

Consumer spending during extreme hydrometeorological events in Costa Rica

Catalina Sandoval, Mónica Rodríguez

Nature and the Macroeconomy Conference

August 10, 2026. Santiago, Chile.

The ideas expressed in this study are those of the authors and not necessarily represent the view of the Central Bank of Costa Rica.

Research question

- How do extreme hydrometeorological events affect consumer spending in Costa Rica?
- Do these effects vary across seasons and consumption categories?
- Short answer:
 - Extreme rainfall events reduce total consumer spending, whereas extreme dry events have no statistically significant effect on aggregate consumption.
 - Effects are heterogeneous across consumption categories and vary by season.

Motivation

- Climate has long played a central role in shaping social and economic activities (Carleton & Hsiang, 2016). The partially predictable nature of climate allows agents to anticipate patterns in economic behavior and plan accordingly.
- However, extreme weather shocks can disrupt these patterns. The usual behavior of economic agents may shift, altering seasonal consumption arrangements (Sandqvist & Siliverstovs, 2021). From a macroeconomic perspective, this is relevant because consumer spending is a key component of aggregate demand.
- If extreme events systematically affect spending, they may also influence the interpretation of short-term economic fluctuations, macroeconomic monitoring, forecasting, and policy design.
- We focus on Costa Rica, a tropical economy where rainfall variation is particularly relevant and where extreme hydrometeorological events may have meaningful economic effects.

Literature review

- Most evidence comes from developed economies in temperate climates, where temperature is often identified as the dominant weather variable affecting consumer spending.
- The literature documents heterogeneous spending responses to weather shocks across weather anomalies, seasons, sectors, products, and time horizons.

(Parnaudeau and Bertrand, 2018; Badorf & Hoberg 2020; Agnew & Palutikof, 2006; Yan, 2026, Sandqvist & Siliverstovs, 2021; Wahdat & Lusk 2024; Busse et al., 2015).

- Weather and its anomalies may affect consumption through multiple channels:
 - Convenience effects, weather-consumption complementarities and psychological effects (Murray et al., 2010; Bonfrer et al., 2023; Badorf and Hoberg, 2020; Starr-McCluer, 2000; Parnaudeau & Bertrand, 2018; Sandqvist & Siliverstovs, 2021, Busse et al., 2015; Agarwal et al., 2020; Bonfrer et al., 2023)
 - Income losses, liquidity constraints, increased uncertainty and changes in risk perceptions (Yan, 2026)
 - Health-related channels remain less explored (Yan, 2026)

Our strategy

- Analysis: Empirical
- Hypothesis: Extreme Events have heterogeneous effects on spending according to the consumption category and season
- Methodology: Two-way fixed effect (TWFE)
- Data: Point-of-sale transaction data and precipitation indicators at the canton level in Costa Rica
- Period of analysis: January 2019 to May 2022

Consumer spending data

- We use value of point-of-sale (POS) transactions made with debit and credit cards from January 2019 to May 2022. Transaction values are expressed in constant US dollars in 2019 and seasonally adjusted.
- The data were provided by a major Costa Rican acquirers. POS terminals capture both physical and online purchases made with cards issued by various financial institutions, whether domestic or international.
- Includes 81 cantons (out of 84) and 7 consumption categories.
- The 80% of value are registered mostly in the Central Region and are more representative of high-income and urban households.
- Using transaction data offers advantages over more aggregated or infrequent sources, such as national accounts or income and expenditure surveys.

Precipitation data and extreme event indicators

- We use monthly total rainfall from January 1989 to May 2022.
- Source: Climate Hazards Center InfraRed Precipitation with Stations (CHIRPS). Grid data with spatial resolution of $0.05^\circ \times 0.05^\circ$.
- Extreme events are defined using relative thresholds based on the 10th and 90th percentiles of the long-term rainfall distribution in each canton and month.
 - We use climatological norms for each canton and month over the 1989 to 2018 period.
 - Binary variables were created to indicate the presence or absence of an extreme event between January 2019 and May 2022.

Where and when did the extreme events occur?

Figure 1. Number of cantons with extreme events

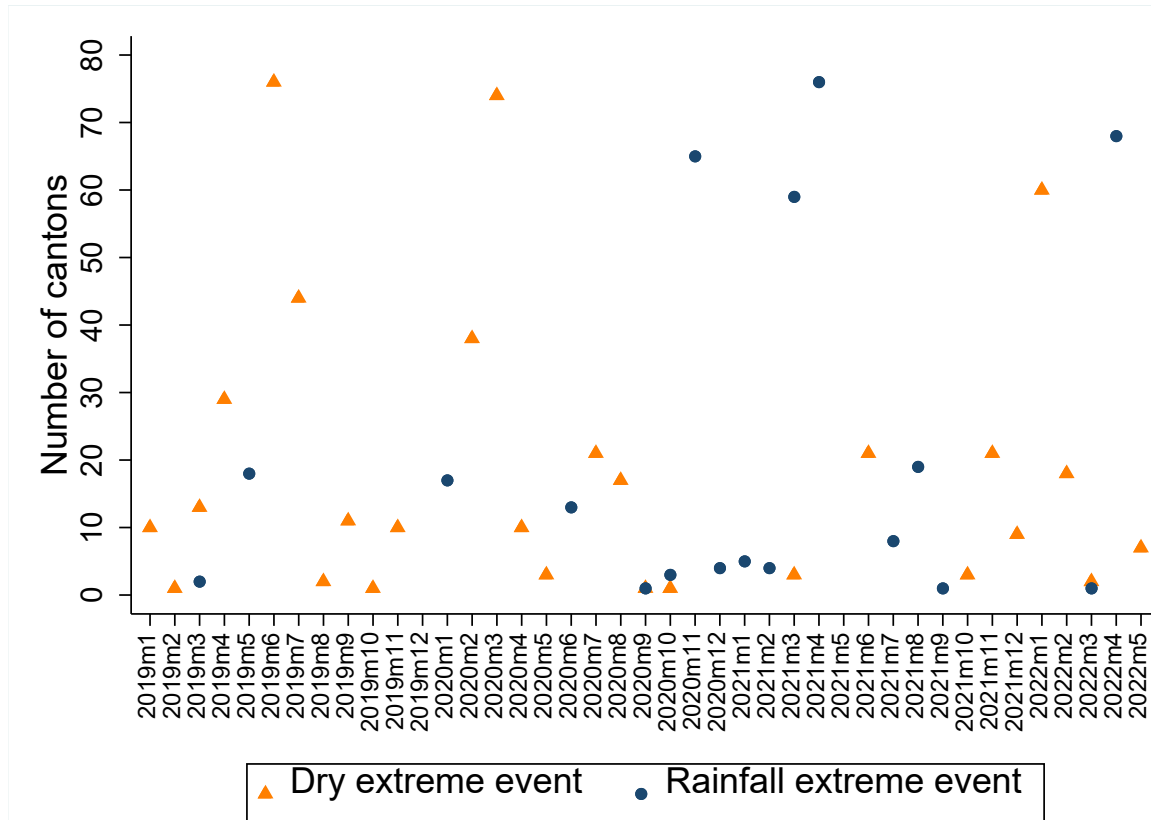
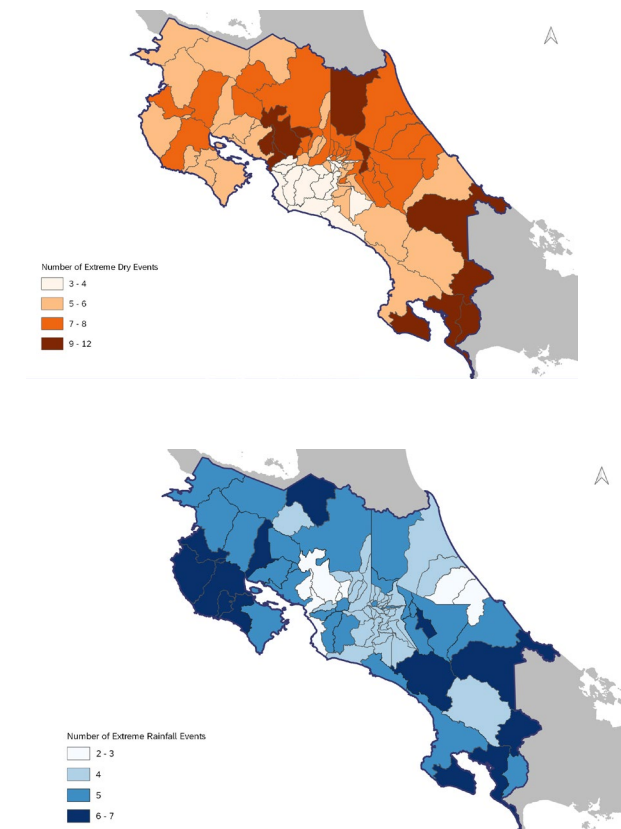


Figure 2. Number of extreme events per canton (Jan 2019-May 2022)



Two-way fixed effect model

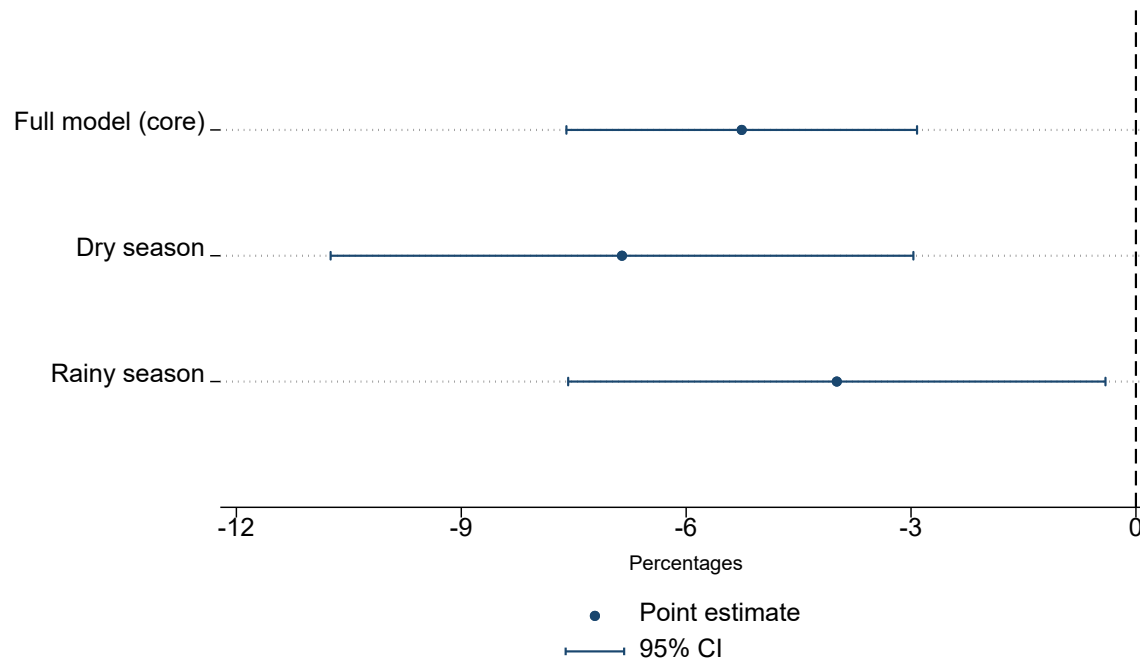
$$\ln(c_{jit}) = \beta_0 + \beta_1 EE10_{it} + \beta_2 EE90_{it} + \beta_3 COVID_{it} + \alpha_{ij} + \mu_t + \epsilon_{ijt}$$

- $\ln(c_{jit})$: natural logarithm of spending in consumption category j , canton i , and month t .
- $EE10_{it}$ and $EE90_{it}$ are indicator of extreme dry and rainfall events, which takes the value of 1 if the event occurred in canton i during month t , and 0 otherwise.
- $COVID_{it}$: number of new coronavirus cases in each month and canton (inverse hyperbolic sine).
- α_{ij} : fixed effects at the level of canton and category of consumption.
- μ_t : time-specific fixed effects (month-year) shared by the cantons.
- ϵ_{ijt} : random error term.
- β_1 and β_2 measure the effect of extreme dry and rainfall events, respectively, on consumer spending.

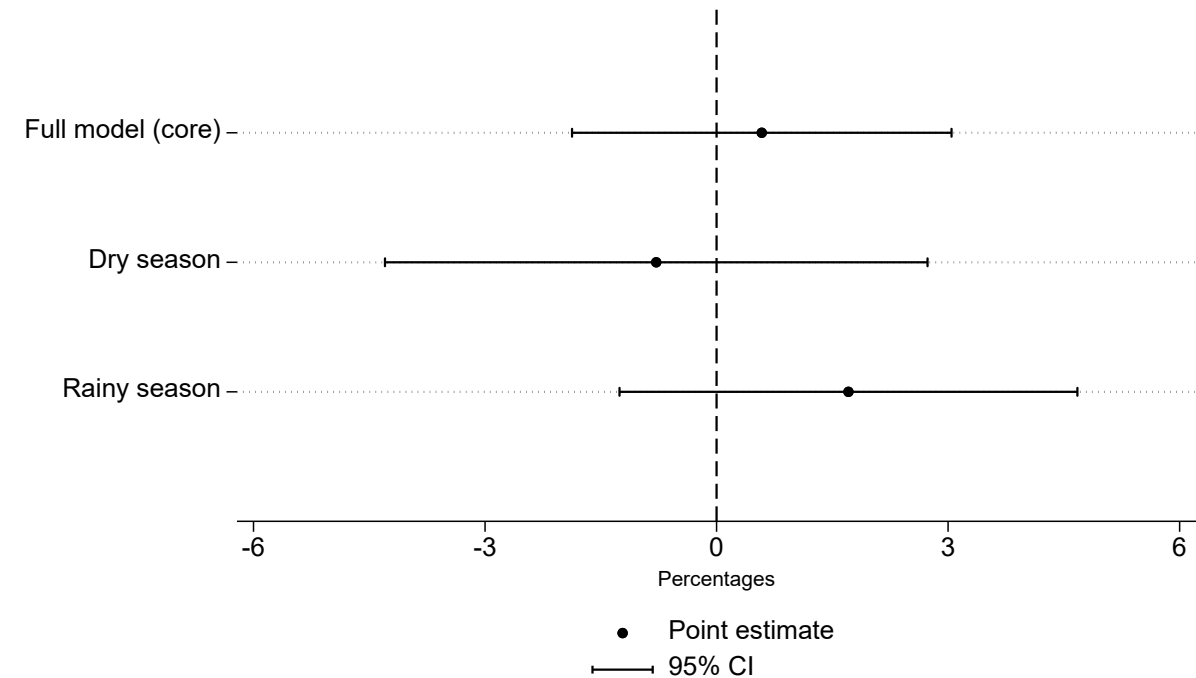
Note: Standard errors are clustered at the canton level.

Estimated effect of extreme events on total consumer spending

(a) Effect of extreme rainfall events



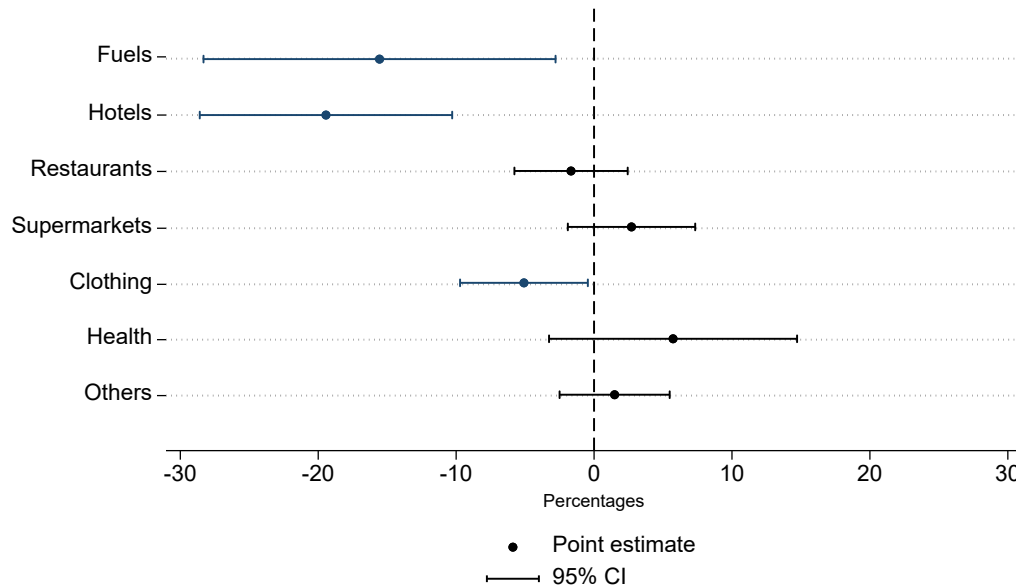
(b) Effect of extreme dry events



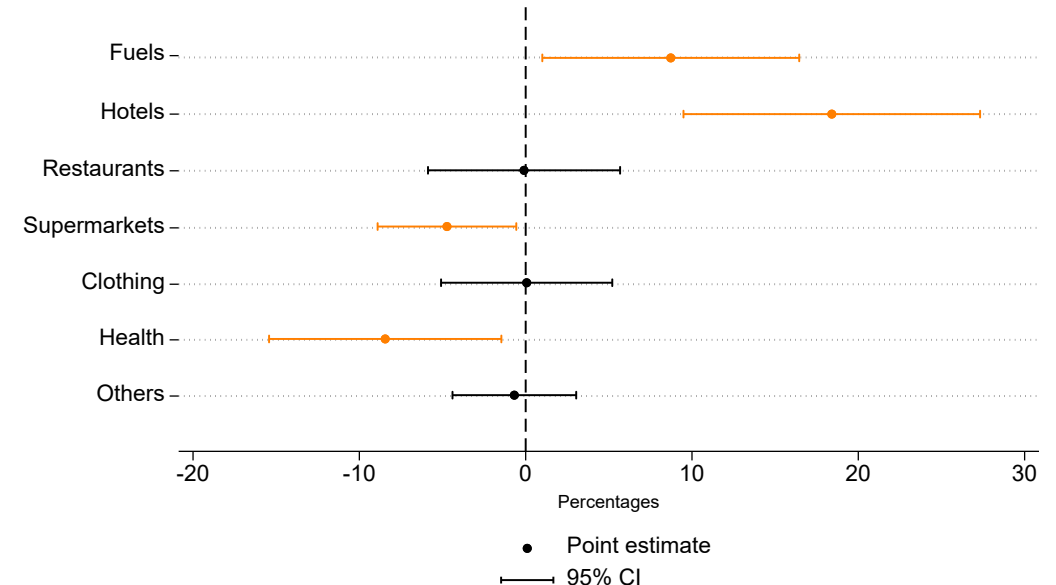
- The occurrence of an extreme rainfall event is associated with a 5.3% decline in consumer spending.
- Extreme dry events do not appear to have a statistically significant effect on aggregate consumption.
- Results are robust to alternative specifications and variations in the set of control variables.

Estimated effect of extreme events on consumer spending by category: rainy season*

(a) Effect of extreme rainfall events



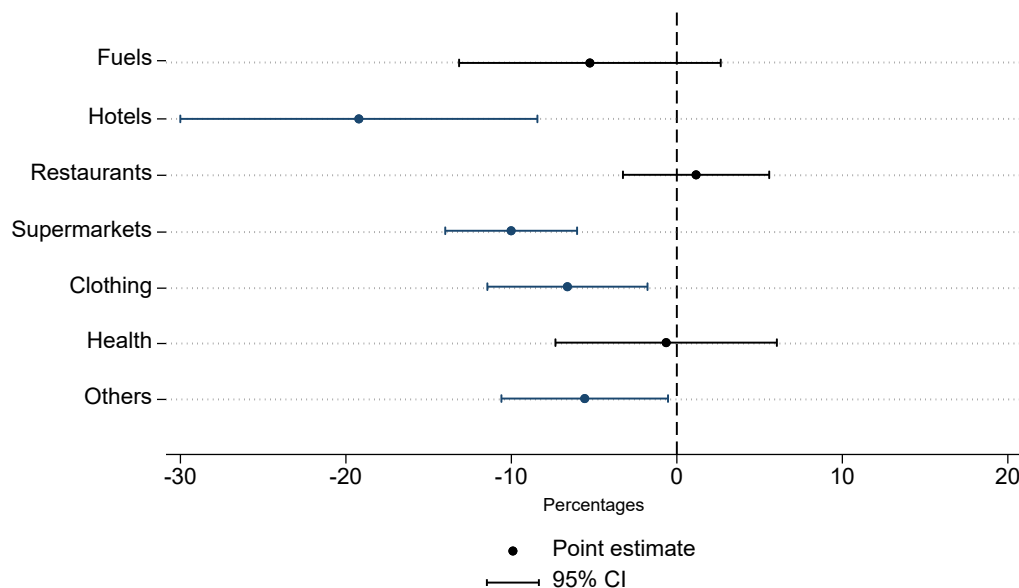
(b) Effect of extreme dry events



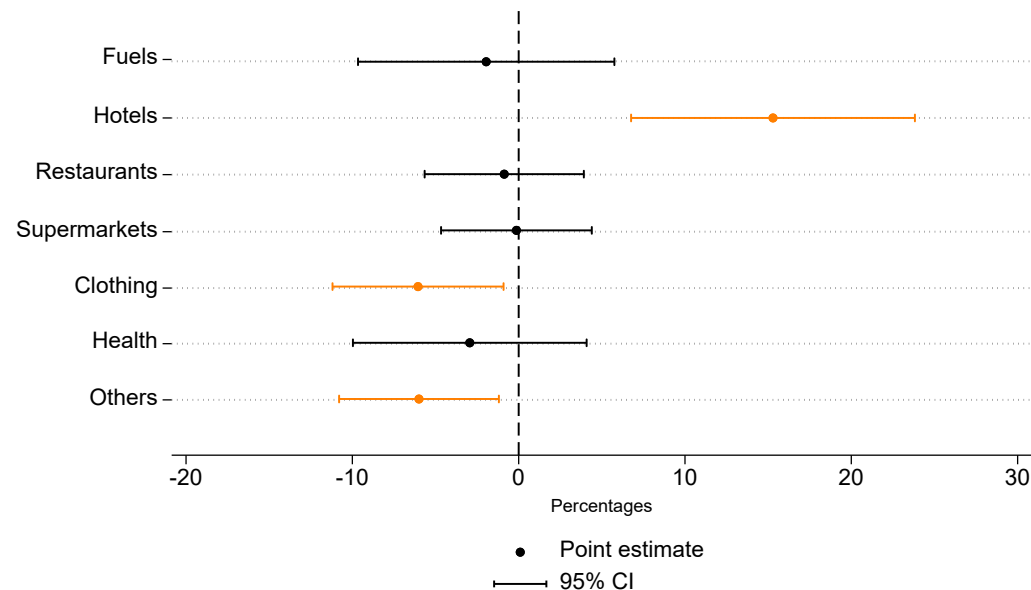
- Rainfall shocks primarily affect categories associated with mobility and non-essential consumption.
- Dry events are associated with higher spending on fuels and hotels and lower expenditures on health services and supermarkets.
- These results are robust to alternative definitions of extreme events.
- Effects disappear after one quarter, except for health.

Estimated effect of extreme events on consumer spending by category: dry season*

(a) Effect of extreme rainfall events



(b) Effect of extreme dry events



- Rainfall events are associated with declines in consumer spending, all of them disappear after one quarter.
- Dry events do not point to an overall decline in consumer spending, but rather to a reallocation across categories.
- Results on hotels and supermarkets, and clothing during dry season are robust to alternative definitions of shocks.

Final remarks and next steps

- The findings highlight the importance of considering climate variability in the analysis of consumer spending in the short-run. Particularly, extreme rainfall events can have an economically negative impact in nonessential consumption.
- As climate variability becomes increasingly relevant, understanding how different types of weather shocks affect expenditure can improve both the interpretation of short-term economic fluctuations and the assessment of climate-related risks in sensitive sectors and, in general, sensitive economies.
- Future extensions: using electronic invoice data from all registered stores in the country to proxy consumption spending.

Consumer spending during extreme events in Costa Rica

Catalina Sandoval, Mónica Rodríguez

Nature and the Macroeconomy Conference

August 10, 2026. Santiago, Chile.