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by Sajjid Chinoy, Pankaj Kumar and Prachi Mishra

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Asia and Pacific Department

What is Responsible for India's Sharp Disinflation?[1]

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Abstract

We analyze the dramatic decline in India's inflation over the last two years using an augmented Phillips Curve approach and quantify the role of different factors. Our results suggest that, contrary to popular perception, the direct role of lower oil prices in India's disinflation was relatively modest given the limited pass-through into domestic prices. Instead, we find that inflation is a highly persistent process in India, reflecting very adaptive expectations and the backward looking nature of wage and support price-setting. As a consequence, we find that a moderation of expectations, both backward and forward, and a rationalization of Minimum Support Prices (MSPs), explain the bulk of the disinflation over the last two years.

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[2] The authors institutions are JP Morgan (Chinoy) and Reserve Bank of India (Mishra and Kumar).

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I. INTRODUCTION

Over the last 15 years, inflation has consistently been a symptom of macroeconomic stability – or lack thereof – in India. Between 2000 and 2006, for example, headline CPI averaged just 4%, a period during which growth and investment began a secular acceleration and external imbalances narrowed rapidly. However, things began to change from the second-half of the last decade. Headline CPI began a worrying ascent from 2006, and averaged more than 9% between 2006 and 2013. The stickiness of inflation coincided with growing macroeconomic stability concerns: the post-Lehman growth rebound was temporary, external imbalances began to widen as households flocked to physical assets and gold, and the currency came under sustained depreciation pressures, with things coming to a head during the taper tantrum of 2013.

But, as sticky as headline CPI was between 2006 and 2013, the disinflation since then has been equally dramatic. After peaking at 12.1% year-on-year growth in November 2013, headline CPI inflation collapsed to 4.3% in December 2014 – a fall of nearly 800 bps in 13 months – before accelerating to 5% in October 2015. The dramatic decline has led to two obvious and related questions. First, what was responsible for the sharp decline over the last two years? And, therefore, is the decline durable or transitory?

Answers to these questions are not trivial, given the various moving pieces during this period. The disinflation over the last two years has been accompanied by a collapse in global oil and commodity prices, a sharp fall in global food prices, a new monetary policy regime aimed at anchoring inflation expectations, a new government working on alleviating food supply bottlenecks, and continued restraint on agricultural support prices. So how does one ascertain the extent to which different factors contributed to the disinflation? This paper uses a simple econometric model and tries to quantify the contribution of the different factors.

Overall, our findings suggest that the evolution of inflation in India is a complex mix of the state of the business cycle (output gaps), adaptive and forward looking expectations,

institutional mechanisms such as the determination of agriculture support prices and backward-looking wage indexation that amplify the persistence of inflation shocks, and global factors that include oil and food prices, and exchange rates.

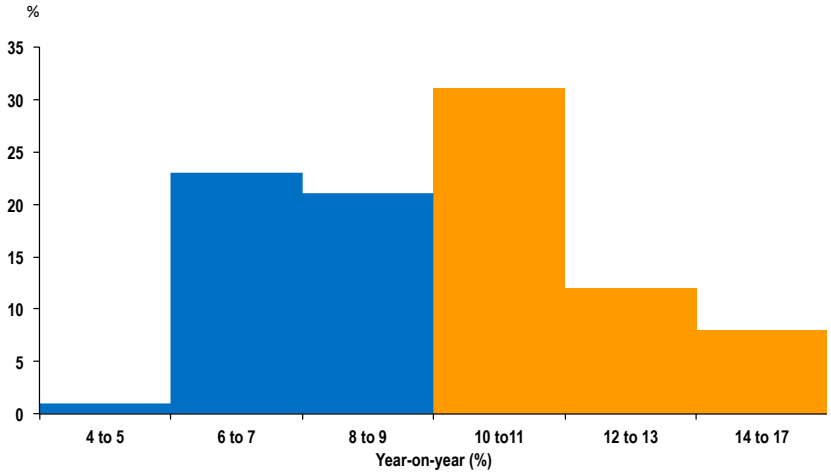
Simulations based on our econometric model suggest that close to half of the disinflation between fiscal years 2013/14 and 2014/15 can be attributed to a moderation in the historical dynamics of inflation which influence contemporaneous inflation. This likely reflects both a softening of backward looking (adaptive) expectations as well as in the institutional process of wage and MSP setting that increase the persistence of past shocks. In addition, about 20% of the disinflation can be explained by a sharp decline in the growth of the discretionary component of MSPs, after controlling for the effects of wages, other input costs, and global food prices that go into the determinants of MSP setting. Finally, about a third of the disinflation can be attributed to forward-looking expectations. This likely captures the effect of the new monetary policy regime announced in January 2014, and potentially the fact that the collapse in oil and commodity prices was, over time, perhaps believed to be increasingly permanent, thereby altering future inflation expectations and underpinning wage and price setting behavior. An additional interesting finding that emerges from our analysis is that lagged inflation is a significant determinant of wages and once we include these in the model, the explanatory power of wages reduces sharply; therefore wages are more an "outcome" than a "driver" of the inflation process, which is consistent with the backward-looking nature of wage indexation.

The rest of the paper is organized as follows. Sections II provides some context on the state of play before the disinflation, and Section III documents the sources of disinflation. In Section IV, we estimate an augmented Phillips Curve for India and use it to quantify the extent to which different factors were responsible for the disinflation. Section V concludes with relevant policy implications.

II. SOME CONTEXT: THE STUBBORNNESS OF RETAIL INFLATION

To appreciate how dramatic the recent disinflation has been, it is important to understand what preceded it. As indicated above, retail inflation (as proxied by CPI-Industrial Workers) averaged 9.1% year-on-year between January 2006 and December 2014, i.e. a period of eight years. Of particular salience is both the persistence and breadth of CPI inflation during this time. Of the 96 months under consideration, CPI was above 9% for 51% of those months and above 8% for 63% of those months. Therefore 1 or 2 years of abnormally high inflation were not skewing the average.

Figure 1. Frequency distribution of CPI-IW inflation: 2006-13



Apart from its persistence, the breadth of inflation was equally worrying. There is a perception that food was the only factor responsible for the high and rising retail inflation. But non-food, non-fuel (core) inflation averaged 7.8% during this period, just 130 bps below headline, suggesting that inflation was not only persistent, but also broad-based.[3]

[3] However, core inflation was persistently below headline for most of the period between 2006 and 2010. The purpose of a core inflation index is to get an accurate measure of the current inflation trend. Since core inflation was lower than the headline till 2010, that may have been suggestive of a downward pressure on future headline inflation (see for example Anand et. al., 2014 and also Cecchetti, 2007 for a critique of using core as a forecast for future headline inflation).

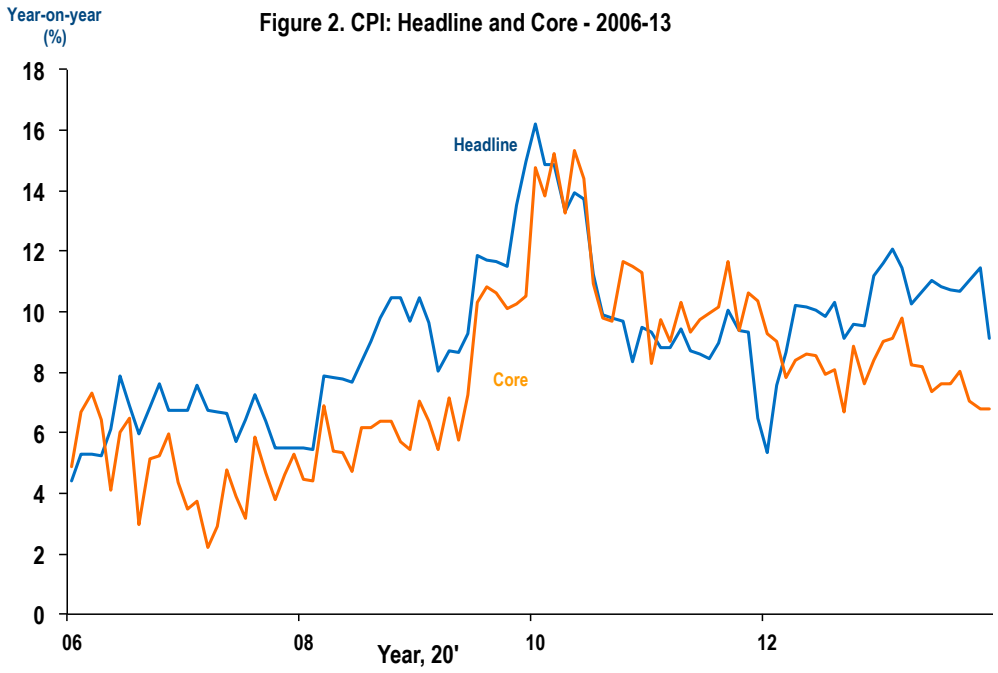


Figure 2. CPI: Headline and Core - 2006-13

III. FOLLOWED BY THE SHARP DISINFLATION

It is against this backdrop that we need to assess the magnitude of the recent disinflation and its contributors. The new all-India CPI was close to double-digits between 2012 and 2014, averaging 10.1% in 2012/13 and 9.8% in 2013/14. Since then, however, there has been a dramatic plunge. Average inflation fell to 6% in 2014/15 – 400 bps lower than the previous two years. And thus far in 2015/16, it is another 140 bps lower, averaging 4.6% between April and October. The momentum of inflation, measured by the annualized quarterly growth in the seasonally adjusted CPI has also declined from 12.9% during the last quarter of 2013 to just 2.9% q/q, saar from August-October 2015.

How has the disinflation been distributed? 62% of the decline in headline CPI inflation between 2013/14 and 2014/15 is attributable to the disinflation in food, and 38% is attributable to non-food. Within non-food, 22% of the decline is attributable to core and

16% to fuel prices.[4] Although the decline in food is a dominant factor, the fact that almost 40% of the disinflation was on the non-food side would suggest a relatively broad-based disinflation driven by various factors.

Table 1a. Dis-inflation dynamics: 2013/14 and 2014/15

	CPI	Food	Fuel	Core
Quantum of disinflation	3.8	5.1	4.0	2.2
Contribution by group (%)	100.0	62	16	22

Note. Fuel includes "transport and communication" which has a large component of fuel. Core excludes food, fuel, transport and communication.

For now, however, we dig one level deeper into food inflation and examine what's driven the sharp moderation in this category. The decline in food inflation is concentrated in a few commodities. Cereals and vegetables – which account for less than 35% of the CPI food basket – are responsible for 92% of the disinflation in food between 2013/14 and 2014/15.

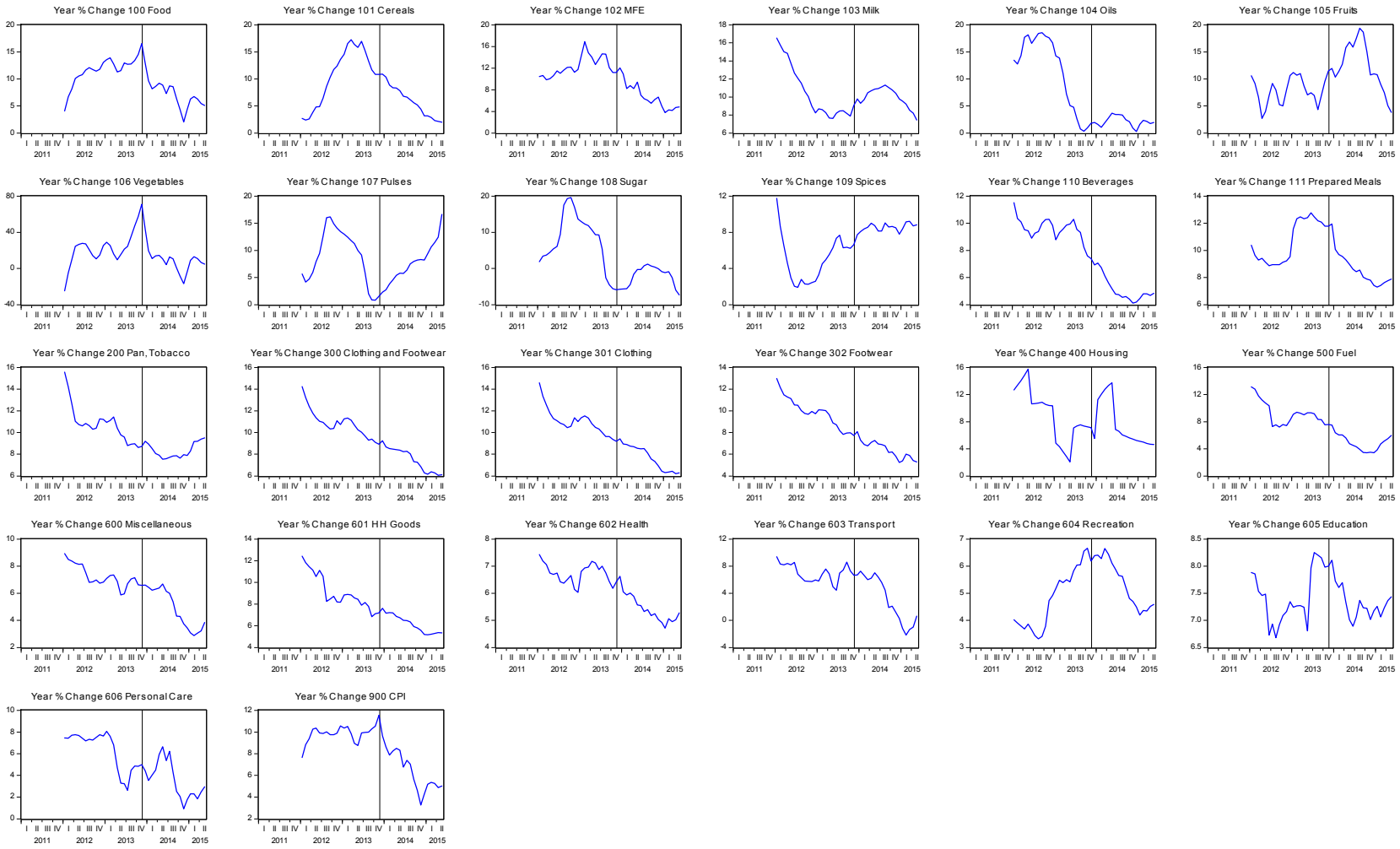
Table 1b. Food disinflation dynamics: FY15 versus FY14

	Food	Vegetable	Cereals
Quantum of disinflation	5.1	22.5	8.2
Contribution by group (%)		58	34

Figure 3 below digs deeper into inflation dynamics for various food groups. The decline in the overall CPI inflation rate almost coincides in timing with the reversal of vegetable inflation, which accelerated sharply through the middle of 2013, but then started decelerating from November 2013. Cereals, on the other hand, showed a declining trend even before the drop in overall inflation. In contrast, inflation rates for food groups such as pulses and spices remained firm, despite the overall decline in headline and food inflation.

[4] Core excludes food, fuel, and transport and communication. The latter is included in the contribution of the fuel category.

Figure 3: Y-o-Y Inflation in the Major Groups and Sub-Groups of CPI



IV. WHY HAS INFLATION DECLINED? QUANTIFYING THE CONTRIBUTION OF DIFFERENT FACTORS

In this section, we analyze the drivers of inflation in India, to help quantify the drivers of the recent disinflation. We do so in two ways. We start by estimating a single equation augmented Phillips Curve approach where we model inflation as a function of the output gap, inflation expectations, global factors such as crude and food prices, and structural characteristics unique to India. In the Appendix, we also estimate a general vector auto regression (VAR) model in order to have a more structured approach to identification, to allow for the fact that several key variables in our model are simultaneously determined, and to capture the full dynamic interactions among the variables included in the model. We then use the estimated parameters from these models to quantify the factors contributing to disinflation over the last two years.

A. Single Equation Model

We start with a very simple single equation model as exposited in leading textbooks in macroeconomics. A large body of research is based on the Phillips curve introduced in Milton Friedman's Presidential Address to the AEA (1968). This relation can be written as

$$\pi_t = \pi_t^e + \alpha(x_t - x_t*) \quad +\in_t \qquad (1)$$

where π_t is inflation, π_t^e is expected inflation, and x_t is a measure of economic activity, typically either the log level of output or the unemployment rate. The variable x_t* is the long run level of x, which is called the natural rate when x is unemployment and potential output when x is output. The term $x_t - x_t*$ captures short-run fluctuations in output or unemployment, which could be attributed to e.g. fiscal and monetary policies. The error term $\in_t$ captures unobservable factors that influence inflation. The expected inflation term captures the idea that expectations of inflation tend to be self-fulfilling: if price and wage setters expect a certain level of inflation, they raise their nominal prices and wages to keep up with that expected level of inflation and, in so doing, they perpetuate the very inflation they

expected. The $x_t - x_t *$ term captures the idea that an increase in activity relative to the economy's normal level raises firms' marginal costs, which causes them to raise prices by more than they otherwise would.

Since modeling inflation expectations is not our key focus, we remain relatively agnostic about the expectations-formation process and assume a hybrid expectation formation process with both an adaptive (backward looking) and a rational (forward looking) component present.[5] We capture adaptive expectations by introducing lags of headline CPI inflation. To capture forward-looking or rational expectations, we introduce a "dummy" variable, which takes a value of one during 2014Q1-2015Q1. The dummy captures the timing of the introduction of the new monetary policy regime by the RBI. [6] The new regime of "flexible inflation targeting" with a public commitment to quantitative targets was a structural break from the old "multiple-indicator" regime, and specifically intended to anchor inflation expectations. Once we control for backward looking expectations, as well as all other potential determinants of inflation, we assume that the dummy can be considered to be a proxy for forward looking expectations. Admittedly, the dummy is a crude proxy for any anchoring of inflation expectations through the introduction of an inflation targeting regime. The dummy, for example, could also reflect forward-looking expectations of oil and commodity prices on the back of their collapse in 2014, to the extent that forward looking expectations are not fully captured by current price changes.[7]

Furthermore, we augment the basic Phillips curve model to include several other domestic and global factors that could potentially influence quarterly movements of inflation in India, quite separate from slack in the economy. Domestic variables include (i) changes in minimum support prices for agriculture (which are a policy variable) that along with a system

[5] See Reserve Bank of India (2014) for a hybrid model of expectation formation, and Ball, Chari, and Mishra (2015) for estimation of a partial-adjustment model of expectations for India. See also Ball and Mazumder (2011), and references therein for a review of the voluminous literature on estimating inflation dynamics.

[6] See RBI monetary policy statement, January 2014.

[7] Note that actual crude prices are already controlled for in the empirical framework, therefore the dummy could only reflect the effect of crude prices on expectations.

of open-ended procurement by the government set a floor for market prices for many commodities; (ii) rural wages -- which are influenced both by slack – and therefore already captured in the output gap – but are also potentially influenced by changes in administratively-set minimum wages or Mahatma Gandhi National Rural Employment Guarantee Scheme (MNREGS) wages which will not be captured by the output gap; (iii) a dummy variable for rainfall shortages, which impacts agricultural production and therefore food inflation, and could lead to a more generalized inflation spiral. The global variables we add are international crude prices, global food prices and exchange rate movements to capture pass-through effects.

Specifically, we assume that inflation is determined by the following equation:

$$\pi_t = \sum_{n=1}^{n=8} \zeta_n \, \pi_{t-n} + \theta D_{new-regime} + \alpha(x \quad - x \quad *)_{t-1} + \beta w_{t-1} + \gamma msp_{t-1} + \delta Rain_t + \sum_{n=1}^{n=8} \rho_n GF_{t-n} + \tau X_{t-1} + v_t \quad (2)$$

where π_t is the year-on-year growth of headline CPI by quarter; $x_t - x_t *$ represents the aforementioned output gap which is lagged by a quarter with the potential output being calculated by a simple HP filter[8]; w_{t-1}, and msp_{t-1} are the one-quarter lagged year-on-year growth rates in rural wages, and minimum support prices (MSP) respectively. MSP is set at an annual frequency based on the crop year from July to June. We spread the annual growth in MSP smoothly over the quarters using a cubic spline methodology. $Rain_t$ is a dummy for below-normal monsoon, which takes a value of 1 when the south-west monsoon rainfall for the year is less than 85%.[9] $D_{new-regime}$ is a dummy variable, which takes a value of 1, for

[8] We use a standard HP filter with a smoothing parameter λ equal to 1600. HP filter is likely to suffer from an end-point bias i.e. potential output may be affected by actual output at the end point of the sample; we also use other measures of potential output which may be less subject to this concern (see Table 4 and the robustness section).

[9] Our choice of an 85% threshold to set the dummy is guided by earlier work, see, for example, "India's food inflation: worrying about the wrong problem," JP Morgan, July 30, 2015. Furthermore, there is significant variation in rainfall across geographic regions in India. If rainfall is, for example, below normal, in regions where crops with high weight in the food basket are grown, that may have a larger impact on food and overall inflation. However, given the absence of a good measure of the spatial distribution of rainfall, it is not included in the empirical analysis. In addition, food inflation is

the period starting the first quarter of 2014, GF_{t-n} denotes global food prices, X_{t-1} denotes other global factors, namely, one quarter lagged year-on-year growth in crude prices, and the Rs./$ exchange rate.[10] If we compare equations (1) and (2), π_t^e in equation (1) is reflected in the first two terms in Equation (2), $x_t - x_t*$ is the standard output gap term in both the equations, and all the other expressions in Equation (2) are captured by $\in_t$ in Equation (1). The variables in $\in_t$ denote factors that go beyond the standard Phillips curve specification, and are potentially important determinants of inflation in India.

All variables are entered as year-on-year growth rates, and we use quarterly data from 2000Q2 to 2015Q1.[11] We choose 8 lags of CPI inflation in our baseline specification. Our choice of 8 lags is influenced by tests of optimal lag length and the need to introduce several lags to minimize serial correlation. Previous work also suggests that a shock to inflation impacts expectations by a lag of at least 4-8 quarters (see Patel Committee Report). In our baseline specification, the output gap is estimated using the HP filer. In alternative specifications, we try different measures of the output gap. We lag output gap, global crude prices, and exchange rate by one quarter to capture the fact that transmission from these variables into inflation takes time and will not be instantaneous.

One major concern in the estimation of our baseline specification is that of reverse causality. Wages and MSP could be determined by contemporaneous inflation (see Box 1 below on the potential simultaneity of MSPs, wages and inflation). To start with we lag MSP and wages by one quarter. In the absence of serial correlation in inflation, contemporaneous inflation is less likely to influence past MSPs or wages, unless these variables have a forward-

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also determined by food management policies of the government, which could be interacted with the monsoon dummy. Again, the lack of good proxies for the latter preclude their inclusion in the empirical specification.

[10] The results are unchanged if we use the nominal effective exchange rate (NEER) instead of the Rs./$ rate. We keep the latter in the baseline as most imports are invoiced in US$.

[11] We tested for non-stationarity in the three key variables of interest – inflation, MSP growth, and wage growth. Using the methodology in Clemente, Montañés, Reyes (1998), we rejected the null hypothesis of a unit root in the series for inflation and MSP growth at the 10 percent level of significance. We could not, however, reject the null of a unit root in the wage growth series. Therefore, we included the first difference of wage growth in the single equation model for robustness, but the main findings remained unchanged (see Table 5).

looking component to them i.e. if for example, expectations about future inflation determine current wages (see Box 1 for why this is unlikely in the Indian context).

Additionally, however, if there is serial correlation in the inflation series, contemporaneous inflation is determined by past lags of inflation, which could be correlated with lags of wages and MSP, and bias these coefficients if the past inflation lags are not explicitly included as regressors.

Alternatively, there could be omitted variables that determine MSP, wages, and inflation. The government sets MSPs based on recommendations by the Commission for Agricultural Costs and Prices (CACP). CACP calculates future MSPs based on costs of inputs such as fuel, fertilizer, wages and global food prices. Since costs of inputs feed into inflationary pressures, lags of inflation are likely to be correlated with MSPs. Similarly, lagged inflation could also play some role in the wage setting process. Although wage indexation is not widespread in India, some wages, for example, those under the rural employment guarantee scheme (MNREGS, or the Mahatma Gandhi National Rural Employment Guarantee Scheme) – which are administratively set – are formally indexed to past inflation. For these reasons, omitting lags of domestic inflation would potentially bias the wage coefficients, while omitting lags of both domestic headline inflation and global food inflation would bias the MSP coefficient. Since MSP and administered wages are typically set annually and are likely to take into account the previous year's inflation (either directly or indirectly), we include eight lags of domestic headline inflation and global food inflation to address the omitted variables problem. So the choice of eight lags is dictated both by statistical and economic reasons.

B. Empirical Findings

Table 2 below presents our main results. The basic variables of the Phillips Curve – the output gap and inflation expectations – are found to have both economic and statistical significance in explaining changes in India's CPI inflation. A one percentage point increase in the output gap (a negative gap closing or a positive gap widening) increases headline

inflation by 52 bps, with a lag of one quarter, and the result is statistically significant at the 5% level.

Inflation expectations too have an economically and statistically significant impact. Several lags of inflation, even beyond a year, are statistically significant, underscoring the persistence of inflation shocks in India[12]. Having controlled for other determinants of inflation, we interpret lagged inflation to proxy for adaptive inflation expectations. More generally, however, lags of inflation could also capture other institutional mechanisms (MSP setting and wage indexation – see Box 1) that propagate the persistence of inflation in India.

The "New Regime Dummy" reduces headline CPI, on average, by 143 bps, and is statistically significant at the 5 percent level. As discussed above, the new regime dummy is likely to proxy for forward looking expectations after controlling for backward looking expectations, output gap, and other structural determinants of inflation. Given that regime credibility – or lack thereof – is a function of time, we would expect this coefficient to evolve over time. Moreover, while the dummy could reflect the effect of the introduction of the new monetary policy regime, the fact that it is turned on starting from the first quarter of 2014 suggests it could also be capturing how forward-looking expectations may have been influenced by the dramatic collapse in oil prices that year. Therefore, we remain more agnostic about what the dummy captures. Overall, our findings suggest that inflation expectations – both backward and forward looking – are important determinants of inflation in India.

Importantly, the estimated coefficient on minimum support prices (MSPs) is also weakly statistically significant at the 15% level. A one percentage point increase in growth of MSP is associated with a 6 bps increase in headline CPI inflation. MSPs are typically a function of input costs, global food prices and a variety of other factors (see Box 1 for details).

[12] Because we year-on-year inflation rates and a quarterly data, concerns may arise that the serial correlation is by construction. However, even if we use annual data, where there is no correlation by construction, we find lagged CPI to be economically and statistically significant – suggesting it is proxying inflation expectations.

Therefore, some of the determinants of MSP are likely to be correlated with historical CPI inflation and lags of global food prices that are already included as regressors in our model. Therefore, the estimated coefficient on MSP can be thought of as the "discretionary" increase in MSPs after controlling for other drivers. So while the influence of MSPs in univariate regressions is larger, they are likely reflecting input cost pressures and the influence of global food prices. After one controls for these factors, what remains – and is of policy interest – is the discretionary component of MSP setting, which we find is economically but only weakly statistically significant. The significant role of MSP in explaining India's inflation is also consistent with other work such as Anand et. al. (2016).

In contrast to the role of MSPs, wages – which are commonly perceived to be a key driver of inflationary pressures – turn out to be statistically and economically insignificant, once we control for the lags of inflation. Specifically, we lag wages by 1 quarter, so that concerns about reverse causality are mitigated, and wages are considered a "predetermined variable". If the inflation series exhibits serial correlation, the latter assumption would not be valid. Including several lags of inflation addresses any problems of serial correlation, and also controls for any role of lagged inflation in the wage setting process. The DW statistic is close to 2, and does not suggest much evidence for serial correlation in the errors. The fact that wages drop out in the presence of inflation lags, suggest that they have no incremental explanatory power, and largely capture variability in previous inflation, which should not be a surprise given the wage indexation process (see Box 1). Wage variability, therefore, can be thought of more as an outcome of the inflation process than a driver of it.

We find that a sub-par monsoon has an appreciable, but non-linear, effect on inflation. When the monsoon is below 85% of its normal quantum, headline inflation rises by almost 67 bps, and it is statistically significant at the 10 percent level. Some lags of global food prices also have some independent explanatory power (at least at the 20% level of significance), but their primary impact appears to be through influencing the MSP setting process.[13]

[13] See, for example, "India's food inflation: worrying about the wrong problem," JP Morgan, July 30, 2015.

Other variables have a smaller impact on inflation in our baseline specification. A one percentage point increase in global crude prices results in a 1 bps increase in headline CPI, and is statistically distinguishable from zero at the 15 percent level. Importantly, the elasticity estimates from our regression model only capture the effect of crude prices on inflation, after controlling for all other potential determinants of inflation. Oil prices could also have effects on inflation through some of the other determinants such as MSP and global food prices, and so the composite impact of oil could be larger.

Finally, a 1 percentage point appreciation of the rupee against the US$ is associated with a reduction in the inflation rate by 8 bps and is significant at the 5% level[14]. The low estimates for the pass-through of exchange rates into inflation are consistent with some of the prior work on India (see for example, Bhattacharya et. al. 2008).

Overall our baseline specification is able to explain about 96% of the variation in headline CPI.

[14] The exchange rate is represented as US$ per rupee; so an increase is an appreciation which should be disinflationary, and hence the negative sign.

Table 2: Determinants of Inflation in India

Dependent variable: Year-on-Year CPI Inflation Rate	
Output gap - HP filter - 1Q lag	0.52**
Annual growth in wages - 1Q lag	-0.04
Annual growth in MSP - 1Q lag	0.06^
Dummy for below normal monsoon	0.67*
Annual growth in $/Re. exchange rate - 1Q lag	-0.08**
Annual growth in world food price index - 1Q lag	0.02
Annual growth in world food price index - 2Q lag	-0.03^
Annual growth in world food price index - 3Q lag	0.01
Annual growth in world food price index - 4Q lag	0.00
Annual growth in world food price index - 5Q lag	0.01
Annual growth in world food price index - 6Q lag	-0.02
Annual growth in world food price index - 7Q lag	0.04*
Annual growth in world food price index - 8Q lag	0.00
Annual growth in world crude price - 1Q lag	0.01^
Dummy for new monetary policy regime#	-1.43**
CPI inflation - 1Q lag	0.41**
CPI inflation - 2Q lag	0.23
CPI inflation - 3Q lag	0.18
CPI inflation - 4Q lag	-0.30**
CPI inflation - 5Q lag	0.47**
CPI inflation - 6Q lag	0.01
CPI inflation - 7Q lag	0.01
CPI inflation - 8Q lag	-0.21**
Observations	60
R-squared	0.96
D-W-statistic	1.96
B-G serial correlation test (LM test)	0.16
AIC	2.50
SBC	3.33

** indicates significant at 5% level, * indicates significant at 10% level, ^ indicates significant at 15% level. #: NEWREGIME is a binary 1 for 2014Q1-2015Q1, a substantially low yoy inflation period.

Box 1: Inflation, Wages and MSPs: What's Driving What?

Given the institutional structures in India, there is an inherent simultaneity about the evolution of rural wages, minimum support prices and inflation in India. As we discuss below, each of these variables is potentially a function of the other two. Understanding these relationships, particularly the temporal element, is important to (i) formulating the right specification for modeling inflation, but also (ii) understanding "what's driving what," i.e. whether MSPs and rural wages are outcomes of inflation or drivers of it, and (iii) understanding the reasons behind high degrees of inflation persistence in India.

The simultaneity between wages and inflation is well understood, particularly in developed economies, where organized labor is a substantial fraction of the labor force, and a centralized wage negotiation process largely determines wages. Higher wages, by pushing up input costs, are a key determinant of inflation. Equally, however, inflation drives the wage setting process, either ex ante or ex post. Higher expected inflation has long been hypothesized to put upward pressure on inflation through the expectations-augmented Phillips Curve. Equally, unanticipated inflation feeds into wages "after the fact" so as to restore real wages and equilibrate the labor market.

In India, however, this relationship is less typical, because a large fraction of the labor force – particularly in the rural economy – is employed in the unorganized sector that is bereft of unionizations and centralized wage negotiation. Therefore, the feedback from inflation to rural wages is largely "ex post" in the form of administered increases to the rural employment guarantee scheme (MGNREGA) wages. These wages are formally indexed every year to the previous year's CPI-RL inflation and, because they have essentially become the floor of all rural wages, put upward pressure on all rural, and with a lag urban, wages. But, because wages are indexed in this "backward looking" manner, worries about "reverse causality" are less of a concern, i.e. today's wages are less influenced by expectations of tomorrow's inflation and more by yesterday's inflation.

The real question, therefore, is to understand whether changes in wages exert independent pressure on inflation, or are simply reflecting past fundamentals: inflation and MSPs. As it turns out, it's the latter. Wages have economic and statistical significance in the presence of MSPs. But they cease to become significant as soon as we add more than one lag of inflation. What this suggests is that wage variability, controlling for slack, are more an outcome of previous inflation – which ties in with the "backward looking" nature of the wage indexation – rather than an independent source of pressure.

The relationship between MSPs and inflation is equally intriguing. By effectively serving as the floor price of key food groups, MSP inflation has an important influence in shaping food, and therefore headline, inflation. The question is whether there is a feedback loop from inflation to MSPs, and

whether MSPs too suffer from the same fate as wages, i.e. become insignificant once past inflation is taken into account. As it turns out, that is not the case. MSPs retain their significance which is unsurprising given that the Commission for Agricultural Costs and Prices (CACP) -- which sets the MSPs – has repeatedly indicated that input costs, which would be expected to correlate with past inflation, are only one factor that drives MSPs, and a variety of other factors play a role. Specifically, the CACP cites a variety of other factors apart from input costs (demand and supply; price trends in the market, both domestic and international; inter-crop price parity; terms of trade between agriculture and non-agriculture; likely implications of MSP on consumers of that product) as factors that influence MSP setting.

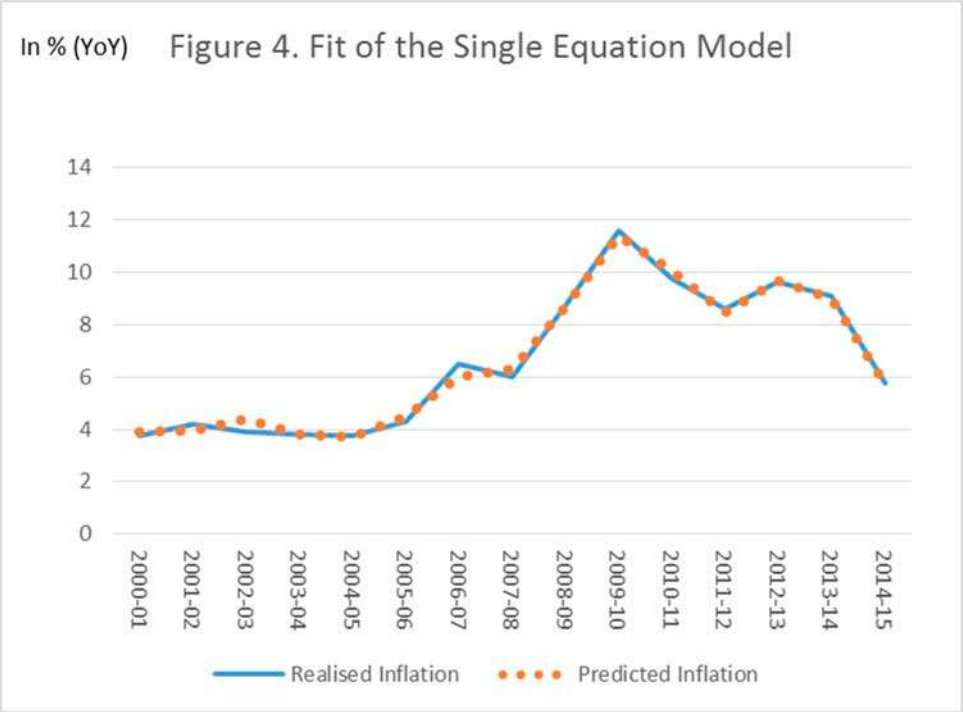
The fact that the influence of MSPs on inflation is robust to the addition of multiple other controls adds credence of this independent explanatory power of MSPs on inflation. Furthermore, concerns about "reverse causality" are mitigated given that the CACP methodology appears to be based more on historical inputs rather than expected inflation. Therefore, in the absence of serial correlation, the reverse causality issue is less of a concern.

Finally, MSPs and wages have their own independent dynamic. As the CACP makes clear, past wages clearly have a role in the MSP setting process. But the reverse is also likely true, that MSPs drive the demand for agricultural labor and thereby likely drive rural wages, quite independent from the state of the business cycle or supply shocks.

All told, there is a complex and dynamic inter-relationship between MSPs, wages and inflation. Our empirical work suggests wages are much more of an outcome of the inflation process, rather than a driver of it. In contrast, a component of MSPs is more "exogenous" and seems to have independent explanatory power, even after controlling for other factors. Finally, the backward looking nature of wage indexation and MSP setting suggest the existence of specific institutional structures in India that can accentuate the impact of exogenous shocks, and lead to persistence of inflation in India.

C. Quantifying the Contribution of Different Factors

Figure 4 below shows the fit of our regression model. Since the quarterly movements are volatile, we show the annual average of the predicted and realized values of inflation. As is evident, the predicted and realized values are strongly correlated and our model explains more than 95% of the quarterly variation in inflation[15].



Next, we decompose the predicted inflation into its components. The quarterly components are averaged over the year. Predicted inflation declined by 3.5 percentage points between 2013/14 and 2014/15, compared to an actual decline of 3.3 percentage points.

Table 3a below shows the contribution of various factors in percentage terms, which sum to 100. Lags of inflation – which are a proxy for adaptive inflation expectations but also reflect

[15] There could be a legitimate concern that the high R^2 is a sign of overfitting given that we have 60 observations and 24 explanatory variables. However, even if we drop several lags to generate a more parsimonious model, the R^2 is still 91%, which should allay concerns about overfitting.

the persistence of the inflation process resulting from the manner in which wages and MSPs are set in India-- account for 46% of the disinflation. The second biggest contributor is the new regime dummy – which proxies forward-looking inflation expectations – and accounts for 33% of the disinflation. The discretionary component of MSPs is the third largest contributor, which account for 21% of the disinflation between 2013/14 and 2014/15. Therefore, inflation expectations and MSPs setting seem responsible for the bulk of the disinflation over the last year.

In contrast, the role of global factors is much smaller during this period, with global crude prices and exchange rate stability together accounting for less than 13% of the disinflation. As explain in the attached Box 2, however, the low contribution of oil prices in explaining the disinflation is both the choice of time period but, more importantly, the fact that only a small fraction of the oil price decline was passed through. Global food prices and a closing output gap, on the other hand were exerting upward pressures on inflation in 2014/15, and therefore contribute negatively to explain the disinflation. We are agnostic in the paper about how fiscal and monetary policies could have contributed to the closing output gap; but clearly despite a fiscal consolidation between 2013/14 and 2014/15, the overall policy stance led to closing output gaps. It is perhaps puzzling that we do not find a bigger role for global factors (food, oil, commodities) in explaining the disinflation. Box 2 argues that it is partly due to the time period during which we are trying to explain the disinflation process. If we choose a different period, the role of global factors increases, but domestic factors continue to be the predominant drivers of the disinflation in India.

Table 3a. Contributors to Disinflation Between 2013/14 and 2014/15

	In percentage points	In %
Decline in model predicted inflation	3.3	100
Lagged Inflation	1.5	46
MSP	0.7	21
New regime	1.1	33
Global crude	0.1	2
Exchange rate	0.4	11
Output gap	-0.3	-8
Global food	-0.1	-4

Note. The decomposition exercise is based on the estimated coefficients in Table 2. The predicted values and the decomposition is based on only those coefficients which are statistically distinguishable from zero at least at the 20 percent levels.

Box 2: Why not a Larger Role for Oil?

One puzzle is why we don't find a bigger role for oil in explaining the disinflation. Part of it has to do with choice of time period. The exercise we conduct is trying to explain the disinflation across two fiscal years: 2013-14 and 2014-15. During this time, for example, (one-quarter lagged) year-on-year oil prices only declined by 8% on average, which is the reason why oil only accounts for a miniscule percentage (2%) of the disinflation during this period. If one changes the time horizon, however, global factors play a more important (though still not a predominant) role. For example, oil prices dropped by a massive 66% during the first three quarters of 2015, relative to the same period in 2014. As a consequence, their contribution to the disinflation rose to 11% during that period. More generally, the role of global factors (food, exchange rate, oil) in explaining the disinflation rose to 42% during that particular time period (as is laid out in Table 3b) – compared to just 10% in the baseline period. So the choice of period matters.

That said, even if we choose the specific time period during which global factors were most important, they explain less than half the disinflation. Lagged inflation – proxying for inflation expectations and institutional mechanisms at home – still account for 52% of the disinflation and, together with MSPs, accounts for 60%. So "domestic factors" are still the predominant driver of the disinflation, no matter what the time period under consideration. What may be driving that? Key is that a very small fraction of the oil price flowed through into actual price cuts both (i) because the retail price for many petroleum products was subsidized before oil prices began to fall; and (ii)a large fraction of the decline was captured by the government through successive tax hike increases. For example, between October 1, 2014 to March 15, 2016, crude prices fell 56%, but retail prices of gasoline and high speed diesel only fell 13% and 21% respectively, explaining the relatively lower share of oil in explaining India's disinflation.

Table 3b. Contributors to Disinflation Between 2015 and 2014 (Q1-Q3)

	In percentage points	In %
Decline in model predicted inflation	4.40	100
Lagged Inflation	2.29	52
MSP	0.36	8
New regime	0.00	0
Global crude	0.48	11
Exchange rate	0.68	15
Output gap	-0.11	-2
Global food	0.71	16

Note. The decomposition exercise is based on the estimated coefficients in Table 2. The predicted values and the decomposition is based on only those coefficients which are statistically distinguishable from zero at least at the 20 percent levels.

D. Robustness

In this section, we check the robustness of the estimated coefficients in Table 2 to a number of alternative specifications. The results are presented in Table 4. Column [1] repeats the specification in Table 2.

In column [2], we include first difference in wage growth to address any potential non-stationary issues in wages. Column [3] uses an alternative definition of weak monsoon, i.e. a deficiency of 10% below normal is defined as a year with below-normal monsoon. Columns [4]-[6] use alternative definitions of output gap. Finally in column [7], we use growth in agriculture production instead of a dummy for weak monsoon.

The key variables of interest reported in Table 2 are robust to all these additional specifications. The coefficient on wages, on the other hand, is statistically indistinguishable from zero in all the specifications. Several lags of inflation and the regime change dummy remain significant across most specifications. Furthermore, the baseline results are also

robust to measurements of the output gap. For example, if we use the Christiano-Fitzgerald filter, the effect of output gap on inflation increases to 60 bps, without affecting any of the other results. The impact of the monsoon also remains positive though a deficiency greater than 15% has a much larger impact on headline inflation (67 bps) against the 10% threshold (27 bps) reinforcing the non-linearity, and consistent with earlier findings[16]. World food prices – first, second and the seventh lags remain statistically significant at least at the 20 percent level.

The coefficient on MSP ranges from 0.05 to 0.12 in columns [1]-[10] of Table 4, with a one-percentage point increase in MSP being associated with in a 5-12 bps increase in headline CPI inflation. The estimated coefficient is statistically significant at least at the 20% level in all specifications. We also repeat the decomposition exercise using the estimated coefficients in columns [2]-[10] of Table 4. The results remain broadly robust. Based on the estimated coefficients in columns [3]-[10], the lagged dynamics of inflation continue to be the biggest contributor of the disinflation between 2013/14 and 2014/15, with their contribution ranging from 37-52%. The new regime dummy accounts for 14-44% of the decline in inflation.

[16] These findings are consistent with earlier work; see, "India's food inflation: worrying about the wrong problem," JP Morgan, July 30, 2015.

Box 3: The Role of MSPs: Separating the Wheat from the Chaff

One ostensible puzzle is that MSPs are only explaining a small fraction of the disinflation –20% in our baseline – when in fact several commentators have postulated a much greater role for them. The difference arises, in part, because we believe MSPs, themselves, are influenced by a variety of factors (input factors proxied by historical lags of CPI, global food prices) and therefore once we control for those factors independently, the "discretionary" component of MSPs explains a much smaller part of the disinflation. To further tease this out, we run regressions that successively drop these determinants, and would expect to see the role of MSPs correspondingly rise. This would proxy for the "overall effect" of MSPs that other studies may find. In columns [8]-[10] of Table 2, for example, we examine the sensitivity of the coefficient of MSP to dropping some of its potential determinants. In Column [8], we estimate a very basic specification with only the output gap, MSP, dummy for monsoon, and a dummy for the new monetary policy regime – thereby dropping all the lags of global food prices and CPI. Not surprisingly, the estimated coefficient of MSP rises sharply from 0.06 in the preferred model to 0.32 in column [8]. These results are important because they suggest that, in fact, MSP growth is proxying the impact of lagged global food inflation and domestic inflation. By excluding these variables, we are mistakenly attributing the role of these factors to MSPs. Importantly, the model in column [8] may also be mis-specified because the omitted variables (inflation lags and global food price lags) could also be independently determining inflation, and thereby biasing the MSP coefficient. In columns [9] and [10], we repeat the idea in column [8], but drop only selected determinants of MSP. Specifically, we include only one and four lags of world food price in column [9] and [10] respectively. Not surprisingly, the estimated coefficients on MSP rise relative to our baseline model in column [1], but are lower than that that in column [8] which strips out a larger set of factors determining MSP.

If we use these larger coefficients, the role of MSPs in explaining the disinflation unsurprisingly rises. For example, MSP completely explains the disinflation between 2013/14 and 2014/15 if we use the estimates in column [8] where we omit several factors that may be driving the MSP. However, as we alluded to above, this approach is mis-specified, given some of the omitted variables are also found to influence CPI inflation. Based on specifications where some of these omitted variables are included, [columns 9 and 10], the contribution of MSP reduces to between 43-48%, suggesting that world food prices, for example, are a significant determinant of MSP, and that the contribution of the exogenous component of MSP reduces once we account for previous years' world food prices. All told, however, we believe that specifications where any of these variables are omitted, may end up bumping up the MSP coefficient, but (a) are mis-specfied, and (b) the higher MSP coefficient is actually just capturing other underlying forces. To confirm this, we estimate a simple regression of MSP on lags of CPI inflation and lags of world food prices. Lags of inflation are included to capture broader input costs. We include eight lags of each. The variables explain a substantial fraction - 68% - but not all of the variation in MSPs (see Figure 6). This is not surprising given that the CACP itself explicitly indicates that it uses a multitude of information to set MSPs (see Box 1).

Table 4: Determinants of Inflation in India: Robustness Checks

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
	Preferred	Differenced Wage	Rain Def>10%	Alternatives to Output Gap			Alternative to Rain	MSP's total effect by dropping several explanatory variables	Alternative Lags of World Food Prices	
Dependent variable: Year-on-Year CPI Inflation Rate										
Output gap - GDP HP filter - 1Q lag	0.52 **	0.50 **	0.48 **				0.56 **	0.77 **	0.40 **	0.40 **
Output gap - Non-agriculture GDP HP filter 1Q lag				0.54 **						
Output gap - GDP Christiano Fitzgerald 1Q lag					0.60 **					
Output gap - IIP 1Q lag						0.15 *				
Annual growth in wages - 1Q lag	-0.04		-0.04	0.00	-0.03	0.01	-0.03		0.01	0.00
Change in annual growth in wages - 1Q lag		0.02								
Annual growth in MSP - 1Q lag	0.06 ^	0.07 *	0.06 ^	0.07 **	0.06 ^	0.05	0.05	0.32 **	0.12 **	0.11 **
Dummy for below normal monsoon(def>10%)			0.27							
Dummy for below normal monsoon (def>15%)	0.67 *	0.70 *		-0.13	1.02 **	0.28		2.20 **	0.86 **	0.79 **
Annual growth in agri-production - 1Q lag							-0.05 *			
Annual growth in $/Re. exchange rate - 1Q lag	-0.08 **	-0.07 **	-0.08 **	-0.06 **	-0.08 **	-0.05 *	-0.07 **		-0.04 *	-0.04 *
Annual growth in world food price index - 1Q lag	0.02	0.02	0.02	0.02	0.01	0.01	0.03 ^		0.00	0.01
Annual growth in world food price index - 2Q lag	-0.03 ^	-0.03 ^	-0.03	-0.03 ^	-0.02	-0.03	-0.03 ^			-0.02
Annual growth in world food price index - 3Q lag	0.01	0.02	0.00	0.00	0.02	0.01	0.00			0.00
Annual growth in world food price index - 4Q lag	0.00	0.00	0.01	0.00	-0.01	0.00	0.00			0.01
Annual growth in world food price index - 5Q lag	0.01	0.01	0.01	0.02	0.02	0.01	0.02			
Annual growth in world food price index - 6Q lag	-0.02	-0.02	-0.01	-0.03	-0.01	-0.01	-0.02			
Annual growth in world food price index - 7Q lag	0.04 *	0.04 *	0.04 *	0.04 *	0.03	0.02	0.04 *			
Annual growth in world food price index - 8Q lag	0.00	0.00	0.00	0.00	0.00	0.01	0.01			
Annual growth in world crude price - 1Q lag	0.01 ^	0.01 *	0.01	0.00	0.01 **	0.01	0.01		0.01 *	0.01 *
Dummy for new monetary policy regime#	-1.43 **	-1.10 **	-1.67 **	-1.25 **	-2.65 **	-1.20 *	-1.54 **	0.71	-0.66	-0.71
Year-on-Year CPI inflation - 1Q lag	0.41 **	0.36 **	0.43 **	0.38 **	0.44 **	0.49 **	0.41 **		0.49 **	0.52 **
Year-on-Year CPI inflation - 2Q lag	0.23	0.22	0.23	0.22	0.19	0.15	0.23 ^		0.14	0.18
Year-on-Year CPI inflation - 3Q lag	0.18	0.14	0.17	0.21	0.19	0.12	0.22		0.15	0.13
Year-on-Year CPI inflation - 4Q lag	-0.30 **	-0.28 *	-0.30 **	-0.39 **	-0.21	-0.28 *	-0.36 **		-0.33 **	-0.35 **
Year-on-Year CPI inflation - 5Q lag	0.47 **	0.43 **	0.45 **	0.41 **	0.45 **	0.39 **	0.45 **		0.44 **	0.42 **
Year-on-Year CPI inflation - 6Q lag	0.01	-0.01	0.02	0.05	0.00	0.06	0.03		-0.01	0.03
Year-on-Year CPI inflation - 7Q lag	0.01	-0.04	0.01	0.02	-0.05	-0.06	0.00		-0.06	-0.05
Year-on-Year CPI inflation - 8Q lag	-0.21 **	-0.16 *	-0.21 **	-0.24 **	-0.16 *	-0.14	-0.21 **		-0.20 **	-0.21 **
Observations	60	60	60	60	60	60	60	60	60	60
R-squared	0.96	0.96	0.96	0.96	0.96	0.94	0.96	0.60	0.95	0.95
D-W-statistic	1.96	1.91	1.90	1.78	1.85	1.67	1.79	0.45	1.74	1.75
B-G serial correlation test (LM test)	0.16	0.01	0.00	1.58	0.60	0.16	0.99	36.66	1.40	1.07
AIC	2.50	2.51	2.56	2.45	2.57	2.82	2.50	4.14	2.54	2.58
SBC	3.33	3.35	3.40	3.29	3.41	3.66	3.34	4.32	3.14	3.28

** indicates significant at 5% level, * indicates significant at 10% level, ^ indicates significant at 15% level. #: NEWREGIME is a binary 1 for 2014Q1-2015Q1, a substantially low year-on-year inflation period.

E. More on Wages and Inflation

In order to explore further the relationship between wages and inflation, we modify the baseline specification in Table 2. Table 5 shows the results. Column [1] repeats the results from Table 2. In column [2], we use contemporaneous wages instead of one-quarter lags. Column [3] drops all lags of inflation. Column [4] use contemporaneous wages and drops the lags of inflation. Column [5] incudes only one lag of inflation.

Column [2]-[4] of Table 5 reveals that wages have a positive association with headline CPI, but only in the absence of lags of inflation. The relationship is strongly positive and statistically significant in Columns [3] and [4]. Using contemporaneous wages instead of lags also increases the explanatory power of wages, but the main effect comes from dropping the lags of inflation. Specifically, a one percentage point increase in wage growth increases headline inflation by 0.26 bps in Column [4], and the effect is statistically significant at the 5% level. However, in the absence of any lags of CPI (Columns 3 and 4), serial correlation concerns rise, reflected in the fact that the Durbin Watson statistic drops dramatically, indicating concerns around serial correlation cannot be rejected. Adding even one lag of CPI Column [5] restores the DW statistic close to 2 (where it should be) but causes the economic significance to drop by 80%. The results confirm that lagged inflation is a significant determinant of wages; and once we include these in the model, the explanatory power of wages reduces sharply, which is consistent with the backward-looking nature of wage indexation, as discussed in Box 1.

Importantly, this is also true after controlling for the output gap. Therefore, the wage coefficient can be interpreted as the portion of wage growth impacting inflation that only arises from administrative increases, (e.g. increases in MGNREGA or minimum wages) since the variability of wages on account of slack is likely correlated with, and captured by, the output gap variable. What this suggests is that administrative increases in wages are correlated with lagged inflation – which is understandable because they are typically motivated by cost of living adjustments – and therefore have no independent explanatory power. Overall, wages are determined within the system and, once we control for MSPs, output gaps and lagged inflation, wages have no *independent* influence on headline CPI.

The results seem to suggest that wages are more an "outcome" than an independent "driver" of the inflation process. The results do not imply that wages do not matter for inflation; they suggest that wages affect inflation, but through lags of inflation; to the extent there is a wage indexation process, wages do indeed matter.

Figure 5 shows the fitted values from a simple OLS regression of wages on 8 lags of inflation. The eight lags of inflation explain about 80% of the variation in wage growth. The figure clearly shows that lags of inflation do a good job of predicting the wage process. Figure 6 plots the actual growth in MSP and the fitted values from a regression of MSP growth on eight lags of CPI inflation and world food price growth.

Table 5: Inflation and Wages in India

		Wages and Prices			
	[1]	[2]	[3]	[4]	[5]
	Preferred	Contemporaneous Wages	CPI lags absent	[2] and [3]	One CPI lag
Dependent variable: Year-on-Year CPI Inflation Rate					
Output gap - HP filter - 1Q lag	0.52 **	0.44 **	0.37 **	0.30 **	0.29 **
Annual growth in wages		0.06		0.25 **	
Annual growth in wages - 1Q lag	-0.04		0.22 **		0.04
Annual growth in MSP - 1Q lag	0.06 ^	0.09 **	0.13 **	0.14 **	0.06 ^
Dummy for below normal monsoon(def>15%)	0.67 *	0.75 **	1.12 *	1.26 **	0.78 *
Annual growth in $/Re. exchange rate - 1Q lag	-0.08 **	-0.06 **	-0.05	-0.05 *	-0.03
Annual growth in world food price index - 1Q lag	0.02	0.01	0.04 ^	0.02	0.03 ^
Annual growth in world food price index - 2Q lag	-0.03 ^	-0.03	-0.04	-0.01	-0.04
Annual growth in world food price index - 3Q lag	0.01	0.01	0.02	0.00	0.02
Annual growth in world food price index - 4Q lag	0.00	0.00	-0.01	0.00	-0.01
Annual growth in world food price index - 5Q lag	0.01	0.01	0.00	-0.01	0.02
Annual growth in world food price index - 6Q lag	-0.02	-0.02	-0.01	-0.01	0.00
Annual growth in world food price index - 7Q lag	0.04 *	0.03 ^	0.00	0.01	0.02
Annual growth in world food price index - 8Q lag	0.00	0.00	0.04 **	0.03 ^	0.00
Annual growth in world crude price - 1Q lag	0.01 ^	0.01 **	0.00	0.01	0.00
Dummy for new monetary policy regime#	-1.43 **	-0.61	0.38	0.67	-0.38
Year-on-Year CPI inflation - 1Q lag	0.41 **	0.37 **			0.68 **
Year-on-Year CPI inflation - 2Q lag	0.23	0.15			
Year-on-Year CPI inflation - 3Q lag	0.18	0.14			
Year-on-Year CPI inflation - 4Q lag	-0.30 **	-0.28 **			
Year-on-Year CPI inflation - 5Q lag	0.47 **	0.38 **			
Year-on-Year CPI inflation - 6Q lag	0.01	-0.06			
Year-on-Year CPI inflation - 7Q lag	0.01	-0.02			
Year-on-Year CPI inflation - 8Q lag	-0.21 **	-0.15 *			
Observations	60	60	60	60	60
R-squared	0.96	0.96	0.86	0.91	0.93
D-W-statistic	1.96	1.81	1.09	1.10	2.05
B-G serial correlation test (LM test)	0.16	0.66	13.65	11.19	0.61
AIC	2.50	2.48	3.45	3.02	2.84
SBC	3.33	3.32	4.01	3.58	3.43

** indicates significant at 5% level, * indicates significant at 10% level, ^ indicates significant at 15% level.#: NEWREGIME is a binary 1 for 2014Q1-2015Q1, a substantially low yoy inflation period.

Figure 5. Growth in Wages and Lagged CPI Inflation

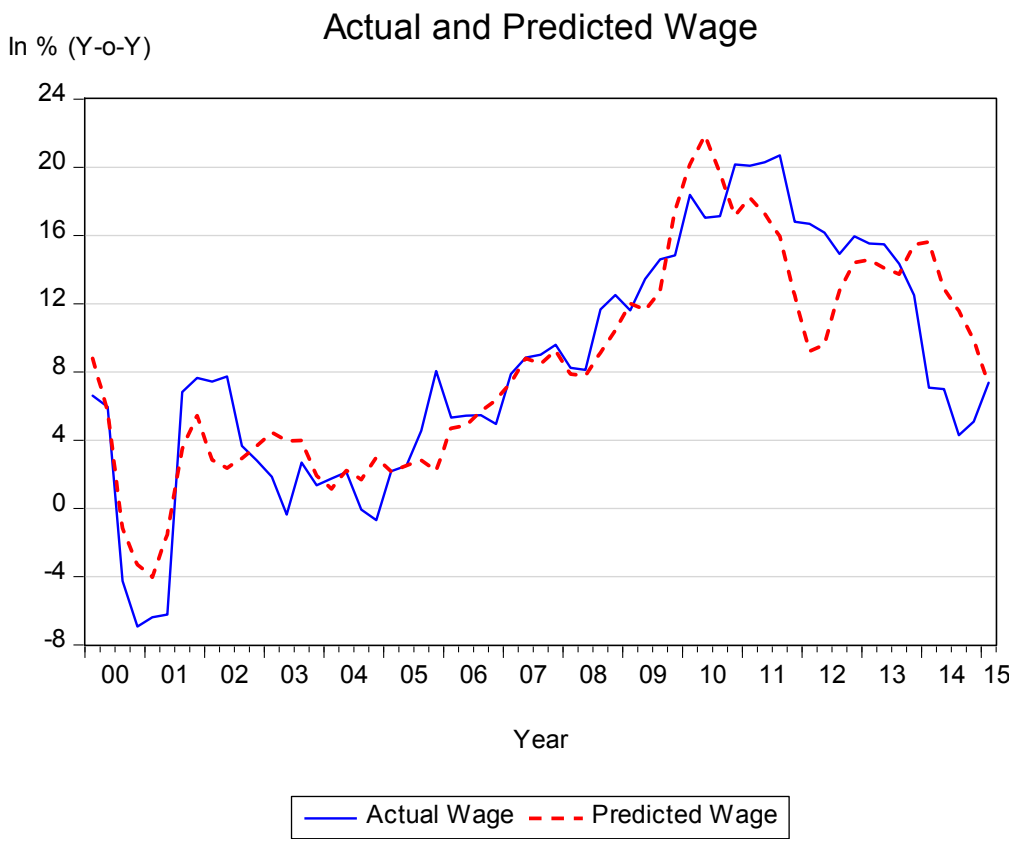
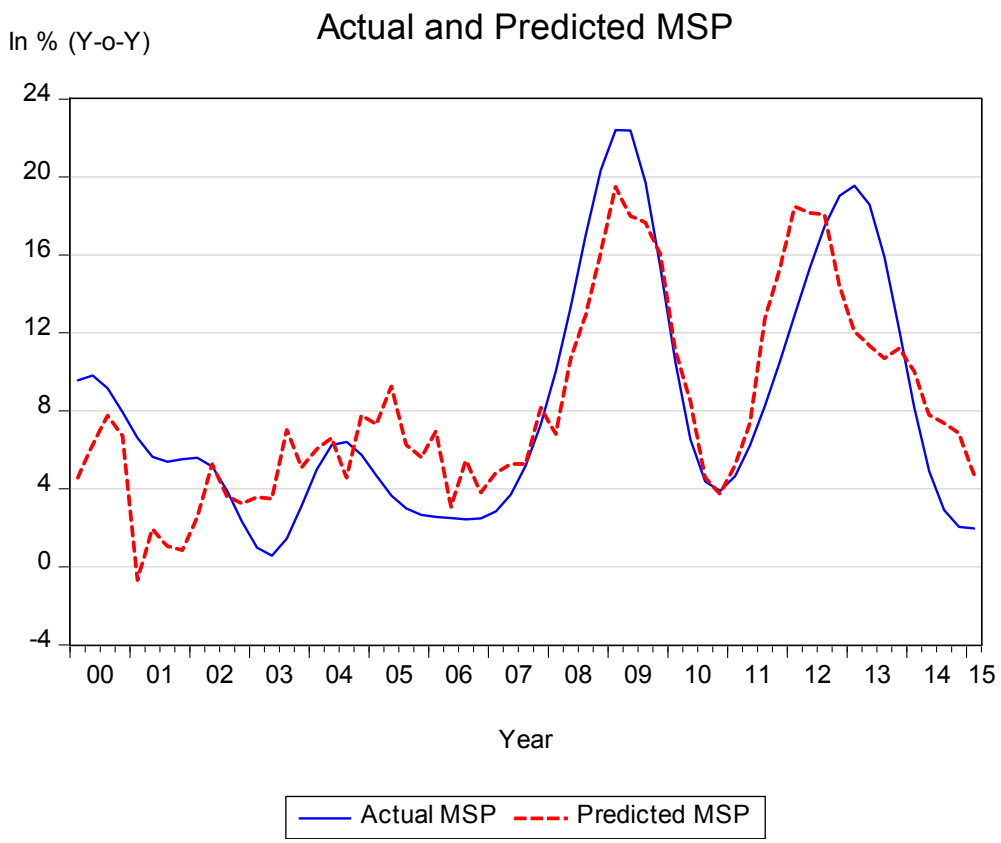


Figure 5 plots the actual wage growth and the fitted values from a regression of growth in wages on eight lags of CPI inflation.

Figure 6. Growth in MSP, Lagged CPI Inflation, and World Food Prices



V. Conclusions and Policy Implications

Over the last decade, inflation has emerged as a primary concern for India's policymakers. Worries grew as the inflation rate rose since 2006 and remained elevated and sticky at around the 9% level between 2006 and 2013. The inflation rate, however, has fallen dramatically since then. After peaking at 12.1% year-on-year growth in November 2013, headline CPI inflation collapsed to 4.3% in December 2014 and has averaged less than 5% in 2015. This paper analyzes the dramatic decline in inflation, and quantifies the contribution of different factors in explaining the disinflation process.

We estimate an augmented Phillips Curve for India and use it to quantify the extent to which different factors were responsible for the disinflation between 2013/14 and 2014/15. Our main findings are described as follows:

- 20% of the disinflation can be explained by a sharp decline in the growth of the "discretionary" component of MSPs.
- The bulk of the disinflation (45%), however, can be attributed to a moderation in the historical dynamics of inflation that influence contemporaneous inflation. This moderation is likely reflecting a softening of backward looking (adaptive) expectations as well as capturing the institutional process of wage and MSP setting that amplifies the effects of shocks and leads to persistence in inflation.
- We also find an important role for forward-looking expectations. Almost 35% of the disinflation can be attributed to this. That said, forward-looking expectations could capture both the effects of the new monetary policy regime announced in the first quarter of 2014, but may also be reflecting more benign future expectations of oil and commodities, that may have translated into wage and price setting behavior.
- Finally, we find that the role of global factors, namely global crude prices and exchange rates, in explaining the disinflation between 2013/14 and 2014/15 is less than 15%, though the contribution of global factors rises if we choose alternative time periods.
- Finally, output gaps are estimated to have closed during this period, and hence the business cycle was actually putting upward pressure on inflation at that time.

There seems a general perception that India's disinflation has been achieved mainly at the altar of good luck due to the collapse in global commodity prices, or through a sacrifice in domestic growth emanating from a sharp fall in domestic demand. Our empirical analysis, however, finds that these factors do not explain the bulk of the disinflation between 2013/14 and 2014/15. Instead, our findings suggest that the evolution of inflation is a complex mix of the state of the business cycle, inflation expectations, institutional structures and global factors. What we essentially find is that exogenous shocks to inflation – from lower discretionary component of MSPs, a new monetary regime, global commodities – were perpetuated through backward looking expectations and domestic institutional structures that amplified the influence of the original shocks.

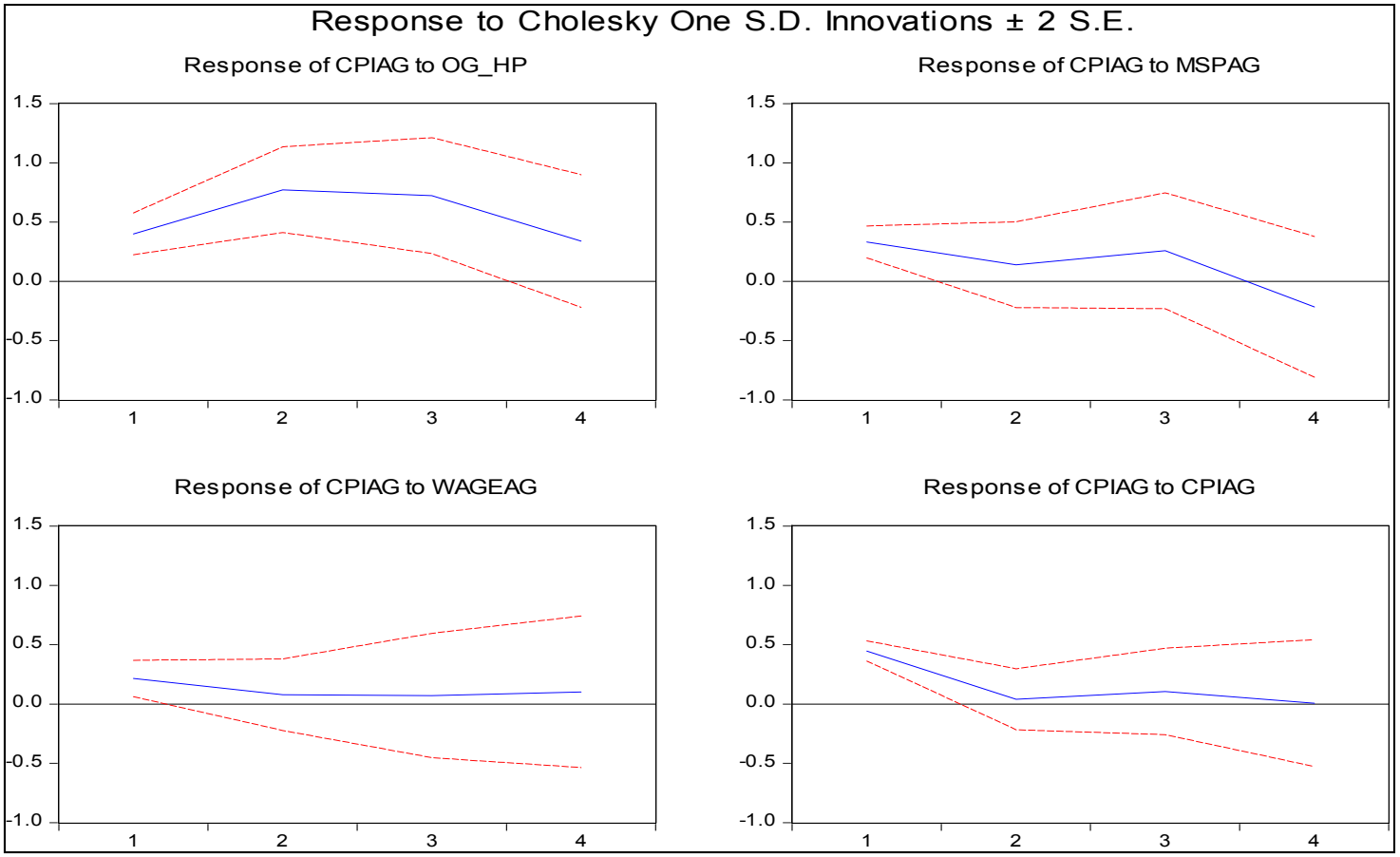
Appendix : Vector Autoregression Model

A natural extension of our single equation model is a more general vector autoregressive model (VAR) where we can consider several endogenous variables together so that they are simultaneously determined, and we can accommodate a more generalized lag structure so that each variable evolves dynamically. The VAR captures the full dynamic interactions among the variables included in the model, so, for example, we can shock MSP and trace out the empirical response of inflation to that shock by quarter.

Based on the institutional processes for the determination of inflation, and tests of residual autocorrelation, we specify a lag length of 8 quarters. We assume a simple Choleski ordering with the global factors being the most exogenous, followed by output gap, wages, MSP and inflation. We assume that shocks to inflation do not affect any of the other variables within the quarter (so that inflation is last in the Choleski ordering). The results are similar if MSP is ordered before wages.

The resulting impulse responses are plotted in Figure 7. The impulse responses suggest that a one standard deviation shock to growth of MSP increases inflation by 0.3 percentage points, which is statistically significant. The effect, however, is not persistent, and is statistically indistinguishable from zero by the second quarter. Wages have a much smaller effect than MSP, and are not persistent. About 50% of the variability in inflation over the entire sample is explained by output gap, 30% by MSP, and 10% by dynamics of inflation. Although the direction of change in the output gap does not play a role in explaining the recent disinflation, the output gap, per se, does play a dominant role in explaining the variability over the sample, confirming the existence of a Phillips curve in India.

Figure 7. Impulse Responses from a Vector Autoregression Model



The VAR broadly validates our single equation results vis-à-vis the drivers of the disinflation. Lagged inflation, MSP and the regime change dummy still account for the largest share of the disinflation between 2013/14 and 2014/15. The role of MSPs is almost identical in both the models. Like the single equation model, crude and the exchange rate only played a minor role in the disinflation, in the time-period under consideration, whereas a closing output gap and a bad monsoon actually put upward pressure on inflation.

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