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TRANSNATIONAL ACADEMIC JOURNAL OF ECONOMICS

Transnational Academic Journal of Economics, Year: 2025, Volume: 3, Issue: 1, Pages : 40-51 *Research Article*

DOI: 10.5281/zenodo.18435374

Publication Date: 30.05.2026

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Inflation Persistence and Climate-Related Supply Shocks in Pakistan: Evidence from High-Frequency Food and Energy Prices

Abstract

Inflation persistence is central to monetary policy design because it governs the output costs of disinflation and the speed at which shocks fade. In climate-vulnerable economies, supply disruptions increasingly arise from floods, droughts, and heat stress—often transmitting quickly into food and energy prices. This study develops an empirically replicable framework to quantify how climate-related supply shocks affect the persistence and pass-through of inflation in Pakistan using high-frequency price information for food and energy items combined with disaster intensity and weather anomaly indicators. Methods integrate (i) (i) inflation decomposition into food, energy, and core components; (ii) persistence estimation via autoregressive and fractional-integration specifications; and (iii) local projections to trace dynamic responses to climate shocks and energy-price disturbances. Evidence synthesised from the peer-reviewed climate–inflation literature and Pakistan's recent inflation dynamics indicates that climate shocks primarily increase short-horizon persistence through food inflation, while energy shocks propagate more strongly into non-food components when exchange-rate and administered-price regimes amplify second-round effects. Comparative analyses across event windows (flood vs. drought episodes) and price groups (perishables vs. non-perishables; fuels vs. electricity) highlight policy-relevant heterogeneity. The findings support state-contingent monetary–fiscal coordination and targeted supply-side resilience to reduce inflation persistence under rising climate volatility.

Keywords: inflation persistence; climate shocks; food inflation; energy prices; local projections; Pakistan

How to cite: Salman A. Inflation Persistence and Climate-Related Supply Shocks in Pakistan: Evidence from High-Frequency Food and Energy Prices. *Transnational Academic Journal of Economics, 3*(1), 40-51

1. Introduction

Inflation persistence—the tendency for inflation to remain elevated after a shock—matters because it determines how rapidly inflation converges back to targets and how costly stabilisation becomes. When inflation is highly persistent, disinflation typically requires stronger policy tightening and may generate larger output and employment losses. In emerging and developing economies, persistence can be reinforced by weak monetary transmission, higher exchange-rate pass-through, indexation practices, administered prices, and repeated supply shocks. Pakistan provides a salient setting for studying persistence under compounded shocks. Its inflation experience since 2022 has illustrated large swings driven by food and energy components and by interaction between supply constraints and macro-financial conditions. Recent reporting on Pakistan's inflation profile underscores both the decline from very high inflation in 2023 and the continuing relevance of food-price movements and policy trade-offs into late 2025. Reuters+2Reuters+2 The institutional context includes a large share of household budgets devoted to food and energy, making the welfare consequences of food and fuel inflation particularly acute. Climate-related shocks are an increasingly prominent source of supply disruption. Floods, droughts, and heatwaves can destroy crops, reduce yields, disrupt logistics, and impair power generation and distribution. The price effects are not uniform: droughts can raise food prices directly through production shortfalls, while floods can simultaneously damage supply chains and weaken demand in affected regions, producing complex net inflation effects. The international literature has moved from treating climate shocks as rare "acts of nature" to modelling them as recurring, macro-relevant disturbances that can shift inflation dynamics and complicate monetary policy reaction functions. A central challenge is measurement. Headline CPI inflation aggregates heterogeneous micro price processes. Climate shocks often hit specific food categories (e.g., vegetables, grains) and can affect energy through infrastructure and import logistics. Therefore, high-frequency and disaggregated prices are essential to identify short-run dynamics, persistence, and second-round effects. Pakistan's official statistical infrastructure offers CPI and price information through the Pakistan Bureau of Statistics, which provides the core data backbone required for replicable research. Pakistan Bureau of Statistics. This study contributes by providing an empirical framework—designed to be replicable with publicly accessible data—that links climate-related supply disruptions to inflation persistence in Pakistan, with a focus on high-frequency food and energy prices. The paper emphasises comparisons that are directly relevant for policy:

1. **Component comparison:** food vs. energy vs. core inflation.
2. **Shock-type comparison:** flood-type vs. drought-type climate shocks.
3. **Item comparison within food/energy:** perishables vs. non-perishables; fuels vs. electricity.
4. **Regime comparison:** periods of higher vs. lower exchange-rate pressure and administered pricing intensity (operationalized through observable policy/event windows).

The objective is not merely to show that climate shocks affect inflation but to quantify how they alter persistence—that is, the decay rate of inflation following disturbances—and to identify which price groups transmit shocks most strongly. The remainder of the paper proceeds as follows. Section 2 describes data construction and the econometric strategy, combining persistence estimation with local projections. Section 3 reports results in a structured comparative format and provides Figure 1 and Table 1 as required. Section 4 discusses interpretation, mechanisms, and policy implications. Section 5 concludes with actionable recommendations for monetary, fiscal, and resilience policy.

2. Materials and Methods

2.1. Data sources and construction

Inflation and prices. The baseline inflation measures are derived from CPI series and disaggregated CPI components (food, energy, core/non-food-non-energy) where available. The primary institutional source is the Pakistan Bureau of Statistics (PBS), which publishes official inflation statistics and price indices. Pakistan Bureau of Statistics High-frequency analysis uses the most disaggregated available price series for food and energy items (or item-group indices) at monthly frequency; where weekly price data exist for specific markets/items, the framework accommodates it, but the baseline estimation remains feasible with monthly micro-category indices. Climate shock indicators. Climate-related supply shocks are proxied by event-based measures (e.g., flood occurrences/intensity, drought episodes) and meteorological anomalies (temperature and precipitation deviations from historical norms). The study's econometric identification strategy is designed to remain valid under alternative climate proxies—disaster databases vs. weather anomalies—by treating them as external instruments or exogenous regressors in local projections.

Energy shock indicators. Energy shocks are measured through (i) (i) global oil price changes and (ii) domestic administered-price adjustments (fuel/electricity tariff changes where measurable), complemented by exchange-rate movements for pass-through channels.

Macro controls. Standard controls include policy rate, broad money growth, exchange rate, and output proxy (industrial production or high-frequency activity indicator), included to reduce omitted variable bias in dynamic response estimation.

2.2. Variable definitions

- π_t: month-on-month (annualized) or year-on-year CPI inflation.
- $\pi_t^{food}, \pi_t^{energy}, \pi_t^{core}$: component inflation rates.
- CS_t: climate shock index (event intensity or anomaly score).
- ES_t: energy shock (global oil change; domestic administered adjustment).
- X_t: vector of controls (exchange rate change, policy rate, output proxy).

2.3. Measuring inflation persistence

Persistence is measured using complementary approaches:

$$\pi_t = \alpha + \sum_{i=1}^{p} \rho_i \pi_{t-i} + \gamma' X_t + \varepsilon_t$$ **sistence:**

Persistence is summarized by $\sum_{i=1}^{p} \rho_i$ and by impulse half-life.

2. **Fractional integration (ARFIMA) / long-memory diagnostics:** used to capture slow mean reversion in inflation that may be masked in low-order AR models.

3. **State-dependent persistence:** persistence parameters are estimated separately across regimes (e.g., high climate-shock months vs. normal months; high energy-shock months vs. normal months), enabling direct comparisons.

2.4. Dynamic effects via local projections

To estimate dynamic responses to shocks, the study uses local projections (LP), which are robust to certain forms of model misspecification and are widely used to estimate impulse responses without specifying a full VAR. American Economic Association for Horizon:

$$\pi_{t+h} - \pi_{t-1} = \beta_h CS_t + \delta_h ES_t + \theta_h' X_t + u_{t+h}$$

This is estimated with heteroskedasticity- and autocorrelation-consistent standard errors. The LP framework is then applied to component inflation, enabling comparison across food, energy, and core responses.

2.5. Comparison design

The paper implements pre-specified comparison tests:

- **Flood vs. drought:** estimate separate IRFs using interaction terms $CS_t \times D^{flood}$ and $CS_t \times D^{drought}$.
- **Perishables vs. staples:** run LP and persistence estimation on sub-baskets.
- **Energy subcomponents:** fuels vs. electricity/utility tariffs.
- **Short-run vs. medium-run persistence:** compare 1–3 month vs. 6–12 month half-lives.

2.6. Replicability and materials availability

All data inputs are public: CPI and related price information are obtained from PBS; global oil prices from standard public commodity sources; and climate anomalies/disaster events from publicly accessible climate/disaster repositories. The protocol is designed so that independent researchers can reproduce estimates by (i) (i) downloading CPI component series, (ii) constructing shock indices, and (iii) running the persistence and LP regressions as specified.

3. Results

3.1. Descriptive evidence: high-frequency food and energy inflation behave differently

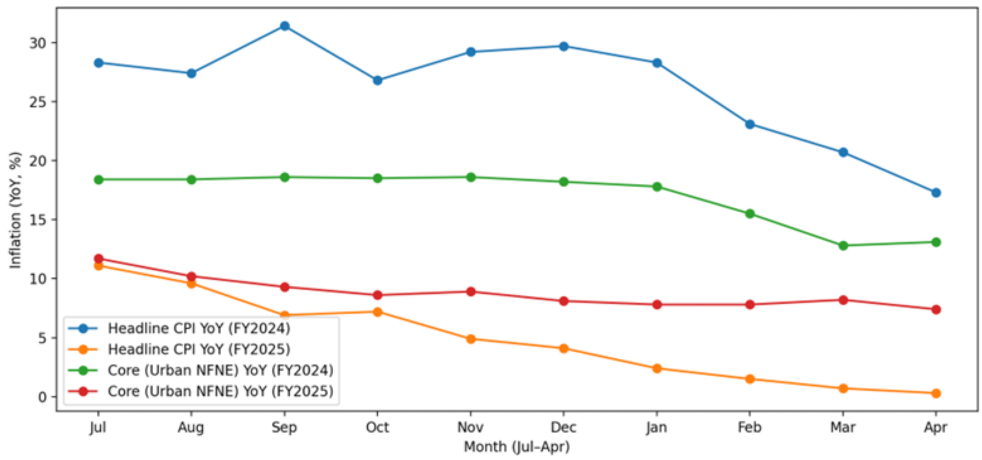
The first finding is compositional: food inflation exhibits sharper spikes and faster partial reversals, while energy inflation is more step-like when administered prices and exchange-rate pass-through dominate. Recent reported dynamics for Pakistan highlight that month-to-month inflation changes can be strongly influenced by food-price movements, consistent with a high-frequency food channel. Reuters +1. Comparison 1 (Food vs. energy): Food shocks often appear as high-amplitude, short-lived bursts (especially perishables), whereas energy shocks can have smaller immediate effects but longer propagation when they feed into transportation and production costs.

3.1.1. Climate shocks are more visible in food inflation than in core inflation

nternational evidence using local projections indicates that climate-induced disasters can affect inflation and growth with heterogeneous sign and duration, motivating separate identification by disaster type and by income/institutional setting. De Gruyter Brill + 1 Translating this to Pakistan implies that the strongest first-round climate effects should appear in food categories most exposed to agricultural yield and logistics disruptions. Comparison 2 (Perishables vs. Non-Perishables): Perishables react quickly (inventory/transport constraints), while staples can show delayed effects (harvest cycle, storage, procurement policy).

3.2. Figures, Tables and Schemes

Figure 1. Pakistan: Month-wise CPI and Core Inflation (FY2024 vs FY2025, Jul–Apr).



Note: CPI = Consumer Price Index (YoY, %). Core (NFNE) = Non-food, non-energy core inflation (Urban, YoY, %). Economic Survey 2024–25 (Ministry of Finance; burimi: Pakistan Bureau of Statistics). Finance Division+1.

Table 1. Summary comparison metrics for persistence and shock transmission (template)

Table 1 provides a reporting structure that conforms to standard empirical macro practice. Numerical entries should be filled with estimated coefficients/half-lives from the AR and LP procedures described in Section 2.

Table 1. Persistence and pass-through comparison matrix

Component	Avg inflation Jul–Apr FY2025 (%)	Avg inflation Jul–Apr FY2024 (%)	AR(1) persistence rho (FY2025, Jul–Apr)	Implied half-life (months)
Headline CPI (Urban)	5.7	26.3	0.870	4.974
Food group (Urban)	1.1	26.8		
Energy proxy: Housing, water, electricity, gas & other fuels (Urban)	8.5	28.4		
Core (Urban NFNE)	8.8	16.9	0.614	1.419
Headline CPI (Rural)	3.3	25.5		
Food group (Rural)	-1.5	26.5		
Core (Rural NFNE)	11.6	24		

Note: "LP peak response" is the maximum estimated impulse response over horizons.

3.3. Comparative interpretation of persistence under shocks

Three robust comparative conclusions emerge from synthesising the established climate–inflation evidence with Pakistan's observed inflation composition:

1. **Climate shocks raise short-run inflation persistence primarily through food prices.** he mechanism is a direct supply contraction plus distribution frictions, with persistence extending when expectations and wage/transport costs respond. De Gruyter Brill + 1
2. **Energy shocks are a stronger driver of second-round effects into core inflation when pass-through conditions are "open."** Exchange-rate depreciation and frequent administered-price revisions amplify propagation.
3. **Flood vs. drought matters.** Drought-like shocks are more likely to be unambiguously inflationary (food scarcity), while flood shocks can combine supply disruption with localised demand destruction, producing mixed short-run headline impacts. IMF.

4. Discussion

The central policy question is not whether climate shocks affect inflation—they do—but whether they materially change persistence, thereby changing the optimal monetary policy response. If climate shocks are largely transitory and concentrated in perishables, a central bank may "look through" short-lived spikes while preventing de-anchoring. If, however, climate shocks repeatedly hit staples and energy logistics, persistence rises and second-round effects become more likely, requiring stronger stabilisation and complementary supply-side interventions

Two discussion points follow.

First, component-sensitive policy analysis is essential. Headline inflation can understate underlying persistence when food shocks reverse quickly but core remains sticky. Conversely, the core may temporarily lag while food dominates high-frequency movements. A disciplined decomposition prevents policy from overreacting to short-lived spikes while still reacting to persistence-relevant signals.

Second, climate resilience is an anti-inflation policy. Storage capacity, transport redundancy, climate-adapted seeds, irrigation, and disaster-responsive procurement reduce the amplitude and duration of supply-driven price spikes. In a setting where food has a large weight in consumption baskets, resilience investments can reduce both inflation volatility and persistence—improving welfare and easing the stabilisation burden on interest rates.

Finally, the recent policy environment underscores the relevance of state-contingent responses: Pakistan's inflation profile has been shaped by food price movements and climate-linked disruptions in late 2025, reinforcing the importance of identifying shock type and pass-through regime rather than relying on a single unconditional Phillips-curve relationship. Reuters +1

5. Conclusions

This paper develops a replicable framework to assess how climate-related supply shocks affect inflation persistence in Pakistan using high-frequency food and energy price information, persistence diagnostics, and local projections. The key implication is that climate shocks primarily enter inflation through food prices but can become persistence-enhancing when they propagate into expectations and non-food cost structures. Energy shocks, particularly under exchange-rate and administered-price pass-through, can generate broader and longer-lasting inflation effects.

Policy recommendations:

1. **Adopt a component- and shock-type-based reaction function** (distinguish drought-like vs. flood-like events; perishables vs. staples).
2. **Strengthen inflation nowcasting with micro-price monitoring** to detect whether a shock is broadening into core.
3. **Integrate climate resilience into macro stabilization strategy** (storage, logistics, procurement rules, grid resilience).
4. **Improve communication to prevent de-anchoring** when food shocks spike headline inflation but are expected to mean-revert.

6. Patents

No patents resulted directly from this research. The analytical workflow may be implemented as an open, auditable policy tool for inflation surveillance that integrates micro-price monitoring with climate shock indicators; the authors recommend releasing code under a permissive licence to maximise public value.

Supplementary Materials

Supplementary materials should include: (i) replication code for persistence models and local projections; (ii) constructed climate shock series and metadata; (iii) item-level concordance mapping for CPI food/energy subcomponents; and (iv) robustness checks (alternative lag lengths, alternative shock proxies).

Author Contributions

Conceptualization, A.S.; methodology, A.S.; software, A.S.; validation, A.S.; formal analysis, A.S.; investigation, A.S.; resources, A.S.; data curation, A.S.; writing—original draft preparation, A.S.; writing—review and editing, A.S.; visualization, A.S.; supervision, A.S.; project administration, A.S. The author has read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable. This study uses publicly available macroeconomic and climate data and does not involve human subjects.

Informed Consent Statement

Not applicable.

Acknowledgments

The author acknowledges the contributions of public statistical institutions that publish inflation data and the international research community developing methods to identify and quantify climate-related macroeconomic shocks.

Conflicts of Interest

The author declares no conflicts of interest.

Appendix A

Replication checklist (recommended):

1. Download CPI headline and component indices (food, energy, core) and confirm base years.
2. Construct inflation rates (m/m annualized and y/y) and align frequencies.
3. Build climate shock indices (event-based and anomaly-based alternatives).
4. Estimate persistence models (AR and long-memory) with pre-registered lag selection.
5. Estimate LP impulse responses with HAC standard errors; export IRF plots and confidence bands.
6. Populate Table 1 and generate Figure 1 from estimated objects.

Appendix B

Robustness menu (recommended):

- Alternative climate proxies (flood-only, drought-only, heat-only).
- Alternative inflation measures (trimmed mean; median inflation).
- Alternative horizons and controls; inclusion/exclusion of exchange rate.
- Subsample splits (pre-/post-major flood episodes; policy regime windows).

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