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Indian industrial pricing under inflation targeting

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Abstract

A puzzling characteristic of post-pandemic Indian inflation is the fall, within 10 years of adopting flexible inflation targeting (IT), in core inflation to lifetime lows despite high growth and recurrent commodity price shocks. Establishing the credibility of IT is expected to take time in emerging markets (EMs) since prerequisites are thought to include independent central banks (CBs) that focus only on inflation, giving up other types of intervention. The Indian CB, however, continued foreign exchange intervention and its coordination with the government improved over the period. Even so, our evidence from multiple exercises with a disaggregated industry panel suggests firms pass-through of supply shocks reduced in the IT period. The results support the effectiveness of the communications and expectations channel in EMs compared to other channels. EM features imply prerequisites for successful IT may not be the traditional ones. Flexible inflation targeting, with procedures adapted to the context, can reduce growth sacrifice while lowering inflation.

Keywords: Inflation targeting, firms’ price-setting, supply shocks, expectations channel

JEL codes: E31, E32

1. Introduction

In the post-pandemic period, as supply-chain bottlenecks wound down, Indian core inflation fell to historic lows, reaching 3.07% in May 2024, despite the ongoing Ukraine and Israeli conflicts and their impact on international oil prices as well as continuing seasonal spikes in some Indian food prices, to which inflation is normally sensitive. Since core inflation is dominated by industrial pricing, this paper seeks to address this puzzle by an analysis of disaggregated industrial pricing.

India had implemented a flexible inflation targeting (IT) regime since 2016. Did it contribute to lower firm pass-through of commodity price shocks and therefore core inflation?

Examining disaggregated wholesale price index (WPI) data, we find rise in manufacturing prices was lower in the post-pandemic period, although commodity price shocks were larger.

A supply shock is a shift of the aggregate supply (AS). In addition to commodity price shocks, supply shocks prominent in India's inflation dynamics also include exogenous exchange rate, financial, administered price and wage rate changes that raise costs for firms at all levels of output. Measuring supply shocks, using international oil price hikes and indices of monsoon failure, cannot capture all these. Asym10 is a comprehensive measure that includes the effect of different types of supply shocks on firm pricing, since it extracts supply shocks from firms' asymmetric response to large compared to small shocks. First proposed by Ball and Mankiw (1995), Goyal and Tripathi (2015) found this variable to outperform traditional measures of supply shocks, such as the changes in the relative prices of food and energy, in AS estimation for India.

We calculate Asym10 separately for commodities and for manufactured products and find the ratio of manufacturing to commodity Asym10 falls to less than half in the IT period, implying lower pass through of commodity price shocks into manufacturing prices.

Third, in an AS estimated using disaggregated industry level data a dummy for the IT period has a significant negative coefficient. The New Keynesian (NK) economics literature derives an AS from firms' maximization of expected profits (Gali and Gertler, 1999), making it relevant for our study of industrial pricing under IT. Alternative estimates of the cyclical variable, potential output are used, one of which is obtained from optimal marginal cost, closer to firms' actual decisions.

There is an issue, however, in identifying the AS, since under forward-looking behaviour all variables enter demand and supply equations. In addition to careful measurement of relevant variables, two-step Generalized Method of Moments (GMM) estimator with instrumental variables (IV) using an industry panel, addresses identification issues since the lagged variables used as instruments are uncorrelated with forecast errors. These variables capture the information available at the time expectations are formed. Mavroeidis et. al. (2014) survey AS estimations that include inflation expectations. Coibion and Gorodnichenko (2015) show this variable explains the observed flattening of AS estimated for the US.

The cross industry panel has more variability and data points, compensating for the limited number of IT years. It gives more instruments for estimation of expected inflation. Since central bank (CB) response to reduce inflation lowers the effect of output gap on inflation, coefficient estimation would be more accurate a panel, since the CB does not respond to individual industry output. Similarly, the covariation observed between inflation expectations and output is likely to be less at the industry level.

The semi-structural specification derived from firms' behavior also gave estimates of structural parameters such as the period of time after which firms adjust prices. Since firm prices tend to be sticky, expectations anchored around the target reduce costly persistence of distorted prices, and reduce the output sacrifice from monetary policy actions. The CB can then vary interest rates to reduce excess demand to zero and lower inflation with no cost in terms of output. A fall in output below potential is required to lower inflation only under supply shocks and is reduced to the extent firms look through the supply-shocks (Clarida, Gali and Gertler 1999).

We find India's IT regime worked well even in a period of large adverse supply shocks and only a few years after it was implemented. The literature on application of IT in EMs anticipated a long time required for appropriate institutions to develop and inflation expectations to be anchored. So the view is a large and lengthy output sacrifice is required in EMs to establish IT[1].

In the early years of IT, India followed this advice. While inflation fell, so did growth. In the post pandemic period IT was flexibly applied as required in Indian conditions. Growth was 8.8% over 2021-24, headline inflation was within the tolerance band of 2%-6% and core inflation fell below 4%. Since the interest rate channel affects output more than inflation in India, while fiscal policy is more effective against the dominant supply shocks, monetary-fiscal coordination worked well and was found to be consistent with CB independence (Goyal, 2022). Our results support the effectiveness of the expectation and communication channel. Goyal and Parab (2021) argued that more influence of hierarchy and fewer alternative news sources in EMs make CB communication more effective. Goyal (2016) is an early description of this expectation channel. Coibon et.al (2022) point out that more attention is paid to CB communication, when inflation is more volatile. This is the case in EMs.

Finally, a floating exchange rate is not a pre-requisite for IT. Since a float can be too volatile as well as driven by global risk unrelated to the domestic cycle, it hurts exporters, raises risk and interest rate spreads[2]. Buffie et al. (2018) find various types of FX interventions greatly enhance the efficacy of inflation targeting and are practiced by most EMs facing capital flow surges.

The lesson for EMs is that successful IT does not require cloning of all AE institutions, but suitable adaption of IT to domestic structure, shocks and circumstances. It can therefore work much faster than purists expect, even as supportive institutions continue to strengthen. Although the interest and exchange rate channel of monetary transmission may be weak[3], the communication and expectation channel may be stronger in EMs.

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[1] See, for example, Stojanovikj & Petrevski (2024), IMF (2005), Fraga et. al (2003), and Zelmer & Schaechter (2000).

[2] It is only theorists, far removed from EM ground conditions, who insist on a float in EMs as a pre-condition for IT, with the CB focusing primarily on price stability and not targeting other variables. See Goyal (2025) for an analysis of the Indian exchange rate regime and its compatibility with inflation targeting. Even the IMF (see Roger, 2010) recognized after the global financial crisis that external shocks driven exchange rate volatility can create financial instability in EMs.

[3] While the interest elasticity of aggregate demand tends to be high, the interest rate has little direct impact on supply shocks. The policy repo rate affects output more, but response to persistent inflation contributes to credibility of monetary policy and helps anchor inflation expectations.

The remainder of the paper is structured as follows: Section 2 presents stylized facts, including a firm behaviour-based measure of supply shocks; Section 3 explains the methodology and data used; Section 4 gives estimates of the AS and identifies changes during the IT period, before Section 5 concludes.

2. Stylized facts

Figure 1 shows the large movements in WPI (wholesale price index) inflation over the inflation targeting period after 2014. Fluctuations were largely due to oil price shocks, since these have a large weight in the WPI. CPI (consumer price index) headline (base 2011-12), which was the inflation target, had an almost 50% weight to food prices. Recurrent food price spikes affected it but its volatility also fell after the pandemic. Core inflation, however, which is calculated ex-volatile commodities, fell to a lifetime low of 3.07% in the post-pandemic period despite large commodity shocks.

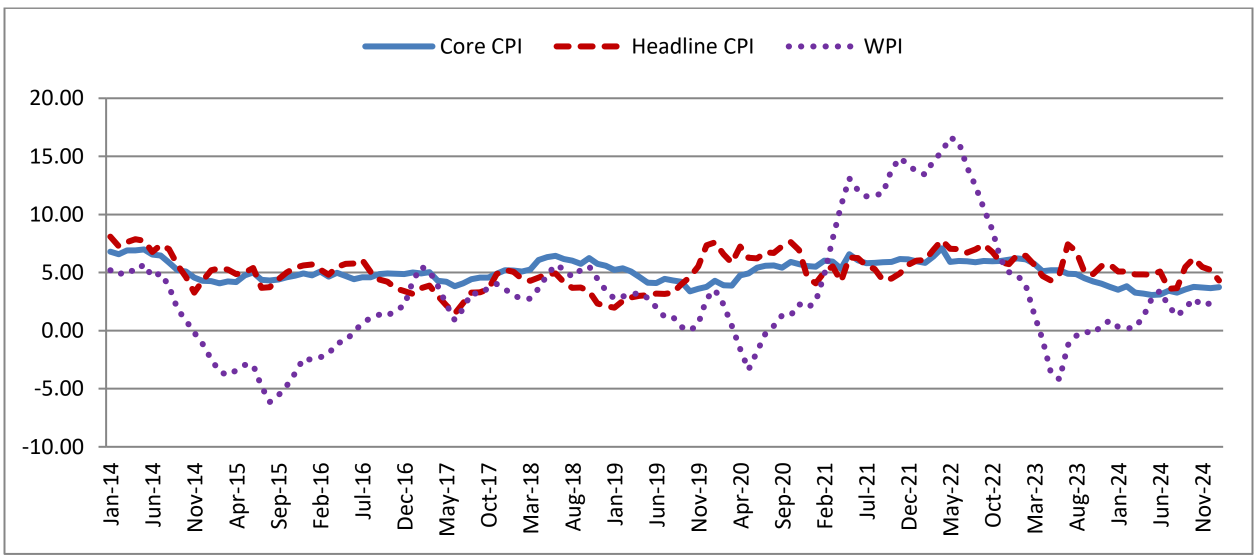

Figure 1: Indian WPI, headline and core Inflation
Source: Drawn using data from www.rbi.org.in

Fundamentally, supply shocks are a change in certain relative prices, which should not affect the price level. In an economy with a constant money supply, as some prices rise and others should fall so the average price level is constant.

But relative prices can affect the aggregate price level if prices like food influence wages. Or some administered prices rise but rarely fall. Or prices are sticky downwards or, firms respond more to large shocks so they have a disproportionately large impact on the price level. Large supply shocks could affect inflation if price changes lead to second round effects and result in a cycle of rising prices.

After a shock to its desired relative price, a firm changes its actual price only if the desired adjustment is large enough cover the ‘menu cost’ involved in changing prices. Since firms respond to large shocks but not to small shocks, large shocks have a disproportionate impact on the price level and can affect inflation (Ball and Mankiw, 1995). Therefore, a change in the price level would be positively related to the skewness of relative price changes. A positive skew implies more firms want to raise prices compared to those who may want to decrease prices. Since firms also respond faster to large shocks, desired increases occur more quickly than the desired decreases under a positive skew and conversely under a negative skew. It follows that shifts in relative prices would affect the price level.

If it is costly to adjust prices, a firm does so only if its desired change exceeds a cutoff (menu cost). That is, if price increase or decrease is within the cutoff range, firms would choose not to respond to shocks as they incur some cost in changing prices. A measure of supply shocks, AsymX, derived from this behavior, directly captures how firms’ pricing responds to supply shocks.

Figures 2 and 3 graph inflation, with the standard deviation and the skewness respectively, calculated from the log WPI for each year[4], since 2000. Periods of positive skew dominate. The IT period started informally in 2014, with the formal MOU signed in 2016. The volatility (standard deviation) of oil prices was higher in the IT period, but negative skew did become larger implying the administrative ratchet effect that raised prices but did not let them fall, was reducing.

[4] To obtain average change WPI industry weights, giving the relative share of industries in the reference year, are used. The process of converting to a uniform base is explained in the data section.

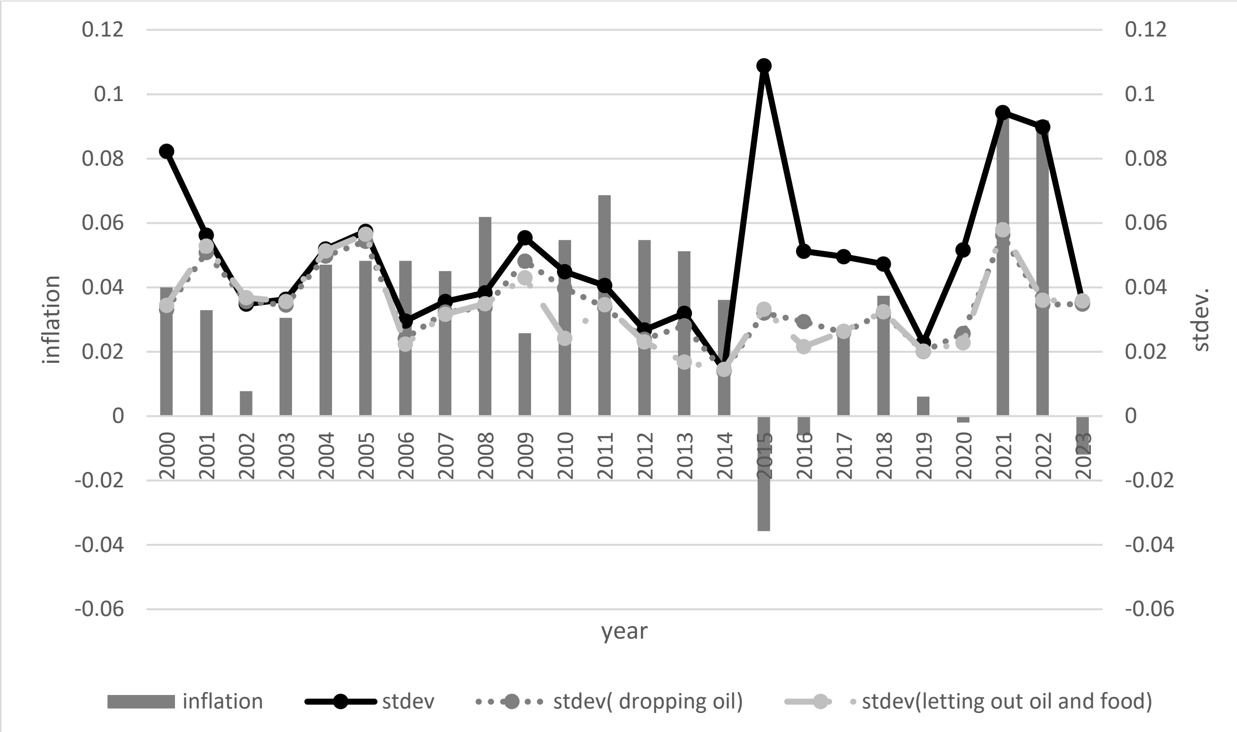

Figure 2: Plot of Inflation and Standard Deviation

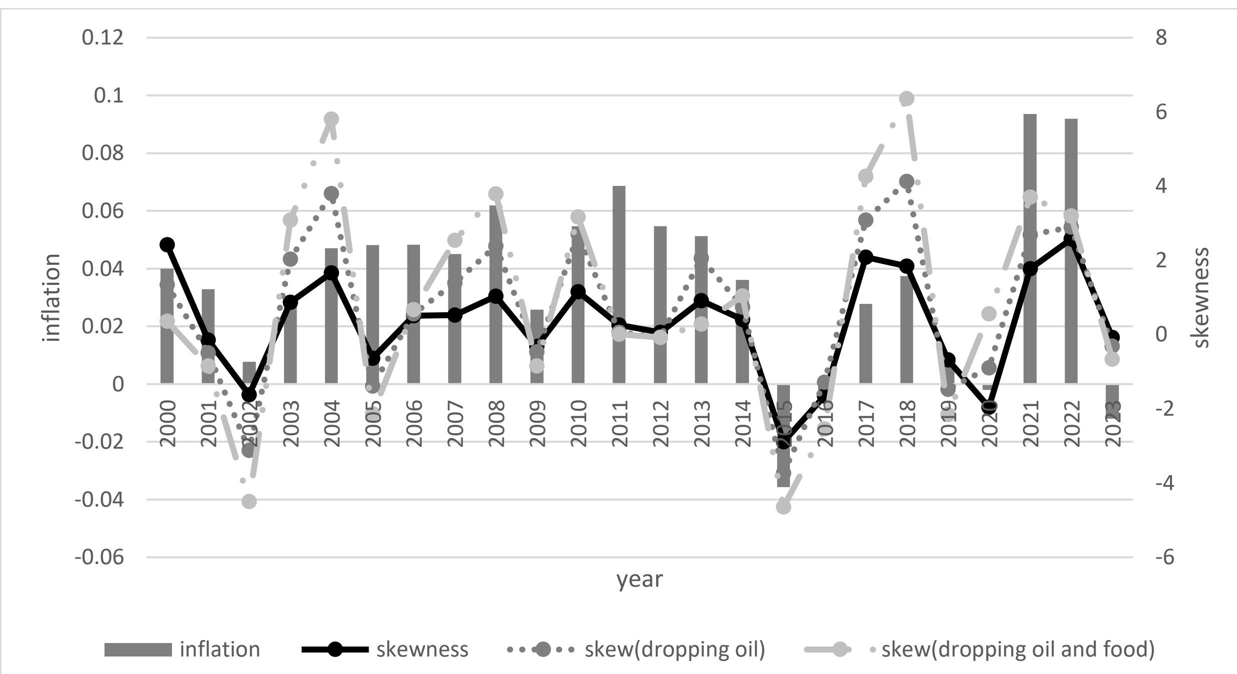

Figure 3: Plot of Inflation and Skewness

Source: Figures 2 and 3 drawn using data from www.rbi.org.in

While volatility was highest including oil products, skew was higher dropping oil and even higher dropping oil and food products, implying firms pass through of commodity shocks was high. But this dropped sharply after 2020, even though the size of supply shocks was higher. Thus this preliminary investigation suggests major changes in firm pricing in the IT period.

Anchoring of inflation expectations under IT allows firms to look through commodity price shocks in the belief that they are transient and will not have persistent effects on inflation. Figure 3 suggests this may have started in the IT period.

2.1 *A measure of supply shocks based on firms' behavior*

Ball and Mankiw's (1995) measure a weighted average of relative price movements that are greater in absolute value than some cut off X. This captures both the direct effect of skewness and the magnifying effect of variance on inflation:

$$AsymX = \int_{-\infty}^{-x} rh(r)dr + \int_{x}^{\infty} rh(r)dr \tag{1}$$

AsymX measures the positive mass in the upper tail of the distribution of price changes minus the negative mass in the lower tail, where *r* is an industry relative price change (log industry inflation rate minus the mean of all industry log inflation rates) and *h(r)* is the density of *r*, and the tails are defined as relative price changes greater than X per cent or smaller than -X per cent. AsymX is zero for a symmetric distribution of relative price changes, positive when the right tail is larger than the left tail and negative when the left tail is larger.

We estimate Asym10 with X=10 per cent, including only price changes above 10 per cent. We also calculate this separately for commodities and for manufactured products and take the ratio of manufacturing to commodity Asym10. The average value over 2002-2013 is 94, which falls to 46.26 over 2014-23. Thus despite supply shocks that were much above 10% in this period, the proportion of manufacturing firms that chose to change their prices by over ten per cent were much lower.

We next estimate a hybrid New-Keynesian aggregate supply (NKAS), with expected inflation as one of the dependent variables. Multiplying this with a dummy for the IT period allows us to test for the effect of IT on inflation expectations.

3. Methodology and data

3.1 Aggregate supply from optimal price-setting

Since the NKAS is derived from firms' setting of optimal prices, it is ideal for our purposes. Following Calvo (1983), a random fraction (1-θ) of firms is assumed to reset price p^*_t in each period, implying an evolution of the (log) price level:

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

Assuming an imperfectly competitive market structure where a firm sets its price as a fixed markup over marginal cost, the optimal reset price is:

$$p_t^* = (1-\beta\theta)\sum_{k=0}^{\infty} \beta\theta^k E_t\left\{mc_{t+k}^n\right\} \tag{3}$$

Where β is the firm's discount factor and mc^n_t is a firm's nominal marginal cost. Since price is likely to be fixed over some period, a firm sets price equal to the weighted average of expected future nominal marginal costs. In the limiting case of perfect price flexibility (θ=0), the firm simply adjusts its price proportionately to the movements in the current marginal cost. The future affects current prices when there is price rigidity (θ>0).

Let $\pi_t \equiv p_t - p_{t-1}$ denote the inflation rate at t, and mc_t the per cent deviation of the firm's real marginal cost from its steady state value. The equations (2) and (3) can be combined to yield a NKAS of the form:

$$\pi_t = \beta E_t \pi_{t+1} + \frac{(1-\theta)(1-\beta\theta)}{\theta}(mc_t) \tag{4}$$

Under relatively general conditions, aggregate real marginal cost is proportional to the gap between output and its potential level.

$$mc_t = kx_t = k\left(y_t - y_t^*\right) \tag{5}$$

With this assumption, the NKAS becomes:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda x_t \tag{6}$$

Where $\lambda = k\frac{(1-\theta)(1-\beta\theta)}{\theta}$. Inflation depends positively on the output gap and a "cost push" term that reflects the influence of expected inflation, $E_t\{\pi_{t+1}\}$.

Iterating equation (6) forward shows inflation now depends on the discounted sequence of future output gaps:

$$\pi_t = \lambda \sum_{k=0}^{\infty} \beta^k E_t \{x_{t+k}\} \tag{7}$$

Next, adding supply shocks to Eq. (6) gives the AS below:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda x_t + shock_t \tag{8}$$

Including some firms that follow simple behavioral rules (Gali and Gertler, 1999), generates inertia in inflation, giving a hybrid AS that includes lagged inflation. A fraction of firms set prices using a backward-looking rule of thumb. Although each firm still adjusts its price in any given period with fixed probability 1-θ as in equation (2), out of those changing their prices in period t, a fraction 1-ω of the firms are "forward-looking", and set prices optimally. The remaining firms are backward-looking and use a simple rule of thumb that is based on the recent history of aggregate price behavior. The rule has the following two features: first, there are no persistent deviations between the rule and optimal behavior; that is, in steady-state, the rule is consistent with optimal behavior. Second, the price in period t, given by the rule, depends only on information dated t-1 or earlier.

If p^f_t denotes the price set by the forward-looking firm at *t*, and p^b_t the price set by the backward-looking firm. Then the index of newly set prices in period *t* is given by:

$$p_t^* = (1-\omega) p_t^f + \omega p_t^b \tag{9}$$

Forward-looking firms continue to behave exactly as in the baseline model described by equation (3). But backward-looking firms obey a rule of thumb given by:

$$p_t^b = p_{t-1}^* + \pi_{t-1} \tag{10}$$

That is, a firm sets its price equal to the average price set in the t-1 period, with a correction for inflation. It may also reflect the use of lagged inflation in a simple way to forecast current inflation. This leads to a hybrid AS including inflation lags.

The theoretical model that underpins the NKAS, equation (4), predicts that it is real marginal cost that drives inflation. It has been estimated using empirical proxies for marginal cost. Gali and Gertler (1999), Gali, Gertler, and Salido (2001), and Shapiro (2007) propose using real average unit cost, or labor's share of income, to measure real marginal cost. Cost minimization implies the firm's real marginal cost will equal the real wage divided by the marginal product of labor. Assuming a Cobb-Douglas production function gives a simple, empirically implementable approximation. Let A_t denote technology, K_t denote capital, and N_t denote labor. Then the output Y_t is:

$$Y_t = A_t K_t^{a} N_t^{\beta} \tag{11}$$

Real marginal cost is a ratio of the real wage (W/P) to the marginal product of labor $\left(\delta Y / \delta N\right)$.

$$MC_t = \frac{W_t}{P_t} \frac{1}{\delta Y_t / \delta N_t}$$

(12)Solving for $\frac{1}{\delta Y_t / \delta N_t}$ from the production function and substituting gives:

$$MC_t = \frac{W_t N_t}{\beta P_t Y_t} \tag{13}$$

Denoting per cent deviation from the steady-state by lower case letters, the real marginal cost can be written as:

$$mc_t = w_t + n_t - p_t - y_t \tag{14}$$

Combining equations (9) and (10) with equation (2) gives the hybrid AS curve that also includes lagged inflation. Subscript i stands for individual industries:

$$\pi_{\{i,t\}} = a_f E_{t(\pi_{\{i,t+1\}})} + \gamma\, mc_{\{i,t\}} + a_b \pi_{\{i,t-1\}} + e_{\{i,t\}} \tag{15}$$

Where:

$$\begin{aligned} \phi &= \theta + \omega\left[1 - \theta(1-\beta)\right] \\ a_f &= \beta\theta\phi^{-1} \\ a_b &= \omega\phi^{-1} \\ \gamma &= (1-\omega)(1-\theta)(1-\beta\theta)\phi^{-1} \end{aligned}$$

The coefficients are explicit functions of three structural model parameters: θ, the degree of price stickiness; ω, the degree of backwardness in price settings; and the discount factor β.

We estimate equation (15), using two-step GMM with instrumental variables (IV), which is well-suited to our dataset given the potential endogeneity of the expectations term and the presence of heteroskedasticity. Under generalized forward-looking behavior, all variables enter demand and supply equations. Since the independent variables are correlated with the random error, parameter estimates would be inconsistent. So, controlling for endogeneity is essential to extract the AS from an underlying aggregate demand and supply system.

Instrument variables that are correlated with the independent variables but uncorrelated with the residual error are required to ensure forecast errors are uncorrelated with information available at the time expectations are formed. GMM-based inferential procedures use lagged variables, which are not correlated with prior-period errors. The number of such orthogonality or moment conditions is larger than the number of parameters, so minimizing the sum of squares finds the unique element of the parameter space that sets linear combination of the expected cross products of the unobservable disturbances and observable instrument variables equal to zero. This gives the required unique solution.

GMM can also be used to estimate an expected variable based on a number of lagged variables thus mimicking the actual broad-based determination of rational expectations. The use of disaggregated price and wage data makes better measurement and better instruments available.

The two-step GMM is consistent and efficient in the presence of heteroskedasticity of unknown form and is particularly effective when dealing with endogenous regressors. In our specification, expected inflation is treated as endogenous and instrumented using its second to fourth lags (inflation_2, inflation_3, inflation_4 inflation_5), helping to address issues of simultaneity and measurement error in expectation formation.

Since measures of output gap are all flawed, three alternative measures are used. Traditional detrending procedures suffer from endpoint bias and assume potential GDP evolves smoothly over time. But especially in EMs, a number of shocks affect potential output, which can vary significantly from period to period. Using marginal cost, the variable that directly enters firms' decisions, captures some of these, as does the deviation of industry growth from average growth. Even so, our variable is only a proxy for the actual marginal cost.

Our dependent variable is the logarithm of inflation, while the independent variables, all in logarithms, include:

- Lagged inflation
- Asym10
- Three alternative output gap (OG) measures (MC, OG (IIP), OG (gr)).
- Expected future inflation, estimated using instrumental variables: Second, third, fourth, and fifth lags of inflation (inflation_2, inflation_3, inflation_4, inflation_5).

Diagnostic tests conducted to validate the empirical model include:
1. Hansen's J Statistic: Tests the validity of instrumental variables under the null hypothesis that all instruments are uncorrelated with the error term.
2. Durbin-Watson (DW) Statistic: Evaluates the presence of serial correlation, where a value close to 2 indicated no serial correlation.
3. Breusch-Pagan (BP) Test: Assesses heteroskedasticity under the null hypothesis of homoskedasticity.

3.2 Data

Our largely annual datasets are sourced from the Annual Survey of Industries (ASI), the Index of Industrial Production (IIP) and the Wholesale Price Index (WPI) (published by the Office of the Economic Adviser, Government of India) cover industries, spanning the period 1990–2023, classified at the three-digit level of the National Industrial Classification (NIC). The key variables include WPI, IIP, wage bill, and value of output. Given that the data spans multiple NIC classification years (1987, 1998, 2004, 2008, and 2020), concordance tables were employed to construct a continuous time series. The WPI and IIP series were harmonized across different base years through splicing. A continuous series was constructed using 2011–12 as the base year.

The skewness charts and the construction of the asym10 variable are based on disaggregate WPI data covering 77 commodities, of which 52 are classified as manufactured products. For the panel regression analysis, we use 23 manufacturing industries, selected based on consistency and availability of data across the sample period.

To calculate marginal cost as the log of wage bill divided by the log of the value of output, the ASI data used was for 49 industry groups and 23 divisions. For inflation, WPI data at the same level of 49 groups and 23 divisions was used.

To calculate HP-filtered IIP and average growth, IIP data for 23 manufacturing industries was used. The data was available in a mix of aggregated and disaggregated formats, and was used in the format provided, based on availability and correspondence with ASI and WPI classifications.

To estimate the output gap (OG), three alternative measures were employed:
1. Marginal Cost (MC): Computed as the logarithm of the wage bill divided by the logarithm of the value of output for the 23 industries.
2. OG (IIP): Log IIP minus HP-filtered IIP: Obtained by applying the Hodrick-Prescott filter, with smoothing factor 1600, to the IIP series and then subtracting that from the IIP series.
3. OG (gr): Defined as the change in the logarithm of annual IIP growth for each product divided by its long-run average growth.

The variable asym10 was our measure of price shocks. It assigned a weight of 1 to price changes exceeding 10% and 0 otherwise.

In all regressions, the left-hand side variable is the log change in WPI. All the variables are in logs and were found to be stationary using the ADF test.

Tables 1 and 2 give the summary statistics and correlations for the regression variables, all in logs. Mean of MC (in logs in Table 1) is negative since the mean of marginal cost itself is 0.65 below unity.

Table-1

Variable	Obs	Mean	Median	Std. Dev.	skewness	Kurtosis	Min	Max	JB Test	P value
Inflation	759	0.83	0.13	1.18	0.77	3.94	-3.02	5.19	103.70	0
Inflation(lag1)	736	0.81	0.01	1.19	0.83	4	-3.02	5.19	116.30	0
Expected inflation	664	0.84	0.74	0.39	0.61	2.44	-0.03	2.01	49.5	0
Marginal Cost	759	-1.62	-0.21	2.75	-1.39	2.95	-6.91	0.40	29.27	0
OG(IIP)	759	2.62	4.78	4.08	-1.54	4.08	-9.16	7.13	227	0
OG(gr)	759	1.03	0.01	2.33	0.22	3.13	-6.81	9.35	6.49	0
Asym10	33	0.49	0.19	0.80	0.64	3.41	-1.39	2.51	57.21	0
it_dummy	759	0.18	0	0.39	1.64	3.7	0	1	360.90	0
it_dummy_ Expected infl.	667	0.15	0	0.32	1.90	5.34	0	1.37	556.63	0

Table-2

Variable	Inflation	Inflation (lag1)	Expected inflation	Marginal Cost	OG(IIP)	OG(gr)	Asym10	It_ dummy	It_dummy Expected infl.
Inflation	1								
Inflation(lag 1)	0.36	1							
Expected inflation	0.33	0.39	1						
Marginal Cost	0.34	0.33	0.44	1					
OG(IIP)	0.21	0.20	0.27	0.57	1				
OG(gr)	0.19	0.14	0.18	0.22	0.24	1			
Asym10	0.17	-0.06	-0.09	-0.02	0.01	0.04	1		
it_dummy	-0.01	-0.10	-0.14	0.26	0.29	-0.14	0.12	1	
it_dummy_ Expected infl.	-0.01	-0.09	-0.03	0.24	0.26	-0.14	0.12	0.93	1

4. Industry-level AS estimation

Tables 3 and 4 give the industry-level estimates of a hybrid AS using panel GMM IV, since the main objective is to assess the effect of the IT regime on industry pricing. All the variables are significant and have the expected signs. The slope coefficients are all low, suggesting a flat AS. Costs do not rise much as output is increased. The slope is least for output gap calculated as deviation of growth from average growth. Expected inflation has the largest coefficient and therefore the greatest impact on firm pricing.

The IT dummy interacted with inflation expectations has a negative coefficient (Table 4), and is significant with MC as the OG, implying that the IT regime reduced firms' expected inflation.

Diagnostic tests are satisfactory. J test statistics, given in the last row of Table 2, are not too large, implying that the instruments used are appropriate and are independent of error processes.

Table 4 column (1) coefficients, that is, the estimation with MC, are used to get estimates of structural parameters, since estimation is with industry level data. Taking the parameter β to be 0.96, the parameter θ measuring the degree of price stickiness is 0.84. The parameter ω is 0.31. That is, 31 per cent of industries are backward-looking in price setting.

Table-3

Inflation			
	(1)	(2)	(3)
Expected inflation	0.57 (0.00)***	0.73(0.00)***	0.73(0.00)***
Inflation (lag1)	0.22(0.00)***	0.26(0.00)***	0.25(0.00)***
MC	0.08(0.00)***		
OG(IIP)			0.03(0.04)***
OG(gr)		0.05(0.01)***	
Asym10	0.36(0.00)***	0.29(0.00)***	0.36(0.00)***
R^2	0.24	0.22	0.22
D.W.	2.2	1.98	1.99
B.P.	2.0 (1.00)	1.93(1.00)	4.1(1.00)
J Test	0.67(0.88)	0.32 (0.95)	0.39(0.94)

Table-4

Inflation			
	(1)	(2)	(3)
Expected inflation	0.55 (0.00)***	0.72(0.00)***	0.72(0.00)***
Inflation (lag1)	0.21(0.00)***	0.25(0.00)***	0.25(0.00)***
Marginal Cost	0.09(0.00)***		
OG(IIP)			0.03(0.00)***
OG(gr)		0.05(0.00)***	
Asym10	0.30(0.00)***	0.29(0.00)***	0.36(0.00)***
it dummy_Expected infl.	-0.26(0.05)**	0.05(0.96)	-0.13(0.31)
R^2	0.24	0.22	0.22
D.W.	2.00	1.98	1.98
B.P.	3.5 (1.00)	6.6(1.00)	6.8(1.00)
J Test	0.94(0.81)	0.38(0.95)	0.50(0.91)

Source: Authors' estimation.
Note: P-values are in brackets; D.W. close to 2 indicates the absence of serial correlation in errors. Breusch Pagan (B.P.) tests the null of homoskedasticity. Hansen's J tests over-identifying restrictions in GMM estimations. * Significant at 10%, ** significant at 5%, *** significant at 1%.

Table-5

Inflation	**(1)**	**(2)**	**(3)**	**(4)**
Expected inflation	1.13 (0.00)***	1.14 (0.00)***	1.09 (0.00)***	1.14 (0.00)***
Marginal Cost	0.39 (0.00)***	0.35 (0.00)***	0.42 (0.00)***	0.42 (0.00)***
Asym10	0.26 (0.04)**		0.09 (0.77)	
It_dummy _Expected infl.			-0.19 (0.12)	-0.22 (0.00)***
R^2	0.54	0.54	0.56	0.55
J test	5.9 (0.3)	8.5 (0.26)	5.9 (0.3)	6.0 (0.26)

That is, an average Indian firm changes prices after a few months. One/sixth of the firms reset their prices in any period, and 69 per cent of firms are forward-looking in their price setting. The share of firms with forward-looking behavior exceeds those with backward-looking behavior. Prices are sticky and the majority of firms are forward-looking, so anchoring of inflation expectations has a major effect in lowering the persistence of deviations from the inflation target.

Policy that anchored inflation expectations would reduce pass through of cost shocks and persistence of second round inflation. This is without any cost to output since inflation is reduced without raising output gaps.

For robustness, the aggregate AS was also estimated by taking a weighted average of the industry level MCs. This is reported in Table 5 below. Coefficients are similar to the panel regression, except that the slope is steeper and the Asym10 coefficient becomes insignificant when the interactive IT dummy is added. The slope of the IT dummy is negative. When Asym10 is dropped the dummy coefficient becomes strongly significant. This also points towards the classic IT effect: Anchoring of inflation expectations so that supply shocks are largely looked through.

5. Conclusion

A puzzling characteristic of post-pandemic Indian inflation is the fall in core inflation to lifetime lows within a brief period of adopting flexible IT, despite high growth and recurrent commodity price shocks.

Once IT is established and long-term price expectations are anchored, firms are expected to increasingly look through commodity price spikes. But establishing the credibility of IT is expected to take a long time in EMs, since it requires independent CBs that focus only on inflation, giving up other types of intervention. The Indian CB, however, continued intervening in FX markets and had good coordination with the government in the second half of the IT period.

Wage negotiations, and therefore second round firm costs, respond to supply shocks, such a food prices, so costs rise at all levels of output during supply shocks. Credible anchoring of inflation expectations can act on some of these responses, reducing second-round effects and persistence of inflation. Our evidence suggests the process has already begun in India in less than ten years of IT and despite the massive supply shocks that accompanied global events in this period.

Our use of disaggregated data for 23 manufacturing industries allows us to examine how firms' response to price shocks has changed in the IT period. This data allows us to (i) extract supply shocks from firms' asymmetric response to large compared to small shocks (ii) obtain a better firm behavior-based measure of the output gap. These are used in our estimate of firms' pricing decisions with GMM IV estimation in which the lagged variables used as instruments are uncorrelated with forecast errors.

Evidence of lower pass through of supply shocks in the IT period, is first, rise in manufacturing prices was much lower than that in commodity prices, even in a period of large supply shocks. Second, the size of relative price movements in manufacturing compared to commodities fell to less than half in the IT period. Third, an AS estimated with a disaggregated industry panel showed IT reduced inflation by reducing the impact of inflation expectations. The result was robust to aggregation.

The results support the effectiveness of the communications and expectations channel in EMs and its ability to compensate for any weakness in other channels. Credibility is contextual and can be established for a range of institutions and procedures. The traditional pre-requisites may not be essential. Flexible inflation targeting, with procedures adapted to context, can reduce growth sacrifice.

These preliminary results need to be corroborated with firm level studies. The Indian central bank would do well to pay more attention to firms' price expectations, which contributed to the success of IT. At present, only data on household inflation expectations is collected.

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