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Irfan Ali KC
University of Hyderabad, India, irfanalikc@gmail.com

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Cover Page Footnote

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DOES INFLATION TARGETING ANCHOR INFLATION EXPECTATIONS IN INDIA? EVIDENCE FROM SURVEYS OF HOUSEHOLD AND PROFESSIONAL FORECASTERS

Irfan Ali K C*

*Corresponding author. University of Hyderabad, India. Email: irfanalikc@gmail.com

ABSTRACT

This study examines whether Inflation Targeting (IT) anchors household and professional forecasters expectations in India. It investigates whether food and non-food inflation affect anchoring inflation expectations differently. Primarily, the results indicate significant decreases in the level and variability of expectations. Further, it provides evidence of successful anchoring for professional forecasters and household expectations. However, it also found food inflation assists anchoring of expectations, while the non-food inflation doesn't. The results suggest the central bank to emphasize more on non-food inflation for better anchoring prospects. Additionally, the study identifies food inflation as the primary contributor to headline inflation variability.

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I. INTRODUCTION

During the 1990s, many countries implemented explicit Inflation-Targeting (IT) monetary policy frameworks, beginning with the central bank of New Zealand. Concurrently, these countries observed a decrease in their inflation rates and a reduction in inflation variability over the same period. The proponents of inflation targeting argue that it helps relieve the problem of dynamic inconsistency, leading to lower inflation expectations and inflation variability.

There are currently more than 35 IT countries. Many times, the unsatisfactory experiences of the pioneering countries with the monetary targeting and fixed exchange rate have led to the adoption of IT. Furthermore, IT is the result of historical efforts to achieve or at least preserve monetary and price stability. IT framework either follow point target, or a range, say 2%, with upper bound and lower bound set as 3% and 1%, respectively. The central bank takes extensive measures to keep inflation in the prescribed target range.

The related literature has explored the mechanism to test the effectiveness of IT. If the expectations lie within the inflation target band, it is considered anchored; thus, the monetary policy is credible. If it is imperfectly credible, the long-term expectations will be volatile; any shocks to realized inflation may have little effect on the expectations and will wither away shortly (Kabundi *et al*., 2015). According to Corsello *et al*. (2019), anchored long-term inflation expectations do not react to macroeconomic surprises and short-term inflation expectations developments.

Reserve Bank of India (RBI) announced a disinflationary glide path with a target of 8% in May 2014 to be achieved by the end of 2014, 6% by the end of 2015, and 5% by the end of 2015 (Patra, 2017). Further, in May 2016, RBI officially adopted inflation targeting with the amended RBI Act. The announced target thereafter has been 4% with a threshold of ±2%. RBI has chosen the headline inflation as the target.

Inflation, as well as inflation expectations in India, has displayed a decline since 2014. However, the downfall of inflation post-2014 has multiple factors other than IT. Fiscal policies that had deflationary pressure on food prices significantly affected inflation's decline (Mohan and Ray, 2019). Goyal and Parab (2020) argue that mild food inflation, decline in oil prices, along with the adoption of IT played a significant role in the decline. Moreover, they argue that the persistently higher food inflation in India led RBI to focus on targeting headline inflation which had higher share of food component. It is also to be noted that India is one of the major emerging market economies whose share of the food group is prominent in the CPI basket.

This paper investigates the anchoring of inflation expectations in India in the context of the adoption of IT. In doing so, we test inflation expectations for (i) a reduction in their volatility, (ii) sensitivity to past inflation, and (iii) convergence toward the inflation target. Specifically, the paper's main contribution is in analysing the differential effects of food and non-food inflations on the anchoring of inflation expectations among household and professional forecasters.

This paper broadly contributes to the literature on inflation targeting. Given limited studies in the context of India, it brings more evidence of the effect of IT in India. To study anchoring differentiated based on food and non-food inflation is relatively novel to India, although India's price decisions hugely rely on

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essential commodities such as food products. It also looks into the effect of IT on both professional forecasters' and household expectations. None of the previous studies have attempted to estimate the rate of convergence of expectations toward the inflation target for India. This study contributes significantly to these domains.

The remainder of the study is organized as follows. Section II presents a review of relevant literature that investigates the impact of IT across various countries. Section III provides an overview of the data utilized in this study. Section IV takes up empirical analysis and discusses the main findings. Finally, Section V provides concluding remarks.

II. LITERATURE REVIEW

Many studies have noted that the downward trend in inflation started early in the 90s. Arestis *et al*. (2011) find the trend of inflation has been downward among BRICS countries regardless of whether the country was IT or non-IT.[1] Carrasco and Ferreiro (2013) find a similar declining trend in inflation for Mexico. There are suggestions that the downward trend in inflation cannot be attributed only to the adoption of IT (Levin *et al*., 2004). Therefore, it is pertinent to investigate the factors behind the downward trajectory of inflation and assess the potential role of IT in this trend.

There are pieces of evidence for both the absence and presence of the effect of IT (Bernanke *et al*., 1999; Lin and Ye, 2007; Mishkin, 1999). Long-run expectations are found to be anchored in developed countries (Crowe, 2010; Gürkaynak *et al*., 2010). The report of the IMF (2005) argued that the expectations are expected to be anchored in developing countries with a decline in their dispersion. Capistran and Ramos-Francia (2009) also suggest the same for developed countries. Moreover, studies find IT an effective monetary policy in anchoring inflation expectations in emerging markets compared to industrialized countries (IMF, 2005; Svensson, 2010).

Several cross-country investigations have been conducted to understand the impact of IT on inflation, expectations, and other macroeconomic variables. Most of these studies have contrasted the experiences of IT and non-IT countries. The empirical literature has focused on determining if the expectations became more aligned with the target after the announcement and if there was a decrease in the variability of expectations. Johnson (2002) report a significant fall in expectations in the case of 11 (IT and non-IT) countries. At the same time, neither the variability nor the average absolute forecast error seems to have decreased due to IT. They also report that disinflations are more prominent in inflation-targeting countries. The standard deviation of inflation forecasts of each country measures the forecast variability. The variability was found to have declined largely in the IT countries compared to the non-IT countries. And finally, they investigated the forecast error. The forecast error was positive for every country, indicating an unexpected disinflation is not prevented by the targeting framework. However, there was an ongoing recession and disinflation in all the countries considered in the 1990s. It also indicates that the disinflation in non-targeting countries was unexpected.

[1] Brazil, Russia, India, China, and South Africa are the BRICS countries.

Overall, the author found that the inflation targeting was a success. It reduced the expectations following the targeting announcement and made possible a disinflation with lesser forecast errors than the non-targeting countries. However, the reduction in dispersion did not significantly contribute to the targeting.

Johnson (2002) is highly regarded for his contribution to the IT literature. However, this study and many others have faced selection bias accusations. This issue has been addressed by Lin and Ye (2007) using propensity score matching. They focused on 22 industrial countries, including seven IT countries. Interestingly, they report no significant IT effect on inflation or inflation variability.[2] Another study with a similar methodology used the economic development of countries as the distinguishing factor among countries and used propensity score matching to manage the selection bias (see Samarina *et al*., 2014). They also found no significant effect of targeting on inflation in emerging and developed countries. While Tas and Ertugrul (2013) report a positive impact of targeting using a panel of 25 countries.

The decline in inflation and expectations in EMEs and developed countries in the last two decades is well documented and evident. Inflation expectations in the EMEs are found to be better anchored following the adoption of IT (Sousa and Yetman, 2016). Kose *et al*. (2019) argue that increased central bank transparency, along with targeting, helps in better anchoring. The interplay between the central bank transparency and anchoring of expectations is further explored by Samanta and Kumari (2021).

Another stream of literature focuses on the effect of IT in countries using a pre- and post-IT scenario. New Zealand was the first country to adopt IT to anchor the expectations in 1990. Many studies bring evidence for the anchoring of expectations. However, there are disagreements. The survey of firms in New Zealand is found to forecast inflation with high levels of uncertainty, resulting in a lack of anchoring even after 25 years of IT (Kumar *et al*., 2015).[3] The expectations in New Zealand exhibit extreme dispersion and volatility at short and long-term forecasts that indicate non-anchoring.

Akyurek *et al*. (2011) examine Turkey's IT experience and look into more implications than a mere reduction in expectations and variability. They evaluate IT effectiveness through fiscal stability, overnight policy rate, and other channels of controlling inflation.[4] Their study finds a positive impact suggesting an improvement in the monetary policy transmission. In short, the macroeconomic variables improved, which in effect, brought a positive change in the overall economic growth in Turkey. Barbosa-Filho (2009) shows that IT managed to reduce inflation in Brazil after its 1999 and 2002 currency crises but with an exchange rate appreciation. The IT regime also contributed to lower volatility in economic growth with an upward trend, though slower than the exchange rate targeting.

It is widely accepted that if inflation expectations are well-anchored, long-term inflation expectations should remain stable in response to macroeconomic events, monetary policy announcements, and fluctuations in short-term expectations. However, there is limited empirical evidence on the effect of announcing an

[2] Inflation variability is defined as the standard deviation of three-year moving average of inflation.
[3] The respondents of the survey of firms in New Zealand are the managers of the firms.
[4] Other channels of controlling inflation includes the interest rate and aggregate demand management.

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inflation target on the anchoring of households' inflation expectations. It is possible that households with limited knowledge about the central bank may not be aware of or able to comprehend such announcements (Binder, 2017). At the same time, economists, entrepreneurs, professional forecasters, amongst others, would have different expectations compared to households.

There are shreds of evidence on anchoring that differ based on the nature of forecasters. The forecast of inflation of New Zealand firms managers with a lesser idea about central bank objectives registered weakly anchored expectations (Kumar *et al*., 2015). At the same time, those working in the financial sector and professional forecasters, who are well aware of the inflation target, largely rely on the central bank's credibility in forming their expectations (Binder, 2017). Similarly, households that do not closely follow monetary policy decisions are liable to deviate from the announced target.

It is to be noted that with better information access and the ability to interpret, agents are expected to know the inflation target set by the central bank. If the central bank has a proven credibility track record and agents believe that the inflation will come down to the target point, expectations will hang around the target. Hence, the agents won't make systematic forecast errors (Carrasco and Ferreiro, 2013). However, this is an impossible proposition as policy communication doesn't reach the agents in full swing, nor do they have the capacity to interpret the available data in a promising way. The only possible way is the in-between, where some agents have access to the information (or agents have some information), and some know how to interpret it. The rest use their personal experience of price changes or make a naïve prediction. The central bank is supposed to work on the credibility part to control inflation and manipulate expectations by using other monetary tools such as policy announcements and policy rate alterations. Regardless of the communication mechanisms, higher inflation levels ruin the credibility of central banks. Mexico is said to have lost the central bank's credibility among the economic agents in the 1980s owing to the high inflation period (Carrasco and Ferreiro, 2013).

Concerning the test for anchored inflation expectations, Carrasco and Ferreiro (2013) argue that if the expectations are anchored, the series should have a normal distribution with the mean equalling the inflation target. To examine the normality of expectations in Mexico, they applied Shapiro–Wilk (SW), Jarque–Bera (JB), and Doornik–Hansen (DH) tests. The result indicated non-normal distribution, hence concluded the expectations are unanchored. More specifically, the Mexican experience of IT revealed unanchored medium-term expectations.

Kontonikas (2004) used a Generalized Auto-Regressive Conditional Heteroscedastic (GARCH) model and a Multivariate GARCH model to assess the capacity of IT policy to reduce uncertainty and inflation variability. He concludes with the relevance of this regime to act positively on uncertainty. According to his findings, adopting an explicit target removes inflation persistence and lowers long-term uncertainty. Dholakia and Kadiyala (2018) argue that a decline in inflation persistence indicates improved anchoring of inflation expectations. Citing the structural break due to IT, Tas and Ertugrul (2013) employed a Markov-Switching Auto-Regressive Conditional Heteroscedastic (SWARCH) model to test the decrease in inflation volatility and found that IT has decreased inflation volatility in both industrial and emerging economies successfully.

It is argued that the influence of the inflation target and realized inflation differently matter depending on the longevity of the forecast (Miyajima and Yetman, 2018). The authors formulate a decay function. The longer the forecast horizon, the lesser the influence of realized inflation and the stronger the influence of the inflation target. An insight behind the decay function is that people cannot depend on past inflation as they may expect inflation to converge to the target in the long term. However, the decay function depends on the rapidity of the decline of influence. Along the same line, King (2022) finds the rate of convergence of long-term expectations to the inflation target of New Zealand and finds that different forecasters have different convergence rates.

Multiple measures have been employed in the literature to study inflation expectations' anchoring. A lower dispersion, variability, and inflation uncertainty denote expectations' anchoring. Short-term inflation expectations may deviate from the target range for multiple reasons. Still, it is expected to align with the target in the long run. The target is expected to be more influential in the long run as the agents do not prioritize the information of past inflation over the target for long-term inflation expectations. In such case, the distribution of expectations depicts a normal distribution with the mean equalling the target.

The relevant literature focusing on India lacks extensive research on the effectiveness of IT. One of the reasons is that it is too early to reach to a conclusive assessment on the effectiveness of IT in India. However, studies find that there is a decline in inflation and expectations following the adoption of IT in India; see, for example (Asnani *et al*., 2019; Eichengreen *et al*., 2021). The reasons for the decline are further explored. Mohan and Ray (2019) argue that the downfall of inflation post-2014 has multiple factors other than IT. They find fiscal policies such as changes in taxation on fuel-related goods, subsidy on food, administered grain prices, etc., significantly impacted the decline. There has been a sharp decline in minimum support prices, considerably reflected in the decline in food prices. Also, the fall in global fuel prices led to decreased fuel inflation in India between November 2015 and July 2016. Furthermore, the global food inflation downfall due to excess supply in the global market decreased domestic food prices in 2016 and 2017.

Goyal and Parab (2020) studies the convergence between core and headline inflation as well as tests the anchoring of inflation expectations in India. Using the household data retrieved from the Inflation Expectations of Households (IESH), they test the impact of realized inflation, inflation target, and central bank projections, over the expectations. They also test whether the short-term expectations affect the long-term expectations. A series of constrained-OLS regressions were run to test anchoring. While the results indicate de-anchored inflation expectations of households, they point towards an improved importance of central bank communication in the expectations formation. It also indicated that the households moved from the naïve to adaptive expectation formation.

Food inflation plays a significant role in the inflation and inflation expectations in India, like many other emerging economies. Moreover, India is a net food exporter with almost a 0.7% difference. However, the share of India's food export and imports has been relatively low in the global market (Sahoo *et al*., 2020). In the aftermath of the global financial crisis, India faced heightened inflation pressure

accounting for excessive capital inflow (Mohan and Ray, 2019). The recovery from the GFC due to fiscal and monetary stimuli eventually, by the end of 2009, started to reflect on prices, primarily on food inflation. The headline inflation followed the trend. Goyal and Parab (2020) finds evidences for influence of food inflation on inflation expectations and the impact of core inflation declined post-IT.

Based on the objectives of this paper, we specifically investigate the anchoring of inflation expectations. Studies such as Asnani *et al*. (2019), Eichengreen *et al*. (2021), and Samanta and Kumari (2021) explore the possibility of anchoring expectations on various grounds in India. Samanta and Kumari (2021) follows Łyziak and Paloviita (2017) and Sousa and Yetman (2016), to assess the impact of monetary policy transparency on anchoring. The transparency measure employed in their study is based on text mining technique. They measure anchoring based on the sensitivity of expectations to the available information. They found that the transparency level has substantially increased since India adopted a flexible IT framework, which generally pays back with better anchoring. Additionally, household and professional inflation expectations have been found to be less volatile since the announcement of the glide path in 2014.[5]

At the same time, the variability in the headline inflation did not reduce owing to the volatility in the food group inflation (Asnani *et al*., 2019). It is also noted that the Indian population internalizes the cyclicity in food prices, especially in the expectations formation, regardless of any change in the adoption of IT by the central bank. At the same time, Eichengreen *et al*. (2021) find that the volatility of inflation is lower, except for food inflation.[6],[7] Such behavior in inflation is noted as an indicator of anchoring in the literature. Their study further documents that the inflation expectations are better anchored as the central banks responded effectively even to the COVID-19 crisis.[8]

Another check on the anchoring rises from the influence of realized inflation over expectations. It has been found that realized inflation does not affect household expectations post-IT (Asnani *et al*., 2019). At the same time, Eichengreen *et al*. (2021) document that the realized inflation to affect both household and professional expectations, except for the 12 months ahead professional expectations, even after controlling for IT. They also find a decreasing effect of inflation on expectations with an increase in the forecast horizon. Asnani *et al*. (2019) also report that the previous expectations did not affect the current expectations, which denotes the absence of stickiness in the expectation formation. In other words, it implies significant revisions in the expectations indicating unanchored expectations. Goyal and Parab (2020) finds that the impact of inflation perceptions on expectations decline post-IT.

The average expectations are found to be higher than realized inflation and inflation target in several countries (Binder, 2017). Similar is the case of India for the entire period of our sample. It has been noted that inflation and expectations declined after RBI adopted IT. However, literature on India has not explored

[5] Volatility is proxied using standard deviation and coefficient of variation.

[6] The inflation volatility in the said study is calculated as the quarterly average of the 15-month rolling standard deviation of monthly inflation series, which is then averaged at quarterly frequency.

[7] Central bank has comparatively less influence on food inflation (Eichengreen *et al*., 2021).

[8] For a survey of the COVID-19 literature; see, inter alia, Phan and Narayan (2020) and Narayan (2021).

the possibility of a structural break in the period considered. Asnani *et al*. (2019) mention a structural break post-IT in India. Saakshi and Sahu (2019) considered a change in the political regime as a structural change in 2014, which they found statistically insignificant.

A recent study by Behera and Patra (2022) report that India experienced a steady decline in trend inflation since 2014, with the rate reaching approximately 4.2% by the end of 2019. Through a decomposition analysis, the researchers determined that trend inflation played a significant role in shaping India's CPI inflation. Additionally, they argue that the decline in trend inflation can be attributed to the adoption of inflation targets in 2014-15, known as the disinflationary glide path, as well as the official declaration of IT in 2016. This suggests that the IT framework has been instrumental in guiding monetary policy decisions and fostering convergence in inflation levels.

III. DATA

The RBI has taken up the survey of inflation expectations since 2006. However, we have collected the quarterly data from 2008 Q3 to 2020 Q1 for analysis. To conduct the empirical analysis, we have considered the following variables: Consumer Price Index inflation rate (*CPI*), Inflation Expectations of Households (*IESH*), Professional Forecasters' Expectations (*PFS*), and a dummy variable for Inflation Targeting (*IT*). All data are obtained from RBI.

Inflation is the annual growth rate of CPI, denoted as π_t, wherein t denotes time. Given that the inflation calculation in India has taken multiple turns during our study period, we utilized CPI inflation for industrial workers over the period September 2008 to December 2011 and CPI combined (CPI-C) for the rest of the period.[9],[10] The CPI inflation is further classified into food inflation and non-food inflation. Non-food inflation is inflation devoid of food-related items from the CPI basket. Inflation expectation is the simple average of the expectations reported by survey respondents. It is denoted as $\pi^{e}_{t,t+q}$, which is the respondent's expectation at time t, regarding the inflation at $t+q$. The value of q=1 for one quarter ahead forecast and q=4 for four quarters ahead forecast. IT dummy variable takes value one post June 2016 and 0 otherwise. As the RBI emphasizes anchoring long-term inflation expectations, we stick to the four quarter-ahead expectations in the tests for anchoring in Section 4.2. Robustness checks are conducted by incorporating the COVID-19 period for our data analysis. The COVID-19 dummy variable takes the value of 1 between June 2020 and September 2021, otherwise zero.

To add more insight to our analysis, we have also calculated the forecast error $\pi^{fe}_{t,t+q}$ as the difference between the realized inflation at $t+q$ and expectations for time $t+q$ forecasted at t. The equation is given by $\pi^{fe}_{t,t+q} = \pi^{e}_{t,t+q} - \pi_{t+q}$. The forecast errors of inflation expectations for households and professional forecasters are

[9] CPI-C is a newly constructed inflation index which is available from 2011, and CPI-IW is found to be a good proxy for it (Goyal and Parab, 2021).

[10] CPI-IW is calculated every month on the basis of retail prices collected from 317 markets spread over 88 industrially important centers in India.

denoted as $\pi_{t,t+q}^{hfe}$ and $\pi_{t,t+q}^{pfe}$, respectively. A positive forecast error denotes overestimating expectations, and a negative value indicates underestimating.

IV. EMPIRICAL ANALYSIS

This section provides a discussion on empirical findings. We have divided our discussion in the following two parts: findings emerging from our preliminary analysis and empirical findings from the tests of anchoring, respectively.

A. Preliminary Analysis

The descriptive statistics of all variables used in this study are presented in Table 1. We observe that the range values of expectations and the corresponding standard deviations at the shorter horizon ($\pi_{t,t+1}^{e}$) are lower than the longer horizon ($\pi_{t,t+4}^{e}$), indicating higher volatility and dispersion in the long-term forecast. At the same time, the mean values of both are closer. The forecast error also exhibits similar features. The mean and standard deviation (SD) is comparatively higher for the $\pi_{t,t+4}^{fe}$ than $\pi_{t,t+1}^{fe}$, indicating a higher uncertainty in the longer-term forecast. Rest of the variables are self-explanatory. However, we can see that the mean is not constant throughout the study which is quite evident from the graphical representation of the variables in Figures 1 and 2. We further calculate the descriptive statistics of the variables pre- and post-IT (see Table 2).

Table 1.
Descriptive Statistics

This table reports selective descriptive statistics (namely mean, Standard Deviation (SD), minimum, and maximum) of the variables used in this study.

Variable	Mean	SD	Min	Max
IESH 1Q ahead	10.22	1.82	5.30	12.80
IESH 4Q ahead	10.81	2.00	6.20	13.50
PFS 1Q ahead	6.96	2.71	2.60	13.50
PFS 4Q ahead	6.21	1.71	3.40	8.90
CPI Inflation	7.50	3.56	2.20	16.60
Food Inflation	7.86	5.01	-1.16	18.83
Non-food Inflation	7.21	2.63	2.43	12.68
IESH 1Q Forecast Error	-2.69	3.46	-8.65	6.43
IESH 4Q Forecast Error	-3.10	4.43	-9.55	10.40
PFS 1Q Forecast Error	0.44	1.62	-3.35	4.53
PFS 4Q Forecast Error	1.05	3.35	-4.05	12.70

Table 2.
Descriptive Statistics Pre- and Post-IT

This table reports mean, and standard deviation of the variables used in this study during the pre-IT and post-IT periods.

Variable	Pre-IT		Post-IT		
	Mean	SD	Mean	SD	Difference
IESH 1Q ahead	10.87	1.95	8.99	0.8	1.88
IESH 4Q ahead	11.15	2.64	9.64	1	1.51
PFS 1Q ahead	8.62	2.07	4.31	1.03	4.31
PFS 4Q ahead	7.34	1.18	4.88	0.46	2.46
CPI Inflation	9.4	2.97	4.15	1.3	5.25
Food Inflation	10.32	4.13	3.5	3.14	6.82
Non-food Inflation	8.5	2.32	4.93	1.22	3.57
IESH 1Q Forecast Error	-1.47	3.72	-4.85	1.31	3.38
IESH 4Q Forecast Error	-1.75	4.91	-5.5	1.79	3.75
PFS 1Q Forecast Error	0.78	1.82	-0.17	0.97	0.95
PFS 4Q Forecast Error	2.06	3.72	-0.74	1.34	2.8

Several observations stand out in the graphical review of the behavior of expectations and CPI inflation (see Figure 1). First, we find that expectations and inflation follow a downward trend, especially following the adoption of IT. The *PFS* seems to have closely followed the target rate since the announcement of the glide path in 2014, while the households' expectations did not. CPI inflation and the *PFS* lie in the target range of 4±2 post-IT. The higher volatility in the initial period seems to be the lagged effect of the global financial crisis and the related economic uncertainty. The forecast errors suggest that the survey respondents overestimate inflation while the realized inflation is falling and vice versa.

As can be observed from Table 2, the mean expectations and CPI inflation are higher in the pre-IT period compared to the post-IT period, wherein the latter registers the highest difference. The average CPI inflation post-IT period is 4.15, with a standard deviation of 1.3. This trend does indicate that inflation is in the target range, and thus it is anchored. However, the expectations are well beyond the target even after the adoption of IT.

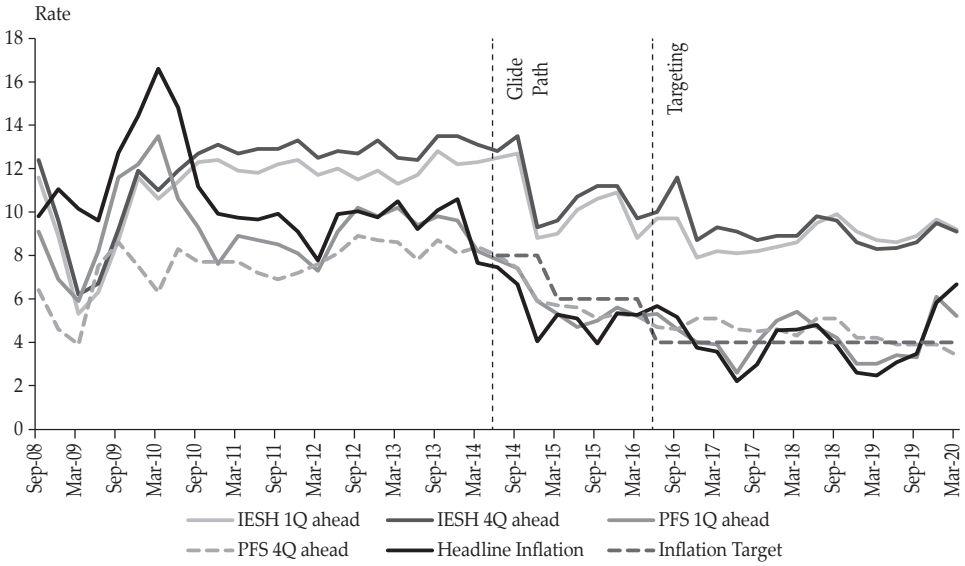
Household expectations have overestimated inflation in both periods, while the *PFS* underestimated it in post-IT period. While at the same time, the *PFS* underestimated the expectations before the adoption of IT by around 1% and overestimated by 0.5% in the post-IT period. The overestimation is very small and is much closer to the target. Finally, the forecast error increased for the households' post-IT while it decreased for *PFS*. Reading it with the decline in the actual CPI, the household forecasts could have ignored the realized inflation information, not revising the expectations.

As can be observed from Figure 1, the decline in the *IESH* happened in the glide period (from 14% to 10%). Then it displays less variance post-IT, hovering between 10% and 8%. The *IESH* was still far from the target. While at the same time, the professional forecasters considered the actual CPI reading and even expected it to go near the IT very soon, ending up overestimating inflation. This study will explore such behavior with the test of convergence of *PFS*. Figure 1

shows that the major decline happened in the glide period, and then the *PFS* stick to the target range.

Figure 1.
Inflation and Expectations in India

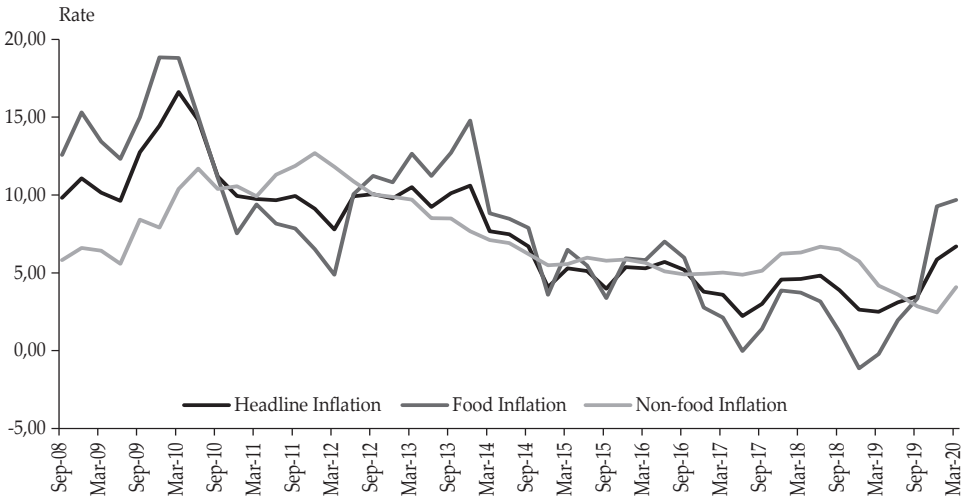
This figure plots inflation expectations of households and professional forecasters over the period September 2008 to March 2020. It also plots headline inflation for comparison. The RBI inflation target given for reference. The Glide Path refers to the initial phase of IT implementation and targeting refers to the official declaration of IT.



Source: RBI Handbook of Statistics on Indian Economy.

Figure 2.
Food and Non-Food Inflation

This figure places a comparison between food inflation and non-food inflation derived from the headline inflation over the period September 2008 to March 2020.



Source: Author's calculation based on RBI data.

Interestingly, the forecast error in the post-IT period increased for the *IESH*, wherein the realized inflation is observed to fall. These inferences are found to be similar in the case of the USA Livingston Forecast and Michigan Forecast (Mehra, 2002). However, the *PFS* forecast error decreased in the post-IT period, along with the change of signs from positive to negative, which indicate overestimation.

B. Tests of Anchoring

B.I. Testing the Effect of IT on Inflation Expectations

It has been graphically discussed that inflation and expectations declined post-IT, though the causal relationships are not confirmed. To empirically test the effect of IT on inflation and expectations, following (Mishkin and Schmidt-Hebbel 2007), we estimate the following regression model:

$$\pi^{e}_{t,t+4} = \alpha_0 + \beta_1 IT + \varepsilon_t \quad (1)$$

where $\pi^{e}_{t,t+q}$ is inflation expectations, IT is the dummy variable for the inflation targeting period. A significant β indicates the effect of IT on expectations. If the coefficient is positive, it suggests an increase in the expectations post-IT and vice versa. The regression is further estimated with realized inflation as the dependent variable. The results of the regression are reported in Table 3.

It is pretty evident from Table 3 that IT has a negative impact on expectations for both the household and the professional forecasts. In other words, we can observe that the expectations declined in the post-IT period. However, it also implies that the *PFS* has had more impact than the *IESH*. The headline inflation, on average, has declined by 5.26 points in the IT regime and has closely followed the target. Food inflation displayed the largest decline of almost 7% among the CPI inflation. As noted before, it invoked the majority of changes in headline inflation (Mohan and Ray, 2019). The robustness test results reported in the Appendix (see Table A.I) affirm our findings.

Table 3.
Decline of Inflation and Expectations in the IT Regime

This table reports regression results depicting the effect of IT on the decline of inflation and inflation expectations. Columns 2, 3, 4, 5, and 6 identify household expectations (*IESH*), Professional Forecasters' Expectations (*PFS*), headline inflation, food inflation, and no-food inflation as dependent variables, respectively. *, **, and *** represent significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are reported in the parenthesis.

	IESH	*PFS*	Headline Inflation	Food Inflation	Non-food Inflation
Target Dummy	-2.48***	-2.69***	-5.26***	-6.82***	-3.57***
	(0.4)	(0.27)	(0.62)	(-1.06)	(0.52)
Constant	11.70***	7.18***	9.40***	10.32***	8.50***
	(0.35)	(0.24)	(0.55)	(.64)	(0.43)
N	47	47	47	47	47
R^2	0.34	0.57	0.51	0.42	0.43

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B. II. Testing The Variability and Sensitivity of Expectations

We already noted that the expectations have declined post-IT. But whether inflation expectations are more anchored since the adoption of IT is yet to be analyzed. In this section, we test two aspects of anchoring: (a) variability of inflation and expectations post-IT, (b) sensitivity of expectations toward the lag inflation.

A. The Variability Test:

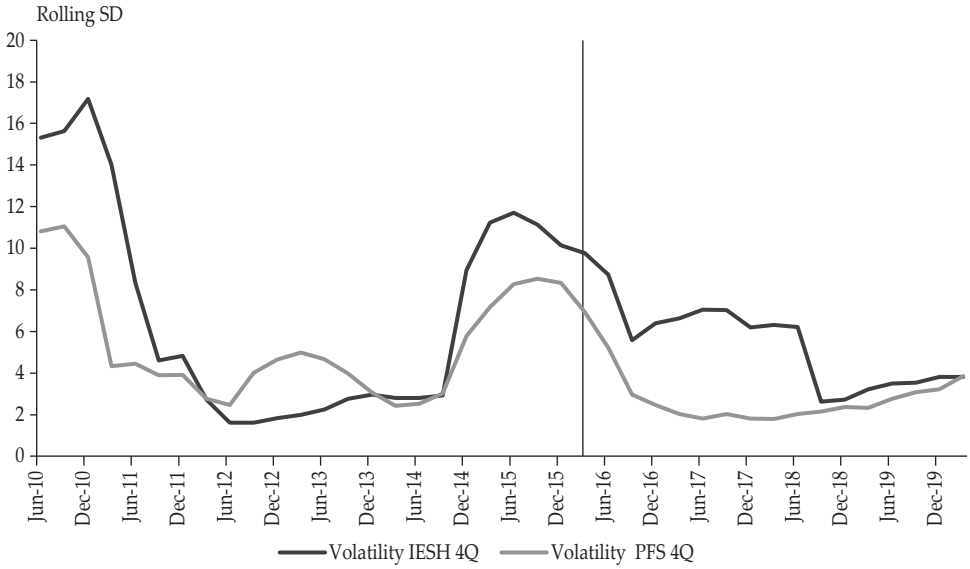
A decline in variability and dispersion of inflation and expectations indicate better anchoring. The lower sensitivity of expectations to the inflation surprises denotes anchoring of inflation expectations. Anchoring depends on the sensitivity of expectations toward inflation surprises (Bems *et al*., 2021). Variability and dispersion of expectations are matrices to understand the anchoring, wherein a low value of these measures denotes better anchoring. Taking insights from Asnani *et al*. (2019), Mohan and Ray (2019), and Sahoo *et al*. (2020), we examine the effect of food and non-food inflation in the dynamics of anchoring expectations in the presence of IT. In doing so, we primarily calculate the variability of inflation and expectations. Lin and Ye (2007) for their analysis, measures inflation variability using the standard deviation of three-year moving average of inflation. Following (Bems *et al*., 2021) we define the generalized equation of rolling window standard deviation as for the variable x_t over each rolling window ω, as the following:

$$V_t = \sqrt{\frac{1}{1-T}\sum_{t=1}^{T}(x_t - \overline{x_t})^2} \tag{2}$$

where $\overline{x_t}$ is the average of x_t at each rolling window ω. The graphical representation of the same is displayed in Figure 3. It shows high variability in the initial period of the sample, which can be due to spill overs of the 2008 global financial crisis. A further increase in volatility is noted between 2014 and 2015, wherein the announcement of the glide path for inflation targeting took place. A decline in variability is visible post-IT which possibly indicates better anchoring. However, food inflation is volatile even post-IT (Figure 4), as was also found by Asnani *et al*. (2019).

Figure 3.
Variability in Expectations

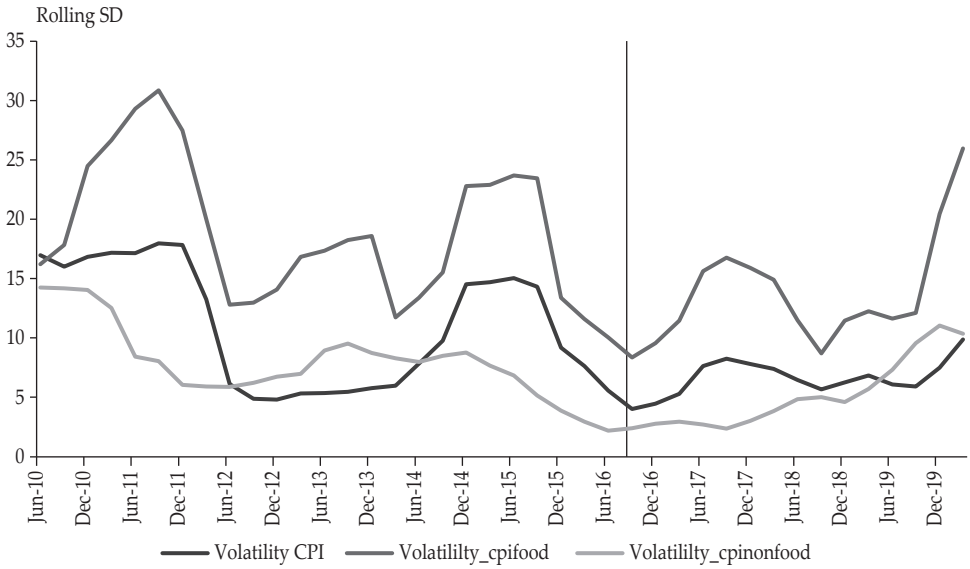
This figure plots the volatility in inflation expectations of households and professional forecasters. The vertical reference line signifies date of IT implementation (May 2016).



Source: Author's own calculation.

Figure 4.
Variability in Inflation

This figure plots the volatility in the food and non-food inflation. The vertical reference line signifies date of IT implementation (May 2016).



Source: Author's own calculation

To explain the decline in variability post-IT, we regress the volatility measure on IT. Results reported in Table 4 indicates a significant decline in variability in inflation and expectations due to IT. However, the coefficient for variability in *IESH* is statistically insignificant. The robustness test results reported in the Appendix (see Table A.II) confirm our findings. Further, to reveal what explains the volatility in the headline inflation, we estimate the following regression model:

$$V_t^{cpi} = \alpha_0 + \beta_1 V_t^{f} + \beta_2 V_t^{nf} + \varepsilon_t \quad (3)$$

where $V_t^{cpi}, V_t^{f}, V_t^{nf}$ are the volatilities of headline inflation, food inflation, and non-food inflation, respectively. These results are reported in Table 5 which suggest that food inflation holds the majority of headline inflation variability. Moreover, non-food inflation variability is small and statistically insignificant. However, Dholakia and Kadiyala (2018) find evidences for absence of second round effects of inflation in India, indicating that the volatility in food and fuel components of inflation will not be generalized to headline inflation.

Table 4.
Effect of IT on Variability

This table reports regression results depicting the effect of IT on the decline of volatility in inflation and inflation expectations. Columns 2, 3, 4, 5, and 6 identify *IESH*, *PFS*, headline inflation, food inflation and no-food inflation as dependent variables, respectively. *, **, and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are reported in the parenthesis.

	IESH	*PFS*	Headline Inflation	Food Inflation	Non-food Inflation
Target Dummy	-1.45	-2.55**	-4.77***	-6.16***	-3.49***
	(1.36)	(0.72)	(1.29)	(1.68)	(0.93)
Constant	6.93***	5.42***	11.40***	19.59***	8.41***
	(0.89)	(0.47)	(0.84)	(1.09)	(0.6)
N	40	40	40	40	40
R^2	0.03	0.25	0.27	0.26	0.27

Table 5.
Components of Inflation Volatility

This table reports the regression results to identify determinants of volatility in headline inflation. Regression in Column 3 controls for the IT effect over the volatility. *, **, and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are reported in the parenthesis.

	Headline Inflation Volatility	
Food Inflation Volatility	0.58***	0.55***
	(0.08)	(0.09)
Non-food Inflation Volatility	0.2	0.16
	(0.15)	(0.16)
Target Dummy		-0.81
		(1.07)
Constant	-1.8	-0.77
	(1.32)	(1.9)
N	40	40
R^2	0.69	0.69

b. The Responsiveness Test:

To bring in more evidence on the anchoring of expectations, we test the responsiveness of expectations to previous inflation. In a targeting framework, it is expected that changes in inflation should be transitory and do not affect long-term expectations (Eichengreen *et al*., 2021). At the same time, the unanchored situation should move people's expectations as per the changes in actual inflation. According to Asnani *et al*. (2019), anchored expectations imply that there are no major revisions in expectations from time to time. Violation of this assumption indicates the stickiness of expectations. To test the anchoring while accounting for the stickiness of expectations, we include lag of expectations, i.e. $\pi^{e}_{t-1,t+q-1}$. The dummy variable IT is also included to control for the structural change. To examine this hypothesis, we test the responsiveness of inflation expectations to realized inflation using the following equation:

$$\pi^{e}_{t,t+q} = \beta_0 + \beta_1 \pi_{t-1} + \beta_2 \pi^{e}_{t-1,t+q-1} + \beta_3\, IT_t + \varepsilon_t \quad (4)$$

where π_{t-1} denotes the lag of inflation, the latest available data on inflation for the respondent. A statistically significant β_1 indicates the dependency of expectations on inflation and thus indicates inflation affects expectations. β_2 is the indicator of revisions in expectations. If it is significant, we can argue that there is an absence of major revision in expectations and thus anchored. Table 6 presents the results of the above-mentioned estimations. It suggests an absence of major revisions in expectations. The coefficient of π_{t-1} denotes the extent to which the inflation at *t*-1 affects the expectations for *t*+*q*.

Table 6.
Effects of Inflation on Expectations

This table provides regression results which examine whether the lag of inflation affects household and professional forecasters' expectations. Models 2 and 5 control for the IT. Additionally, Models 3 and 6 control autoregressive elements. *, **, and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are provided in the parenthesis.

	IESH			*PFS*		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Inflation (t-1)	0.30***	0.11	0.06	0.35***	0.17**	0.08
	(0.07)	(0.1)	(0.07)	(0.05)	(0.07)	(0.07)
Expectations (t-1)			0.66***			0.65**
			(0.14)			(0.23)
Target Dummy		-1.86*	-0.55		-1.79***	-0.54
		(0.74)	(0.53)		(0.48)	(0.54)
Constant	8.54***	10.63***	3.33*	3.58***	5.61***	1.7
	(0.59)	(1.01)	(1.43)	(0.41)	(0.65)	(1.39)
N	46	46	46.00	46	46	46
R^2	0.28	0.37	0.66	0.53	0.64	0.79

Results tabulated in Table 6 suggest that IT is statistically significant and negative even with the presence of π_{t-1}. A statistically significant coefficient of lagged expectations suggests no major revisions in expectations formation. A statistically insignificant lag of inflation indicates detachment of expectations from the temporal inflationary fluctuations. The results thus confirm the anchoring of household and professional expectations. It also underlines the previous findings in which professional forecasters give more importance to realized inflation than households do.

Table 7 suggests that food inflation did not affect expectations, but non-food inflation always did. As we already noted, most of the variability of headline inflation rests in food inflation. Moreover, food inflation is statistically insignificant, indicating the insensitivity of expectations. As mentioned earlier, the decline in headline inflation is majorly led by the decline in food prices. Hence, we argue that the expectations are anchored in India. As a robustness check, we further include the COVID-19 period in testing Equation 4. The results tabulated in Table A.III of the Appendix are not different from the earlier reported results in Table 6, and hence the inferences remain the same.

Table 7.
Effects of Food and Non-food Inflation on Expectations

This table elaborates Table 6 by bifurcating the effects of lags of food and non-food inflation separately on household and professional forecasters' expectations. Models 2 and 5 control for the IT. Additionally, Models 3 and 6 control autoregressive elements. *, **, and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are provided in the parenthesis.

	IESH			***PFS***		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Food Inflation (t-1)	0.03	-0.02	-0.01	0.11**	0.06	0.03
	(0.06)	(0.06)	(0.05)	(0.04)	(0.04)	(0.04)
Non-food Inflation (t-1)	0.54***	0.47***	0.25**	0.41***	0.32***	0.17**
	(0.08)	(0.1)	(0.11)	(0.07)	(0.08)	(0.07)
Expectations (t-1)			0.52***			0.53**
			(0.16)			(0.24)
Target Dummy		-0.92	-0.38		-1.19**	-0.45
		(0.56)	(0.55)		(0.37)	(0.49)
Constant	6.62***	7.84***	3.46*	2.33***	3.91***	1.5
	(0.43)	(0.89)	(1.42)	(0.32)	(0.69)	(1.33)
N	46	46	46	46	46	46
R^2	0.545	0.564	0.703	0.69	0.732	0.812

B.III. Testing Convergence of Expectations

King (2022) suggests that the long-term expectations ideally should be equal to the target if the expectations are anchored. But the agent is not always forward-looking. However, with an increase in the horizon of the forecast, the influence of π_t^* will increase in the formation of expectations. For a forward-looking agent, the expectations at time t for $t+q$ is $\pi^e_{t|t+q}$. If an inflation shock happens at t, the impact will be observed at $t+q$, of which the monetary policy reaction takes effect at $t+q+j$.

In order to study the convergence of agents' expectations, we formulate the change in the inflation rate that an agent expects to occur between one forecast horizon (q) and the next ($q+j$, where $j > 0$) should reflect the extent to which the shorter horizon forecast deviates from their value of π_t^*. It can be denoted as follows:

$$\Delta_j \pi^e_{t,t+q+j} = \beta_0 + \beta_1\left(\pi^e_{t,t+q} - \pi^*_t\right) + \varepsilon_t \quad (5)$$

where $\Delta_j \pi^e_{t|t+h+j} = \pi^e_{t|t+q+j} - \pi^e_{t|t+q}$, and the β_1 denote the rate of convergence towards the target. Hence, β_1 approaching -1 denotes the effectiveness of π_t^* as an anchor and for the credibility of a central bank that the inflation shocks are transitory. β_0 is expected to be zero, otherwise suggesting a systematic forecast error. It is also to be noted that the inflation target in India is a range and not a digit, as described in π_t^*. The results presented in Table 8 indicate that the β_1 is negative and lies between 0 and -1. The convergence coefficient for the professional forecast is significantly closer to -1, indicating a faster convergence compared to households with (-0.24), which will take longer to converge to the target.

The empirical estimations found evidence for anchoring professional and household inflation expectations in India. It is also to be noted that the responsiveness of expectations to headline inflation and food inflation was absent. However, non-food inflation was still significant, regardless of control for IT. It also implies that the professional forecasters' expectations converge faster to the target than the household. In short, though expectations are anchored, well-informed agents such as professional forecasters better understand and resort to the inflation target than the general public.

Table 8.
Convergence of Expectations

This table represents results obtained from estimating Equation (5). The results denote speed of convergence of household and professional forecasters' inflation expectations to the inflation target. *, **, and *** represent statistical significance at 10%, 5%, and 1% levels, respectively. Robust standard errors are reported in the parenthesis.

	IESH	*PFS*
Convergence	-0.24	-0.99***
	(0.27)	(0.13)
Constant	1.51	0.49**
	(1.26)	(0.13)
N	17	17
R^2	0.05	0.78

V. CONCLUSION

Many countries, including India, have adopted IT to control inflation via the expectations channel. This paper attempts to examine the effect of IT on CPI inflation and expectations in India, with special reference to food and non-food inflation. Further, it investigates whether inflation affects expectations. In doing so, we test for the effectiveness of IT, anchoring of expectations, and convergence of expectations in the presence of IT. A preliminary analysis found that the

expectations with longer horizons are more volatile and dispersed than shorter ones. Moreover, the headline inflation and *PFS* are much closer to the target since the IT announcement. Contrary to professional forecasters, household expectations have consistently overestimated inflation.

Given the IT regime was officially adopted in 2016, we have considered a structural break in the series. We found statistically significant negative changes in household expectations, professional forecasts, and realized inflation post-IT. We also find that IT to effectively reduce both the level and variability of both inflation and expectations significantly. The food inflation displayed more volatility than non-food inflation, accounting for most of the headline inflation variability. This study provides evidence for anchoring both professional forecasters' and household expectations, for the headline inflation is muted in the expectations formation. However, it is also found that non-food inflation affects expectations, regardless of the regime change. The expectations are also found to be sticky. Finally, we note that professional forecasters' expectations converge faster towards IT than the household.

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APPENDIX

Table A.I
Robustness Test Results of Equation 1

This table publishes results of robustness check based on equation 1. *, **, and *** represent significance at 10%, 5%, and 1%, respectively. Robust standard errors are in the parenthesis.

	IESH	*PFS*	Headline Inflation	Food Inflation	Non-food Inflation
Target Dummy	-1.19***	-2.52***	-4.69***	-6.17***	-3.17***
	(0.53)	(0.27)	(0.63)	(0.97)	(0.50)
Covid Dummy	0.22	-0.31	1.18*	2.03	0.40
	(0.28)	(0.27)	(0.44)	(1.15)	(0.45)
GFC	-5.34***	-1.82**	0.87	3.54***	-2.79***
	(0.58)	(0.77)	(0.69)	(1.03)	(0.5)
Constant	11.86***	7.42***	9.29***	9.85***	8.87***
	(0.4)	(0.22)	(0.63)	(0.84)	(0.45)
N	60	60	60	60	60
R^2	0.48	0.69	0.49	0.45	0.50

Table A.II
Robustness Test Results of Equation 3

This table publishes results of robustness check based on equation 3. *, **, and *** represent significance at 10%, 5%, and 1%, respectively. Robust standard errors are in the parenthesis.

	IESH	*PFS*	Headline Inflation	Food Inflation	Non-food Inflation
Target Dummy	-2.19	-2.71***	-5.04***	-6.03***	-3.66***
	(1.2)	(0.64)	(1.11)	(1.45)	(0.81)
Covid Dummy	-0.71	0.46	3.24**	9.24***	3.45***
	(0.46)	(0.44)	(1.17)	(2.34)	(0.71)
Constant	6.93***	5.42***	11.40***	19.59***	8.41***
	(1.11)	(0.57)	(1.08)	(1.2)	(0.60)
N	53	53	53	53	53
R^2	0.09	0.30	0.31	0.34	0.33

Table A.III
Robustness Test Results of Equation 4

This table publishes results of robustness check based on equation 4, wherein we expand Table 6 by including the Covid-19 period. *, **, and *** represent significance at 10%, 5%, and 1%, respectively. Robust standard errors are in the parenthesis.

	IESH			***PFS***		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Inflation (t-1)	-0.01	-0.35***	-0.06	0.36***	0.15***	0.08
	(0.11)	(0.12)	(0.12)	(0.05)	(0.05)	(0.06)
Expectations (t-1)			0.68***			0.66***
			(0.11)			(0.20)
Target Dummy		-3.19***	-0.88		-2.00***	-0.52
		(0.65)	(0.70)		(0.34)	(0.52)
Covid19	0.27	1.45***	0.56*	-0.41*	0.33*	0.13
	(0.27)	(0.29)	(0.28)	(0.20)	(0.16)	(0.14)
Constant	10.70***	14.62***	4.34	3.33***	5.79***	1.64
	(0.70)	(1.16)	(2.17)	(0.29)	(0.55)	(1.31)
N	59	59	59	59	59	59
R^2	0.002	0.3	0.638	0.51	0.675	0.82