upto 2016, reported in Table 5, to forecast inflation after inflation targeting was adopted, up to 2020-21Q1, being the last year for

which data were available at the time of the exercise[11]. The actual and forecast inflation rates are presented in Figure 2, and show a close fit. Note that the fitted trend of forecasts shows a downward trend in the inflation rate after 2016, the year in which inflation targeting was adopted. This implies that the trajectory of inflation can be fully understood within the framework of structuralist macroeconomics and its inflation model. *As the NKPC has been shown to be invalid for India, inflation history post-2016 cannot be attributed to the monetary policy of the RBI.*

Figure 2. Forecasts from a structuralist model of inflation



As the main determining variable of inflation in the structuralist model is the relative price, we tested for a change in its growth rate for the period under consideration. Rates

[11] The out-of-sample forecast using GMM-IV estimates give the same prediction. Under OLS, the correlation coefficient between actual inflation and predicted inflation is 0.80 for the entire period and 0.78 for the period of inflation targeting. The corresponding estimates for GMM-IV estimates are 0.80 and 0.77, respectively.

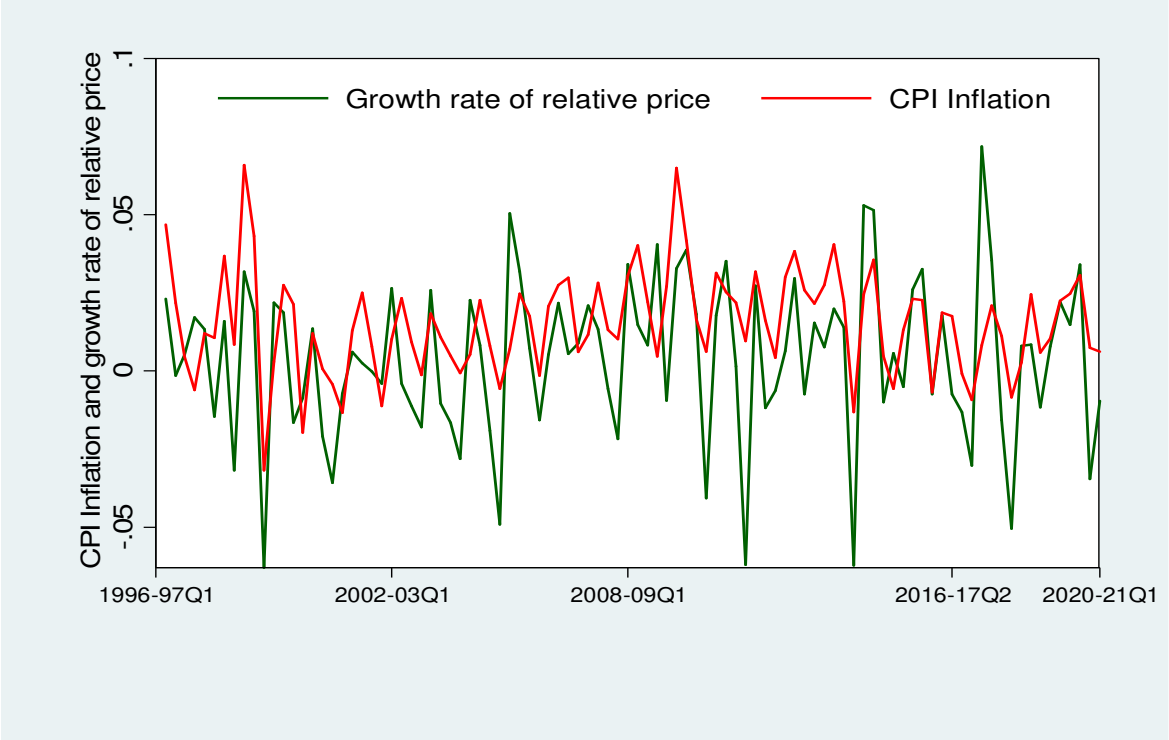
of growth for sub-periods established by the Bai-Perron method are in Table 6. A statistically significant reduction in the rate of growth of the relative price is evident from 2011-12 and, very strongly, from 2017-18. Given our regression results, this leads to the conclusion that the lowering of inflation in India since 2011, and particularly since 2016, owes overwhelmingly to the slower growth of commodity prices. Finally, in Figure 3 is presented a plot of inflation and the growth of the relative price. A co-movement is evident. The correlation coefficient is 0.59.

Table 6 Growth rates of relative price agriculture output

Period	Growth rate (in %)
1996-97 Q1 to 2000-01Q1	0.00
2000-01 Q2 to 2004-05 Q3	-0.45
2004-05 Q4 to 2010-11Q4	0.93
2011-12 Q1 to 2017-18 Q3	0.69
2017-18 Q4 to 2020-21 Q1	0.28

Note: The exponential growth rate reported. The periodisation is done on the basis of the breakdates estimated using the Bai and Perron (1998) methodology.

Figure 3 Inflation and the relative price



4.1 Expectations

In theory inflation targeting works via the anchoring of inflation expectations by the central bank. In this vein, it has been claimed[12] that inflation in India has been contained within the target range since 2016 because the RBI successfully anchored the expectation of inflation. We investigate the claim. Figure 4 presents three months ahead and one year ahead inflation expectations of households and actual inflation. The expected inflation rates are averages across households and collected from the RBI website. Visual inspection suggests the following stylized facts. First, for the period from 2016 - when inflation targeting was adopted - while there is a mild upward movement in 3-month ahead inflation expectations and none for 1-year ahead inflation expectations there is a discernible downward trend in actual inflation. Secondly, while expectations have been relatively steady since 2016, suggesting that they have been anchored, they had been revised downwards dramatically in the 2 years prior to that, when inflation targeting had not yet been adopted. Thirdly, even if were to be asserted that expectations have been anchored after 2016 they have remained higher than the upper end of the target range and at times far higher than the target itself[13]. Finally, actual inflation has fluctuated considerably more than expectations, implying that the latter are unlikely to have been a major factor in generating inflation. These facts make it difficult to sustain the argument that inflation in India has been tamed by anchoring expectations. More formally, the stability of inflation expectations since 2016 cannot be ascribed to inflation targeting as the output gap model that undergirds it cannot, as we have demonstrated, account for inflation in India. Now, if the claim of an anchoring of expectations is made without reference to the output gap model, it may be pointed out

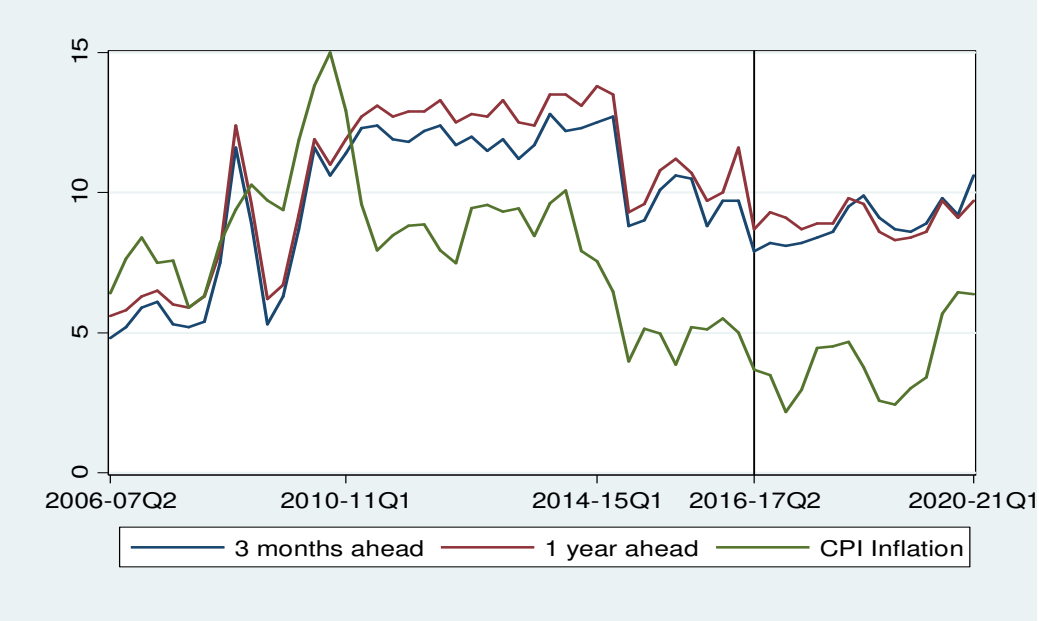
[12] See Eichengreen, Gupta and Chowdhary (2020).

[13] The current Governor of the Reserve Bank of India has stated "… we (also) want to anchor inflation expectations within the tolerance band and closer to the inflation target in the medium term." 'Economic Times' (2021).

that an observed decline in inflation expectations would be consistent with agents using the structuralist model to forecast lower inflation in line with the observed continuing decline in the growth of the relative price of agriculture demonstrated here.

Figure 4

Households' inflation expectations and actual inflation



5. Conclusion

In 2021, India completed 5 years of inflation targeting. Reviews have asserted that the fact of inflation remaining within the mandated band is evidence of the success of inflation targeting. We have argued here that such an approach cannot exclude observational equivalence, that observed inflation may have been generated by a process unrelated to the model undergirding inflation targeting. Accordingly, we investigated which of two alternative models of inflation account for the Indian experience. It was found the New Keynesian Phillips curve, on which central banks across the world base inflation targeting, is not validated for Indian data but the structuralist model of inflation, based on relative price movements, is. Further, when

used to forecast, the latter was found to capture upto a reasonable degree of accuracy the movement of the inflation rate after 2016, the year in which inflation targeting was adopted. This implies that subdued inflation in India can be put down to the behaviour of commodity prices. The econometric results presented by us suggest that is doubtful that inflation targeting has had a role.

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Appendix

A1. Data

The details and sources of various datasets used in the study are explained below.

Output: The study used quarterly GDP data for the period 1996-97 Q1 to 2020-21 Q1. The quarterly GDP data in current and constant prices were collected from the website of the Central Statistical Office (CSO). The annual GDP data is extracted from the website of CSO. The annual data is for the period 1980-81 to 2015-16.

Price: The wholesale price index for mineral oils, Consumer Price Indices (CPI) for industrial workers and agricultural workers and the Combined CPI were collected from EPW Research Foundation's India Time Series database.

Labour share: The labour share is computed using the data collected from the publication "National Account Statistics: Factor Incomes" published by the Central Statistical Office (CSO).

Inflation Expectations: Inflation expectations data were collected from the website of Reserve Bank of India. Average of the three months ahead and one year ahead inflation expectations of households are reported.

A2. Testing for a unit root and seasonal stability

Unit root properties of the time series were tested using the Augmented Dickey-Fuller (ADF) test, the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test, and the Zivot and Andrews test. The Zivot-Andrews test is used because a trend stationary series with a break in the trend can be wrongly diagnosed as an I(1) process by both the ADF and KPSS tests. This test allows for an unknown break in trend and intercept when testing for a unit root. The lag length for the ADF test was selected on the basis of the Bayesian Information Criteria (BIC) and lag length in KPSS test was fixed at 1, as the simulation

results reported in Kwiatkowski, Phillips, Schmidt, and Shin (1992)[14], showed that for a sample size similar to ours, a lag length of one provides correct size of the test. As the data is quarterly, we also test for a seasonal unit root or seasonal stability using the tests developed in Canova and Hansen (1995)[15] and Hylleberg, Engle, Granger, and Yoo (HEGY, 1990)[16], respectively known in the literature as the Canova-Hansen test and HEGY test. The test results are reported in Tables A1 to A4.

Table A1. Unit Root test: quarterly data, level

Variable	ADF	KPSS	Zivot-Andrews	Remark
Relative Price	-2.14 (-3.45)	0.194 (0.146)	-3.64 (-5.08)	I(1)
Oil Price	-0.705 (-3.45)	0.212 (0.146)	-4.61 (-5.08)	I(1)
Output gap	--3.22 (-2.89)	0.056 (0.463)		I(0)
Inflation	-3.08 (2.89)	0.145 (0.463)		I(0)

Note: Critical values at 5 percent level are given in parentheses. The null hypothesis in the ADF and Zivot and Andrews tests is that the series is I(1) and alternative is that it is I(0). In the KPSS test the null hypothesis I(0) and alternative I(1). In all the cases, the alternative hypothesis is trend stationarity, except in the case inflation, where the plot against time showed no trend and hence the alternative of stationarity around the mean was chosen.

[14] Kwiatkowski, D.; Phillips, P. C. B.; Schmidt, P. & Shin, Y. (1992), 'Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root?', *Journal of Econometrics* **54**, 159--178.

[15] Canova, F. & Hansen, B. E. (1995), 'Are Seasonal Patterns Constant Over Time? A Test for Seasonal Stability', *Journal of Business & Economic Statistics* **13**(3), 237-252.

[16] Hylleberg, S.; Engle, R. F.; Granger, C. W. J. & Yoo, B. S. (1990), 'Seasonal integration and cointegration', *Journal of Econometrics* **44**(1), 215 - 238.

Table A2. Unit Root test: quarterly data, first -difference

Variable	ADF	KPSS	Remark
Relative Price	-10.14 (-2.89)	0.246 (0.46)	
Oil Price	-5.56 (-2.89)	0.43 (0.46)	

Note: Critical values at the 5 percent level are given in parentheses. The null hypothesis in the ADF test is that the series is I(1) and the alternative is that it is I(0). In the KPSS test the null hypothesis is that the series is I(0) and the alternative is that it is I(1). In all the cases, the alternative hypothesis is stationarity around mean, as the plots revealed no trend.

Table A3. Testing for a seasonal unit root: quarterly data, level

Variable	Canova-Hansen test	HEGY Test
Inflation	0.599 (0.46)	22.82 (0.00)
Relative Price	1.891 (0.01)	34.40 (0.00)
Oil Price	1.74 (0.01)	79.41 (0.00)
Output Gap	2.08 (0.01)	4.14 (0.17)

Note: The null hypothesis in the Canova-Hansen test is stationarity of the series and the null hypothesis of the HEGY test is that the series has a unit root. In both cases, the joint-F statistics is reported. P-values are given in parentheses. For the HEGY test, the p-values are bootstrapped.

Table A4. Testing for a seasonal unit root: quarterly data, first-difference

Variable	Canova-Hansen test	HEGY Test
Relative Price	0.645 (0.416)	20.97 (0.00)
Oil Price	0.754 (0.317)	17.56 (0.00)

Note: The null hypothesis in the Canova-Hansen test is stationarity of the series and the null hypothesis in the HEGY test is that it contains a unit root. In both cases the joint-F statistic is reported. P-values are given in parentheses and in HEGY test the p-values are bootstrapped.