Institute for International Economic Policy Working Paper Series
Elliott School of International Affairs
The George Washington University

A Variable Mark-up Model of Inflation in India

IIEP-WP-2025-6

Ajay Chhibber
George Washington University

July 2025

Institute for International Economic Policy
1957 E St. NW, Suite 501, Washington DC 20052
Email: iiep@gwu.edu Web: iiep.gwu.edu

•

7/31/2025

A Variable Mark-up Model of Inflation in India

Ajay Chhibber
INSTITUTE FOR INTERNATIONAL ECONOMIC POLICY, GEORGE WASHINGTON UNIVERSITY

A Variable Mark-up Model of Inflation in India

Ajay Chhibber[1]

Abstract: Past studies of India's inflation follow either a Philips Curve or a structuralist approach which use a fixed mark-up cost push model. In our model we combine the two approaches with a variable markup model where excess money balances determine the markup. This allows our model to capture the effects of monetary policy as well as cost push factors such as food prices and oil prices in understanding India's inflation which has in periods deviated from world inflation despite increasing trade and financial integration with the rest of the world.

JEL Classification Codes: E02, E12, E31, E41, E51, E52.

I. India's Inflation History

India is not regarded as a high inflation country, but when you examine the evidence carefully it shows that it has experienced much higher inflation than world averages (see Figure 1). This deviation from world inflation persisted even after the 1991 balance of payments crisis when India liberalized its economy and became more integrated with the world economy. India's inflation since 1991 has also been much higher than US inflation and a period over which the Indian rupee has depreciated from Rs 18 per USD in 1990 to about Rs 83 per USD in 2023 and Rs 86 in 2025.

India's inflation this century has also, surpringly, been much higher than in Latin America – considered a region of high inflation. Latin Americas suffered high inflation in the previous century. Since 2000 Latin America's inflation has fallen to closely mirror world inflation (Figure 2) and this success has been attributed to the introduction of inflation targeting Medina and Wlasiuk (2024). India on the other hand has seen bouts of high inflation much higher than world averages, and certainly higher than low-inflation countries in East Asia and the Pacific. But the success of controlling inflation in East Asia cannot be attributed to

[1] Distinguished Visiting Scholar, Institute for International Economic Policy, George Washington University. The author is grateful to Mohammed Alassaf and for his excellent research assistance provided by IIEP, GWU and to Ila Patnaik and Radhika Pandey for use of a figure from their paper and to Ahmad Ahsan, Shankar Acharya, Prachi Mishra and Franziska Ohnsorge for very useful comments.

inflation targeting as only Korea, Indonesia, Indonesia, and Thailand are explicit inflation targeters. In a recent BIS working paper Filardo and Greenberg (2024) investigate the reasons for low inflation in East Asia conclude that "*In terms of inflation levels, non-inflation targeting central banks have shown roughly the same success as inflation targeting central banks in achieving low inflation.*"

India also introduced a flexible inflation targeting (FIT) regime formally [2]in 2016 which had become fashionable in large parts of the world. In August 2016, the Government notified a CPI inflation target of 4% within a band of 2% on either side, for the period from August 5, 2016, through March 31, 2021. The amended RBI Act provided that the government shall, in consultation with the RBI, determine the inflation target once every five years. Accordingly, after the scheduled review in 2020, this target was renewed for the next five-year period. There is considerable debate over how successful this policy has been with some suggestions that it has been applied too tightly in its initial phase. We will examine this later.

In a wider study of inflation in Emerging Market Developing Economies Ha, Kose and Ohnsorge (2019) concluded that in the median country, three global factors—global demand shocks, supply shocks, and oil price shocks—have accounted for about one-quarter of domestic inflation variation since 2001. Of these, the most important were global demand (especially the global recession of 2008-09) and oil price shocks (especially the plunge of 2014-16). Nonetheless, domestic shocks—especially domestic supply shocks—have remained the main source of domestic inflation variation.

This was the situation before the pandemic. Once the pandemic struck the same authors produced a new study in which they factored in the effects of the pandemic with the following conclusion "Even in the absence of dislocating financial market stress, EMDEs may face rising inflation as global price pressures feed into domestic inflation through input prices and exchange rate movements. A temporary increase in inflation may not warrant a monetary policy response. However, if rapidly rising price pressures risk de-anchoring inflation expectations, EMDE central banks may be forced to tighten monetary policy before the recovery is fully entrenched."

India's case is like this with external shocks making a major contribution to inflation in some periods and domestic factors playing a bigger role in other periods. Three periods of extremely high inflation stand out. The first was in 1991, 1992 when India faced a huge balance of payments crisis. High inflation in India during 1991 and 1992 was primarily driven by a fiscal crisis, a balance of payments crisis, and the devaluation of the rupee. These issues, coupled with a rise in oil prices and a decrease in remittances, significantly impacted the Indian economy.

The second was in 1998 just after the Asian crisis but its causes were internal. A major contributor was a sharp rise in the prices of primary products, particularly vegetables,

[2] Some experts suggest that the RBI informally followed the FIT regime as early as 2014.

fruits, oilseeds, and pulses. Consumer price inflation, which heavily weights food items, reached 12.5% in June 1998. While a "bumper harvest" in 1998-99 led to favorable supply conditions for some crops, inflationary pressures emerged due to "tight supply conditions for some food items". The Reserve Bank of India (RBI) weakened the Rupee against the dollar, potentially in response to the Pokhran blasts in 1998. The depreciation of the Rupee, coupled with efforts by the RBI to absorb incoming dollars, led to increased liquidity in the economy, triggering inflation, especially in non-traded goods.

Figure 1: CPI Inflation India, USA, and the World 1980-2023

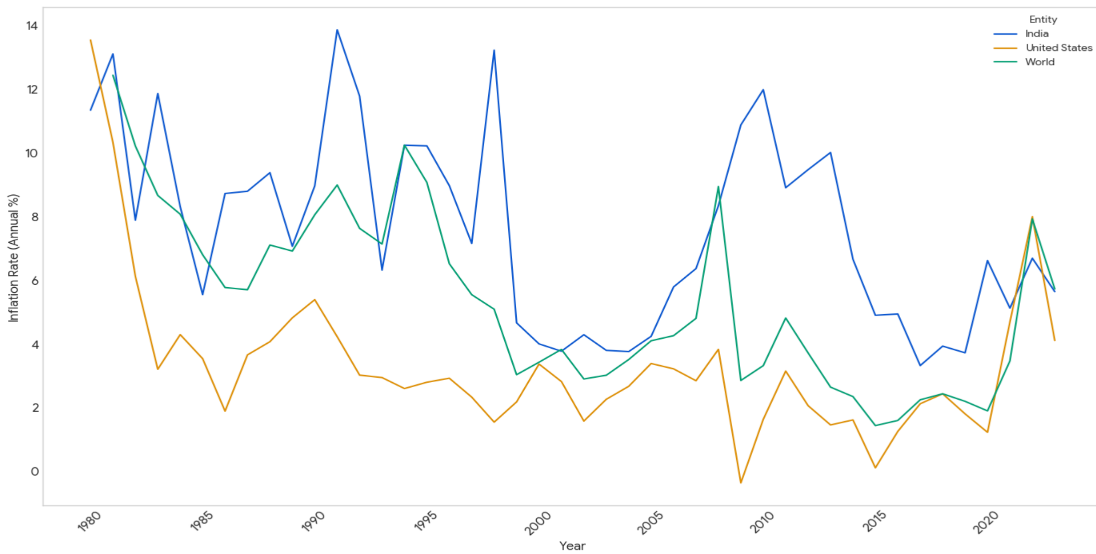
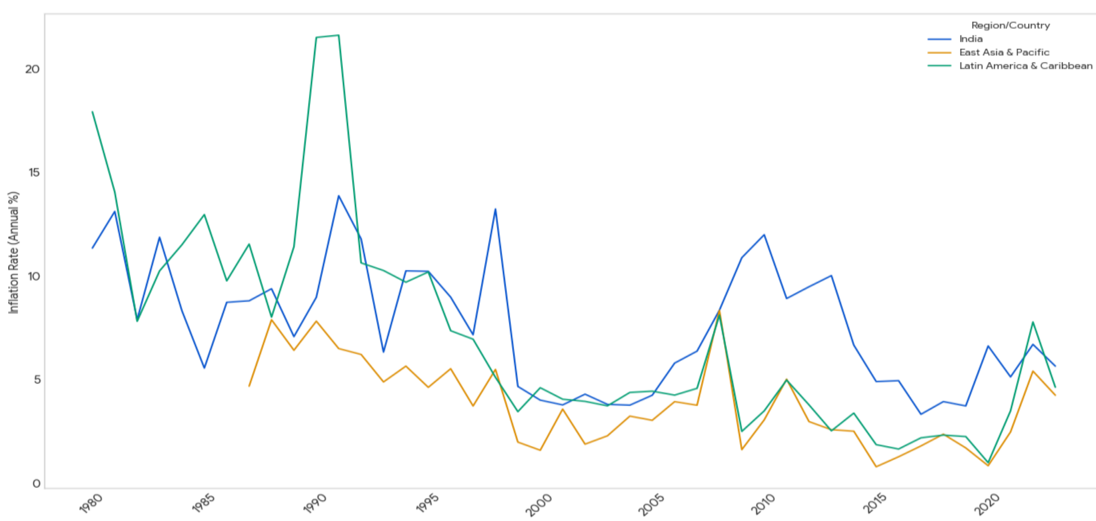
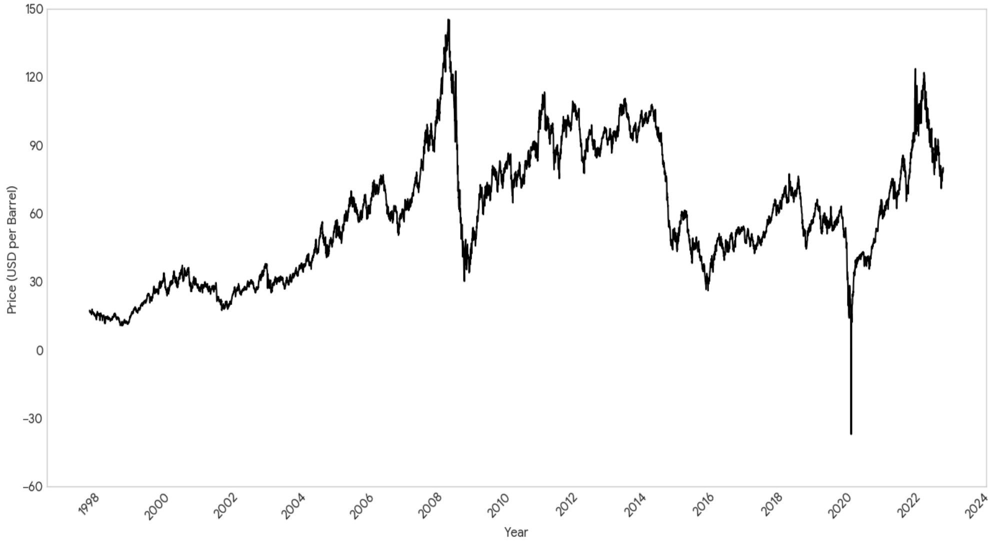


Figure 2: CPI Inflation: India, Latin America, and East Asia 1980-2023



Source: World Bank

Figure 3 : Crude oil prices 1998-2023



Source: The U.S. Energy Information Administration (EIA)

The third is the period from 2009 to 2013 when India's inflation was on average almost 7 % points higher than world inflation. India's inflation rose in 2008 when oil prices rose sharply and peaked at $140 per barrel in 2008. Oil prices came down in 2009 but then rose again and remained over $100 per barrel for the period 2010 to 2014 (Figure3). This was one crucial factor in generating inflation in that period. But India's inflation in that period also deviated from world prices because of loose monetary policy when the RBI's repo rate was kept too low for too long. As a result, the real repo rate remained negative all the way to 2013, and this may have contributed to high inflation in India when world inflation had already dropped (see Table 1). We will analyze the relative contribution of domestic and external factors through our analysis in this paper.

The RBI has been a poor predictor of inflation in the past. It has been slow in bringing down the repo rate from 6.5% through all of 2024 and has only started bringing it down very slowly since then with 25 basis points cuts each in February and April. Meanwhile the real repo rate even after a 50 bp cut in June is still at +3.4 %, which indicates further scope for rate cuts. This is the same mistake made between 2015 and 2019 when real rates were kept extremely high, averaging +2.2 % points and hurting economic growth (see Table 1 and Figure 4) and well above the RBI's own estimate of a neutral policy rate.[3] At that time, the RBI's inflation expectations were seriously flawed and were consistently higher than

[3] The Reserve Bank of India (RBI) has revised its estimates of the neutral rate of interest for Q3-2022-22 from 0.8-1.0 per cent to 1.1-1.3 per cent, reflecting GDP data revisions. The current range suggests a wide range between 1.4-1.9 per cent for Q4-2023-24 after the pandemic.

actual inflation. In an assessment of inflation targeting Patnaik and Pandey (2020) showed that in that period the RBI's survey of household expectations were exceedingly high compared to actual inflation and outside the RBI's upper bound of 6% inflation (Figure 5). This persistent error kept real repo rates too high for a prolonged period. The RBI (and the MPC) became what economic literature refers to as "inflation nutters" i.e., they focused solely on inflation and not on their dual mandate of growth and inflation.

Table 1: RBI's Repo Rate, Inflation and Real Repo Rate 2008-2025

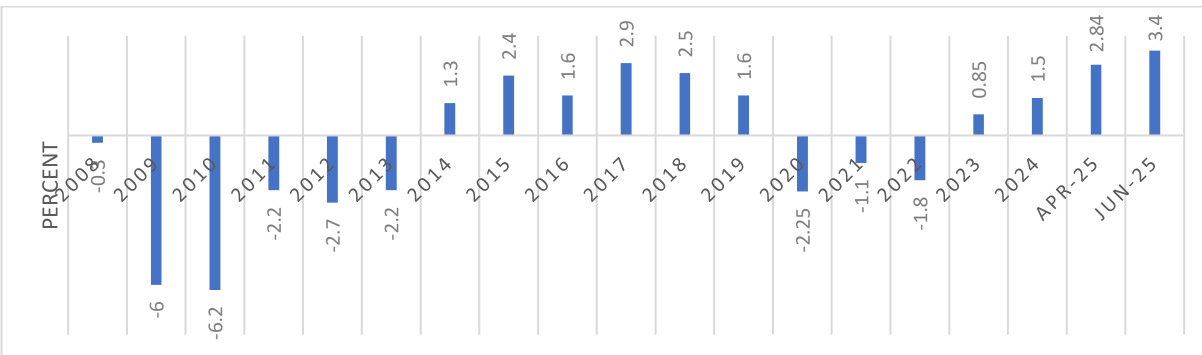
Year	CPI Inflation	Repo Rate	Real Repo Rate	World Inflation	Diff from World Inf
2008	8.3	8	-0.3	8.9	-0.6
2009	10.9	4.9	-6	2.9	+8.0
2010	12	5.8	-6.2	3.3	+8.7
2011	8.9	6.7	-2.2	4.8	+4.1
2012	9.5	6.8	-2.7	3.7	+5.8
2013	10	7.8	-2.2	2.7	+7.3
2014	6.7	8	+1.3	2.4	+4.3
2015	4.9	7.3	+2.4	1.4	+3.5
2016	4.9	6.5	+1.6	1.6	+3.3
2017	3.3	6.2	+2.9	2.3	+1.0
2018	3.9	6.4	+2.5	2.4	+1.5
2019	3.7	5.3	+1.6	2.2	+1.3
2020	6.6	4.35	-2.25	1.9	+4.5
2021	5.1	4	-1.1	3.5	+1.6
2022	6.7	4.9	-1.8	7.9	-1.2
2023	5.6	6.45	+0.85	5.7	-0.1
2024	5	6.5	+1.50	3	+2.0
April 2025	3.16	6	+2.84		
June 2025	2.1	5.5	+3.4		

Source RBI and World Bank

Subsequently, under a new team the RBI deftly helped India navigate the COVID crisis. The RBI kept monetary policy loose (but not too loose) from 2020 to 2022 to deal with pandemic induced crisis but began to tighten monetary policy by August 2022 to reduce inflation which reached 6.7 % that year. This was more than the upper band of 2% points above the target inflation rate of 4% under India's FIT regime (see Table1).

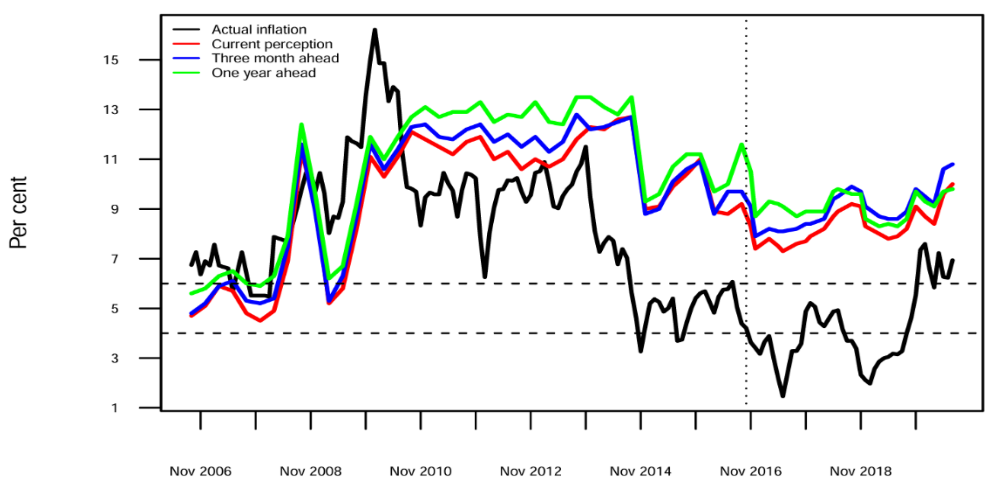
To their credit they avoided the mistakes made by the RBI in the period after the global financial crisis of 2008/9, when the RBI kept repo rates too low for too long and combined with very loose fiscal policy set off a period of very high inflation averaging above 10% from 2009-2013. This prolonged period of high inflation contributed significantly to the UPA's election loss in 2014. By 2013 the RBI was forced to raise the repo rate to 7.75% and in January 2014 to 8% to bring inflation down. Inflation eventually fell to 4.9% by 2015 due to tighter monetary policy and much lower oil prices. Oil prices fell from $108.56 per barrel in 2013 to $98.47 per barrel in 2014 and then very sharply to $52.32 in 2015 and $ 43.67 by 2016.

Figure 4: RBI's Real Repo Rate 2008-2025



Source: RBI

Figure 5: RBI's Survey of Household Expectations of Inflation



Source: Patnaik and Pandey (2020)

Many experts attribute the subsequent period of low inflation to the introduction of the FIT regime but that is not necessarily the real reason behind the drop in inflation. By the time India introduced the FIT in 2016 inflation had already dropped inside the inflation target band[4]. It remained low all the way to 2019 due to excessively tight monetary policy and low oil prices. Bhalla, Bhasin and Loungani (2023) show more widely across countries that the benefits of targeting inflation are hugely exaggerated, and that when you include pre -inflation targeting inflation as an additional explanatory variable the effect of inflation targeting in controlling inflation disappears.

Given the long lags in monetary policy working on growth and inflation, the main problem now, in my view, lies not necessarily with the targeting inflation regime but in getting better predictions of inflation, where the RBI needs considerable improvement. Clearly India's inflation is triggered by external and internal shocks, but these are validated by monetary policy and affect exchange rates which in turn then affect inflation and create an exchange rate inflation spiral. Food prices also play a significant role through their impact of real wages and by their effect on expectations of inflation. But by no means can India be considered a low inflation country. In the next section we will review the relevant literature for understanding India's inflation.

II. Selective Literature Review on Inflation in India

There are two schools of inflation in India. One follows variations of the Philips Curve approach which argues that when the output gap tightens it triggers inflation. The other is the structuralist school which argues that inflation is primarily driven by cost-push factors, which are triggered by supply shocks such as sudden increases in food prices or oil prices.

Ball, Chari, and Mishra (2016) estimate a Philips Curve model of inflation using quarterly WPI data. They argue that previous estimates which failed to find a Philips curve for India were because they were based on annual data. They find that, current core inflation depends on many lags of past inflation with weights that decline slowly. They interpret this finding as reflecting the slow adjustment of expected inflation. This inertia in expectations is consistent with the view that, once an elevated level of inflation becomes embedded in expectations, it is not easy to reduce. Second, for a given level of expected inflation, there is a positive relationship between inflation and the deviation of output from trend. Along with their finding about the slow adjustment of expectations, the estimated effect of output implies that monetary policy can reduce inflation, but with a short-run cost in output. One finding of their study is that movements in headline inflation appear to influence expected inflation and hence future levels of core inflation. As a result, a one-time supply shock, such as a large spike in food prices, can have a persistent effect on inflation. One major problem

[4] Chinoy, Kumar and Mishra (2016) argue that the RBI had introduced the inflation targeting regime as early as Q12014 but that it was approved and formalized later.

with this study is that the use of the Hoddick-Prescott method for estimating the output gap is not very satisfactory.

Eichengreen, Gupta and Chaudhry (2021) argue that India witnessed high inflation because it did not adopt inflation targeting which worked well all over the world. Without a clear nominal anchor India was unable to keep inflation under control. They did an assessment of India's inflation targeting regime and concluded that the Reserve Bank of India is best characterized as a flexible inflation targeter: contrary to criticism, it does not neglect changes in the output gap when setting policy rates. The paper does not find that the Reserve Bank of India became more hawkish following the transition to inflation-targeting; to the contrary, adjusting for inflation and the output gap, policy rates became lower, not higher. But in their results IT has no effect on the policy rate when the lagged policy rate is included in their model. They claim that inflation has become better anchored: increases in actual inflation do less to excite inflation expectations, indicative of improved anti-inflation credibility. Again, they use the Hoddick-Prescott method to estimate the output gap with all its known problems Hamilton (2017). But their analysis has been questioned also for the way they test the efficacy of inflation targeting.

Chinoy, Kumar, and Mishra (2016) also estimate a variant of the Philips Curve to determine what led to a sharp drop in India's inflation in 2014. They extend the standard Philips Curve by introducing administered minimum support prices (MSP's), rural wages, rainfall, and exchange rates into their model and using quarterly data for the period 2000Q2 – 2015Q1, they conclude that much of the decline in inflation can be attributed to what they call "*a moderation in the historical dynamics of inflation which influence contemporaneous inflation* ". Another 20% to moderation in MSP's and a third to the introduction of a new monetary policy regime. They argue that the FIT was formally introduced in 2016 but was already being implemented by the RBI as early as the first quarter of 2014 and put a dummy variable for the new inflation regime from 2014Q1 to 2015Q1 which shows a significant effect on inflation. But they also acknowledge that declining oil prices could have played a role in inflation expectations, and they show that lagged inflation is a significant determinant of rural wages and once lagged inflation is introduced rural wages become insignificant.

Balakrishnan and Parmeswaran (2022, 2025) evaluate the role of inflation targeting with a New Keynesian Phillips Curve. They argue that to claim inflation targeting works would require demonstrating that the inflation model on which the policy of inflation targeting is based, namely the New Keynesian Phillips Curve (NKPC), with its emphasis on forward-looking expectations is empirically valid in the Indian case.

The model they use is.

$$\hat{p} = \beta_0 + \beta_1 E\hat{p}_{+1} + \beta_2 y + \beta_3 \hat{p}_{-1}$$

where $\hat{p}$ is inflation, $\hat{p}_{-1}$ is lagged inflation, $E\hat{p}_{+1}$ is the RBI's expected inflation 3 months forward and y is the output gap. They show that in a model estimated quarterly inflation from Q2 FY 2006-07 to Q1 FY 20-21 the coefficient for expected inflation is insignificant and that the sign of the output gap is negative. They also use future inflation for expected inflation in another variant but this is also insignificant. They reject the NKPC as a suitable model to explain inflation in line with previous studies by Paul (2009) and Hatekar, Sharma, and Kulkarni (2011) and Patra, Beheraand and John (2021). They conclude that inflation targeting had no additional effect on reducing inflation through its effects on inflation expectations. They instead argue that India's inflation can be better explained by structural approach with a fixed markup model where they use the relative price of agricultural goods, oil prices and lagged inflation to explain inflation. But it is not clear why they use a fixed markup and only oil prices instead of import prices more broadly.

Kundurthi and Kalluru (2024) emphasize the role of agricultural output and administered prices – the minimum support price (MSP) to explain inflation. But their model has a very ad-hoc specification and simply asserts that demand side factors are not important. In another recent study, but one which uses ARDL estimation techniques with annual CPI data from 1981-2023.

With the pandemic there has been considerable literature on profit-led inflation where it is argued that firms are able to increase profits by increasing mark-ups and keep prices high. Nikifouris, Groethe and Weber (2024) show that higher profits do not necessarily require higher mark-ups as firms are able to reduce wage share to keep profit shares higher. In India's case Acharya and Chouhan (2024) and Commander et al (2025) show that since 2013-14 the Big 5 firms have been able to increase mark-ups – defined as revenues divided by variable costs. But by itself this does not mean higher inflation for two reasons. First, the top -5 firms as against the Big 5 in each industry have not seen an increase in mark-ups. Second, higher mark-ups by the Big 5 means higher profits for them but not necessarily higher inflation unless there is another mechanism that changes overall price-setting behavior. Balakrishnan and Parmeswaran (2023) dismiss the argument that corporate pricing power affects inflation by examining several factors and episodes of high inflation.

Both the Philips Curve and the structuralist approach are inadequate to fully explain inflation in India. The structural approach uses a fixed mark-up model which can explain a one-time increase in prices but cannot explain sustained inflation. The Philips Curve approach is also inadequate as it relies on a mechanical determination of an output gap which is hard to justify in a developing economy with huge under-employment and does not bring cost-push factors into the estimation in an ad-hoc manner. We turn now to our approach where we use a variable mark-up model where we argue that excess money balances drive inflation and determine the mark-up.

III. The Model

Overall inflation $\hat{p}$ is a weighted average inflation in traded goods prices ($\hat{p}_t$), non-traded goods prices ($\hat{p}_n$).

$$\hat{p} = \alpha_1 \hat{p}_t + \alpha_2 \hat{p}_n \quad (1)$$

where $0 \leq \alpha_1, \alpha_2 \leq 1$, and $\alpha_1 + \alpha_2 = 1$.

For traded goods, the domestic inflation is equal to the change in the import price ($\hat{p}_m$) plus the change in the nominal exchange rate ($\hat{e}$).

$$\hat{p}_t = \hat{p}_m + \hat{e} \quad (2)$$

For non-traded goods inflation $\hat{p}_n$ we use a standard mark-up model.[5] The mark-up is applied to change in unit labor costs ($\widehat{ulc}$) and the change in the cost of imported inputs ($\hat{m}$i).

$$\hat{p}_n = (1 + \mu)(\widehat{mi}, \widehat{ulc}) \quad (3)$$

Instead of using a fixed mark-up (mu) as is commonly assumed we make the change in the mark-up a function of excess demand in the system following McCallan and Parker (2008).

Using a quadratic cost- function we get the following simplified mark-up equation for inflation in non-traded goods.

$$\hat{p}_n = \beta_0 + \beta_1 \log exd + \beta_2 \widehat{mi} + \beta_3 \widehat{ulc} \quad (4)$$

where $\beta_2 + \beta_3 \leq 1, \beta_1 \geq 0$

Changes in import costs are the sum of changes in import prices and the nominal exchange rate.

$$m\hat{i} = \hat{p}_m + \hat{e} \quad (5)$$

Combining (1)-(5) we get the reduced form inflation equation.

$$\hat{p} = \Phi_0 + \Phi_1(\hat{p}_m + \hat{e}) + \Phi_2 \widehat{ulc} + \Phi_3 exd \quad (6)$$

This general model inflation shows that inflation is caused by imported inflation ($\hat{p}_m$), inflation due to the cost-push effect of devaluation ($\hat{e}$), wage-push inflation (ulc), and demand-pull inflation (exd). The excess demand is not directly measurable, and the commonly used output gap is not very adequate. So instead, we go back to a basic monetary identity that postulates that in an economy with no supply constraints.

$$\text{ms} * \text{v} = \text{p} * \text{t}$$

where ms is money supply, v is the velocity of money, p is prices and t are the number of transactions. Now velocity is defined as the number of transactions divided by money demand.

$$\text{v} = \text{t}/\text{md}$$

[5] Non-traded goods refer both to goods that it is not feasible to trade, such as land, and goods that are de-facto non-tradables such as those subject to non-tariff barriers.

where md is money demand. Velocity of money is inversely related to money demand. If money demand goes up for any given money supply, the velocity of money falls and prices will decline. We suggest that excess demand is determined by an imbalance between money supply and money demand and that prices rise or fall to clear this imbalance.[6] In our model then the excess demand becomes a function of the ratio of money supply and money demand and expressed in logs as

$$\text{Log exd} = F(\log(ms/p) - \log(md/p))$$

This formulation is predicated on the existence of a stable money demand function (MDF) for India. Adil, Husain and Matuka (2022) finds cointegration among variables under consideration and a well-specified MDF, implying a stable short-and long-run money demand relationship in India for the period 1996: Q2 to 2016: Q3. Bhardwaj and Pandit (2010) provide a review of the literature on the stability of the MDF for India and go on to show empirically that a stable MDF exists for both M1 and M3 is dependent on income, interest rates as well as effective real exchange rate changes reflecting the substantial inflows and outflows of capital since liberalization.

Real money demand in logs is a function of the real deposit interest rates, changes in the real effective exchange rate and log real income. For empirical purposes we use real gdp for real income.

$$\ln(md/p) = \mu_0 + \mu_1(i - \hat{p}) + \mu_2 \ln gdp + \mu_3(\hat{e} + \hat{p}_m - \hat{p}) \quad (7)$$

Where $\mu_1 \leq 0, \mu_2 \geq 0$ and $0 \leq \mu_3 \geq 0$.

Inserting Equation 7 into Equation 6 we get the final reduced form equation for inflation.

$$\hat{p} = \pi_0 + \pi_1(\widehat{p_m} + \hat{e}) + \pi_2(\widehat{ulc}) + \pi_3 i + \pi_4 \ln(\text{ms/p}) + \pi_5 \ln gdp \quad (8)$$

where $\pi_1 \geq 0, \pi_2 \geq 0, \pi_3 \geq 0, \pi_4 \geq 0$ and $\pi_5 \geq 0$.

Fuel price shocks are captured in the import price index. food price shocks are also important for India but in our model work through their impact on wage costs. Later we can also test whether food prices also have a direct effect on inflation.

$$\ln(ms/p) = \ln(ms/p_{-1}) + \ln(p/p_{-1}) \quad (9)$$

or

$$\ln(ms/p) = \ln(ms/p_{-1}) + \hat{p} \quad (10)$$

Inserting (10) into (8) gives us another reduced form equation.

[6] In advanced countries with fully functional financial markets interest rates could adjust to change money demand and change the velocity of money but in less developed countries like India without fully functional financial markets and where interest rates are administered, an increase in money supply will lead to inflation and some adjustment in interest rates but with a lag.

$$\hat{p} = \lambda_0 + \lambda_1(\widehat{p_m} + \hat{e}) + \lambda_2(\widehat{ulc}) + \lambda_3 i + \lambda_4 \ln(ms/p_{-1}) + \lambda_5 \ln gdp \quad (11)$$

$$\text{where } \lambda_1 \geq 0, \lambda_2 \geq 0, \lambda_3 \geq 0, \lambda_4 \geq 0, \lambda_5 \leq 0$$

We use CPI inflation (not the wholesale price index) for the dependent variable $\dot{p}$ and the change in import price index for $\hat{p}_m$, the change in Rupee/dollar exchange rate $\dot{e}$ and the log of real gdp. For interest rates i we have used the weighted average nominal deposit rate for scheduled commercial banks.

$$\widehat{ulc} = \hat{w} + \hat{p} - \widehat{lp} \quad (12)$$

Where $\widehat{W}$ is the change in real wages, $\hat{p}$ is CPI inflation and $\dot{\widehat{lp}}$ is the change in labour productivity. Inserting (12) into (11) to get our estimated equation.

$$\hat{p} = \eta_0 + \eta_1(\widehat{p_m} + \hat{e}) + \eta_2(\hat{w} - \widehat{lp}) + \eta_3(i) + \eta_4 \ln(ms/p_{-1}) + \eta_5 \ln gdp \quad (13)$$

In another option we use expected interest rates in the money demand function instead of actual interest rates. We can make the expected interest rate equal to last year's interest rate.

In this case the estimated equation becomes:

$$\hat{p} = \psi_0 + \psi_1(\widehat{p_m} + \hat{e}) + \psi_2(\hat{w} - \widehat{lp}) + \psi_3(i_{-1}) + \psi_4 \ln(m/p_{-1}) + \psi_5 \ln gdp \quad (14)$$

$$\text{where } \psi_1 \geq 0, \psi_2 \geq 0, \psi_3 \geq 0, \psi_4 \geq 0, \psi_5 \leq 0 \text{ and } \psi_6 \geq 0$$

Note that in our model an increase in the deposit rate lowers money demand and raises inflation. This seems counter-intuitive, but it is important to understand how monetary transmission takes place. If the RBI increases the repo rate it causes both lending and deposit rates to rise. The increase in lending rates lowers inflation by reducing the demand for credit, but at the same time if deposit rates rise money demand is reduced, increasing inflation. Changes in money demand reduce the effectiveness of the RBI's policy rate on affecting inflation. Our model factors in those effects.

IV. The Estimated Equations:

The data on labor productivity is only available up to 2019 so we estimate Equation 13 for the period 1991 to 2019 with annual data (see Table 2). In equation I.1, except for unit labor cost all the other variables are significant at the 5% level of significance. A 1% increase in GDP reduces inflation by 14 % points. A 1 percent increase in the money supply increases inflation by 12.6% points. An increase in the deposit interest rate reduces the demand for money and thereby increases inflation. Our estimated equation shows that a 1 %-point increase in the deposit interest rate increases inflation by 1.2%[7]. Import prices increase inflation by making imported finished products costlier but also by making intermediate prices costlier. India is heavily dependent on imported oil and that is the main

[7] Granger Causality test show that deposit rates affect inflation but not the other way around (see Appendix).

mechanism by which imported inflation affects domestic inflation. A 1 percent increase in imported prices increases domestic inflation by 0.14% percent.

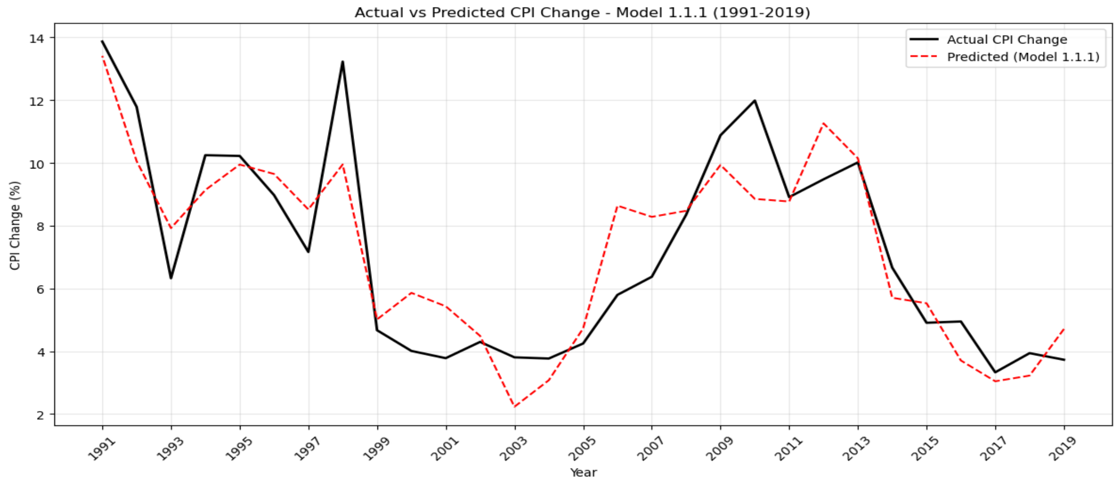
Figure 6 shows the actual and predicted inflation in this model. The model predicts well except for the year's when India was hit by an external crisis such as the Asian financial crisis 1998, the effect of the global financial crisis in 2009. In Equation I.2 we add a crisis dummy variable (CR) for the year's 1991(BOP crisis), 1998 (Asian crisis), 2009 (global financial crisis). The crisis dummy is highly significant and improves the equation fit. It shows that in a crisis year's inflation is about 2.6 % higher than in other normal years. The impact of GDP remains significantly negative and money supply positive and significant. The impact of unit labor costs remains insignificant. The coefficient of import prices is a bit smaller with the addition of a crisis variable but still significant. This is not surprising because when the crisis hits import prices are affected by global conditions but also because the rupee depreciates sharply. The coefficient for the deposit interest rate also as expected remains positive and significant. In Equation I.3 we show the estimated results for Equation 14 for our model with lagged deposit interest rates. In this equation once again the coefficients for ln gdp, ln (ms/p_{-1}) and i_{-1} as well as the crisis variable are significant but the coefficients for unit labor costs and imported inflation are not significant.

Table 2: India CPI Inflation Equation OLSQ and ARDL with Unit Labor Cost, 1991–2019

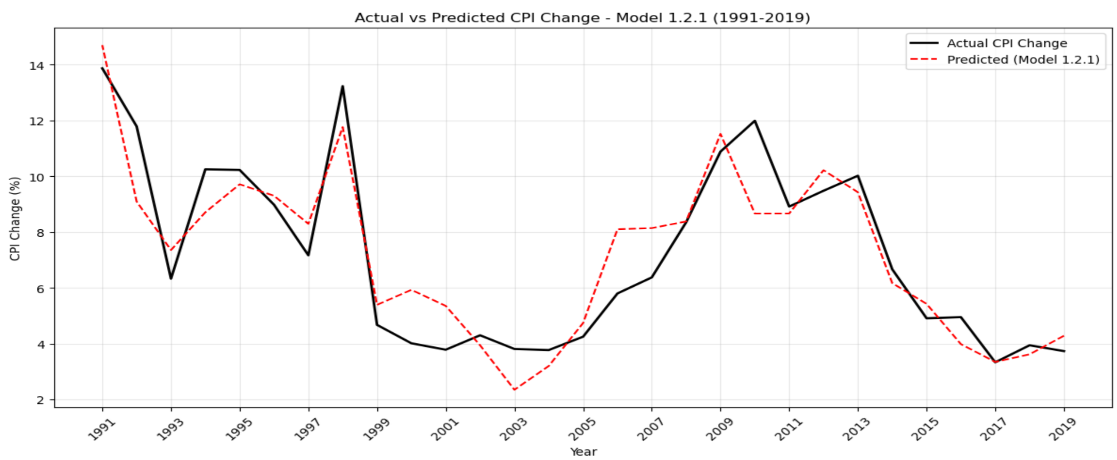
Eqn	Const	$\hat{e} + p\hat{m}$	$\hat{w} + \hat{l}^p$	Ln(gdp)	Ln(ms/p_{-1})	i	i_{-1}	CR	R^2	$\bar{R}^2$	D.W
OLS											
1.1	84.65	0.14	0.02	-14.3	12.62	1.24			0.80	0.76	1.82
	(3.4)*	(3.8)*	(0.8)	(4.5)*	(5.0)*	(6.0)*					
1.2	69.84	0.10	0.01	-12.2	10.98	1.19		2.63	0.84	0.80	2.01
	(3.0)*	(2.4)*	(0.5)	(4.0)*	(4.6)*	(6.3)*		(2.4)*			
1.3	90.89	0.06	-0.03	-14.14	11.95		1.07	3.36	0.71	0.63	1.68
	(2.9)*	(1.14)	(0.83)	(3.4)*	(3.6)*		(3.9)*	(2.3)*			
ARDL Model Long Run Elasticity with $\hat{p}$											
1.4		0.08	0.02	-14.8	12.4	1.11					
		(2.4)*	(1.04)	(12.7)*	(14.3)*	(8.3)*					

Note: $\hat{p}$ is CPI inflation, $\hat{e}$ is change in the exchange rate, $p\hat{m}$ is change in import prices, gdp is real output, ms is money supply, i is the weighted average deposit rate for scheduled commercial banks, $\hat{w}$ is change in real wages, $\hat{l}^p$ is change in labor productivity, and CR is a dummy for crisis years 1991, 1998, 2009. $\ln(ms/p_{-1})$ is the log of money supply divided by lagged CPI. * denotes significance at the 5% level.

Figure 6: Actual vs Predicted CPI Inflation from Equations I.1 and I.2: 1991-2019



Equation I.1



Equation I.2

There is simultaneity among the dependent variable $\hat{p}$ cpi inflation and several independent variables such as the change in the exchange rate $\hat{e}$, changes in real wages $\hat{w}$ and the deposit interest rate I, and lngdp is stationary in first differences only I (1). To address these simultaneous short run relationships between these variables would require a complex simultaneous equation model. We are not able to do that, but we can get the long-run relationships between them by using Auto Regressive Distributed Lag (ARDL) cointegration methods – see Chen (1997) and Kang (1999). Since the variables are all either stationary I (0) or stationary in first differences I (1) such as Ln gdp , we used the Johansen co-integrations tests and these show that the dependent and explanatory variables in our model are co-integrated at rank (2) with an optimal lag of 2 years. So, we estimated the ARDL short run (see Appendix) and long run cointegration equations.

The ARDL long run elasticity results are in Equation I.4. They show the long-run elasticities between the dependent variable CPI inflation $\hat{p}$ and the co-integrated variables. This shows that 1% increases in real money supply would increase inflation by 1.24 percentage points. A 1% decline in GDP would increase inflation by 1.48% points. A 1-point increase in deposit rates increases inflation by 1.1% as it lowers the demand for money. Real wage increases have a positive and significant effect on inflation once you factor in the cointegrated lag effects of wages on inflation and vice versa, but the effect is not large. A 10% increase in unit labor costs leads to a .2 % increase in CPI inflation. Import prices have a significant and positive effect on CPI inflation. If changes in import prices in rupees (including exchange rate changes) increase by 10 % points it leads to an increase in CPI inflation by about 0.8 % points.

The data on labor productivity is from Penn World Tables via the World Bank database. It is not clear how accurate it is and is only available up to 2019. So, as a variant of the model, we assume constant labor productivity growth. This allows us to extend the estimation to 2023 and changes equation (13) to

$$\hat{p} = \omega_0 + \omega_1(\widehat{p_m} + \hat{e}) + \omega_2(\hat{w}) + \omega_3(i) + \omega_4 \ln(ms/p_{-1}) + \omega_5 \ln gdp \quad (15)$$

Table 3: India CPI Inflation Equation OLSQ and ARDL with Real Wage 1991-2023

Eqn	Const	$\hat{e} + \hat{pm}$	$\hat{w} + \hat{l}^p$	Ln(gdp)	Ln(ms/p_{-1})	i	i_{-1}	CR	R^2	$\bar{R}^2$	D.W
OLS											
II.1	76.85	0.13	0.03	-13.3	11.97	1.17			0.74	0.70	1.77
	(3.2)*	(4.0)*	(1.2)	(4.3)*	(4.7)*	(5.8)*					
II.2	68.10	0.08	-0.01	-11.97	10.79	1.22		2.74	0.84	0.80	1.98
	(3.5)*	(2.8)*	(0.01)	(4.7)*	(5.2)*	(7.4)*		(3.8)*			
II.3	86.38	0.08	-0.01	-13.52	11.54		0.98	2.90	0.69	0.62	1.68
	(5.2)*	(2.0)**	(0.38)	(3.8)*	(4.0)*		(4.1)*	(2.9)*			
ARDL Model Long Run Elasticity with respect to $\hat{p}$											
II.4		0.10	0.04	-13.99	11.72	1.03					
		(3.3)*	(4.0)*	(11.2)*	(12.7)*	(8.6)*					

Note: $\hat{p}$ is CPI inflation, $\hat{e}$ is change in the exchange rate, $\hat{pm}$ is change in import prices, gdp is real output, ms is money supply, i is the weighted average deposit rate for scheduled commercial banks, $\hat{w}$ is the change in real wages, $\hat{l}^p$ is the change in labor productivity, and CR is a dummy variable for crisis years 1991, 1998, 2009, and 2020–2022. $\ln(ms/p_{-1})$ is the log of money supply divided by lagged CPI. * denotes significance at the 5% level; ** at the 10% level.

The results of this equation estimated for the period 1991-2023 are in Table 3. The results from this equation are not hugely different when we use changes in real wages $\hat{w}$ instead of changes in unit labor costs $\widehat{ulc}$. All the variables except for real wage growth are significant with the expected signs. But when we go to the long run elasticities using an ARDL model we see that the elasticity of real wage growth on inflation is small 0.04 but is now significant. The loop between wage growth and inflation takes about two years to complete and a jump in real wages by 10% has a 0.4% effect on inflation. We also try a different variation in deposit interest rates where we make the expected deposit rate equal to last year's deposit rate. This is reported in Equation II.3 in Table 3. It does not change the results very significantly. Figure 3 provides the actual and predicted CPI inflation from Equation II.2. We added a dummy for Inflation targeting from 2016 onwards, but it was insignificant showing that once you factor in the effects of monetary policy, imported inflation and wage inflation and supply shocks there is no additional effect from inflation targeting.

Food prices can affect inflation through their impact on wages, but also through other mechanisms such as its effect on core inflation and inflation expectations. Earlier empirical studies by Ball, Chari, and Mishra (2016) and by Eichengreen, Gupta and Chaudhry (2021) have shown that food prices affect core inflation. When food prices start to rise people expect higher inflation and start adjusting prices. We hypothesize that the wholesale food price impacts inflation with a lag. For example, we posit that wholesale prices for FY 2022-23 affects CPI inflation for CY 2023 – a three-quarter year lag. An increase in the price of food items no doubt increases the CPI, but this is a onetime effect. For it to affect inflation requires a mechanism – either by influencing inflation expectations or by some mechanism that increases money supply.

This could come through an increase in food subsidies which increases the fiscal deficit, pari passu. If the deficit gets monetized it generates inflation. If the higher fiscal deficit is financial by borrowing (often in the past through financial repression using the Statutory Liquidity Ratio) it lowers growth and that generates greater inflation for a given supply. To assess the effects of food price inflation we extend our model and make real wage growth a function of the growth in lagged wholesale food prices and log of real GDP.

$$\widehat{w} = b_0 + b_1 f\widehat{wpi}_{-1} + b_2 \ln gdp \qquad (16)$$

where $b_1 \geq 0$, and $b_2 \leq 0$.

Inserting (16) into (15) gives the following reduced form equation.

$$\hat{p} = \rho_0 + \rho_1(\widehat{p_m} + \hat{e}) + \rho_2(\widehat{fwpi}) + \rho_3(i) + \rho_4 \ln(ms/p_{-1}) + \rho_5 \ln gdp \qquad (17)$$

The results of all the equations in our model with lagged wholesale food price inflation instead of real wages are in Table 4.

In the first two equations the results are not hugely different, and the effect of changes in lagged wholesale food prices is insignificant. But when we use the lagged deposit interest rate in Equation III.3 we get a significant coefficient for the lagged wholesale food price with an elasticity of 0.18. In the ARDL estimation the long run elasticity of the wholesale food price on inflation is larger (0.25) and significant but the elasticities for all other variables gdp, money supply ms, deposit rates i all decline but remain statistically significant. The elasticity of imported inflation is now insignificant but smaller and positive.

The higher long-term elasticity of lagged wholesale prices possibly shows that it affects the expectations of future inflation. The actual and predicted CPI inflation from Equation III.2 is presented in Figure 8.

Figure 7: Actual and Predicted CPI Inflation from Equation II.2 1991-2023.

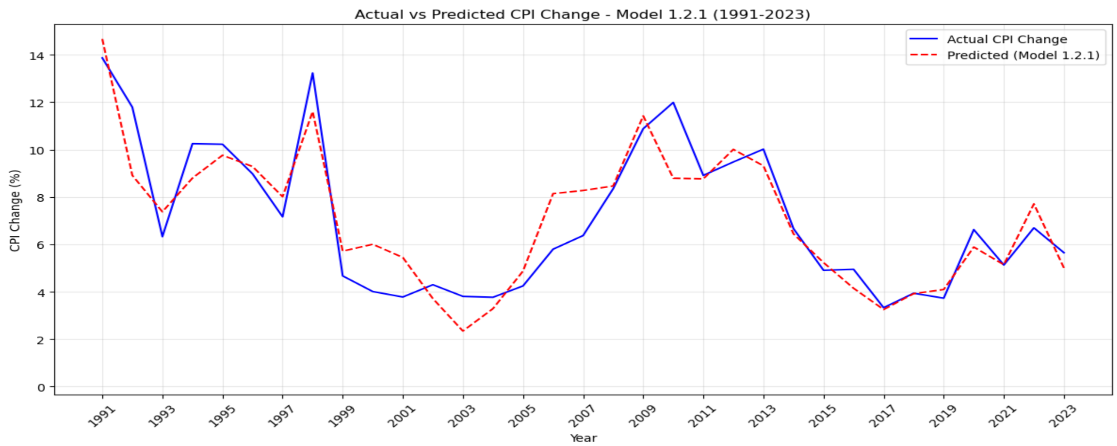


Figure 8: Actual and Predicted CPI Inflation from Equation III.2

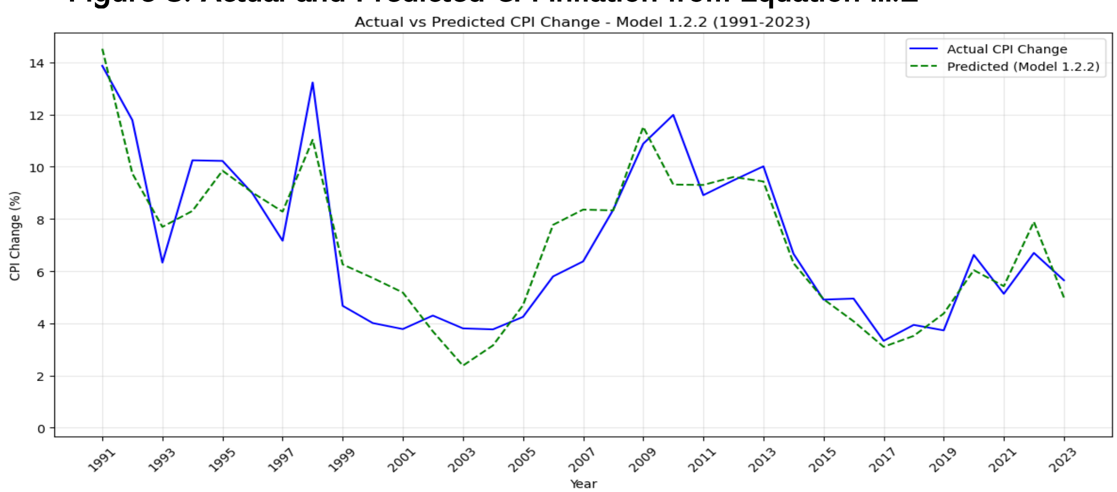


Table 4: India CPI Inflation OLSQ and ARDL with Lagged Wholesale Food Price, 1991–2023

Eqn	Constant	$\hat{e}+\hat{pm}$	$f\hat{w}pi$	Ln(gdp)	Ln(ms/p_{-1})	i	i_{-1}	CR	R^2	$\bar{R}^2$	D.W
OLS											
III.1	70.47	0.12	0.05	-12.23	11.04	1.11			0.74	0.69	1.79
	(2.9)*	(3.5)*	(0.63)	(3.8)*	(4.2)*	(4.6)*					
III.2	64.03	0.07	0.09	-11.07	9.92	1.07		2.87	0.85	0.81	2.20
	(3.4)*	(2.5)*	(1.4)	(4.4)*	(4.8)*	(5.7)*		(2.5)*			
III.3	76.77	0.06	0.18	-11.52	9.62		0.68	3.00	0.74	0.68	2.11
	(3.1)*	(1.6)	(2.22)*	(3.5)*	(3.4)*		(2.8)*	(3.4)*			
ARDL Model Long Run Elasticity with respect to $\hat{p}$											
III.4		0.03	0.25	-6.86	5.96	0.77					
		(0.7)	(3.1)*	(3.7)*	(3.0)*	(4.2)*					

Note: $\hat{p}$ is CPI inflation, $\hat{e}$ is change in the exchange rate, $\hat{pm}$ is change in import prices, gdp is real output, ms is money supply, i is the weighted average deposit rate for scheduled commercial banks, $f\hat{w}pi$ is the change in wholesale food prices lagged three quarters, and CR is a dummy for crisis years 1991, 1998, 2009, and 2020–2022. $\ln(\text{ms}/p_{-1})$ is the log of money supply divided by lagged CPI. * denotes significance at the 5% level.

To summarize we have established that a variable mark-up model can explain a substantial variation in inflation in India. The impact of imported inflation is significant but not too large because intermediates make up only 30% of total imports, which in turn are about 26% of GDP. Therefore, the long run elasticity of inflation to import prices and exchange rate change is 0.8-0.10. India also does not suffer from wage-price spirals as the share of organized labor is small. The long run elasticity of inflation to real wages is only 0.04. Food prices affect overall inflation, and we have shown that a 1% increase in wholesale food prices has a 0.25% effect over the long run on CPI inflation. Let us now turn to explain why India's inflation has deviated from world inflation using our model results.

V. Concluding Comments: Understanding Inflationary Episodes and Policy Responses

In our model both structural factors and monetary and exchange rate policy play a role in explaining inflation. Among the structural factors food price shocks and commodity price shocks – especially oil prices have triggered inflation. But their effects have been exaggerated by the structuralist school in whose framework monetary policy plays no role because they use a fixed mark-up model, whereas we have used a variable markup model with the mark-up determined by excess demand. But instead of using an output gap (typically requiring an HP filter which has problems) to determine excess demand we have used excess real money balances as a measure of excess demand. This goes back to a core finding of Milton Friedman that its excess money that drives inflation with his quote

"Inflation is caused by too much money chasing after too few goods." This allows us to capture both cost push factors and demand-pull factors in driving inflation.

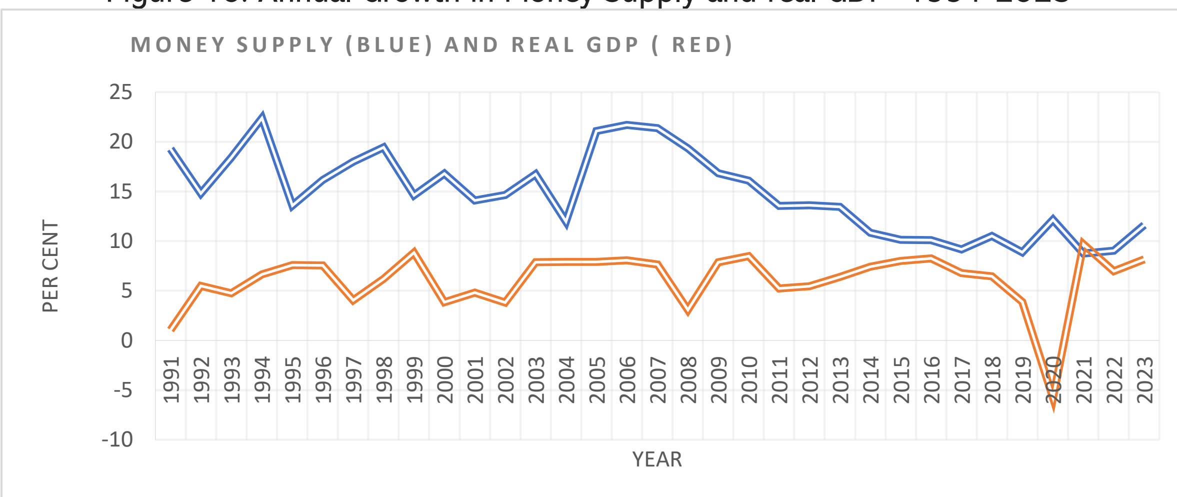
For example, the period 2009-2013 when India's inflation was remarkably high global commodity prices played a significant role in explaining that huge deviation from world inflation. We use two variants – the first are based on results from equations with unit labor costs and real wages in Tables 2 and 3. Our long-term elasticity of imported inflation is in the range 0.08-0.10. If oil prices had been 50% lower inflation in India would have been 4-5% lower over this period. But as the exchange rate was overvalued in this period by about 12% it helped reduce inflation by 1-1.2% (see Figure 9). On the other hand, the growth in money supply fell sharply after an extended period of high growth (see Figure 10). The growth in money supply averaged 17 % annually from 1991 to 2010, then stayed at 13% for the three years 2011-2013 and eventually fell to an average of 10% from 2014 to 2023. Had the growth of money supply declined to 10% in the period 2011-13 inflation would have been 3 % lower. GDP growth also slowed down in 2011 and 2012 and contributed to higher inflation. If we were to apportion the reasons for inflation in India for the three years 2011-2013 which averaged of 10% points, we could attribute 4.5% points to elevated oil prices, -1% to an overvalued exchange rate, 3% to monetary policy, 1 % to drop in GDP growth and the rest about 2.6% to higher wholesale food prices (Figure 11) which also spiked in this period. Contrary to earlier analysis by Eichengreen, Gupta and Chaudhry (2021) we see from our analysis that external commodity prices did play a substantial role in explaining elevated inflation in India from 2010-2013.

Figure 9: Real Effective Exchange Rate: India 2004-2025

In Variant II (Figure 12) we use results from the introduction of lagged wholesale prices presented in Table 4. In this variant the impact of imported inflation (oil prices) is much smaller and can even be considered insignificant but if we use the estimated coefficients of the explaining about a quarter of the inflation, whereas domestic factors play a bigger role – especially wholesale food prices. Of course, these may be capturing some of the effects of imported inflation such as fertilizer and fuel prices which are important inputs in agricultural production affect wholesale food prices.

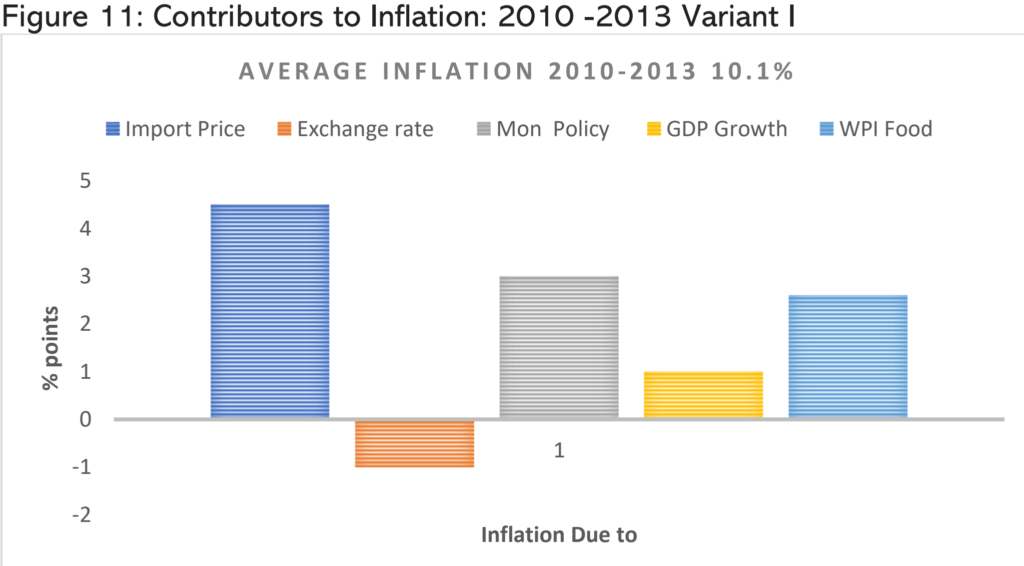
Subsequently, a very substantial share of the drop in inflation from 10% in 2013 to 4.6% by 2015 can also be attributed significantly to the sharp fall in oil prices which fell by over 50% in that period. With our estimated elasticity of 0.08 -0.10 we can attribute 4-5%-point fall in India's CPI inflation to the fall in import prices – mainly oil. And the real exchange rate which over-valued in the period 2009-2011 because the RBI allowed inflows to pass through into the economy and did not build up reserves depreciated sharply more sharply in 2013 contributing to inflation in that year.

Figure 10: Annual Growth in Money Supply and real GDP 1991-2023



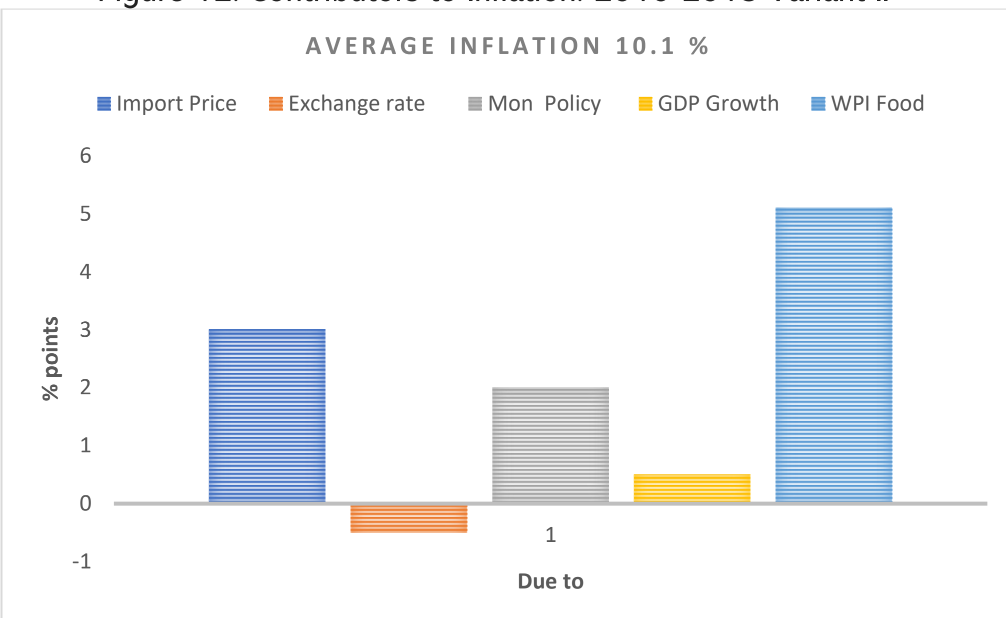
Source: RBI Handbook of Statistics

Figure 11: Contributors to Inflation: 2010 -2013 Variant I



Tightened monetary policy in 2015 also played a role in bringing inflation down along with sharp drops in the price of oil. The real repo rate was raised to +2.5 % - and the combined effect of dropping oil prices and tighter monetary policy was a very substantial reduction in inflation. Excessively tight monetary policy also played a role in keeping inflation low all the way to 2019 despite some strengthening in oil prices. Oil prices increased between 2016 and 2019 by about 20% adding 2% to India's CPI inflation but monetary policy was kept very tight in this period and kept inflation low but also hurt growth with real GDP growth dropping from 8.2% in 2016 to 3.9% in 2019 even before the pandemic.

Figure 12: Contributors to Inflation: 2010-2013 Variant II



Source: Authors Calculations

India also saw lower inflation that world inflation in 2022 and 2023 which is quite rare. Strong gdp growth played a role as well as the fact that while India had a monetary stimulus to deal with the pandemic it was never too loose, and the RBI tightened monetary policy in 2023 by raising the repo rate rapidly. India's inflation was much higher than world inflation in 2020 the year the pandemic began as monetary policy was eased very sharply, and the RBI dropped its repo rate from 5.2 % in February 2020 to 4% by May 2020. But as the RBI reversed this loose monetary policy very sharply between May 2022 and August 2022 when it raised the repo rate from 4% to 5.4% India's inflation was lower than world inflation in 2022 when world inflation spiked upwards to 7.9% and US inflation spiked up to 8% and stayed just below world inflation even in 2023.

Wage-price spirals do not play a significant role in India- in our estimates the long run elasticity of real wages on inflation is only 0.04. This is because India's labor market has plenty of slack with lots of under-employment. According to UNDP almost 77% of the employment in India is unorganized and therefore not subject to unionized wage bargaining as discussed in Chhibber and Soz (2021). Repeated pay commissions have provided very substantial wage increases to public sector employees. As a result, 90% of public sector employees get paid more than their private sector counterparts at their skill level. Therefore, there is a huge demand for public sector jobs. A pay commission award can set off a small wage price spiral but is not large enough to have a significant impact as is also seen in our econometric results.

Food price surges can set off inflation – but not necessarily only through wages but because they affect inflation expectations. The long-term elasticity of food prices on inflation in our ARDL equations is 0.25 much larger than the short run effects of food prices on inflation which range from 0.09-0.18. This means that a 10% surge in food prices can lead to inflation increasing by 2.5% over time. Among food items cereal prices which form the bulk of food consumption expenditure are kept under control through administered prices and free rations but surges in prices of vegetables, oilseeds and pulses which now form a larger share of food expenditure can trigger surges in inflation.

Despite greater trade and financial integration with world markets India has seen considerable deviation from world prices. These deviations have declined over the last decade or so – which is a good sign. The key to maintaining this record lies in maintaining growth, following a balanced monetary policy (not too tight or loose with a neutral policy rate of 1-1.5%) and managing the surges in prices in key agricultural commodities where localized shortages can set off a price spiral. Excess demand which can be due to overly loose monetary policy and oil and food price shocks has been a major contributor to inflation in India in the past and explain the deviations from world inflation. Our results also confirm that in India monetary policy matters and the structuralist school which argues for no role for monetary policy in explaining inflation in India are also wrong.

While flexible inflation targeting may not affect inflation expectations, it does provide the RBI and its attendant MPC guideposts to conduct monetary policy. It was used deftly during the pandemic to provide a quick and largish monetary stimulus but also to tighten monetary policy when the sign of robust economic recovery was there. But when used too strictly with poor predictions of inflation expectations as was the case from 2016-2019 it can hurt growth.

Bibliography

Acharya Viral V and Rahul Singh Chauhan (2024): Great Reversal? The Fall and the Rise of Industrial Concentration in India during 1991-2022 forthcoming in an edited book at Cornell University.

Adil, M.H., Hussain, R. & Matuka, A. Interest rate sensitivity of demand for money and effectiveness of monetary policy: fresh evidence from combined cointegration test and ARDL approach. *SN Bus Econ* **2**, 65 (2022).

Balakrishnan P. and M Parmeswaran (2022): What lowered inflation in India: monetary policy or commodity prices**?** *Indian Econ Rev*. 2022 Jun 27;57(1):97–111.

Balakrishnan P. and M. Parmeswaran (2023): Effect of food prices on inflation: Is monetary policy an effective tool? *Ideas for India* 19 July 2023.

Balakrishnan P. and M. Parmeswaran (2025): Inflation in India: Dynamics, distributional impact, and policy implication. *Structural Change and Economic Dynamics* Volume 74, September 2025, Pages 556-566.

Ball, Lawrence, Anusha Chari, and Prachi Mishra (2016): UNDERSTANDING INFLATION IN INDIA*" NBER Working Paper* 22948 Cambridge, MA 02138 December 2016.

Bhalla, S Karan Bhasin, Prakash Loungani (2023):Macro Effects of Formal Adoption of Inflation Targeting *IMF Working Paper* 2023/007. January 13, 2023.

Bhardwaj, M. B., & Pandit, V. (2010). Policy Reforms and Stability of the Money Demand Function in India. *Margin: The Journal of Applied Economic Research*, *4*(1), 25-47.

Bruno, Michel. (1978): "Exchange Rates, Import Costs, and Wage-Price Dynamics." *Journal of Political Economy* 86(3): 379–404.

Cheng, Hsiao (1997): "Cointegration and Dynamic Simultaneous Equations Model." *Econometrica*, vol. 65, .no 3, Econometric Society, 1997, pp. 647-670.

Chhibber, Ajay and Salman Soz (2021): "Unshackling India: Hard Truths and Clear Choices" *Harper-Collins India* November 2021.

Chinoy, Sajjid Pankaj Kumar, and Prachi Mishra (2016): What is Responsible for India's Sharp Disinflation? *IMF Working Paper* WP/16/166.

Commander Simon, Saul Estrin, Naveen Thomas, Varun Lingineni (2025): Liberalisation, concentration, and diversification: Business Groups in India, 2000-2020, *Working Paper presented at the 5th Envisioning India Conference, Goerge Washington University*, April 2025.

Eichengreen Barry, Poonam Gupta and Rishabh Choudhary (2021): Inflation Targeting in India An Interim Assessment *World Bank Policy Research Working Paper* 9422, January 2021.

Kang, H. (1999): The Applied Cointegration Analysis for the Open Economy: A Critical Review. *Open Economies Review* **10**, 325–346 (1999).

Filardo Andrew and Hans Genberg (2024): Targeting inflation in Asia and the Pacific: lessons from the recent past: *BIS Working Paper* 52.

Ha, Jongrim, M. Ayhan Kose, and Franziska Ohnsorge. 2019. Inflation in Emerging and Developing Economies: Evolution, Drivers, and Policies. Washington, DC: World Bank.

Ha, Jongrim; Kose, M. Ayhan; Ohnsorge, Franziska; Yilmazkuday, Hakan. 2023. What Explains Global Inflation. *Policy Research Working Papers World Bank*.

Hamilton James D. (2017): Why You Should Never Use the Hodrick-Prescott Filter *NBER Working Paper* No. 23429 May 2017 JEL No. C22, E32, E47.

Hatekar N, Sharma A, Kulkarni S (2011) What drives inflation in India: Overheating or input costs? *Economic & Political Weekly*. 2011; 34:46–51.

Kundurthi R, Kalluru S.R. (2024), "Inflation dynamics in India: A structural view", *PSL Quarterly Review,* 77(311), pp.471-491.

Macallan, Claire and Miles Parker (2008): How do mark-ups vary with demand? *Quarterly Bulletin* 2008 Q2 Bank of England.

Medina Juan Pablo and Juan Marcos Wlasiuk (2024): Inflation Dynamics in Latin America: Lessons from the COVID and Other Episodes, *Hutchins Center Working Paper* #99 October 2024.

Nikifouris Michael , Simon Grothe , Jan David Weber (2024): **Markups, profit shares, and cost-push-profit-led inflation** *Industrial and Corporate Change*, Volume 33, Issue 2, April 2024, Pages 342–362,

Patnaik Ila and Radhika Pandey (2020): Four Years of the Inflation Targeting Framework *NIPFP Working Paper* No. 325.

Patra M.D., H. Beheraand, J. John (2021): Is the Phillips curve in India dead, inert and stirring to life or alive and well? *Reserve Bank of India Bulletin,* Reserve Bank of India (2021), pp. 63-75.

Paul B P. (2009): In search of the Phillips curve for India. *Journal of Asian Economics*. 2009; 20:479–488.

1

Appendix

I. ARDL CPI Inflation Equation with Unit Labor Costs

Selected AR lags: [1, 2]

Selected Exog lags:

{'log money supply/lagged CPI': [0, 1, 2], 'Log GDP': [0, 1, 2], 'deposit_rates': [0, 1, 2], 'change in unit labour costs': [0, 1, 2], 'price_fx': [0, 1, 2]}

ARDL Model Results

Dep. Variable:	CPI Change	No. Observations:	29
Model:	ARDL(2, 2, 2, 2, 2, 2)	Log Likelihood	-12.113
Method:	Conditional MLE	S.D. of innovations	0.379
Date:	Fri, 23 May 2025	AIC	62.226
Time:	10:25:45	BIC	86.847
Sample:	2	HQIC	69.547
	29		

	coef	std err	z	P>|z|	[0.025	0.975]
const	150.1299	36.830	4.076	0.003	66.816	233.444
CPI Change.L1	-0.1394	0.195	-0.716	0.492	-0.580	0.301
CPI Change.L2	-0.3528	0.140	-2.519	0.033	-0.670	-0.036
log money supply/lagged CPI.L0	48.5985	5.111	9.509	0.000	37.037	60.160
log money supply/lagged CPI.L1	-37.5549	9.980	-3.763	0.004	-60.132	-14.978
log money supply/lagged CPI.L2	7.7856	7.429	1.048	0.322	-9.021	24.592
Log GDP.L0	-11.6926	16.734	-0.699	0.502	-49.548	26.163
Log GDP.L1	2.9184	18.539	0.157	0.878	-39.021	44.857
Log GDP.L2	-13.7485	11.133	-1.235	0.248	-38.933	11.436
deposit_rates.L0	1.1139	0.247	4.515	0.001	0.556	1.672
deposit_rates.L1	-0.8765	0.360	-2.435	0.038	-1.691	-0.062
deposit_rates.L2	1.4809	0.350	4.229	0.002	0.689	2.273
change in unit labour costs.L0	0.0457	0.018	2.478	0.035	0.004	0.087
change in unit labour costs.L1	0.0061	0.020	0.305	0.767	-0.039	0.051
change in unit labour costs.L2	-0.0202	0.016	-1.294	0.228	-0.056	0.015
price_fx.L0	0.0875	0.022	3.908	0.004	0.037	0.138
price_fx.L1	-0.0447	0.029	-1.527	0.161	-0.111	0.022
price_fx.L2	0.0753	0.031	2.440	0.037	0.005	0.145

Johansen trace and λ-max statistics (critical values)

r ≤	Trace	λ-max	Trace CV90	λ-max CV90	Trace CV95	λ-max CV95	Trace CV99	λ-max CV99
0 :	140.41	63.39	91.11	37.28	95.75	40.08	104.96	45.87
1 :	77.02	30.33	65.82	31.24	69.82	33.88	77.82	39.37
2 :	46.69	20.81	44.49	25.12	47.85	27.59	54.68	32.72
3 :	25.88	14.15	27.07	18.89	29.80	21.13	35.46	25.86
4 :	11.73	8.23	13.43	12.30	15.49	14.26	19.93	18.52
5 :	3.49	3.49	2.71	2.71	3.84	3.84	6.63	6.63

Estimated cointegration rank (95 % level): trace → $\hat{r} = 2$, λ-max → $\hat{r} = 1$

II. ARDL CPI Inflation Equation with Real Wages

```
Selected Exog lags:
{'log money supply/lagged CPI': [0, 1, 2], 'Log GDP': [0, 1, 2], 'deposit_rates': [0, 1, 2], 'Wage': [0, 1], 'price_fx': [0, 1, 2
                                ARDL Model Results
==============================================================================
Dep. Variable:                CPI Change   No. Observations:                   33
Model:               ARDL(2, 2, 2, 2, 1, 2)   Log Likelihood                 -17.594
Method:              Conditional MLE   S.D. of innovations              0.427
Date:               Wed, 14 May 2025   AIC                             71.187
Time:                       04:05:44   BIC                             96.999
Sample:                            2   HQIC                            79.601
                                  33
==================================================================================================
                                    coef    std err          z      P>|z|      [0.025      0.975]
--------------------------------------------------------------------------------------------------
const                           125.8735     29.942      4.204      0.001      61.653     190.094
CPI Change.L1                    -0.0073      0.167     -0.043      0.966      -0.366       0.352
CPI Change.L2                    -0.3225      0.109     -2.972      0.010      -0.555      -0.090
log money supply/lagged CPI.L0   48.8578      4.748     10.290      0.000      38.674      59.042
log money supply/lagged CPI.L1  -42.3656      8.875     -4.774      0.000     -61.401     -23.330
log money supply/lagged CPI.L2    9.0930      7.150      1.272      0.224      -6.242      24.428
Log GDP.L0                       -2.7258      6.296     -0.433      0.672     -16.230      10.779
Log GDP.L1                        5.4235      8.022      0.676      0.510     -11.781      22.628
Log GDP.L2                      -21.2981      7.041     -3.025      0.009     -36.400      -6.196
deposit_rates.L0                  0.9604      0.208      4.619      0.000       0.514       1.406
deposit_rates.L1                 -1.0412      0.312     -3.342      0.005      -1.709      -0.373
deposit_rates.L2                  1.4534      0.284      5.115      0.000       0.844       2.063
Wage.L0                           0.0382      0.014      2.781      0.015       0.009       0.068
Wage.L1                           0.0174      0.015      1.192      0.253      -0.014       0.049
price_fx.L0                       0.0931      0.020      4.597      0.000       0.050       0.137
price_fx.L1                      -0.0286      0.022     -1.303      0.214      -0.076       0.018
price_fx.L2                       0.0701      0.019      3.639      0.003       0.029       0.111
```

```
Johansen trace and λ-max statistics (critical values)

 r ≤       Trace       λ-max    Trace CV90    λ-max CV90    Trace CV95    λ-max CV95    Trace CV99    λ-max CV99
------------------------------------------------------------------------------------------------------------------------
   0 :    138.70       60.74         91.11         37.28         95.75         40.08        104.96         45.87
   1 :     77.96       39.91         65.82         31.24         69.82         33.88         77.82         39.37
   2 :     38.05       21.94         44.49         25.12         47.85         27.59         54.68         32.72
   3 :     16.11       11.71         27.07         18.89         29.80         21.13         35.46         25.86
   4 :      4.40        4.39         13.43         12.30         15.49         14.26         19.93         18.52
   5 :      0.01        0.01          2.71          2.71          3.84          3.84          6.63          6.63

Estimated cointegration rank (95 % level): trace → r^ = 2,   λ-max → r^ = 2
```

III. ARDL CPI Equation with Lagged Wholesale Food Price

```
Selected Exog lags:
{'log money supply/lagged CPI': [0, 1, 2], 'Log GDP': [0], 'deposit_rates': [0, 1, 2], 'FA Price': [0, 1, 2], 'price_fx': [0, 1, 2]}
                                ARDL Model Results
==============================================================================
Dep. Variable:                 CPI Change   No. Observations:                 33
Model:             ARDL(2, 2, 0, 2, 2, 2)   Log Likelihood               -20.940
Method:                   Conditional MLE   S.D. of innovations            0.475
Date:                    Wed, 14 May 2025   AIC                           75.880
Time:                            04:43:11   BIC                          100.258
Sample:                                 2   HQIC                          83.827
                                       33
================================================================================================
                                    coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------------------------
const                            52.8050     18.910      2.792      0.014      12.500      93.110
CPI Change.L1                     0.0241      0.156      0.154      0.879      -0.308       0.357
CPI Change.L2                    -0.2325      0.090     -2.583      0.021      -0.424      -0.041
log money supply/lagged CPI.L0   36.6075      5.616      6.518      0.000      24.637      48.578
log money supply/lagged CPI.L1  -39.2779     10.659     -3.685      0.002     -61.997     -16.559
log money supply/lagged CPI.L2    9.8726      7.525      1.312      0.209      -6.166      25.911
Log GDP.L0                       -8.2890      2.434     -3.406      0.004     -13.476      -3.102
deposit_rates.L0                  0.8697      0.233      3.740      0.002       0.374       1.365
deposit_rates.L1                 -0.8724      0.305     -2.863      0.012      -1.522      -0.223
deposit_rates.L2                  0.9332      0.232      4.021      0.001       0.439       1.428
FA Price.L0                       0.0506      0.039      1.297      0.214      -0.033       0.134
FA Price.L1                       0.1673      0.069      2.438      0.028       0.021       0.314
FA Price.L2                       0.0797      0.062      1.288      0.217      -0.052       0.212
price_fx.L0                       0.0490      0.027      1.831      0.087      -0.008       0.106
price_fx.L1                      -0.0519      0.021     -2.494      0.025      -0.096      -0.008
price_fx.L2                       0.0364      0.020      1.788      0.094      -0.007       0.080
```

Johansen trace and λ-max statistics (critical values)

r ≤	Trace	λ-max	Trace CV90	λ-max CV90	Trace CV95	λ-max CV95	Trace CV99	λ-max CV99
0 :	147.67	52.32	91.11	37.28	95.75	40.08	104.96	45.87
1 :	95.36	43.35	65.82	31.24	69.82	33.88	77.82	39.37
2 :	52.01	34.39	44.49	25.12	47.85	27.59	54.68	32.72
3 :	17.62	12.60	27.07	18.89	29.80	21.13	35.46	25.86
4 :	5.01	4.98	13.43	12.30	15.49	14.26	19.93	18.52
5 :	0.04	0.04	2.71	2.71	3.84	3.84	6.63	6.63

IV. Causality Test Inflation and Deposit Rate

Granger Causality Test Results:

==============================

	Cause	Effect	Lag 1 p-value	Lag 2 p-value	Lag 3 p-value	Evidence of Causality
0	CPI Change	deposit_rates	0.5372	0.8690	0.4299	No
1	deposit_rates	CPI Change	0.0199	0.0875	0.0320	Yes