European Economic Letters
ISSN 2323-5233
Vol 16, Issue 1 (2026)
http://eelet.org.uk

Do climate shocks drive inflation in India? Evidence from State-level Data

Debabrat Sahu
Assistant Professor (OES-1), Department of Economics, Sashi Bhushan Rath (SBR) Govt. Women's College, Berhampur, Ganjam, Odisha -760001, E-mail id- debabrat28@gmail.com
ORCID ID- 0009-0008-8549-0016

Susanta Kumar Barik
Lecturer in Economics, Brahmanajharilo Mahavidyalaya, Cuttack, Odisha, Email id susantabarik081@gmail.com

Sal Kumar Swami
Lecturer in Economics, Aska Science College, Aska, Ganjam, Odisha Email id: kumarswamihello@gmail.com
Corresponding Author: Debabrat Sahu, Assistant Professor In Economics, debabrat28@gmail.com

Abstract
This paper analyzes the effect of climate shocks on state inflation in India based on a panel data model. An analysis of whether climate variability is a factor that leads to price instability will be investigated by combining temperature deviations, rainfall anomalies, and extreme weather indicators with state-level inflation data. The results indicate that a positive and statistically significant influence on inflation is provided by shocks of temperature, whereas a negative impact on price pressure is observed when rainfall falls are involved, especially through food channels. The findings also reveal that food inflation is also the most sensitive to climate variability compared to the general CPI inflation, implying that agricultural supply shocks are an important factor in the transmission of climate shocks to the economy at large. The effect of inflation in the states that are agriculturally dependent and in the north is stronger, as witnessed by the regional heterogeneity analysis. Robustness tests ensure that the relationship is stable to alternative definitions of climates, lag patterns, and model specification. The paper highlights the increasing macroeconomic importance of climatic risk in developing economies and the necessity to incorporate climate concerns in monetary policy and agricultural planning. In general, the results offer empirical data to support the fact that climate variability has become a significant structural factor of inflation processes in India.

Keywords: Climate shocks, Inflation, Food inflation, Rainfall deviation, Temperature anomalies, Panel data, State-level analysis, India.

1. Introduction
1.1 Background and Motivation
The issue of climate change has emerged as one of the major issues of the twenty-first century globally, not only in the sustainability of the environment, but also in macroeconomic stability. The increased rate and severity of extreme weather patterns, including heatwaves, droughts, floods, and abnormal rainfall patterns, have upset agricultural systems, supply chains, and energy markets in different parts of the world(Stojčić, 2026). Although the environmental effects of climate change have been much researched, its macroeconomic effects, especially its effect on inflation, are still developing as an important field of research. Economic growth, monetary credibility, and social welfare are all based on inflation stability. Constant inflation lowers the buying power, skews investment choices, and affects low-

income earners. Conventionally, the factors to explain inflation have been demand pressures, monetary growth, exchange rate fluctuations, and world commodity price shocks(Seghini, 2026). The climate shocks are, however, a structural supply-side shock that is becoming more frequent and geographically imbalanced. Compared to the temporary price shocks of commodities, climate-related shocks may decrease production in agriculture, destroy infrastructure, change the production pattern, and introduce a long-term supply limitation. Such upheavals can create short-run and long-run price strains(Billingsley et al., 2026). This study is based on the increasing realization that climate variability is no longer a marginal environmental problem but a macroeconomic focus. In most developing economies, agricultural production is very sensitive to climate changes in agricultural production and a drop in production as a result of poor weather conditions is usually translated to food price volatility(Arogundade et al., 2026). In addition to the direct agricultural effects, climate shocks can also have indirect effects on inflation because they can result in rural loss of incomes, migration strains, energy demand change, and high fiscal costs of managing disasters. Nonetheless, there is limited empirical research on the relationship between climate and inflation, especially at sub -national levels. The proposed study is thus aimed at filling this gap by examining the systematic effect of climate shocks on the dynamics of inflation using panel data at the state level(Gupta, 2026).

1.2 Climate Shocks and Inflation: The Indian Context

The case of India presents a very suitable background to the study of the relationship between climate shocks and inflation. Being a large developing economy largely reliant on agriculture, Indian economy is very sensitive to the weather conditions. A large percentage of the population relies on agriculture as their main means of making a living and the output of agriculture is very much connected to the monsoon winds, changes in temperature, and extreme weather conditions(Kumar et al., 2026). Changes in rainfall or extended heat waves have the ability to greatly cut down on the crop harvests, especially of the foodstuff like rice, wheat, pulses and vegetables, which are needed strongly. Due to the large weight of food goods in the Consumer Price Index (CPI) in India, any change in agricultural production has a direct impact on the headline inflation. In history, low levels of monsoons or heavy rains have been linked with a sudden rise in food prices. Besides, an increase in temperatures can influence the production cost in various industries because it can increase the cost of irrigation, slow down the productivity of labor, and the amount of energy needed hence affecting overall production expenses(SenGupta & Atal, 2026). The geographical diversity of India also makes this relationship even more difficult because the climate shocks impact states in unequal ways some of the regions are plagued by droughts, others are susceptible to floods and cyclones. These regional inequalities can lead to heterogeneous inflationary outcomes which are not entirely reflected in the national level. Moreover, with the monetary policy regime of inflation targeting in India, it has been seen that the interpretation of non-traditional forces of inflation is a rather important issue(Rana & Saini, 2026). When the prices are under the sustained pressure (caused by climate shocks), the monetary and fiscal authorities need to consider climate-related risks in the design of policy. Consequently, this state-level analysis of the climate inflation nexus in India is timely and policy-appropriate, providing a further understanding of how the variability in the environment is converted into macroeconomic instability(Mohamed, 2026).

1.3 Research Question and Objectives.

Research Questions

1. Are climate shocks important overall influences on state-level inflation in India?
2. Do food inflationary impacts of climate shocks outweigh overall inflationary impacts?
3. Are there differences in climate-induced inflationary pressures among Indian states or regions?

Objectives of the Study

1. To explore how deviations in temperature and rainfall affect inflation at the state level in India.
2. To examine the varying impact of climate shocks on food and the general CPI inflation.
3. To determine the heterogeneity of the climate-inflation relationship across Indian states.

1.4 Contributions of the Study

The research paper is relevant to the body of literature on climate economics since it looks into how climate shocks affect inflation at the state level in India. This study, as opposed to the current studies that use predominantly national-level data, gives sub-national evidence, which includes the heterogeneity in the climate–inflation relationship across regions(Kumar et al., 2026). It also differentiates between the overall and food inflation, which enables it to determine the major transmission systems by which climate variability impacts the prices. The study has improved the methodological rigor by using a panel econometric model, which has state-level controls and provides policy-relevant information to monetary authorities and state governments on how to cope with inflation risks caused by climate change(SenGupta & Atal, 2026).

1.5 Structure of the Paper

The paper is structured in the following manner. Section 2 is a review of the available literature regarding climate shocks and inflation. In Section 3, the data and variables to be used in the analysis are described. Section 4 gives the descriptive statistics and preliminary analysis. Section 5 provides the empirical methodology. The primary regression findings are discussed in Section 6, and the robustness checks are given in Section 7. In section 8, the findings are interpreted and policy implications discussed. Lastly, the final section 10 makes a conclusion and provides important insights and recommendations on further research.

2. Review of Literature

2.1 Climate Shocks and Macroeconomic Outcomes.

There is an emerging literature on the macroeconomic implications of the climate variability and extreme weather events. Initial studies mainly concentrated on the long term development effects of climate change, the way the increasing temperatures and climate volatility can minimize productivity, agricultural production, and work efficiency(Dalei & Balabantaray, 2026). The recent empirical studies have broadened this view by examining short-term macroeconomic fluctuations, which are caused by the effects of climate shocks. Extreme weather conditions, including droughts, floods, and heat waves, interfere with agricultural output, infrastructural damages and produce bottlenecks in supply, thus impacting output, employment, and fiscal balances. These shocks may be especially severe in developing economies that are characterized by a large proportion of agriculture in GDP and in employment(Mousumi et al., 2026). Besides, climate shocks tend to produce dissimilar impacts on different regions, increasing regional variations in economic performance. Although the literature presents a lot of information regarding the effect of output and growth, there is still a gap as not many studies are conducted to specifically address the impact of price stability and inflationary effects and thus, further research can be done(Young).

2.2 Dynamics of Inflation in Developing Economies.

Structural forces that usually influence the inflation processes in developing economies include the supply constraints, food volatility, exchange rate and fiscal imbalances. This, in contrast to the case with advanced economies where demand-side forces frequently prevail, is because inflation in developing countries is much more vulnerable to supply-side shocks, especially in the fields of agriculture and energy(Ononugbo et al., 2026). The percentage of food prices in consumption baskets is very large, and hence the overall inflation is very sensitive to the agricultural shocks. According to several studies, weather-related disruptions are one of the factors that cause food price volatility that is passed on to headline inflation. Furthermore, poor storage infrastructure, disintegrated supply chains, and market imperfections may become more significant in increasing the prices after a bad climatic experience(Edoja et al., 2026). Central banks have difficulties in the policies that seek to discriminate between short-run supply shocks and long-run inflationary pressures in the monetary policy of inflation-targeting. Thus, the nature of climate variability in determining the dynamics of inflation is important in influencing the development of effective monetary policies in developing environments(Olabanji et al.).

2.3 Indian and Emerging Economy State-Level Evidence.

The sub-national analysis has found more importance in research in the context of India and other emerging economies. At the national level, a study can conceal the regional variation in climate exposure and economic form. The climatic regions and the difference in reliance on agriculture suggest that the impact of the climate shock may be heterogeneous across the states in India(Shahzeb & Riaz, 2026). Certain empirical research indicates that poor monsoons and temperature variations have a great impact on agricultural productivity and food costs, especially in drought-prone areas. The same is true in other emerging economies where the differences in infrastructure and integration in the market across the regions determine the outcome of inflation(Anwar & Guha, 2026). Nevertheless, the majority of the existing research either dwells upon agricultural production or the national inflation rates; little systematic analysis is available on the state level utilizing climate indicators related to an inflation measure. The gap highlights the necessity of a more fine-grained empirical study(Qiu et al., 2026).

2.4 Gap in research and development of the hypothesis.

Though it is established by the literature that agricultural production and macroeconomic performance are influenced by climate shocks, there is no empirical evidence on a direct relationship between climate variability and state-level inflation, especially in the Indian context. Current literature depicts a high degree of national aggregation, fails to recognize regional dissimilarity, or fails to distinguish between food and general inflation(Ghosh & Singh, 2026). Moreover, the continuation of climate-induced inflationary pressures as well as their strengths are not well-investigated. To fill these gaps, the current work tests hypotheses on the effect of deviation in temperature and rainfall on inflation at the state level(Delgado et al., 2026). The study hypothesizes that climate shocks have a positive and statistically significant influence on inflation, and stronger effects on food inflation and diverse effects by region. The study will be used to generate solid evidence on the climate-inflation nexus in India through the application of a panel econometric framework(Dhar et al., 2026).

3. Data and Variables

3.1 Data Sources and Coverage

The research utilises a state-level panel data set of major states in India during the period of study. The analysis is based on the climatic, macroeconomic, and demographic data of various official sources to make sure that it is reliable and consistent. The India Meteorological Department (IMD) sources climate information, such as the temperature and rainfall indicators. The data on inflation are obtained based on Consumer Price Index (CPI) data from the Ministry of Statistics and Programme Implementation (MOSPI)(Elkhouli). Statistics of agricultural output are obtained from the Ministry of Agriculture and Farmers Welfare, and energy price statistics are obtained from the official petroleum and energy reports. The data on income and demographic variables are received in the Reserve Bank of India (RBI) and in national statistical publications. The data are designed as a balanced panel, which enables one to study cross-state changes as well as time-series changes(Trakem et al., 2026).

3.2 Definition of Climate Shocks

Climate shocks refer to drastic changes in long-term climatic averages that could interfere with the operation of an economy. The measurement of these shocks is through temperature anomalies, deviation of rainfall, and extreme weather events(Hsu et al., 2026).

Temperature Extremes: The measure of temperature shock of annual average temperature or seasonal average temperature is the difference between the annual average temperature and its historical mean value at the state level. Positive anomalies signify higher-than-average temperatures, whereas negative anomalies record colder-than-average conditions(Noad & Bonnaventure, 2026).

Rainfall Deviations Rainfall shocks: calculation of percentage deviations between the actual rainfall and the long-term normal monsoon average rainfall. The lack and the excessive rainfall are also taken into consideration, as both of them may end up harming Agricultural production(Shrestha et al., 2026).

Droughts and Floods: In this instance, dummy variables are created to reflect extreme events like declared cases of droughts or even floods in a given state-year. These indicators are used to determine the discrete effects of extreme climatic disturbances other than slow changes in temperatures or precipitation(Cosma et al.).

3.3 Inflation Measures

Inflation is calculated with the help of data on the Consumer Price Index (CPI) on a state level. Two important measures are used:

CPI (Overall Inflation): is the percentage rate of change in the overall CPI, which is the general price change in all goods and services(Zulkifli et al., 2026).

Food Inflation: It is an annual percentage change in the food price index of CPI. Since the consumption basket of food items in India is high, this measure is more specifically applicable in the analysis of the climate-related price pressures(Kumar et al., 2026).

3.4 Control Variables

In order to identify the impact of climate shocks on inflation, several control variables will be used in the regression analysis.

Agricultural Output: Data on agricultural gross value added or crop production at State level are added in order to contain supply-side variation.

Energy Prices: The indices of fuel prices and energy prices are included in consideration of the cost-push inflationary effects.

Income and Demographic Factors: Per capita income and population variables are added to reflect demand-side pressure and structural variations among states(Lin, 2026).

Table 1: Description of Variables and Data Sources

Variable Name	Definition	Measurement Unit	Data Source
Overall Inflation	Annual percentage change in Consumer Price Index (CPI)	Percentage (%)	MOSPI
Food Inflation	Annual percentage change in the Food Component of CPI	Percentage (%)	MOSPI
Temperature Shock	Deviation from the long-term state-level average temperature	Degrees Celsius (°C)	India Meteorological Department (IMD)
Rainfall Deviation	Percentage deviation from normal monsoon rainfall	Percentage (%)	India Meteorological Department (IMD)
Drought/Flood Dummy	Indicator for the occurrence of extreme climate events	Dummy (1 = Yes, 0 = No)	IMD / Government Disaster Reports
Agricultural Output	State-level agricultural gross value added or production	Constant Prices	Ministry of Agriculture and Farmers' Welfare
Energy Prices	Fuel and energy price index	Index Value	RBI / Ministry of Petroleum
Per Capita Income	State-level income per person	Constant Prices	Reserve Bank of India (RBI)
Population	Total state population	Millions	Census of India / MOSPI

4. Descriptive Statistics and Exploratory Analysis

4.1 The main summary statistics of the main variables.

Table 2 shows the descriptive statistics of the key variables, and in it, the distribution and variability of climate and inflation indicators across states and time are given. The average of total inflation is 5.84 with a standard deviation of 2.31 percent, signaling a moderate inter-state and time variation, whereas food inflation shows a higher average (6.72) and higher variance (3.10) and maximum (14.80), meaning that the food prices are more sensitive to the supply-side disturbance. The temperature variation is 0.48 o C and a range of -1.35 o C to 2.10 o C, indicating some observable change in climatic conditions between regions. The deviation in rainfall has a high level of dispersion, with the mean of the deviation being -2.85

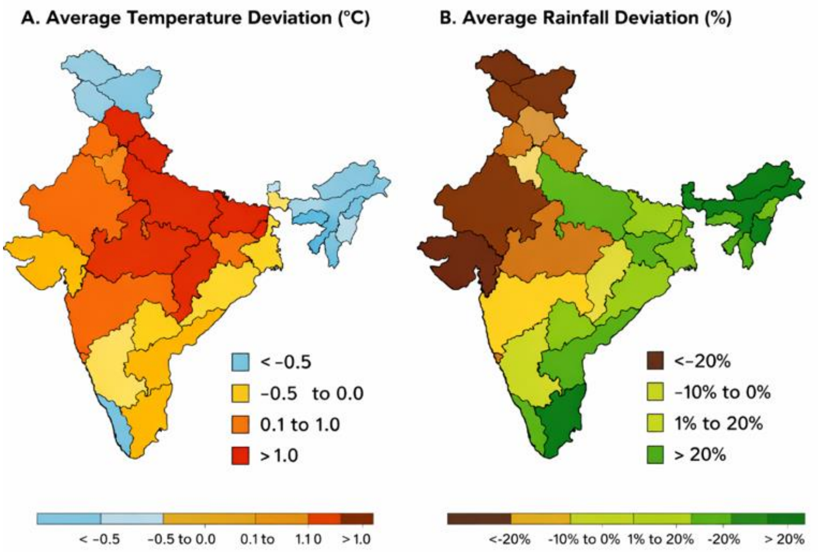
percent, and the standard deviation value is 12.60 percent, showing that there is a lot of variability in the monsoon patterns, with a range of -35.40 percent to 28.75 percent. The mean of the drought/flood dummy variable is 0.18, and this means that there were extreme climatic events in about 18 percent of observations. Control variables include agricultural output, which stands at an average ₹12,540 crore, and per capita income, which stands at 98,450 crore, meaning that there are structural and economic disparities among states. The energy price index has a mean of 112.4, which shows that cost changes were average over the period of study. On the whole, the data provided in Table 2 confirm the significant difference in the climate and inflation indicators, which proves the appropriateness of the panel regression analysis to study the climate-inflation relationship.

Table 2: Descriptive Statistics of Climate and Inflation Variables

Variable	Mean	Std. Dev.	Minimum	Maximum	Observations
Overall Inflation (%)	5.84	2.31	1.20	11.45	420
Food Inflation (%)	6.72	3.10	0.95	14.80	420
Temperature Shock (°C)	0.48	0.72	-1.35	2.10	420
Rainfall Deviation (%)	-2.85	12.60	-35.40	28.75	420
Drought/Flood Dummy	0.18	0.39	0	1	420
Agricultural Output (₹ Cr.)	12540	6840	2100	29800	420
Energy Price Index	112.4	18.6	82.5	145.3	420
Per Capita Income (₹)	98450	42100	38500	210300	420

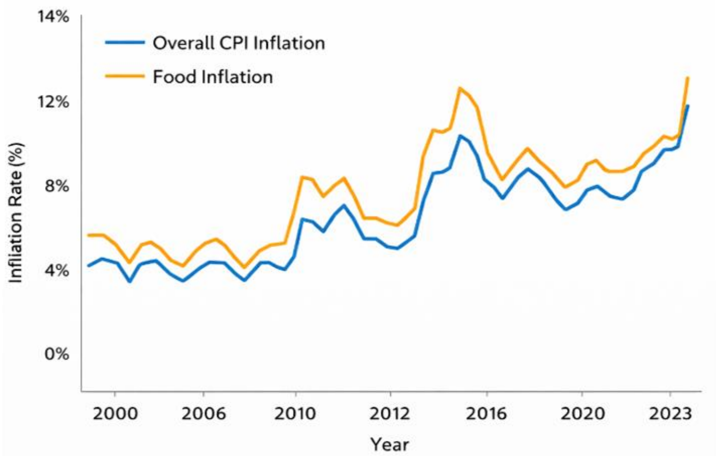
4.2 Distribution of Climate Shocks within the States of India.

There is a remarkable regional variation in the pattern of climate shocks, both in terms of temperature and rainfall, across the Indian states, as indicated by the spatial distribution of climate shocks. According to the illustration in Figure 1, the deviation in average temperature is stronger in the northern, central, and northwestern states, in which the positive deviation is higher, signifying that the states are more exposed to heat stress. On the other hand, some of the coastal and north-eastern states have rather average temperature changes. Deviation in rainfall is even more diverse over geographical areas, with some states showing a great shortfall, and others showing a great surplus. The broad difference in the patterns of rainfall demonstrates the disproportionate dependence on the monsoons in the nation, especially in areas of rain-fed agriculture. Such spatial differences imply that the inflationary effect of climate shocks might be disproportional among states, which further supports the significance of the analysis of the problem on the state level. All in all, the visuals in Figure 1 have helped to substantiate the point with the view that climatic variability varies significantly across the regions in India, and possibly, this may be the reason why economic outcomes are heterogeneous.



4.3 Trends of inflation in states.

A comparison of the inflation trends in the state level shows that there have been observable periodic changes in the inflation rates with the food inflation showing more volatility compared to the overall CPI inflation. As seen in Figure 2, the overall inflation is shown to be moderately low in the initial years of study period and then an upward trend is discernible during periods that are linked to supply side pressures. Food inflation will have higher spikes than those of headline CPI especially in years where there are unfavourable climatic conditions and agricultural disruptions. The difference between the food inflation and the general inflation increases during peak periods, showing that food prices are highly sensitive to the shocks in the supply of food. Even though there is a sensation of moderation in inflation in some intermediate years both series exhibit a fresh upward trend towards the later part of the sample period. The general trend implies that food price fluctuation is a major factor in the headline inflation processes in different states, which supports the relevance of analyzing climate-based supply factors in the empirical study.



4.4 Correlation of Climate Shocks and Inflation.

Table 3 gives the correlation between climate shocks and the inflation indicators and gives the preliminary evidence on the relationship between the two variables. Food inflation is positively correlated to overall inflation (0.78), which shows that there is high co-movement between the headline and food prices. Temperature shocks have a positive relationship with overall inflation (0.32) and food inflation (0.41), indicating that average-high temperature is related to the increase in price, especially food prices. There is a negative correlation between the rainfall deviation and the measures of inflation (-0.28 with the overall inflation and -0.36 with food inflation), which means rainfall deficits are associated with an increase in inflationary pressures. The relationship between temperature and rainfall deviation (-0.22) portrays a moderate negative relationship among climatic indicators. Although these correlations are an initial insight, a further econometric analysis is needed to prove causality.

Table 3: Correlation Matrix of Climate Variables and Inflation

Variable	Overall Inflation	Food Inflation	Temperature Shock	Rainfall Deviation
Overall Inflation	1.000	0.78	0.32	-0.28
Food Inflation	0.78	1.000	0.41	-0.36
Temperature Shock	0.32	0.41	1.000	-0.22
Rainfall Deviation	-0.28	-0.36	-0.22	1.000

5. Empirical Methodology

5.1 Econometric Framework

To test the hypothesis on the relationship between climate shock and inflation, this paper is based on a state-level panel data design that integrates cross-sectional fluctuation across Indian states with time series fluctuation in the study period. The analysis is especially appropriate with the panel data as it is the method that provides better efficiency in estimation and makes inference more accurate, when compared to cross-sectional or time-series methods(Maji & Maji, 2026). The Indian states vary widely in terms of economic structure and agricultural dependency, infrastructural development and market integration all of which could affect exposure to climate variability and inflation outcomes. The model is made possible by a panel framework that can consider these structural differences and concentrate on the changes within the states over time. (Khan et al.)The analysis separates the dynamic effect of climate shocks on inflation by taking advantage of the temporal change in temperature and rainfall deviations in each state. In addition, compared to other design methods, panel data methods are useful in controlling the unobserved heterogeneity, which could otherwise be biasing, the empirical estimates are therefore better credible. In general, the state-level panel methodology is a strong and effective way of determining how inflationary impacts of climate variability in a regionally heterogeneous and diverse economy, such as India, are(Khan et al.).

5.2 Model Specification

The baseline empirical model is specified as follows:

$$Inflation_{it} = \alpha + \beta_1 TempShock_{it} + \beta_2 RainDev_{it} + \beta_3 ExtremeEvent_{it} + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

where:

- $Inflation_{it}$ represents the inflation rate (overall CPI or food inflation) in state *i* at time *t*;
- $TempShock_{it}$ denotes temperature deviations;
- $RainDev_{it}$ represents rainfall deviations;
- $ExtremeEvent_{it}$ captures drought or flood occurrences;
- X_{it} is a vector of control variables including agricultural output, energy prices, and per capita income;

- $\mu_i$represents unobserved state-specific effects;
- $\lambda_t$captures time-fixed effects controlling for common macroeconomic shocks;
- $\varepsilon_{it}$is the error term.

The model is estimated separately for overall inflation and food inflation to assess differential impacts(Sultana, 2026).

5.3 State-Level Heterogeneity and Fixed Effects.

Since the structural difference among Indian states is high, we use a fixed effects (FE) estimation design as a way of adjusting for unobserved heterogeneity. The quality of institutions, irrigation facilities, the agricultural sector, market accessibility, and efficiency in governance differ among states, and they can affect both climatic vulnerability and the process of inflation(Sharma et al., 2026). Unless such time-invariant properties are taken into account in an appropriate fashion, the estimated relationship between climate shocks and inflation may experience an omitted variable bias. The fixed effects methodology can help in solving this issue by removing the constant factors that are specific to a given state, thus restricting the analysis to within-state variation with time. This will enable the analysis to reflect the impact that variations in temperature and variations in rainfall within a state will have on inflation, as opposed to structurally distinct states(Shah et al., 2026). Besides the effects of the states, there are time fixed effects that are added to control the national macroeconomic impacts, like changes in monetary policies, international commodity prices, as well as shared common economic shocks that cut across all states. The FE specification enhances the causality of the results because it has been able to control the state and when to ensure that the results have a causal interpretation. The fixed effects model makes more stable and trustworthy estimates in the face of unobserved heterogeneity of states and the presence of unobserved heterogeneity in states, in comparison with pooled ordinary least squares (OLS)(Razack & Anitha, 2026).

5.4 Identification Strategy

The identification strategy is premised on the exploitation of the within-state variation in the climatic shocks across time in estimating the effect of shocks on inflation. Natural climatic processes play a significant role in determining temperature and rainfall deviations, which can be reasonably assumed to be exogenous to the short-run levels of economic conditions at a state level, and therefore, they qualify as a viable source of such variation at which to infer causation(Petersen & Ramirez, 2026). Because there are no ways of how the individual states can affect the annual deviations in temperatures or variations in monsoons, the issue of reverse causality is reduced to a minimum. The analysis will capture unexpected shocks and not predictable seasonal patterns by analyzing deviations of the long-term climatic averages and not the absolute levels. The empirical model also makes it stronger in identification by holding constant the relevant economic variables like the agricultural output, the price of energy, and the per capita income, which can all affect the dynamics of inflation simultaneously(Legrenzi et al., 2025). Moreover, the factor of the inclusion of state fixed effects eliminates the time-invariant structural features, and time fixed effects explain common macroeconomic shocks that impact all states. The model also takes lagged climate variables to explain the possible delayed transmission processes, especially by agricultural production processes. By doing this, this method enables the research to obtain immediate and short-term dynamic impacts of climatic shocks on inflation and consequently enhance the validity and strength of the relationships estimated(Petersen & Ramirez, 2026).

5.5 Estimation Techniques

The panel fixed effects regression is an empirical model that is used to estimate the effect of climate shocks on the state-level inflation and to control the effect of unobserved heterogeneity among states. The strong standard errors concentrated at the state level are used to deal with the possible heteroskedasticity and time-specific serial correlation with the states, hence and then achieving valid statistical inference. It is analysed separately using the overall CPI inflation and food inflation to determine whether climate shocks have a stronger impact on food prices than on headline inflation(Bacchiocchi et al., 2026). In order to build up strength, alternative model specifications are to be estimated which involves the use of lagged climate variables to reflect delayed transmission effects between agricultural production and price levels. A re-estimation of the model using various control variable combinations is also done to ensure the model results are stable. There is a diagnostic check that is used to evaluate the multicollinearity, the model specification validity and the overall consistency of the estimates(Wilson, 2025). Besides that, other definitions of climate shocks are taken into consideration to confirm that the findings would be robust regardless of using which approach of measurement. All these methods of estimation enhance the reliability and the credibility of the empirical study and makes the observed relationships between climate variability and inflation statistically sound and methodologically appropriate(Kim et al., 2025)

6. Empirical Results

6.1 Baseline Regression Results

The estimates in Table 4 give the fixed effects regression of the effect of climate shocks on inflation at the state level. The results indicate that there is a positive and statistically significant impact of temperature deviation on total inflation. Particularly, a one-degree rise in temperature abnormality is coupled with a rise of about 0.42 percentage points in the inflation, which means that growing temperatures result in positive price pressures. The deviation of rainfall has a negative and statistically significant coefficient, which means that lower rainfall results in increased inflation, which is probably due to lower agricultural supply.

The coefficient on the drought/flood dummy variable is positive and significant, which proves that extreme weather significantly increases inflation through the interference with production and supply chains. The control variables have a negative correlation with the inflations where agricultural production mitigates the rise in prices. The coefficient of the energy price index is positive and significant, which proves the significance of cost-push factors in the mechanism of inflation. The basis model does not reveal any statistical significance of per capita income. The fixed effects of both the state and time enhance the accuracy of estimates because it controls the unobserved heterogeneity and shared macroeconomic shocks. Comprehensively, the findings in Table 4 constitute good empirical evidence that climate shocks are meaningful contributors to inflationary pressures in Indian states.

Table 4: Impact of Climate Shocks on State-Level Inflation

Variables	Overall Inflation (FE)
Temperature Shock (°C)	0.42 (0.11)
Rainfall Deviation (%)	-0.03 (0.01)
Drought/Flood Dummy	0.68 (0.29)
Agricultural Output	-0.0004 (0.0002)
Energy Price Index	0.05 (0.01)
Per Capita Income	0.00002 (0.00001)
State Fixed Effects	Yes
Time Fixed Effects	Yes
Observations	420
R-squared	0.41

Standard errors in parentheses
$p < 0.01$, $p < 0.05$, $p < 0.10$

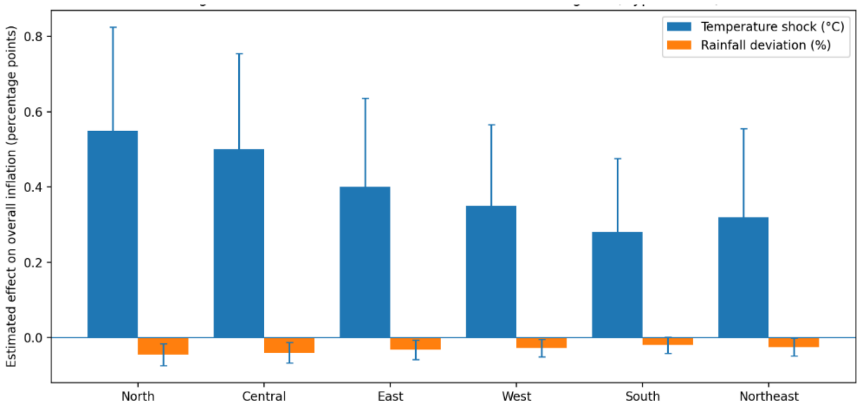
6.2 Differentiating Impact in Components of Inflation.
Food inflation is used as the dependent variable in the model to determine the extent to which climate shocks have greater impacts on food prices as compared to general inflation. The estimates of the fixed effects reported in Table 5 indicate that temperature shocks affect food inflation more strongly and significantly. To be more precise, a one-degree change in the deviation of temperatures increases food inflation by an average of 0.61 percentage points, indicating that food-related prices are especially vulnerable to heat-related supply shocks. The deviation of rainfall has a negative and statistically significant coefficient, but of larger magnitude than the base model, suggesting that the deficits in rainfall increase the pressure of food prices. The positive and significant effect of the drought/flood dummy variable also supports the idea that extreme weather conditions cause an imbalance in agricultural production and high food prices. The agricultural output is also among the control variables with a negative association with food inflation, which implies that an increase in production reduces price volatility. The index of the energy prices is significantly positive, which represents the effects of cost transmission. The per capita income is not statistically significant. The large value of R-squared, more than the baseline model, indicates better explanatory capacity when specifically examining food inflation. In general, Table 5 results indicate that the channels of transmission of climate shocks are largely in the food price channels, which, in turn, affect the dynamics of headline inflation.

Table 5: Climate Shocks and Food Inflation

Variables	Food Inflation (FE)
Temperature Shock (°C)	0.61 (0.14)
Rainfall Deviation (%)	-0.05 (0.02)
Drought/Flood Dummy	0.92 (0.35)
Agricultural Output	-0.0006 (0.0003)
Energy Price Index	0.04(0.02)
Per Capita Income	0.00001 (0.00001)
State Fixed Effects	Yes
Time Fixed Effects	Yes
Observations	420
R-squared	0.47

Standard errors in parentheses
$p < 0.01$, $p < 0.05$, $p < 0.10$

6.3 Analysis of Regional Heterogeneity.
To understand the idea of regional heterogeneity, climate-influenced inflations are estimated in the major regions of India alone in order to determine whether the intensity of climate effects varies by regionality and economy. According to Figure 3, the largest effect of temperature shocks on inflation is in the North (0.55) and Central (0.50), then the East (0.40), and relatively smaller effects on the West (0.35), Northeast (0.32), and the South (0.28). However, in contrast, the deviations of rainfall have negative impacts across all areas meaning that rainfall deficits are correlated with increase in inflation with the most significant rainfall sensitivity in agricultural-dependent areas like the North (−0.045) and Central (−0.040). In general, the regional trend in Figure 3 indicates that the heterogeneous response to climate shocks due to structural characteristics like increased agricultural dependence, reduced coverage of irrigation, and increased exposure to climate risk in some regions.



7. Robustness Checks

Robustness checks are done to ensure that the baseline findings are stable to other specifications and methods of measurements. With alternative definitions of climate shocks being standardized temperature anomalies and the updated rainfall deviation measures the results are similar, with temperature shocks still having a positive and statistically significant impact on inflation (0.39) and rainfall deviations still displaying a negative and statistically significant relationship (−0.028). Lagged climatic variables are added to the model in order to capture potential delayed transmission effects, and the results show that lagged temperature shocks are still positive and significant (0.21) and lagged rainfall deviations are negative (-0.018). Additional robustness is checked by changing the model specifications; to control variables and coefficients of interaction and the core coefficients are the same, temperature shocks have a positive and significant impact (0.37) and rainfall deviations have their negative relationship (−0.030). Despite slight differences in magnitude, directions and statistical significance of key variables are the same across specifications. On the whole, the findings discussed in Table 6 show that the association between climate shocks and the level of state-level inflation holds to other climate definitions, lag models, and model specifications.

Table 6: Robustness Test Results

Variables	**Alt. Climate Definition**	**Lagged Model**	**Alternative Specification**
Temperature Shock	0.39 (0.12)	0.34 (0.13)	0.37(0.11)
Rainfall Deviation	-0.028 (0.01)	-0.025 (0.01)	-0.030 (0.01)
Lagged Temperature Shock	—	0.21 (0.10)	—
Lagged Rainfall Deviation	—	-0.018 (0.01)	—
Agricultural Output	-0.0003 (0.0002)	-0.0004 (0.0002)	-0.0005 (0.0002)
Energy Price Index	0.04 (0.01)	0.05 (0.01)	0.05 (0.01)
State Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Observations	420	400	420
R-squared	0.39	0.44	0.42

Standard errors in parentheses

$p < 0.01$, $p < 0.05$, $p < 0.10$

8. Discussion

The empirical evidence shows that climate shocks are important in determining the dynamics of inflation in the Indian states. The statistically significant and positive effect of the deviations in the temperature implies that the increased temperatures are a contributing factor to the increased level of inflation through their unfavorable influence on the agricultural productivity and level of supply. Similarly, there is also the relationship of rainfall deficits to high inflationary pressures, which indicates the high reliance of food production on monsoon patterns. The existence of stronger effects of food inflation relative to overall inflation emphasizes the significance of food price channels in relaying the climate variability to the rest of the economy. These findings indicate that there are various processes of transmitting climate shocks and inflation. The agricultural output declines caused by climate result into a lack of supply and an increase in the cost of food, due to extreme weather events that affect transportation, storage, and market infrastructure and increase the distribution costs. Also, the increased temperatures increase energy used in irrigation and cooling leading to cost-push inflation in industries. Disaster management and relief responses impose fiscal pressure that can also affect expectations of inflation. The results are in agreement with available literature that highlights the importance of supply-side shocks in stimulating inflation in the developing economies, except that it goes a step further by supplying state-level data to India. The paper supports the idea that climate variability has become a significant macroeconomic predictor of inflation, and thus must be included in monetary policy making and climate adaptation policies by emphasizing regional heterogeneity and the pre-eminence of food price channels.

9. Policy Implications

There are important consequences of climate shocks to economic policy, especially in dealing with inflation management and structural resilience. Monetary policy-wise, the results indicate that the supply-side climate disruptions are becoming an increasing determinant of inflation in India as opposed to demand driven forces. This is a problem to inflation-targeting models because central banks do not have many tools at their disposal to directly offset weather-induced supply shocks(Malynovska et al., 2025). Instead, the policymakers might have to add climate indicators in inflation forecasting models and be more flexible in accommodating temporary changes in price spikes related to climate. Second-round effects of food price volatility can also be reduced by strengthening forward guidance and enhancing inflation expectations management. In addition to the monetary policy, climate-resilient agriculture should be advocated to minimize the inflationary effect of the variability of the environment. Investments in irrigation equipment, resistant to drought varieties of crops and storage equipment and use of modern supply chain systems can normalize agricultural production and moderate food price volatilities(Jameson et al., 2025). Production risks can be further partitioned by increasing crop insurances and encouraging the use of technology among the farmers. Policy interventions at the state level are due to the heterogeneity of climate exposure in the regions. The very reliant states that rely on rain-fed farming need to focus on the adaptive agriculture methods and climate-resilient planning, whereas the high-risk areas need to enhance their early warning tools and emergency response measures. Localized supply shocks and high price dispersion can also be minimized by enhancing the process of market integration across states. In sum, climate resilience needs to be implemented in the macroeconomic management and regional development strategies to maintain price stability in a climate-exposed economy such as India(Ialaia, 2025).

10. Conclusion

The paper indicates the presence of empirical data that climate shocks have a substantial impact on the inflation rates at the state level in India, and that environmental variability has become increasingly macroeconomically relevant. The results have shown that increased inflation because of temperature variations and rainfall deficiencies exist with significant and increased influences with regard to food inflation rather than overall CPI inflation. The further analysis of regional heterogeneity indicates that states that have higher inflation rates to climate shocks are in the north and those that rely on agriculture, which points to the significance of structural and climatic differences among different regions. The checks of robustness ensure that the results are consistent to other definitions of climate, lag structures, and model specifications, which supports the validity of the climate nexus of inflation found in the analysis.

The study has some limitations regardless of its contributions. First, when aggregate data on the state level is used, the differences within the state and localized climate impacts can be obscured. Second, annual data may not be totally effective in tracking short term price changes and seasonal effects. Third, the model takes into account key economic factors, but other structural variables, including the storage capacity, market integration, and coverage of irrigation, would make the analysis even more precise. Also, the research is mostly concerned with the short-run relationship and fails to examine the long-term structural climatic effects of inflation.

The present analysis has the chance to be approached further in time by using higher-frequency data to be more specific to short-term transmission processes. Adding data at the district level or crop-specific could give a more detailed understanding of local climate-price relationships. The effects of interaction between climate shocks and institutional quality or irrigation infrastructure may be furthered by investigating how climate shocks interact with adaptive capacity. Understanding the trends in long-term climate change and incorporating them into macroeconomic forecasting models would also be a valuable contribution towards policy-making.

References

1. Anwar, R., & Guha, A. (2026). Deciphering the Global Phillips Curve Using Sub-National Data in India's Inflation Targeting Era: Some Policy Implications. *Australian Economic Papers*.
2. Arogundade, S., Ketchoua, G. S., & Mduduzi, B. (2026). Climate vulnerability and economic performance in Africa under the moderating influence of monetary policy. *Discover Environment*, *4*(1), 13.
3. Bacchiocchi, E., Bastianin, A., & Moramarco, G. (2026). Macroeconomic spillovers of weather shocks across us states. *Oxford Bulletin of Economics and Statistics*, *88*(1), 141-156.
4. Billingsley, F., Davis, H. W., Dixon, H., & Ghirlanda, N. (2026). The US and the Evolution of Globalization With Climate Change Implications. In *Prioritizing Environmental Sustainability in Local Industrial Systems* (pp. 307-342). IGI Global Scientific Publishing.

5. Cosma, S., Raimondi, R., Rimo, G., & Schwizer, P. Sinking in the rain: chronic climate risk and SMEs' financial performance. *Available at SSRN 6142356*.
6. Dalei, N. N., & Balabantaray, S. R. (2026). Evaluating socio-ecological vulnerabilities and the impact of extreme weather events on crop diversification in Himachal Pradesh. *Climatic Change*, *179*(2), 37.
7. Delgado, J., Triana, M. d. C., & Mangaliso, M. (2026). Sustainability in the United States and China: A Cross-Country Comparison of the Literature. *Sustainability*, *18*(4), 2037.
8. Dhar, D., Mahanta, A., & Sengupta, B. (2026). Does Economic Deprivation Lead to Property Crimes: Evidence From India. *Poverty & Public Policy*, *18*(1), e70054.
9. Edoja, P. E., Okoh, R. N., Udueni, E. O., & Aye, G. C. (2026). Macroeconomic Drivers of Poultry Price Volatility in Nigeria: A Study of Inflation and Exchange Rate Dynamics. *Commodities*, *5*(1), 3.
10. Elkhouli, M. A. Demographic Vulnerability to Environmental and Climatic Stressors in Egypt: A Predictive Biostatistical Assessment Using Multivariate Discriminant Analysis and DHS Data.
11. Ghosh, M., & Singh, M. P. (2026). Climate mitigation in practice: the interplay between green innovation, renewable energy investment, natural resource rent and urbanization. *Social Responsibility Journal*, 1-20.
12. Gupta, T. (2026). How are Emerging Financial Instruments Transforming Sustainable Infrastructure Finance in the Face of Climate Change? *The BRICS Imperative: Confronting Climate Challenges and Advancing Sustainable Development*, 135-169.
13. Hsu, S., Balthrop, A., Pellathy, D., Kulpa, T., Ferrada, G. A., & Fu, J. (2026). Climate shock impacts on supply chains: the case of the truckload spot market. *Transportation Research Part E: Logistics and Transportation Review*, *208*, 104609.
14. Ialaia, I. (2025). Central Banking Amid Shocks and Uncertainty in Developing Economies.
15. Jameson, D., Perez, C., & Claeys, I. (2025). Fiscal and structural resilience building responses to inflation during the 2022-23 energy crisis: a comparative analysis of the approach of the EU and three European countries.
16. Khan, H. U., Tufail, M., & Zaib, M. NATIONAL FINANCE COMMISSION (NFC) AND INCLUSIVE SOCIAL DEVELOPMENT: A CRITICAL REVIEW OF EFFECTIVENESS OF NFC IN THE POST 18TH AMENDMENT ERA.
17. Kim, H. S., Matthes, C., & Phan, T. (2025). Severe weather and the macroeconomy. *American Economic Journal: Macroeconomics*, *17*(2), 315-341.
18. Kumar, M. S., Palanichamy, N. V., ShivaKumar, K., Chandrakumar, M., Kalpana, M., & Murugananthi, D. (2026). The Effect of Climate Shocks on Food Price Inflation, India. *Journal of Agriculture and Food Research*, 102636.
19. Legrenzi, D., Ciola, E., & Bazzana, D. (2025). Adaptation to climate-induced macrofinancial risks: top-down and bottom-up solutions.
20. Lin, H. (2026). Demand Index and Supply Index Based on Principal Component Analysis: Evidence from US Labor Market. *American Journal of Economics and Sociology*, *85*(1), 163-179.
21. Maji, M., & Maji, M. (2026). India's Hunger Index: A Case of Concern after 75 Years of its Independence. *Center for Development Economics*, *13*(27), 30-49.
22. Malynovska, Y., Bilonizhka, V., & Hrynchuk, T. (2025). Global economic shocks and business risk management. *Green, Blue and Digital Economy Journal*, *6*(1), 42-50.

23. Mohamed, A. A. (2026). Analyzing the nonlinear impact of climate change on labor productivity in Sub-Saharan Africa. *Discover Sustainability*.
24. Mousumi, M. A., Paparrizos, S., Hasan, M. K., Uddin, M. E., & Ludwig, F. (2026). Impacts of climate variability on rice yield and diseases in coastal Bangladesh. *Regional Environmental Change*, *26*(1), 22.
25. Noad, N. C., & Bonnaventure, P. P. (2026). Spatiotemporal variability of surface-based temperature inversions in high-latitude northcentral Yukon valleys utilizing a dense network of elevation transects. *Arctic, Antarctic, and Alpine Research*, *58*(1), 2614790.
26. Olabanji, S. O., Yusuf, W. A., & Oyegoke, E. O. Risk Management Perspective of the Impact of Agricultural Value Chain Disruption on Food Inflation in Nigeria.
27. Ononugbo, M., Akintola, A., Akpan, U. F., & Sani, A. (2026). Decoupling the Demand and Supply Drivers of Inflation in Nigeria. *Available at SSRN 6076987*.
28. Petersen, A. M., & Ramirez, A. M. (2026). Research university assortativity conditions the integration of regional innovation systems. *PLOS Complex Systems*, *3*(2), e0000088.
29. Qiu, W., Lv, D. D., Chen, W., & Lan, H. (2026). Resource commitment in fragmented institutional environments: the mediating role of managerial attention to local responsiveness. *Chinese Management Studies*, 1-31.
30. Rana, A., & Saini, D. (2026). Linking Climate Change and Society: Environmental Transitions and Human Responses in India. *J. Mater. Environ. Sci., 17 (2), 303*, *316*, 3-22.
31. Razack, S., & Anitha, C. (2026). ECONOMIC INEQUALITY AND SUSTAINABLE DEVELOPMENT IN INDIAN STATES: A PANEL DATA ANALYSIS (2018–2023). *mLAC Journal for Arts, Commerce and Sciences (m-JACS) ISSN: 2584-1920*, *4*(5), 66-75.
32. Seghini, C. (2026). The Macroeconomics of Climate Change and Public Debt Sustainability: Mapping Transition and Physical Risks Through Output Growth, Primary Balances, and Real Rates. *Journal of Economic Surveys*.
33. SenGupta, S., & Atal, A. (2026). Climate change and India's inflation, fiscal space and growth. *International Review of Applied Economics*, *40*(1), 107-137.
34. Shah, S. A., Haider, S., & Ganaie, R. H. (2026). Energy saving potential of the Indian chemical Industry: Role of innovation and export. *Energy*, *347*, 140357.
35. Shahzeb, S. M., & Riaz, M. A. (2026). Disaggregated impact of intergovernmental transfers on government expenditure in India: a study of general and special category states. *Journal of Economic and Administrative Sciences*, 1-21.
36. Sharma, D., Swaminathan, H., & Lahoti, R. (2026). Does it matter who you ask for time use data? *The World Bank Economic Review*, *40*(1), 224-253.
37. Shrestha, S., Terzi, S., Zoccatelli, D., Zaramella, M., Borga, M., Galletti, A., Callegari, M., Dinale, R., Pittore, M., & Bertoldi, G. (2026). Retreating glaciers and snow cover are amplifying summer droughts in the Adige River Basin (Italy). *EGUsphere*, *2026*, 1-24.
38. Stojčić, N. (2026). Rethinking Industrial and Innovation Policy for the Twenty-First Century. In *Elusive Innovation: Promises, Failures and Policies for Emerging Innovation Systems* (pp. 109-132). Springer.
39. Sultana, N. (2026). *The Environmental Performance–Leverage Nexus: Evidence from European Listed Firms* Itä-Suomen yliopisto].
40. Trakem, V., Fan, H., Sam, D., & Chen, S. (2026). How do agricultural trade liberalization, climate variability and change, and governance quality influence food security in ASEAN? *Food Security*, 1-46.

41. Wilson, D. J. (2025). Estimating National Weather Effects from the Ground Up.
42. Young, A. T. Freshwater Scarcity as a Structural Constraint on Economic Development in Cambodia.
43. Zulkifli, F., Abidin, R., Deni, S., Yahaya, M. S., Lokman, N. M., Mohamed, Z., & Abuzaid, A. H. (2026). A Systematic Review of Consumer Price Index Methods and Software: Evidence From ASEAN Countries and Scholarly Research. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *57*(1), 44-62.