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Inflation Convergence and Anchoring of Expectations in India

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Abstract

Careful research on the inflation targeting regime's impact on anchoring inflation expectations as well as an empirical examination of convergence is used to assess the direction of convergence between core and headline inflation as well as the efficacy of the expectation channel compared to the aggregate demand channel of monetary transmission. There is evidence of more anchoring, with RBI communications as well as headline inflation affecting short-run inflation expectations and core inflation dominating in the long-run. The Repo rate has hardly any affect. While persistently high headline affects core, normally a volatile headline reverts to a more stable core. Transitory shocks to components of core have kept it sticky, but it is also softening, so that both core and headline can be expected to approach the inflation target. Our evidence supports the expectation channel of monetary transmission to inflation but not the aggregate demand channel. It follows monetary policy should focus on clear communication and accurate forecasts, while avoiding excessively high policy rates.

Keywords: Inflation expectations; targeting; convergence; anchoring; transmission channel

JEL Code: E31; E58; E52

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1. Introduction

There is an ongoing debate on the direction of convergence between headline and core inflation and its probable impact on the future course of monetary policy. Our objective is to distinguish between these convergence hypotheses as well as the efficacy of expectation channel compared to the aggregate demand channel through careful research on the inflation targeting (IT) regime's impact on anchoring inflation expectations and an empirical examination of convergence.

Anand et al (2014) argued that Indian headline inflation affected core over the period 1996-2013. Food and fuel shocks had persistent effects on inflation, through second round effects on wages generalized through sticky inflation expectations, and therefore a long period of tight monetary policy would be required to reduce inflation. The argument was influential in the RBI's choice of headline inflation as the inflation target and the implementation of strict IT although what had been adopted was flexible IT.

Goyal and Tripathi (2011) found consumer price index (CPI) Granger causes wholesale price index (WPI) rather than the reverse, although wholesale prices should be affecting retail (CPI). The reason was CPI has a larger share of food and food inflation affected other inflation components in their estimation period. Goyal and Baikar (2015) in analyzing India's high inflation episode, however, find wage rise to be persistent only when food inflation crosses double digits, so that causality from headline to core would not occur in more moderate conditions. Dholakia and Kadiyala (2018) estimated that headline inflation reverts to core over Jan 2012-Nov 2017 implying second round effects are now weak. They also estimate the persistence of core inflation and attribute its fall since early 2016 to anchoring of inflation expectations. Chinoy and Jain (2019) also find it is headline inflation that converges to core after 2012. The reasons they point to are moderation of supply side shocks, while core inflation is sticky due to aggregate demand pressures. These raise wages and, therefore, headline inflation. They expect headline inflation to rise towards a persistently high core.

It is unlikely that the aggregate demand channel affects wages and core inflation since supply has been in excess for a long time but did not reduce core inflation. Many surveys show

rising unemployment since 2016. It is probably reduction in inflation expectations that is reducing persistence of core inflation and making it less sticky.

The literature finds inflation expectations are driven mainly by transitory shocks like food and fuel for advanced nations like US, UK, Sweden, etc. These results conform with Indian studies as well (RBI, 2014; Goyal and Parab, 2019; Pattanaik et al, 2019; Saakshi and Sahu, 2018). But one of the key features of an IT regime is the anchoring of inflation expectations. Well anchored expectations contribute to the success of IT, since second round affects that could lead to persistent inflation from transitory shocks are aborted. Inflation expectations affect wage-price setting and formulation of consumption and savings decisions by the households and thus affect future inflation. Pattanaik et al (2019) find inflation expectations of households influence inflation dynamics in India through the wage channel.

Literature on anchoring of inflation expectations can be dated back to speeches by former Federal Reserve Governor Ben Bernanke (2004, 2007). He gave a simple definition: Inflation expectations are well anchored if long-run expectations are not influenced by movements in short-run expectations. Lyziak and Paloviita (2017) implement econometric tests of aspects of this definition. They discover inflation expectations in the Euro Area have been de-anchored and continue to face risk of further de-anchoring in the recent times.

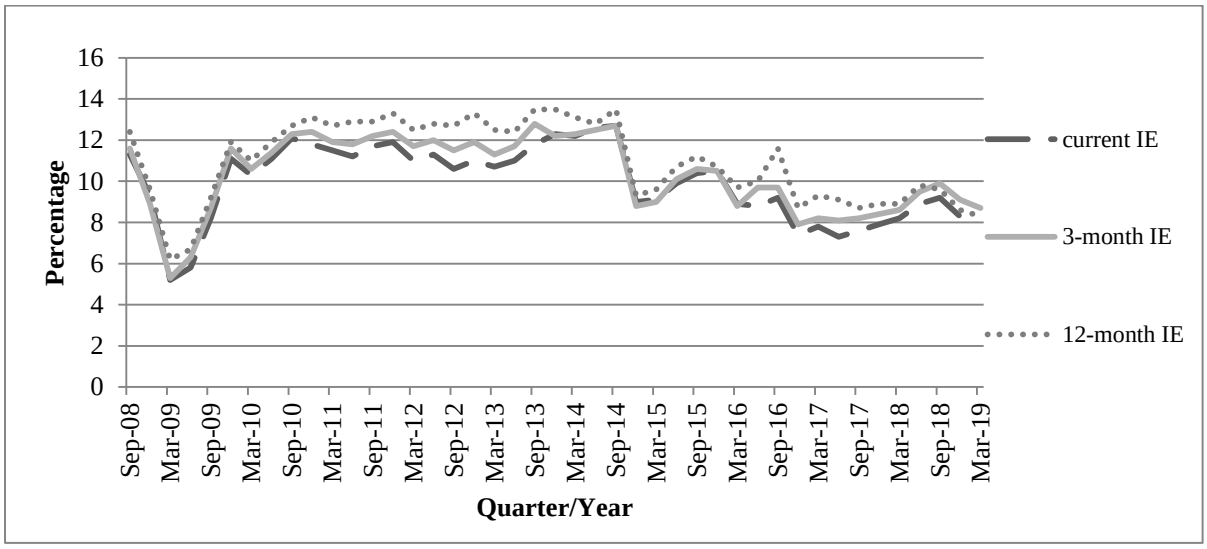
After an examination of historical trends in CPI-C inflation and its components to set a context in which to assess the ongoing debate, we estimate the determinants of inflation expectations, the degree of anchoring and its implications for the convergence debate. There is evidence of more anchoring, with Reserve Bank of India (RBI) communications and headline factors affecting short-run expectations and core inflation dominating in the long-run. The Repo rate has hardly any affect. While persistently high headline affects core, under normal conditions a volatile headline reverts to a more stable core. Transitory shocks to components of core have kept it sticky, but it is also softening, so that both core and headline can be expected to approach the inflation target. There is support for the expectation channel of monetary transmission to inflation but not for the aggregate demand channel. It follows monetary policy should focus on clear communication and accurate forecasts, while avoiding keeping the Repo rate too high.

The remainder of this paper is structured as follows: Section 2 presents stylized facts on household inflation expectations in India, including the distinction between core and headline inflation, while Section 3 gives a historical perspective on inflation, its components and measurement; Section 4 estimates determinants and anchoring of Indian inflation expectations; Section 5 examines the implications of the above analysis for, as well as estimates convergence of headline and core before Section 6 concludes.

2. Inflation and inflation expectations in India

A primary source of information on household inflation expectations is the RBI's Inflation Expectations Survey of Households (IESH). This survey began in 2005 with four cities and currently includes 18 cities. Households submit qualitative as well as quantitative responses on their inflation expectations for three time horizons: Current inflation expectations (also called perceptions), 3-month ahead inflation expectations and 1-year ahead inflation expectations.

Figure 1 – Inflation Expectations and Perceptions of Households



Note: IE denotes inflation expectations
Source: Inflation Expectations Survey of Households, RBI

Data prior to 2008 September has many technical inconsistencies (RBI, 2009) so we work with quarterly data from September 2008. This is plotted in Figure 1. It shows inflation expectations and perceptions were sticky till 2014, and then dropped sharply. The sudden drop after December 2014 coincides with the decline in oil prices, benign food inflation and adoption of a flexible IT regime for monetary policy. Since all these factors came together it

is difficult to decide whether inflation expectations are getting anchored and if IT has played a significant role in the fall. Although there were a few transitory upticks subsequently, the earlier double digit plateau was never regained and there was a softening bias.

Prior to venturing into rigorous analysis to identify causality, it is useful to see how inflation has evolved historically.

3. Consumer Price Index in India: A historical perspective

An all-India combined Consumer Price Index (CPI-C) has been constructed recently with 2011-12 as the base year. Prior to that CPI was measured for heterogeneous consumption baskets namely Industrial Workers (IW), Rural Labor (RL), Agricultural Labor (AL) and Urban Non-manual Employees (UNME). Table 1 describes these indices.

Table 1 – Composition of Different Measures of Consumer Price Index Based Inflation

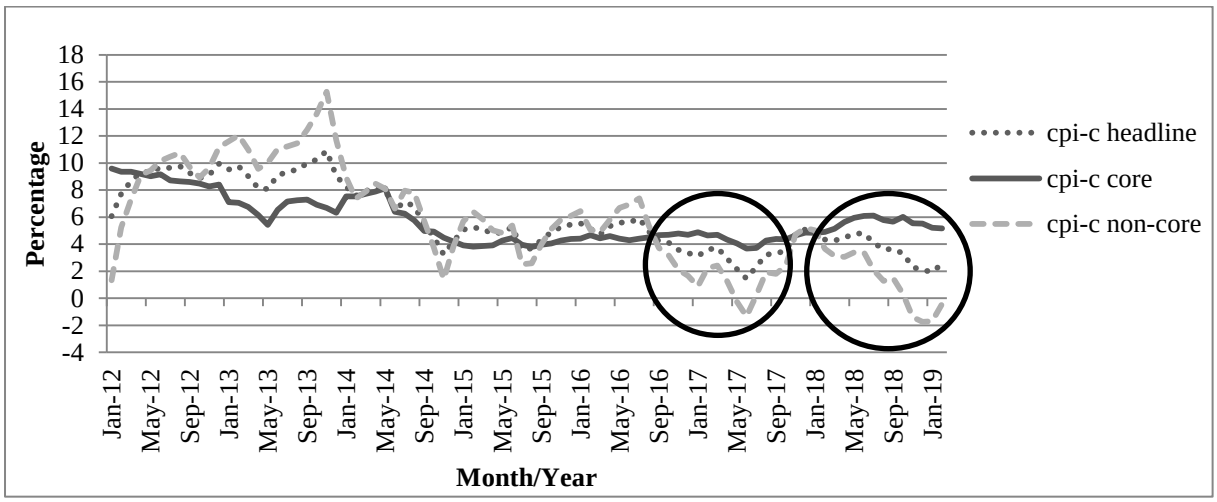
	CPI-C	**CPI-IW**	**CPI-AL**	**CPI-RL**
Base year	**2011-12**	**2001**	**1986-87**	**1986-87**
Universe	All India Rural and Urban Households	Households of Industrial Workers	Households of Agricultural Labor	Households of Rural Labor
Centres/Price quotations	1181 villages (268351 quotations) and 1114 urban (281001 quotations)	Selected Markets in 78 centres	Shops and Markets catering to 20 states (600 villages)	
Items covered	299	393	182	

Source: Das and George, 2017 (RBI)

Major heads of goods and services included in CPI-C are food and food groups, fuel, housing, pan, tobacco and other intoxicants and miscellaneous items. The last include important services like health, education, transport and communication, recreation household goods and personal care. Weights of components belonging to these indices are closest for CPI-C and CPI-IW (Goyal, 2015; Das and George, 2017) although CPI-C includes services that were missing in CPI-IW. All the items apart from food and food groups, fuel and pan, tobacco and other intoxicants constitute "core" inflation. Volatile items like food and food groups and fuel are included in the "headline" inflation.

Figure 2 plots CPI-C headline and core inflation. Due to a larger share of non-core components in the CPI-C basket, headline CPI-C inflation tends to be influenced more by food and fuel inflation than its core components. Food inflation has shifted to a downward trend after 2014. Food inflation that was high and persistent for a long time was a major reason why headline CPI inflation was chosen as the target during the adoption of IT. Headline inflation normally tends to be volatile. Core inflation on the other hand has periods when it is sticky. Even so, it has softened considerably since 2012. A sharp fall followed a sustained fall in headline inflation in 2014. Bouts of small increase for a limited time span, for example as in 2018 due to a rise in House Rent Allowance (HRA) and a temporary rise in headline inflation, were followed by a gradual decline once those factors faded away.

Figure 2 – CPI-C Headline, Core and Non-Core Inflation



Note: Non-core components include food and food products, fuel and pan, tobacco and other intoxicants
Source: Database on Indian Economy, RBI

Examining disaggregated components of headline and core inflation gives a better understanding of the overall picture. Figures 3a, 3b and 3c plot the components of headline and core inflation. Vegetables, pulses, sugar, fruits and eggs contribute significantly to the volatility in headline inflation. The impact of fuel prices in influencing headline inflation is, however, minimal. Favorable supply shocks both domestic and international, coupled with subdued demand pressures contributed to keep headline inflation to a historically low level after 2016. Figure 3c shows the contribution of the jump in HRA to persistence in core inflation. Temporary measurement problems, as a new agency was used, led to peaks in rural health and education inflation.

Figure 3a – Components of Headline CPI-C

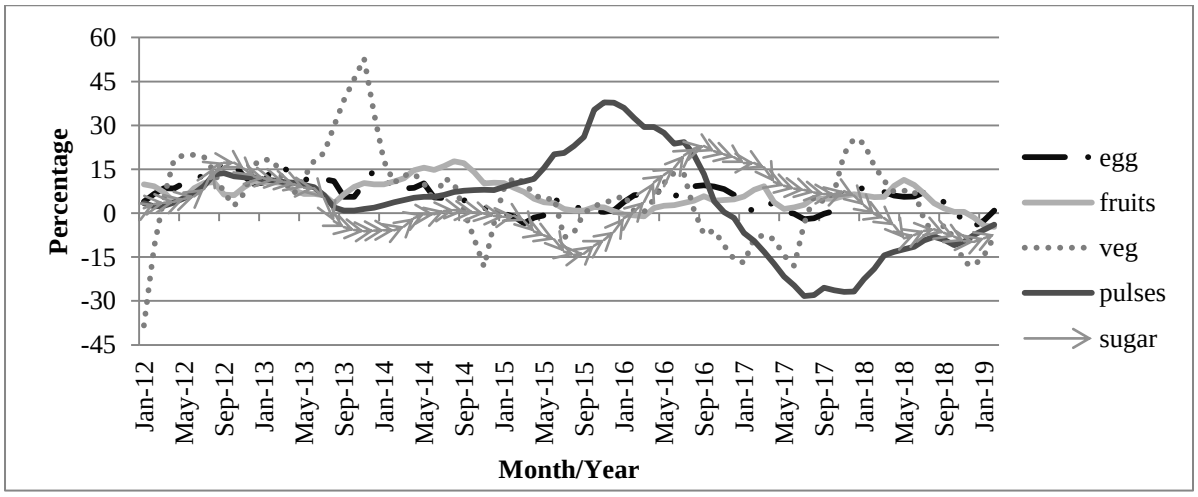


Figure 3b – Components of Headline CPI-C

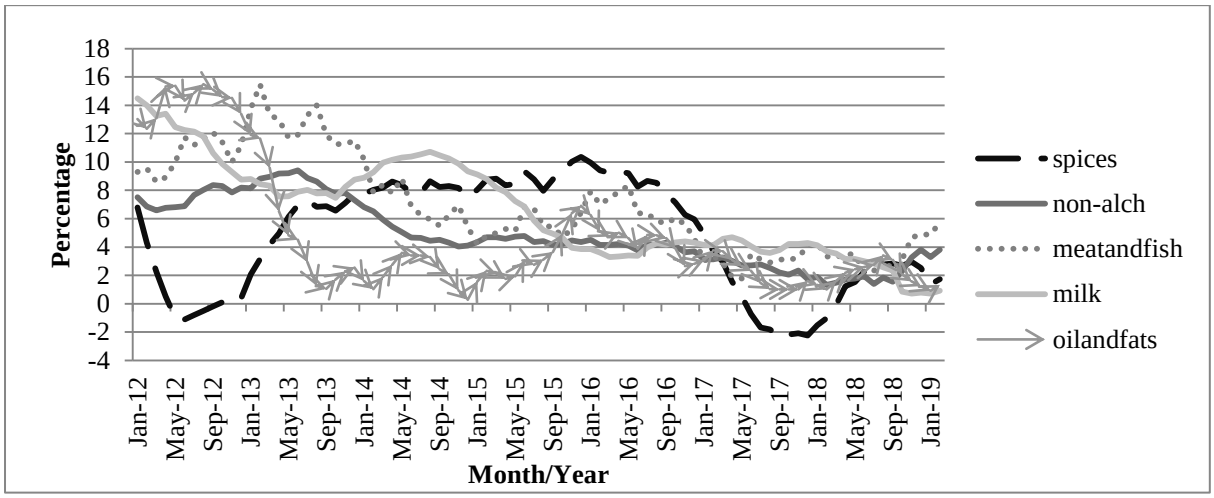
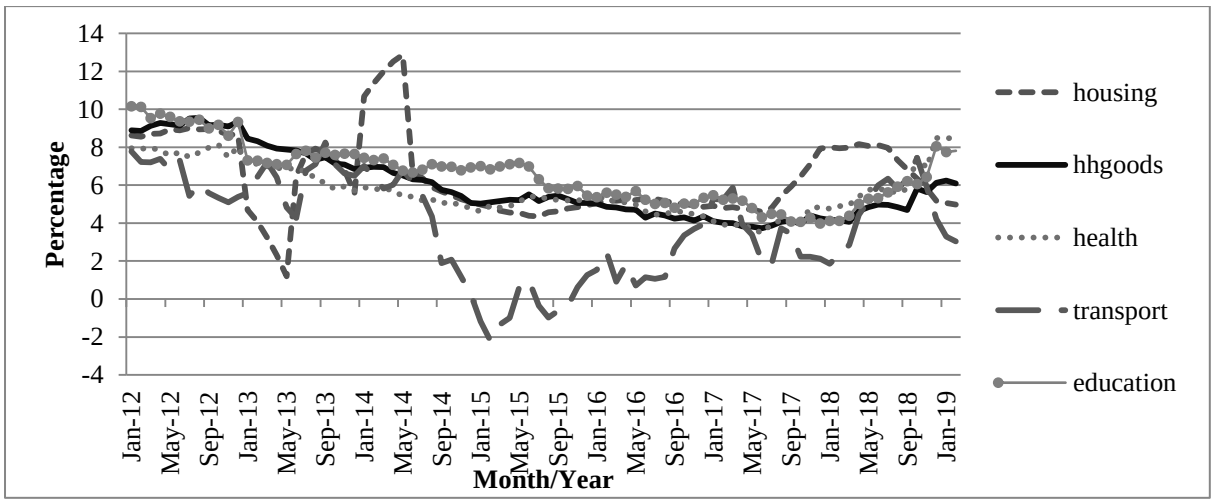


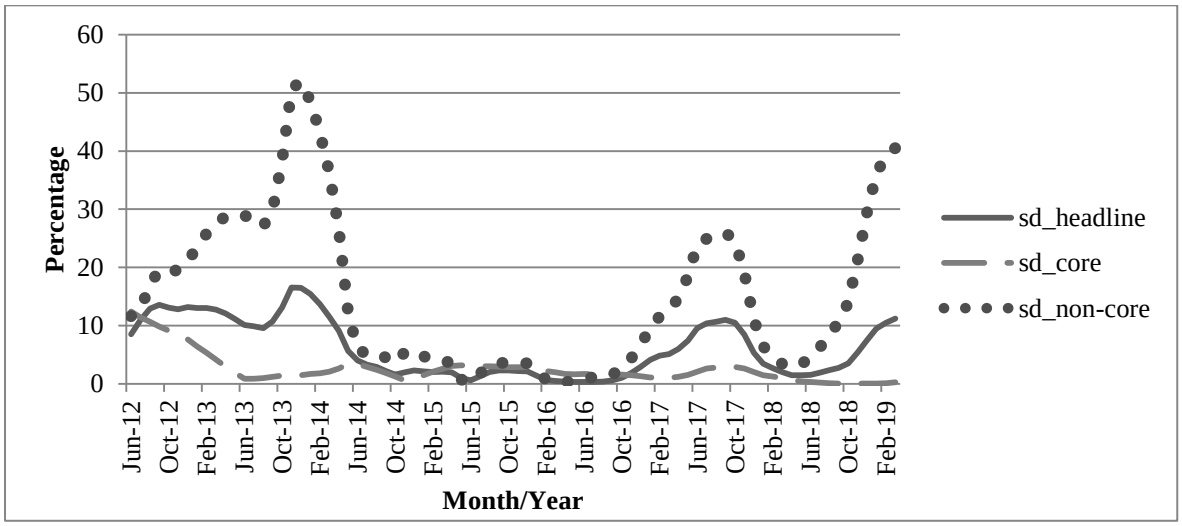
Figure 3c – Components of Core CPI-C



Source: Database on Indian Economy, RBI

Figure 4 plots squared 6-month moving averages of deviations of the components of CPI-C inflation from their respective means. Volatility in headline inflation gradually declined from mid-2014 to 2016, after peaking in September 2013 due to depreciation associated with the taper tantrum accompanied by other unfavorable supply side shocks. Spikes recurred after a period of calm, but were less persistent. These can be attributed to unanticipated fluctuations in the oil prices as well as the base effects of food inflation. Volatility has been increasing from February 2018. Core inflation volatility is low and has declined even further during the recent times accounting for its persistence.

Figure 4 – Squared Deviations from Mean CPI-C and its Components



Source: Authors' Calculations

4. Aspects of inflation expectations

We examine this first in a structural vector auto regression (SVAR), then short-term ordinary least squares (OLS) as well as rolling regressions, and finally present stylized facts from the survey of professional forecasters.

4.1. Estimating determinants

Goyal and Parab (2019) analyzed macroeconomic determinants of inflation expectations of Indian households. Some key relevant findings are: (1) Inflation expectations are adaptive or naïve— that is, they depend on households' past experiences (2) Long run effect of core inflation on inflation expectations is greater than that of food inflation (3) Households do not overreact to new information in the short run (4) RBI communication influences households

expectations (5) RBI communication has a larger effect on short term inflation expectations than on long term expectations.

The study discovers that headline inflation, core inflation and the projections by RBI (used as a proxy for communication) significantly influence inflation expectations of households and these are the variables that households tend to anchor upon.

We modify and re-estimate the SVAR framework in Goyal and Parab (2019) for the time period 2008 Q3 to 2019 Q1 and report the error variance decomposition (FEVD) in Table 2. The short run identification restrictions are as follows.

$$B_0 * Z_t = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & b4 & 1 & 0 & 0 & 0 & 0 \\ 0 & b5 & 0 & 1 & 0 & 0 & 0 \\ b1 & b6 & b9 & b12 & 1 & 0 & 0 \\ b2 & b7 & b10 & b13 & b15 & 1 & 0 \\ b3 & b8 & b11 & b14 & b16 & b17 & 1 \end{pmatrix} \begin{pmatrix} PETROL \\ HP\_GDP \\ CPIIW\_FOOD \\ CPIIW\_CORE \\ REPO \\ RBI\_PROJ \\ HH\_INF\_PER \end{pmatrix} \quad \text{(I)}$$

where **HH_INF_PER** – current inflation expectations (perceptions) of households, **CPIIW_FOOD** – Food inflation measured using CPI-IW, **CPIIW_CORE** – Core inflation measured using CPI-IW, **PETROL** – logarithm of petrol prices in rupees, **HP_GDP** – output gap measured using Hodrick-Prescott filter, **REPO** – the policy Repo rate announced by the RBI, **RBI_PROJ** – Inflation projections of the RBI.

One difference from the previous study is the use of logarithms of domestic petrol prices instead of international oil prices, since petrol prices are market determined, capture domestic pass through, and directly impact domestic consumers[1]. Aggregate petrol prices for India are obtained using Principal Component Analysis. Instead of GDP growth rate, we use output gap estimated using Hodrick-Prescott filter (HP_GDP). The identification assumes PETROL and HP_GDP are not affected by other variables in the same period, while all the variables affect inflation perceptions (HH_INF_PER). Results differ a bit from the previous analysis, but conclusions remain the same.

[1] The pass-through from international oil prices to petrol prices is estimated to be around 0.18 in a bivariate SVAR of monthly petrol and oil prices in India over 2007June to 2019April, but rises to 0.23 after the 2014 full deregulation of petrol prices.

In the short run, shocks in food prices and RBI projections have a significant influence on the variance of inflation perceptions of households. Influence of core inflation increases after third quarter. We observe a larger effect of RBI communications on inflation perceptions over the first quarter. It exceeds the effect of food and petrol prices. Communication can therefore stabilize short term inflation expectations. Households give very high weightage to food inflation and news received from media while formulating their expectations in the initial stages. While it is initially negligible the effect of aggregate demand, coming through the output gap and Repo rate, accounts for 7.6% of the change in inflation expectations at the end of two years. As forecast horizon widens, the impact of fundamentals such as core inflation rises, while the effect of RBI projections and food prices declines gradually. This may partly be due to the choice of sample of IESH dataset, whose respondents belong only in the cities and around 40 percent of them are from Mumbai, Chennai, Delhi and Kolkata.

Table 2– Variance Decomposition of Inflation Perceptions of Households

FORECAST HORIZON	PETROL	HP_GDP	CPIIW_FOOD	CPIIW_CORE	REPO	RBI_PROJ	HH_INF_PER
1	2.10	0.65	16.24	0.16	0.00	19.98	60.86
2	9.10	1.70	22.24	11.95	0.99	12.67	41.35
3	13.83	1.15	17.75	30.83	0.86	8.81	26.76
4	15.49	1.11	12.93	44.89	0.62	6.27	18.69
5	15.74	1.78	9.92	52.52	0.82	4.79	14.44
6	15.56	2.75	8.26	55.87	1.39	4.05	12.13
7	15.28	3.76	7.41	56.78	2.15	3.75	10.86
8	15.03	4.67	7.05	56.44	2.96	3.68	10.17
9	14.83	5.38	6.97	55.60	3.69	3.72	9.81
10	14.67	5.85	7.04	54.76	4.25	3.79	9.63

Notes: Lag length - 1 lag, chosen using Bayesian Information Criterion
Source: Authors' estimation

4.2 Testing for anchoring

Next, we conduct analysis on lines of Lyziak and Paloviita (2017) to test for the anchoring of inflation expectations in India, using a dummy for inflation targeting. The analysis involves individually testing different variables that may anchor inflation expectations. Based on the literature, inflation expectations are said to be well anchored if some or all of the following results hold: (i) Realized inflation has a smaller impact on inflation expectations over time, (ii) Inflation target has a significant influence on inflation expectations (iii) Central Bank

projections have a significant influence on inflation expectations (iv) Long term inflation expectations are not affected by movements in short term expectations.

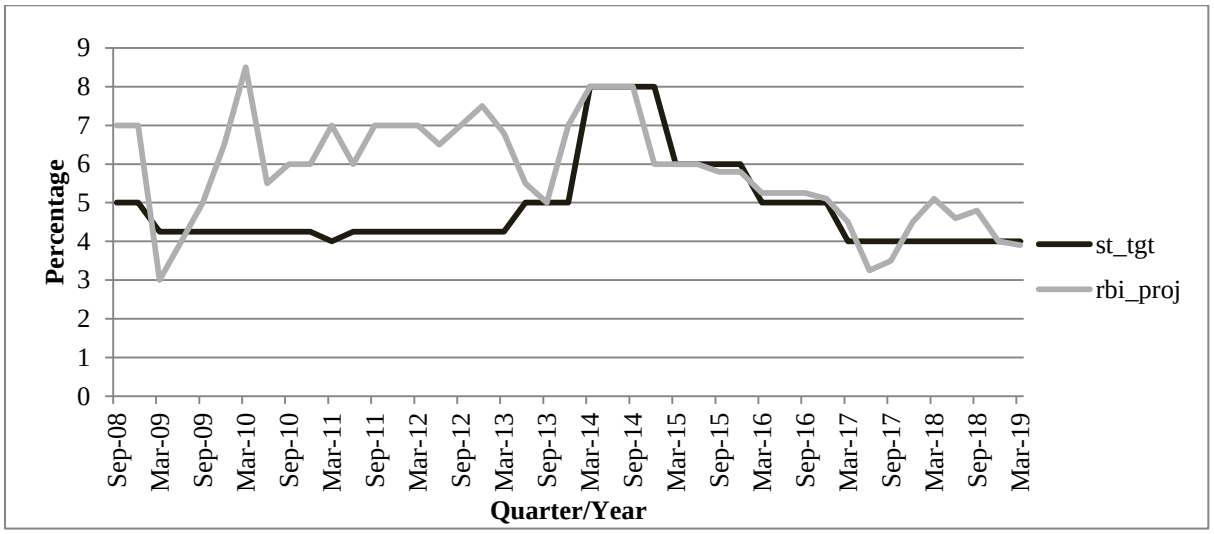
4.2.1. Data and methodology

Constrained OLS regressions are estimated using quarterly data from September 2008 to March 2019. The variables are: HH_INF_ONEYR (one year ahead inflation expectations of households), HH_INF_THRM (three month ahead inflation expectations of households), HH_INF_PER (current inflation expectations/ perceptions of households), RBI_PROJ (Inflation projections by the RBI), ST_TGT (Short term inflation targets by the RBI), CPIIW (Inflation based on Consumer Price Index of Industrial Workers), CPIIW_FOOD (Food Inflation based on Consumer Price Index of Industrial Workers), CPIIW_CORE (Core Inflation based on Consumer Price Index of Industrial Workers) and IT (Dummy variable for inflation targeting, which takes value 1 from March 2015 to March 2019 and 0 from September 2008 to December 2014).

ST_TGT and RBI_PROJ significantly differ from each other. Many projections and targets are announced in monetary policy meets. There are quarterly, half yearly and annual projections of inflation and GDP growth rates provided with fan charts made by RBI research staff. Of these, we use the annual projections of inflation as RBI_PROJ variable. They appear in the speeches as follows, *"the Reserve Bank will endeavor to condition the evolution of inflation to a level of 5.0 per cent by March 2014…"* (RBI May, 2013).

After the adoption of inflation targeting, RBI began to explicitly communicate medium term inflation targets. Prior to the adoption of this regime, the monetary policy speech contained short term and medium term targets in a very implicit manner. For instance, *"…the objective is to contain headline WPI inflation at around 5.0 per cent in the short-term, and 3.0 per cent over the medium-term, consistent with India's broader integration into the global economy*." (RBI May, 2013). Although using medium term targets would be ideal, a few speeches did not have these targets. Hence, we use short term targets for analysis.

Figure 5 - RBI Projections vs. Short Term Inflation Targets



Source: Reserve Bank of India, Monetary Policy Speeches

Figure 5 compares RBI projections and short term targets from September 2008 to March 2019. A visible discordance between the two in the initial years of analysis diminishes since the beginning of 2014, as inflation converged towards the target. Communication has also improved. Not only have the surveys changed to a higher frequency (from quarterly to bi-monthly) but the length of speeches have reduced drastically from 13,000 words pre-IT to 3084 words in the post IT period (Mathur and Sengupta, 2019). Such an increase in the clarity of communication improves credibility and transparency of the central bank.

We test for anchoring of inflation expectations using the following regression:

$$\pi^{e}_{t+h|t} = \rho\pi^{e}_{t+h-1|t-1} + (1-\rho)\{(1-IT)^{*}(\alpha_1 + \beta_1 ANCHOR_t) + IT^{*}(\alpha_2 + \beta_2 ANCHOR_t)\} + \varepsilon_t \qquad (1)$$

where ANCHOR variables vary: CPIIW, CPIIW_FOOD and CPIIW_CORE are used to test for the effect of realized inflation on inflation expectations, ST_TGT are used to test the effect of inflation targets on inflation expectations, RBI_PROJ are used to test the impact of communication on inflation expectations. $\pi^{e}_{t+h|t}$ represents 'h' period ahead inflation expectations made at time 't'; h takes values 1 and 4 for 3-month ahead and 1-year ahead inflation expectations respectively.

IT is the inflation targeting dummy. β_1 and β_2 are the coefficients of the ANCHOR variable in the pre and post IT periods; ρ is the coefficient of persistence in inflation expectations. The formulation of the model implies real effect of β_1 and β_2 would be deflated by a factor

of $1-\rho$. For instance, the value of β_1 and β_2 coefficients of CPIIW in panel A of table 3 are given to be 0.26 and 0.54 respectively. Their actual effect on inflation expectations is 0.11 [0.26*(1-0.59)] and 0.22 [0.54*(1-0.59)].

One year is the longest time period for which households' inflation expectations are measured. Hence, we test for the effect of fluctuations in inflation perceptions on long term inflation expectations using the following equation:

$$\pi^e_{t+4|t} = \rho\pi^e_{t+3|t-1} + (1-\rho)\{(1-IT)^*\left(\alpha_1 + \beta_1\pi^e_{t|t}\right) + IT^*\left(\alpha_2 + \beta_2\pi^e_{t|t}\right)\} + \eta_t \qquad (2)$$

where $\pi^e_{t+4|t}$ represents one year ahead inflation expectations and $\pi^e_{t|t}$ represents inflation perceptions of households.

To test for the efficacy of the inflation targeting regime in anchoring inflation expectations Wald test is used to compare β_1 and β_2 for the above equations. A rejection of Wald test implies that β_1 is significantly different from β_2, suggesting that the IT regime has made a difference.

4.2.2. Results

Table 3 gives results. We control for time and persistence in inflation expectations to yield more robust results.

Household inflation expectations (both 3 months and 1 year) do not display very high persistence. The coefficient of persistence (ρ) does not exceed 0.64.Wald statistics are significant for CPIIW_CORE, HH_INF_PER (only for one year ahead expectations) and ST_TGT. Inflation expectations (both 3 months and 1 year) are influenced by realized inflation and food inflation in the post inflation targeting period as compared to the pre-inflation targeting period.

Table 3 – Anchoring of Inflation Expectations

	β_1	β_2	ρ	Wald test ($\beta_1 = \beta_2$) (p-values)		
				t-test	F-test	Chi-Squared test
PANEL A – HH_INF_ONEYR						
CPIIW	0.26	0.54	0.59***	0.49	0.49	0.48
	(0.45)	(0.11)	(0.00)			
CPIIW_FOOD	0.16	0.48**	0.63***	0.30	0.30	0.29
	(0.54)	(0.02)	(0.00)			
CPIIW_CORE	1.52	-0.38*	0.62***	0.09*	0.09*	0.08*
	(0.82)	(0.09)	(0.00)			
ST_TGT	-1.09*	2.28***	0.48***	0.01***	0.01***	0.01***
	(0.06)	(0.01)	(0.00)			
RBI_PROJ	0.94*	1.18**	0.39**	0.78	0.78	0.78
	(0.06)	(0.04)	(0.02)			
HH_INF_PER	1.09***	0.80***	0.07	0.05**	0.05**	0.04**
	(0.00)	(0.00)	(0.28)			
PANEL B – HH_INF_THREE MONTHS						
CPIIW	0.63	0.54*	0.64***	0.84	0.84	0.83
	(0.15)	(0.06)	(0.00)			
CPIIW_FOOD	0.13	0.34**	0.62***	0.48	0.48	0.47
	(0.56)	(0.04)	(0.00)			
CPIIW_CORE	0.84	-0.18	0.60***	0.12	0.12	0.11
	(0.11)	(0.36)	(0.00)			
ST_TGT	-0.93	1.98***	0.48***	0.02**	0.02**	0.01**
	(0.11)	(0.01)	(0.00)			
RBI_PROJ	0.87*	1.02**	0.36**	0.83	0.83	0.83
	(0.08)	(0.03)	(0.00)			

Notes: Level of Significance: *, ** and *** - 10%, 5% and 1%, p values given in parentheses
Source: Authors' estimation

According to the literature, this result suggests that inflation expectations may be de-anchored. But it is a very conducive result in comparison to the one obtained in Goyal and Parab (2019), who found household inflation expectations to be naïve, i.e., households give little importance to realized inflation and depend largely on their own past expectations. Here when we use dummies for the inflation targeting period, we find households have begun paying significant attention to realized inflation in the new regime. There is a gradual movement of household inflation expectations from naïve to adaptive. Influence of core inflation on one year ahead inflation expectations has significantly declined in the post inflation targeting period. This suggests households may have factored in headline inflation as an explicit inflation target. Since the share of food and fuel components is high in the consumer basket, the effect of these volatile headline components on inflation expectations

has increased. It is consistent with the SVAR results since in the longer run fundamental factors incorporated in core inflation may dominate.

RBI started explicitly communicating an inflation target since 2015. Prior to that, RBI used to present short term and medium term targets during their quarterly policy meets. In addition, they also communicate their projections on inflation and GDP growth rate for the near future. ST_TGT and RBI_PROJ are the short term inflation targets and inflation forecasts communicated by RBI respectively, every quarter till 2013 and every two months after that. In the inflation targeting period, targets were replaced by explicit inflation targets, which are communicated more transparently.

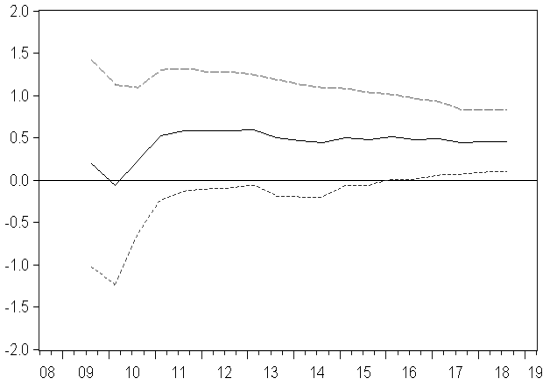
Household inflation expectations are significantly influenced by RBI projections in pre and post inflation targeting period. But their difference is not significant due to a persistently high impact in both the regimes. It could also be because RBI inflation projections often deviated from actual during the IT regime period. Short term targets, however, have a positive and significantly large influence in the post inflation targeting period. Dependence of household expectations on RBI projections has increased, but the Wald statistic is not significant for the same. However, a significant Wald statistic for short term projections, suggests households have started to incorporate the inflation target while forming inflation expectations. Coefficients of ST_TGT and RBI_PROJ are higher than those of CPIIW_FOOD and CPIIW_CORE suggesting a greater influence of RBI communication on inflation expectations than of lagged inflation.

Coming to the last part of the definition of anchoring inflation expectations, we also test for the effect of inflation perceptions on one year ahead inflation expectations (Table 3, panel A). Coefficient of persistence term is insignificant in this scenario owing to very high degree of correlation between inflation perceptions and one year ahead inflation expectations. Though there is a substantial degree of dependence in both the periods, a significant Wald statistic and lower coefficient suggests that the influence of inflation perceptions on expectations has reduced significantly. In other words, inflation expectations are gradually getting anchored in the inflation targeting regime.

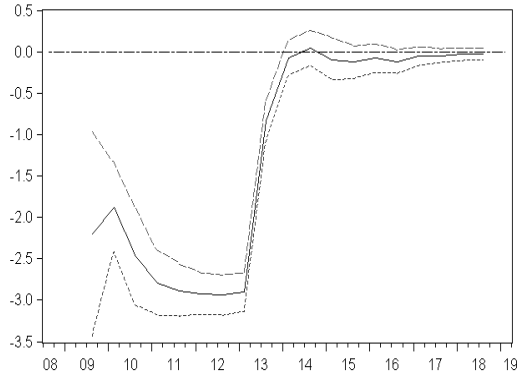
Estimating rolling regressions further enhances these results. Figure 6 gives the results of rolling regressions for one year ahead inflation expectations with ±2 standard error bands.

Figure 6 – Rolling Regressions of One Year Ahead Inflation Expectations

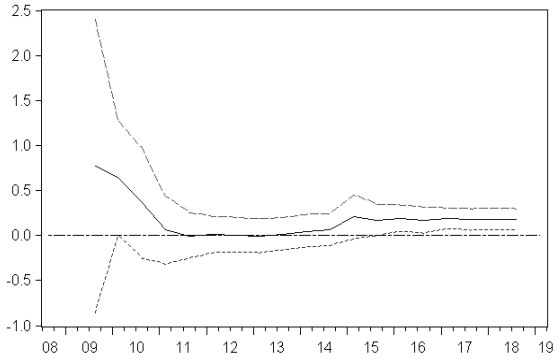
RBI_PROJ



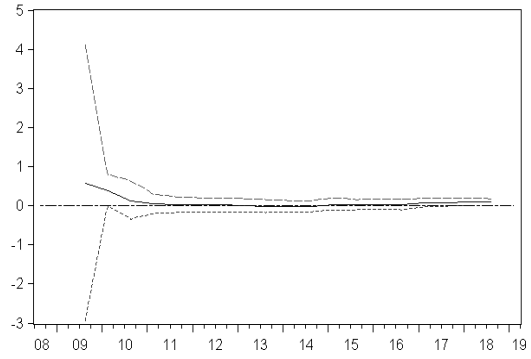
ST_TGT



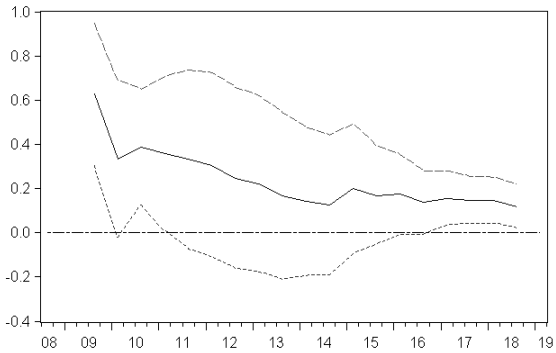
CPIIW



CPIIW_FOOD



CPIIW_CORE



Note: Coefficients of the variables mentioned above are on the y-axis, x-axis displays years
Source: Authors' calculations

Rolling regression results support the previous dummy variable analysis. RBI projections have a persistent effect on inflation expectations in pre as well as post inflation targeting adoption period. All three inflation measures, CPIIW, CPIIW_FOOD and CPIIW_CORE have a declining effect on inflation expectations supporting the hypothesis that inflation expectations are getting more anchored over time. ST_TGT had a negative effect for a long

period of time, which shot up to zero around the time of adoption of inflation targeting. This is consistent with the results in Table 3 where the pre-IT coefficient is negative. ST_TGT may not have been credible in the pre-IT period.

4.3 Survey of Professional Forecasters

Survey of Professional Forecasters (SPF) has been conducted by the RBI since 2008. This was a quarterly survey till December 2013 and was converted to bimonthly from March 2014. A questionnaire is circulated across 30-40 economists of big corporate houses who formulate expectations on macroeconomic indicators across different time horizons. Of these, CPI-IW, CPI-C Core, CPI-C Headline, WPI headline (WPI-H) and WPI manufacturing products (WPI-MP) are the variables related to inflation. Prior to 2014, inflation based on CPI Industrial Workers (CPIIW) was the forecast variable. Forecast variables were changed to CPI-C (Headline and Core) post 2014. Forecasts are conducted over short term (up to 1 year) as well as long term (5 years and 10 years) since professional forecasters incorporate sophisticated models for their analysis. Due to inadequate number of data points, it is difficult to estimate regressions for the SPF dataset, as in the above section. Both sub-periods do not have enough observations to conduct a time series analysis. Hence, we just display basic descriptive statistics, including coefficient of variation (CV), of the survey data in Table 4 to draw some conclusions.

Table 4 – Survey of Professional Forecasters' Short Term Inflation Expectations

VARIABLES	MEAN	SD	SKEWNESS	KURTOSIS	CV
CPI-IW (PRE 2014)	9.12	1.83	0.15	3.19	20.07
CPI-C HEADLINE (POST 2014)	4.66	1.06	0.20	3.40	22.75
CPI-C CORE (POST 2014)	5.07	0.62	1.05	3.87	12.23
WPI-H (PRE 2014)	6.80	3.33	-1.01	4.12	48.97
WPI-H (POST 2014)	2.65	2.31	-0.85	2.62	87.17
WPI-MP (PRE 2014)	5.05	2.79	-0.23	3.23	55.25
WPI-MP (POST 2014)	2.30	1.64	-0.60	2.31	71.30

Source: Authors' calculations

CPI-IW before 2014 and CPI-C Headline post 2014 are comparable estimates. Inflation expectations have fallen significantly since 2014. Not only has the average declined for CPI, but its volatility (measured using standard deviation) has also shown a significant decline. However, a contrasting result is visible from the coefficient of variation (CV) column. It shows a slight increase in volatility (measured using CV) post 2014 from 20.06 to 22.75 for

CPI inflation, because the mean has fallen more than the standard deviation. The picture is similar with WPI-H and WPI-MP.

Inflation has been benign since the adoption of IT. Not all the professional forecasters would have incorporated this immediate drop in inflation. This also points to adaptive nature of professional forecasters' expectations. Due to persistently high inflation in the past, professional forecasters would still be skeptical about longer persistence in low level of inflation.

There is a definite change in behavior in the inflation targeting period. But the divergence between core and headline inflation has persisted for a number of years. In the recent past also the core component has been somewhat sticky while food and fuel prices have declined. Is this decline in headline inflation transitory and will it revert to core inflation or will core converge to headline? A convergence debate, to which we turn next, addresses this question.

5. Convergence of headline and core inflation

We conduct causality tests between headline and core inflation for the period after 2011 when CPI-C data is available on a monthly basis, using monthly data from January 2012 to March 2019. Table 5 gives results for Toda-Yamamoto (1995) causality tests between headline and core inflation. Bidirectional causality between headline and core inflation exists for the entire sample period. This result also holds for the inflation targeting period. Bidirectional causality is consistent with differing short- and long –run effect of food and headline inflation on inflation expectations, and convergence of both to an inflation target.

Table 5 – Toda-Yamamoto Causality Test between Core and Headline Inflation

Toda-Yamamoto Causality Core and Headline CPI-C Inflation		
	p-value(Headline to Core)	**p-value(Core to Headline)**
January 2012-March 2019	0.03**	0.01***
February 2015-March2019	0.01***	0.00***

Notes: Lags 1 – chosen using Bayesian Information Criterion, Level of Significance- *** - 1%, ** - 5%, * - 10%
Source: Authors' estimation

We repeat tests by Anand et al (2014) that check for convergence between headline and core inflation. The equations estimated are:

$$CPIH_t - CPIH_{t-12} = \alpha_1 + \beta_1(CPIH_{t-12} - CPICORE_{t-12}) + \varepsilon_{1t} \quad (3)$$

$$CPICORE_t - CPICORE_{t-12} = \alpha_2 + \beta_2(CPICORE_{t-12} - CPIH_{t-12}) + \varepsilon_{2t} \quad (4)$$

CPIH and CPICORE are headline and core inflation measures respectively. Equation (3) analyzes reversion of headline inflation to core inflation and equation (4) analyzes convergence of core to headline. A negative and significant value of β_1 implies convergence of headline to core. Similarly, a negative and significant value of β_2 implies convergence of core to headline. Due to monthly frequency of the data, 12 months lag has been chosen for analysis[2]. If β = *-1* convergence will be complete in 12 months. Tables 6 and 7 give results for equations (3) and (4) respectively.

Table 6 – Convergence of Headline to Core Inflation

VARIABLES	(1) CPIH_GAP (Full sample)	(2) CPIH_GAP (Jan12-Jan15)	(3) CPIH_GAP (Feb15-Apr19)	(4) CPIH_GAP (Jan12-Jul16)	(5) CPIH_GAP (Aug16-Apr19)
β_1	-1.09***	-1.20***	-1.32***	-1.09***	-1.63***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
α_1	-0.42**	0.28	-0.70***	-0.05	-1.05***
	(0.02)	(0.62)	(0.00)	(0.84)	(0.00)
R-squared	0.50	0.62	0.45	0.45	0.76

Notes: p-values given in the parentheses, Level of Significance- *** - 1%, ** - 5%, * - 10%
Source: Authors' estimation

Table 7 – Convergence of Core to Headline Inflation

VARIABLES	(1) CPICORE_GAP (Full sample)	(2) CPICORE_GAP (Jan12-Jan15)	(3) CPICORE_GAP (Feb15-Apr19)	(4) CPICORE_GAP (Jan12-Jul16)	(5) CPICORE_GAP (Aug16-Apr19)
β_2	0.17	-0.41**	0.46***	-0.36**	0.42***
	(0.34)	(0.02)	(0.01)	(0.03)	(0.00)
α_2	-0.45**	-1.93***	-0.11	-1.62***	0.37***
	(0.03)	(0.00)	(0.47)	(0.00)	(0.00)
R-squared	0.02	0.18	0.10	0.09	0.29

Notes: p-values given in the parentheses, Level of Significance- *** - 1%, ** - 5%, * - 10%
Source: Authors' estimation

In tables 6 and 7, CPIH_GAP ($CPIH_t - CPIH_{t-12}$) and CPICORE_GAP ($CPICORE_t - CPICORE_{t-12}$) are the dependent variables in equations (3) and (4) respectively. We analyze

[2] Dholakia (2018) conducts a similar analysis with varying time horizons, although their data stops at Nov2017.

the convergence for different time periods. In both the tables, column 1 gives the results for the entire time period of the sample. Columns 2 and 3 give the results for pre and post inflation targeting regimes, with February 2015 taken as the break. Columns 4 and 5 take August 2016 as the break point for a pre and post analysis. We chose this point because since August 2016, core inflation has been persistently higher than headline inflation (Figure 2).

Headline inflation always reverts to core inflation irrespective of the time period. Coefficients are negative, significant and exceed unity. Given that it has more transitory components, it is more likely to have larger but temporary fluctuations that revert to a relatively stable measure of core inflation. On the other hand, core inflation does not revert to headline inflation in the full sample or in the post inflation targeting period. This reversion seems to have been specific to the high food inflation period. The coefficient of convergence of headline to core is higher than that of core to headline. This is precisely due to the transitory nature of headline inflation, a large share of which is comprised of food and fuel inflation.

Prior to the adoption of inflation targeting, core inflation did revert to headline. In order to further see whether this effect was specific to that period, we divide the sample in two periods, one with core inflation persistently higher than headline inflation (August 2016-April 2019) and the other prior one with headline inflation exceeding the core component. We discover that core inflation reverted to headline inflation in the earlier period when it was lower than headline inflation. Once headline inflation goes below the core component, direction of convergence reverses, so that persistence of core inflation from headline shocks that Anand et. al (2014) emphasized disappears. That result was specific to a period of high food inflation.

There was a sharp fall in oil prices in late 2014. Food inflation also fell, so headline inflation was low. The Goyal and Baikar (2015) argument of absence of second round effects on core when headline inflation is below double digits is supported. The evidence of better anchoring suggests inflation is unlikely to persist above the inflation target. The persistence of core even after the implementation of inflation targeting was probably due to the shocks to house rent allowance etc. As Dholakia and Kadiyala (2018) argue, and as we empirically estimate, inflation expectations are getting anchored so core can be also expected to decline to the target, even as headline inflation fluctuates around this value. Since there is no evidence of excess demand hypothesis it is unlikely to be the explanation for sticky core inflation.

6. Conclusions

It is early yet to draw a definite conclusion on whether inflation expectations in India are well anchored, and to decide on the contribution of the IT regime, especially given the multiple factors that have impacted inflation in this period. But results on improvement in anchoring, greater impact of RBI communication, and enhanced role of fundamentals compared to own perceptions all bode well for the efficacy of the new regime. After the adoption of IT, household inflation expectations are more dependent on communicated targets. Short term inflation targets are more credible, the RBI's inflation projections have more impact on inflation expectations. Bidirectional causality between headline inflation and core inflation and their significant influence on inflation expectations, with headline components affecting short-run and core long-run, implies expectation formation is becoming less naïve. The results that households do not over-react to new information and pay attention to RBI projections indicate expectations are likely to stay anchored as long as long-run fundamentals are stable.

The expectations channel of transmission is working (Goyal, 2016) although the aggregate demand channel is weak since both the Repo and the output gap have little effect on inflation expectations. Careful communication and accurate forecasts can make the expectations channel more effective.

Since expectations are showing signs of being anchored, and headline reverts to core, so that headline shocks do not persist, monetary policy can afford to look through headline shocks that are likely to be transient.

Persistence of core inflation has been due also to specific components. It has shown periods of stickiness, but fallen after that. The trend is downward. Given the steady improvements in the anchoring of inflation expectations, and both headline and core inflation could be expected to converge to the inflation target of 4 percent as opposed to converging towards each other.

References

Anand, R., Ding, D., & Tulin, V. (2014). Food Inflation in India: The Role for Monetary Policy. *International Monetary Fund, Working Paper Series* no. WP/14/178.

Bernanke, B. S. (2004). Remarks by the Governor of Fed, At the Meetings of the American Economic Association. *American Economic Association.* California.

Bernanke, B. S. (2007). Inflation Expectations and Inflation Forecasting. *Speeches by Federal Reserve Governor*.

Chinoy, S., & Jain, T. (2019). *India: What to expect when you're (not) expecting.* Asia Pacific Emerging Markets Research, J P Morgan.

Das, P., & George, A. T. (2017). Comparison of Consumer and Wholesale Prices Indices in India: An Analysis of Properties and Sources of Divergence. *Reserve Bank of India, DEPR, Working Paper*.

Dholakia, R. H., & Kadiyala, V. S. (2018). Changing Dynamics of Inflation in India. *Economc & Political Weekly*, 65-73.

Goyal, A. (2016). 'Introduction: Unconventional Monetary Policy in Emerging Markets' in special issue on, 'Unconventional Monetary Policy in Emerging Markets', *Goyal, A., D. Nachane and S. Sarkar (eds.). Macroeconomics and Finance in Emerging Market Economies*, 9(2) pp. 101-108 | DOI: 10.1080/17520843.2016.1180835 June.

Goyal, A. (2015). Understanding High Inflation Trend in India. *South Asian Journal of Macroeconomics and Public Finance*, 4(1): 1–44. 2015..

Goyal, A., & Baikar, A. K. (2015). Psychology or Cyclicality: Rural wage and inflation dynamics in India. *Economic and Political Weekly*, 50 (23): 116-125. June 6.

Goyal, A., & Parab, P. (2019). Modeling Heterogeneity and Rationality of Inflation Expectations Across Indian Households. *Indira Gandhi Institute of Development Research, Working Paper* no.WP-2019-002.

Goyal, A., & Tripathi, S. (2011). New Keynesian Aggregate Supply in the Tropics: Food prices, wages and inflation. *International Journal of Monetary Economics and Finance*, 4 (4): 330-354.

Łyziak, T., & Paloviita, M. (2017). Anchoring of Inflation Expectations in the Euro Area: Recent evidence based on survey data. *European Journal of Political Economy*, 52-73.

Mathur, A., & Sengupta, R. (2019). Analysing Monetary Policy Statements of the Reserve Bank of India. *Indira Gandhi Institute of Development Research, Working Paper* no. WP-2019-012.

Pattanaik, S., Muduli, S., & Ray, S. (2019). Inflation Expectations of Households: Do they influence wage price dynamics in India? *Reserve Bank of India, DEPR, Working Paper*.

Reserve Bank of India (2009). *Report of the Technical Advisory Committee on Surveys* (Chairman: Dr. Rakesh Mohan). September 2009.

Reserve Bank of India (2013). *First Quarter Review of Monetary Policy 2013-14.* May 2013.

Reserve Bank of India (2014). *Report of the Expert Committee to Revise and Strengthen the Monetary Policy Framework* (Chairman: Dr. Urjit Patel). January 2014

Saakshi, & Sahu, S. (2018). An Analysis of Heterogeneity in Inflation Expectations across Cities in India. *MPRA Working Paper*.

Toda, H. Y., & Yamamoto, T. (1995). Statistical Inference in Vector Autoregressions with Possibly Integrated Processes. *Journal of Econometrics* , 225-250.