Floods, Droughts, and Inflation Expectations

Vinod Dharmarajan* Abhiprerna Smit†

March 2025

Abstract

This paper examines whether precipitation related natural disasters like floods and droughts affect inflation expectations of consumers. We exploit variation in the frequency of floods and droughts related disasters across Indian states to understand whether climatic shocks can explain variations in expectation formation process of households. Using data from Reserve Bank of India's inflation expectations survey, we find that, on average, an additional flood event in past three months within a state raises households' short term (three month ahead) inflation expectations by 6.7%. An additional drought event raises the short term inflation expectations by 5.2%. Floods and droughts also affect the second moment by raising dispersion of expectations, especially for the one-year ahead inflation. Our findings highlight the increasing risk of unanchored inflation expectations, which can impede the effectiveness of monetary policy, in a world with increasing climatic events.

JEL Classification: E31, E50, E71, Q54

Keywords: Inflation expectations, floods, droughts, climate change, monetary policy

*Amazon (Economist); vinoddharmarajan90@gmail.com

†Corresponding Author: William & Mary; asmit@wm.edu

1 Introduction

Climate change has threatened economic stability across many dimensions including consumption, manufacturing, agricultural production, and prices of goods and services. This paper focuses on the effect of climatic events on household's beliefs about the macroeconomy. We examine the sensitivity of household inflation expectations in response to precipitation related disasters, i.e. floods and droughts. India is one of the most vulnerable countries in world to flood and drought risks, with India ranked first in terms of number of people affected by floods and among the top five countries most affected by drought risk.[1]

In this paper, we ask whether frequent occurrence of disruptive climatic events such as floods and droughts increase inflation expectations of households. Inflation expectations matter significantly for household decision making. Households base their consumption spending, especially on durable goods, on their inflation expectations (Andrade et al., 2023). It also matters for employment decisions, and decisions to borrow and save, among other things. Understanding how inflation expectations of households evolve with climatic events allow us to infer whether households perceive these disasters to be significant shocks to their financial health.

Our data on inflation expectations comes from Inflation Expectations Survey of Households (IESH) conducted by the Reserve Bank of India. This data includes point estimates of inflation expectations over two horizons- expectations for three months ahead (short-term) and one-year ahead (long-term) inflation. The data on disasters is sourced from EM-DAT, a database for recording natural disasters across the globe. We use the variation in flood and drought incidences across states to determine how occurrence of floods and droughts influence average inflation expectations within a state. Higher occurrence of both floods and droughts within a state significantly raise inflation expectations of households at all horizons. The effect of floods on expectations is relatively transient, and floods increase inflation expectations most significantly if households within a state experienced flooding in last three months. On average, households within a state expected 6.7% more inflation over next three months and 14.5% over next year if they experienced floods in the last quarter. The effects of droughts on expectations is lower but more persistent. On average, households within a state expected 5.2% more inflation over next three months and 6.3% over next one year if they experienced droughts in the last quarter. Experiencing floods and droughts also increases the disagreement among households about inflation expectations, especially at the one year horizon.

Recent literature has tried to understand the economic cost in countries facing high risk

[1] Kuzma and Luo (2020); Kuzma et al. (2023)

of natural disasters. Agarwal et al. (2024) study the effect of Chennai floods on household finances and find that both consumption and income fell significantly after the disaster. Karim (2018) also uses survey data for Bangladesh to understand the impact of flood related disasters on household income and expenditure and find significant negative effects on both variables in the short run. Economic damage from climate change are also a source of concern for developed countries. Frame et al. (2020) find that damages associated with flooding events in New Zealand have cost upwards of $140M and those associated with drought events have cost $300M to consumers and insurers in the past decade. Cavallo et al. (2014) show that earthquakes in Chile and Japan had significant effects on supply disruptions but also find that price adjustments were slow and prices did not rise until a few months after the shock. Events such as floods and droughts also affect household decision making. Gandhi et al. (2022) use a panel of global dataset to test how households living in areas with recurrent floods respond to increasing risk, and find evidence of adaptation with damages caused by floods decreasing over time. Our paper also contributes to the large literature studying determinants of inflation expectations of households.

How consumers and firms form inflation expectations directly influence actual inflation. Most modern central banks have significantly improved their communication with the public and voiced their commitment to keep inflation low and stable in order to keep expectations anchored. Our paper looks at the effect of under-studied but increasingly important climate shock on inflation expectations. Higher inflation expectations due to climate shocks threaten the anchoring of expectations and may result in greater price disparities across regions in India.

2 Data

We construct a panel data combining household level inflation expectations with occurrences of flood and drought events at the state level since 2013. This section provides details on each of the main datasets used in our paper.

2.1 Disasters

Data on disasters is obtained from the Geocoded Disasters Dataset (GDIS). GDIS provides locations and coordinates for all global disasters recorded in the Emergency Events Database (EM-DAT). While the dataset records all types of natural disasters, we restrict our analysis to precipitation related disasters, i.e. floods and droughts, that occur within the geographical regions of India.[2] The dataset includes geographical coordinates that allows us to identify the Indian state(s) affected by each disaster. However, the geocoded data is only available from 1970 to 2018 in EM-DAT. Since 2018, EM-DAT records the locations of the disaster. We use this information to identify each state that experienced the event (for both floods and droughts) and extend our data till end of 2021.[3]

Figure 1 shows the average number of floods and droughts per year from 2009 to 2021 in each state. The highlights the geographical heterogeneity of precipitation related disasters in Indian states. Floods are common occurrence across most of the country with states such as Assam, Uttar Pradesh, Madhya Pradesh, Odisha, and Karnataka being most affected in recent years. The risk of floods in eastern states is aggravated by the presence of Ganga and Brahmaputra, two of world's largest river basins, while the western states are susceptible to both riverine and coastal flooding. The drought risks are more significantly concentrated in the western states like Rajasthan and Maharashtara. Large states like Uttar Pradesh and Madhya Pradesh are most prone to uneven precipitation, including extreme events like floods and droughts.

2.2 Household Inflation Expectations

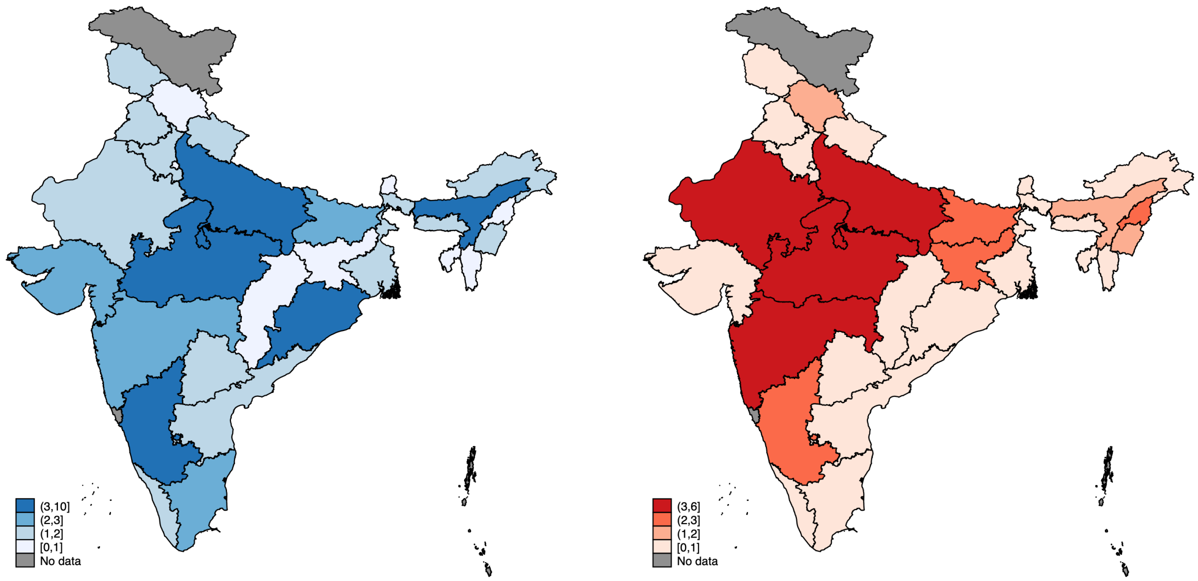
We measure inflation expectations using the Inflation Expectations Survey of Households (IESH) conducted by the Reserve Bank of India. The survey data is available since September 2008 and measures inflation expectations of Indian consumers. The survey was conducted once every three months (quarterly) until September 2016, and once every two months since November 2016. The data includes information on the individual's age, employment status, gender, city of residence, and their current inflation expectations, as well as their three-month ahead and twelve-month ahead inflation expectations. Respondents pick their inflation expectations from a range between a minimum of 1% and a maximum of 16%, with increments of 1% in each bracket. Individuals who expected inflation to be less than 1% or greater than 16% are prompted to enter the numerical value for their inflation expectations.

For each respondent, we define their average inflation expectations as the average of the bin. For example, the average inflation expectation of a respondent who reported inflation of $13-14\%$ is 13.5%. Individuals who do not enter a number less than 1% or greater than 16% after selecting those brackets are dropped from the sample [4]. We winzorize the responses for

[2] We include all events categorized as general floods in EM-DAT which include coastal flood, riverine flood, and flash floods. Droughts are measured in Em-DAT as extended period of low precipitation which create a shortage of water for animals and humans.

[3] Our dataset contains all 28 states and 6 union territories excluding the UT of Daman & Diu, and Ladakh. For simplification, union territories will be referred to as "states" in rest of the analysis.

[4] These are 5.6% of the whole sample of households from 2009-2021.



(a) Floods (b) Droughts

Figure 1: Precipitations based Disasters per year from 2009 to 2021

Average number of floods and drought events per year in each state. The sample period of disasters data for states range from 2009 to 2021.

inflation expectations at 1st and 99-th percentile for both three-months and twelve-month horizons[5]. We then take average of the inflation expectations across all respondents within a state for each round of the survey[6].

Ranjan and Mallick (2023) criticize the use of inflation expectations in India due to its high correlation with the current inflation data. This observation is not unique to India and exists even for the Survey of Professional Forecasters in the U.S. However, the correlation of inflation expectations with current inflation does not imply insignificance of survey data. The correlation between current inflation and expectations also weaken at longer horizons (ex, two years) which is not included in the IESH survey.

2.3 Empirical framework

We combine the two datsasets to create a panel data at the state level between 2008 and 2021. This is an unbalanced panel as number of states for which data on inflation expectations were collected increased over time. Thus, the final dataset comprises of monthly inflation

[5]The reported inflation expectations range from 1.5% to 124% for three-month ahead, and 1.5% to 291% for twelve-month ahead during the period of analysis.

[6]IESH surveys households representatively across a city, not state. We merge the cities with states to conduct state level analysis.

expectations and total monthly floods and drought events in each state to get an unbalanced panel of state-month observations from December 2008 until November 2021. We use a panel data model with fixed effects to investigate how precipitation events affect inflation expectations within a state. The empirical specification is as follows:

$$E_t\pi_{i,t+j} = \alpha_i + \beta_1 \text{Disaster}_{i,t-k} + \beta_2 X_{i,t-1} + \gamma_t + \epsilon_{i,t} \tag{1}$$

where $E_t\pi_{i,t+j}$ is the average of self-reported three month ahead ($j = 1$) and one year ahead ($j = 4$) inflation expectations of households in a month t in state i. We test the effect on inflation expectations of two major climatic disasters: floods and droughts. $\text{Disaster}_{i,t-k}$ is the total number of disaster events in a state i in k quarter before the survey was conducted where $k \in \{1, 2, 3, 4\}$. The slow adjustment of prices after earthquakes found by Cavallo et al. (2014) motivates us to investigate the effects of flood and drought shocks at different lags, starting from three months before the expectations were formed and including six-month, nine-month, and twelve-month lags. The lag on disaster ensure that all climatic events are part of the individual's information set when reporting their inflation expectations. We also control for the lagged average inflation expectation in a state ($X_{i,t-1}$). All regressions include state and year fixed effects.

3 Results and Discussion

Figure 2 summarizes our main results across time horizons and precipitation disasters. The left panel shows the effect of flood events and right panel shows the drought events within a state on three months and one year ahead inflation expectations of households in that state. The solid dots are the point estimates from regression of flood and drought events at four different horizons- three months (3m), six months (6m), nine months (9m), and twelve months (12m). The bars are the 95% confidence intervals for each estimate.

Inflation expectations within a state increase significantly at both three month and one year horizons when the state experiences a flood event in past three months. The effects are lower but significant if a flood event is experienced in past six months, and is insignificant at nine month horizon. Recent experiences of flood related disasters increase concerns about inflation significantly. However, effect on inflation expectations dissipate from flood events that were further in the past. The results for droughts are similar with statistically significant effects on inflation expectations within a state from drought events in past three months in that state. Contrary to the evidence for floods, we find that the effects of drought events are highly persistent on inflation expectations - both short-term (three month ahead) and

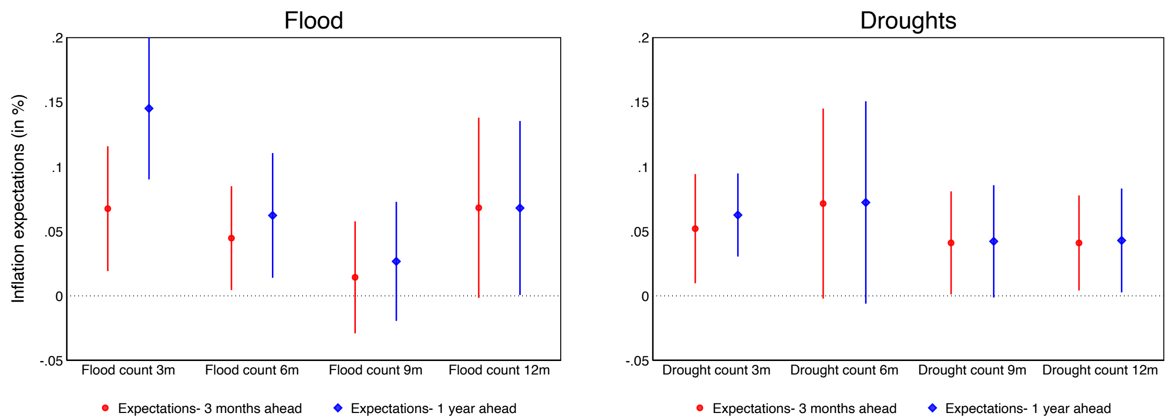


Figure 2: Estimates of β_1 at different horizons

The estimated β_1 on regression of three-month ahead and twelve-month ahead inflation expectations on floods and droughts are represented as circles and diamonds, respectively. Estimates are reported at four different horizons: events in past three months, six months, nine months, and twelve months. The bars around the circles and diamonds represent the 95% confidence intervals around the point estimates.

long-term (twelve-month ahead expectations).

The key mechanism is through the supply side- precipitation related disasters reduce agricultural productivity (Goyari, 2005) and rural wages in the short run (Banerjee, 2007). The results suggest that households expect significant damages to supply chains from flood disasters in short horizon but do not expect these effects to be highly persistent. The results are in line with studies that show that negative effects of climatic disasters are temporary and even reversible in the long run (Banerjee, 2007; Parida et al., 2020). The effects of droughts on inflation expectations are quantitatively smaller but more persistent than floods. The literature on precipitation disasters have also found droughts to have more persistent effects on agricultural production and employment (Carpena, 2019).

Table 1 and 2 show the point estimates that were represented graphically in Figure 2. An additional flood event within a state raises three month and twelve-month ahead inflation expectations of households. We do a simple back of envelope calculation can help us better understand the results. Take the example of the Bihar which, on average, experienced 2.2 flood events per year. In our sample, the average three month ahead and twelve-month ahead inflation expectations of households in Bihar is 9.7% and 10.8% respectively. On experiencing an additional flood event within Bihar in past three months, three month ahead inflation expectations of an average household in Bihar increases by 6.74% (Column 1, Table 1) to 10.35% while the one year ahead expectations increased by 14.5% (Column 1, Table 2) to 12.37%. Smaller quantitative effects are present for drought events. An additional drought event within Bihar raises three month ahead inflation by 5.2% (Column 5, Table 1) to 10.2% and the one year ahead inflation by 6.25% (Column 5, Table 2) to 11.48%.

Table 1: 3 months ahead inflation expectations

	Floods			
	(1)	(2)	(3)	(4)
	3m	6m	9m	12m
Lagged Inflation Exp	0.516***	0.512***	0.517***	0.506***
	(0.0413)	(0.0433)	(0.0423)	(0.0432)
Flood Events	0.0674***	0.0446**	0.0143	0.0681*
	(0.0226)	(0.0189)	(0.0203)	(0.0327)
Observations	738	738	738	738
Within R sq.	0.416	0.416	0.414	0.422

	Droughts			
	(5)	(6)	(7)	(8)
	3m	6m	9m	12m
Lagged Inflation Exp	0.523***	0.522***	0.522***	0.522***
	(0.0421)	(0.0411)	(0.0411)	(0.0409)
Drought Events	0.0519**	0.0713*	0.0410**	0.0409**
	(0.0198)	(0.0345)	(0.0187)	(0.0173)
Observations	738	738	738	738
Within R sq.	0.416	0.420	0.417	0.418

Table 2: 1 year ahead inflation expectations

	Floods			
	(1)	(2)	(3)	(4)
	3m	6m	9m	12m
Lagged Inflation Exp	0.552***	0.546***	0.551***	0.545***
	(0.0351)	(0.0378)	(0.0369)	(0.0369)
Flood Events	0.145***	0.0622**	0.0266	0.0679**
	(0.0257)	(0.0226)	(0.0216)	(0.0316)
Observations	738	738	738	738
Within R sq.	0.485	0.479	0.476	0.481

	Droughts			
	(5)	(6)	(7)	(8)
	3m	6m	9m	12m
Lagged Inflation Exp	0.559***	0.557***	0.557***	0.558***
	(0.0367)	(0.0358)	(0.0359)	(0.0358)
Drought Events	0.0625***	0.0722*	0.0421*	0.0428**
	(0.0151)	(0.0367)	(0.0204)	(0.0188)
Observations	738	738	738	738
Within R sq.	0.478	0.480	0.478	0.479

Another dimension across which climatic events can affect inflation dynamics is through its influence on disagreement among households about future inflation. We measure dispersion by calculating the standard deviation of inflation expectations of individuals within a state and survey round for both three month and one year ahead expectations, and use this dispersion as our main dependent variable in equation 1. The results are reported in Table A1 and A2 in the appendix. At three months, recent episodes of droughts increase disagreement among households while flood events do not cause higher disagreement. We find that both flood and drought events increase disagreement of one year ahead inflation expectations. For droughts, both recent and relatively distant events increase disagreement of one year ahead expectations. Putting together with our baseline results, we find that floods and droughts increase the level of inflation expectations as well as the disagreement about the level of future inflation especially in the medium term (one year).

We also replicate our analysis for inflation expectations at the individual level to complement our main state-level analysis. Here, the dependent variable or the outcome of interest is the inflation expectations of each individual surveyed. The survey does not repeat households which means we have data on cross-section of households in each round. We are thus unable to control for lagged inflation for the household-level model. However, we can control for household-level characteristics known to influence inflation expectations - gender, employment status, and age of the respondent.The results are similar to the state-level results and are not reported here.

4 Policy Implications and Conclusion

> *Monetary policy is ultimately about managing expectations of various economic agents-from households to financial markets. In this context, over the past three years, we backed our actions with clear forward guidance and tweaked it as necessary with reference to the evolving circumstances.*
>
> - Shaktikanta Das, Ex-Governor, RBI

“Anchoring” of inflation expectations is a key objective of monetary policymakers in order to keep inflation stable, especially for central banks pursuing inflation targeting which includes the Reserve Bank of India (RBI). This sentiment was echoed by then governor of RBI, Shaktikanta Das in his speech on conduct of monetary policy (Das, July 2022). Inflation expectations also matter for household decision making - how much to spend and save, how much to work - are a few of the decisions that are affected by household’s inflation expectations. There is also evidence that higher inflation expectations are self-fulfilling and raise local prices (Binder et al., 2025).

Rising climate disaster events have threatened the stability of inflation around the world (Faccia et al., 2021). We look at how increasing risk of precipitation based disasters like floods and droughts change inflation expectations of Indian households. While households in all states experience similar national prices, a regional shock such as floods and droughts can make short-run inflation expectations differ across states which experienced the shock relative to those that did not experience such shocks. Such "unanchoring" of inflation expectations can impede the effectiveness of monetary policy, making the job of monetary policymakers harder. We also find evidence of higher dispersion of inflation expectations following climatic events. The dispersion matters as the effects of monetary policy on inflation can vary by the level of disagreement of inflation expectations as shown by Falck et al. (2021).

With the expected rise in global temperatures and larger, more variable temperature and precipitation events, our paper's findings suggest that anchoring inflation expectations will be harder especially in regions more vulnerable to such disasters. Goyal and Parab (2020) find that adoption of inflation targeting and increased communication from the RBI has achieved greater anchoring of inflation expectations of the households. To keep expectations anchored in the face of climatic shocks, the communications from the central bank should also include more information about transient nature of price effects from disasters.

There is also evidence that stronger commitment to inflation targeting lowers the inflationary pressure of natural disasters (Fratzscher et al., 2020) thus, lowering inflation expectations. Therefore, while monetary policy cannot directly mitigate supply side inflation pressures in the short run, a strong commitment to keeping inflation low can lower expectations in the medium and long run.

Keeping inflation stable is a key objective for not only the central bank but also the regional and central government. As disasters exacerbate the supply side constraints, fiscal policies supporting supply chains in flood and drought prone areas can lower inflationary pressures of these events. In general, significant disaster management and mitigation efforts could reduce the negative effects of climatic events on economic activity (Parida et al., 2020) reducing adverse effects on inflation expectations.

We use survey data to understand how precipitation related disaster affect household inflation expectations. We find that occurrence of both floods and drought events increases inflation expectations with a larger short run quantitative effect from floods but a more persistent effect from droughts. Our analysis shows that households perceive natural disasters as adverse supply shocks in the short run which raises their inflation expectations at both three month and one year horizon.

References

Agarwal, S., Ghosh, P., and Zheng, H. (2024). "Consumption response to a natural disaster: Evidence of price and income shocks from chenna flood." *Energy Economics*, *131*, 107323.

Andrade, P., Gautier, E., and Mengus, E. (2023). "What matters in households' inflation expectations?" *Energy Economics*, *138*, 50–68.

Banerjee, L. (2007). "Effect of flood on agricultural wages in bangladesh: An empirical analysis." *World Development*, *35*(11), 1989–2009.

Binder, C., Kamdar, R., and Ryngaert, J. M. (2025). "Partisan expectations and covid-era inflation." *Journal of Monetary Economics*, *148*, 103649.

Carpena, F. (2019). "How do droughts impact household food consumption and nutritional intake? a study of rural india." *World Development*, *122*, 349–369.

Cavallo, A., Cavallo, E., and Rigobon, R. (2014). "Prices and supply disruptions during natural disasters." *Review of Income and Wealth*.

Das, S. (July 2022). "Globalisation of inflation and conduct of monetary policy." Speech.

Faccia, D., Parker, M., and Stracca, L. (2021). "Feeling the heat: Extreme temperatures and price stability." Working paper.

Falck, E., Hoffmann, M., and Hurtgen, P. (2021). "Disagreement about inflation expectations and monetary policy transmission." *Journal of Monetary Economics*, *118*, 15–31.

Frame, D. J., Rosier, S. M., Harrington, L. J., Carey-Smith, T., Sparrow, S. N., Stone, D. A., and Dean, S. M. (2020). "Climate change attribution and the economic costs of extreme weather events: a study on damages from extreme rainfall and drought." *Climate Change*, *162*, 781–797.

Fratzscher, M., Grosse-Steffen, C., and Rieth, M. (2020). "Inflation targeting as a shock absorber." *Journal of International Economics*, *123*, 103308.

Gandhi, S., Kahn, M. E., Kochhar, R., Lall, S., and Tandel, V. (2022). "Adapting to flood risks: Evidence from a panel of global cities." *NBER Working Paper 30137*.

Goyal, A., and Parab, P. (2020). "Expectations convergence and anchoring of expectations in india." *Economics and Political Weekly*, *55*(47).

Goyari, P. (2005). "Flood damages and sustainability of agriculture in assam." *Economics and Political Weekly*, *40*(26), 2723–2729.

Karim, A. (2018). "The household response to persistent natural disasters: Evidence from bangladesh." *World Development*, *103*, 40–59.

Kuzma, S., and Luo, T. (2020). "The number of people affected by floods will double between 2010 and 2030." Article.

Kuzma, S., Saccoccia, L., and Chertock, M. (2023). "25 countries, housing one-quarter of the population, face extremely high water stress." Article.

Parida, Y., Saini, S., and Chowdhury, J. R. (2020). "Economic growth in the aftermath of floods in indian states." *Environment, Development, and Sustainability*, *23*, 535–561.

Ranjan, R., and Mallick, H. (2023). "Role and impact of inflation targeting regime on households' inflation expectation." *Economics and Political Weekly*, *LVIII*(35).

A Dispersion of Expectations

Table A1: Dispersion of 3 months ahead inflation expectations

	Floods			
	(1)	(2)	(3)	(4)
	3m	6m	9m	12m
Lagged Dispersion	0.544***	0.541***	0.544***	0.541***
	(0.0448)	(0.0450)	(0.0437)	(0.0427)
Flood Events	0.00542	0.0261**	0.00745	0.0335
	(0.0171)	(0.00903)	(0.0130)	(0.0193)
Observations	738	738	738	738
Within R sq.	0.559	0.560	0.559	0.562

	Droughts			
	(1)	(2)	(3)	(4)
	3m	6m	9m	12m
Lagged Dispersion	0.544***	0.543***	0.543***	0.543***
	(0.0442)	(0.0454)	(0.0454)	(0.0453)
Drought Events	0.0375***	0.0169**	0.0118	0.00960
	(0.0116)	(0.00769)	(0.00679)	(0.00624)
Observations	738	738	738	738
Within R sq.	0.561	0.560	0.560	0.560

Table A2: Dispersion of 1 year ahead inflation expectations

	Floods			
	(1)	(2)	(3)	(4)
	3m	6m	9m	12m
Lagged Dispersion	0.586***	0.583***	0.585***	0.584***
	(0.0296)	(0.0299)	(0.0295)	(0.0279)
Flood Events	0.0468**	0.0282**	0.0123	0.0337
	(0.0191)	(0.00995)	(0.0110)	(0.0195)
Observations	738	738	738	738
Within R sq.	0.616	0.615	0.615	0.617

	Droughts			
	(1)	(2)	(3)	(4)
	3m	6m	9m	12m
Lagged Dispersion	0.586***	0.585***	0.585***	0.585***
	(0.0302)	(0.0309)	(0.0309)	(0.0307)
Drought Events	0.0394***	0.0194**	0.0119*	0.0105*
	(0.00922)	(0.00697)	(0.00617)	(0.00561)
Observations	738	738	738	738
Within R sq.	0.616	0.615	0.615	0.615