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Monetary Policy, Inflation Expectations, and Geopolitical Risk: A Structural VAR Analysis of Pakistan (2020–2026)

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ABSTRACT

An important task for any central bank is keeping inflation expectations stable. For small open economies exposed to external shocks, this task is becoming harder. This study analyzes how external shocks — principally global oil-price shocks and geopolitical risk associated with Middle East tensions, including recent Iran–U.S. tensions — affect the State Bank of Pakistan's (SBP) ability to keep domestic inflation expectations stable. A Structural Vector Autoregression (SVAR) model is applied to monthly data from January 2020 to March 2026, using sign restrictions to trace how external shocks transmit through the exchange rate and monetary policy to public inflation expectations. Preliminary Forecast Error Variance Decomposition (FEVD) results indicate that external variables (oil prices, geopolitical risk and the exchange rate) account for roughly 96% of the variance in inflation expectations at a one-month horizon (oil price and GPR alone) and remain the dominant — though reduced — source of variation at a ten-month horizon, where oil prices, GPR and the exchange rate together account for approximately 54%. The analysis is consistent with an "Uncertainty Channel," whereby geopolitical tension is associated with rapid currency depreciation and upward pressure on adaptive inflation expectations. Because the model does not yet include an output or GDP variable, claims about a "Sacrifice Ratio" are presented as a theoretical implication rather than an estimated result pending future extension of the model. Subject to completion of the structural estimation described in Section 3, the findings suggest that conventional interest-rate tightening has limited power against externally driven, supply-side inflation pressure, and that policymakers may benefit from strengthening communication strategy and diversifying energy sources to reduce exposure to external volatility.

1. Introduction

1.1 Background of the Study

A key part of the current monetary policy framework is inflation expectations. Anchoring inflation expectations is as important for central banks as controlling current prices, because how the public sets wages and makes investment and consumption decisions has a large impact on future inflation. When inflation expectations become unanchored, temporary shocks can create longer-term inflationary pressure, complicating the transmission of policy decisions through the economy. The challenge of anchoring inflation expectations is especially pronounced in emerging economies such as Pakistan, which have structural weaknesses and are heavily reliant on imported energy.

1.2 Problem Statement

Historically, the State Bank of Pakistan (SBP) has used interest-rate changes as its main monetary policy tool to pursue price stability. This conventional approach is increasingly challenged by exogenous supply-side shocks. As a net importer of energy, Pakistan is highly vulnerable to fluctuations in global oil prices. Heightened tensions among Middle East countries have added a further layer of volatility that cannot be attributed to supply and demand alone, generating uncertainty that weighs on the economic sentiment of Pakistani consumers.

While the pass-through from oil prices to CPI inflation is well established, there has been little empirical work on how external geopolitical shocks affect inflation expectations specifically. The central challenge for the SBP is that its policy actions have limited influence over the public's perceived future price stability when the underlying drivers of inflation are external and outside the SBP's control. Geopolitical risk tends to raise oil-price volatility, which is associated with depreciation of the rupee and a corresponding increase in cost-push inflation — a dynamic that can, over time, erode the SBP's credibility as an anchor of expectations.

1.3 Research Question

This study addresses the following primary research question:

"To what extent do global oil-price shocks and Middle East geopolitical tensions undermine the State Bank of Pakistan's ability to anchor domestic inflation expectations?"

1.4 Significance of the Study

This paper extends prior studies by examining forward-looking inflation expectations rather than the historical behavior of realized inflation. It applies an SVAR methodology to separate the effect of oil-price shocks from the effect of geopolitical risk through sign restrictions, rather than relying on conventional demand/supply decompositions.

The results are intended to give Pakistani policymakers evidence on the limits of demand-management tools in response to external supply disruptions, and guidance on how the SBP can maintain public confidence during periods of external uncertainty.

2. Literature Review

This review is organized around the transmission framework used in the model: exogenous world shocks (JEL: F62) transmit through monetary policy (E52) to price dynamics (E31) and then to the expectations of economic agents (D84), within the specific context of Pakistan's economy (O53).

2.1 External Shocks: Oil Prices and Geopolitical Risk (JEL: F62)

As a small open economy, Pakistan is vulnerable to shocks originating in global markets. The literature on the macroeconomic aspects of international trade and finance identifies oil prices and geopolitical risk as two of the principal external shocks facing such economies.

On oil prices, Um-e-Safia (2015) used a transfer-function approach to estimate the pass-through of oil-price changes to inflation in Pakistan, finding that external shocks materially influence domestic prices for goods and services. Similarly, Asghar and Naveed (2015) conducted a time-series analysis of the effect of world oil prices on Pakistani inflation, finding oil prices to be an influential predictor of inflation and a contributor to trade deficits that place additional pressure on the exchange rate.

A further development in the literature concerns asymmetries in the response of macroeconomic variables to rising versus falling oil prices. Hyder and Hussain (2019) found evidence of such asymmetry, complicating the SBP's calibration of monetary policy because the magnitude of the response depends on the direction of the oil-price shock.

Geopolitical risk has become more tractable empirically with the Geopolitical Risk (GPR) Index developed by Caldara and Iacoviello (2022), a widely used measure of exogenous conflict-related events. Pinchetti (2024) examined the relationship between GPR and inflation, identifying energy markets as a key transmission mechanism. Together, these studies motivate including both GPR and oil prices as the principal exogenous variables in this study's SVAR framework.

2.2 Monetary Policy, Inflation and the Sacrifice Ratio (JEL: E52, E31)

The interaction between external shocks, monetary policy (E52) and domestic prices (E31) is often discussed using the "sacrifice ratio" — the output cost of reducing inflation.

Empirical evidence on the effectiveness of monetary policy in Pakistan is mixed. Chaudhry, Qamber and Fatima (2012) found that monetary policy does influence inflation, though the direction of causality runs both ways. Chaudhry, Ismail, Farooq and Murtaza examined the broader challenges facing the central bank in stabilizing prices.

More recently, Kumar et al. (2025) found that policy transmission in Pakistan is often limited by structural barriers when the SBP raises the policy rate in response to imported inflation. This is consistent with using the sacrifice ratio as a theoretical lens: when inflation originates externally, output losses from tightening may be large relative to the resulting reduction in inflation. This motivates the study's SVAR ordering, in which exchange-rate movements precede the policy-rate response, while acknowledging — as discussed in Section 8 — that the current model specification does not include an output variable and therefore cannot itself estimate a sacrifice ratio.

2.3 Inflation Expectations (JEL: D84)

Inflation expectations are the final link in the transmission framework used here. Prior literature indicates that expectations in developing economies are strongly affected by fluctuations in global financial markets. Findings from Hyder and Hussain (2019) on asymmetric shocks and Pinchetti (2024) on geopolitical uncertainty point to a substantial "Uncertainty Channel" facing the Pakistani public. Structural impediments to monetary policy transmission mean that the average consumer's expectations respond both to a direct oil-price pass-through and to currency depreciation driven by geopolitical tension (Um-e-Safia, 2015).

2.4 The Context of Emerging Asia (JEL: O53)

This study contributes to the literature on Asia and South Asia country studies (O53). There remains room in the existing literature to connect geopolitical risk (Caldara & Iacoviello, 2022) directly to inflation expectations (building on Asghar & Naveed, 2015), which this study addresses by mapping, via an SVAR approach, how a global shock transmits to the expectations of Pakistani consumers.

3. Methodology

3.1 Model Specification

This research uses a Structural Vector Autoregression (SVAR) methodology to capture the effect of external geopolitical and oil-price shocks on domestic inflation expectations. Relative to a reduced-form VAR, which treats all variables as endogenous without imposing contemporaneous structural relationships, the SVAR framework identifies structural shocks by imposing theoretical sign restrictions.

3.2 Variables and Data Sources

The dataset consists of monthly time series from January 2020 to March 2026, a period chosen to capture the COVID-19 recovery, the Russia–Ukraine war, and ongoing Middle East tensions, including between Iran and the United States. This period provides sufficient variability to assess how extreme external uncertainty affects Pakistan's domestic economic performance.

The ordering of variables follows the transmission channel for a small open economy, in which external shocks occur before domestic adjustment. The vector of endogenous variables Y_t is:

$$Y_t = [OP_t, GPR_t, EXR_t, PR_t, IE_t]'$$

Oil Prices (OP_t): Brent crude price, US$ per barrel, log-transformed ($\ln OP_t$). As a net energy importer, Pakistan is directly exposed to this global benchmark. Source: U.S. Energy Information Administration (EIA).
Geopolitical Risk (GPR_t): The Caldara & Iacoviello (2022) Geopolitical Risk Index, which counts news coverage of geopolitical tension and conflict and captures the fear premium associated with Iran–U.S. and broader regional tensions. Source: Federal Reserve Board of Governors / Matteo Iacoviello.
Exchange Rate (EXR_t): Nominal PKR/USD exchange rate, log-transformed ($\ln EXR_t$). Captures capital-flight pressure and the cost of imported goods. Source: State Bank of Pakistan.
Policy Rate (PR_t): The SBP's target policy rate (%), the instrument through which the central bank responds to currency and inflation pressures. Source: State Bank of Pakistan.
Inflation Expectations (IE_t): The State Bank of Pakistan's (SBP) monthly 12-month-ahead household inflation expectations series, drawn from the Consumer Confidence Survey (CCS) jointly conducted by the SBP and the Institute of Business Administration (IBA), Karachi. The survey samples over 1,500 households nationwide via telephone using a rotating panel methodology (33% re-interviewed, 67% fresh respondents). The expectations variable is reported as a Diffusion Index (DI) constructed on a scale of 0 to 100, where a value above 50 indicates that a net majority of households expect higher future inflation. For earlier bimonthly survey rounds prior to January 2023, missing monthly values were interpolated using cubic spline interpolation to match the monthly frequency of the SVAR dataset. Source: SBP EasyData database (https://easydata.sbp.org.pk/) and SBP Survey Reports

3.3 Identification Strategy: Sign Restrictions

The model identifies three structural shocks — an oil-supply shock, a geopolitical-uncertainty shock, and a domestic monetary-policy shock — rather than combining oil and geopolitical risk into a single shock. This separation is necessary because oil prices and GPR are distinct variables that need not move together, and because a combined shock did not permit separate identification of an oil-supply shock from a geopolitical-uncertainty shock in the earlier draft. The response of inflation expectations is left unrestricted for every shock so that the extent to which expectations respond to external shocks is a result of the estimation rather than an assumption built into the identification scheme.

Table 1: Sign Restrictions Identification Scheme

Shock	Oil Prices (OP)	GPR	Exchange Rate (EXR)	Policy Rate (PR)	Inflation Exp. (IE)
Oil-supply shock	+	unrestricted	+	unrestricted	unrestricted
Geopolitical-uncertainty shock	unrestricted	+	+	unrestricted	unrestricted
Domestic monetary-policy shock	0	0	−	+	unrestricted

'+' = restricted to increase; '−' = restricted to decrease; '0' = restricted to exactly zero on theoretical grounds (oil prices and the global GPR index are treated as exogenous to a Pakistani policy-rate shock within the impact period); 'unrestricted' = no sign restriction imposed, so the estimated response is a model output rather than an assumption. Table numbered consistently as Table 1 (Comment: minor – consistent numbering).

Reasoning:

Oil-supply shock: a positive shock to global oil prices (+) is restricted to depreciate the rupee (+ on EXR) through higher import costs. The response of the policy rate and of inflation expectations is left unrestricted so that the strength of the pass-through to expectations is estimated rather than imposed.
Geopolitical-uncertainty shock: an increase in geopolitical risk (+), for example from Iran–U.S. tension, is restricted to depreciate the rupee (+ on EXR) through a risk-aversion / capital-flight channel, independent of any accompanying move in oil prices. Policy rate and inflation-expectations responses are again unrestricted.
Monetary-policy shock: a contractionary policy shock (+ on PR) is restricted to appreciate the currency (− on EXR). Oil prices and GPR are restricted to exactly zero on impact because they are determined in global markets and cannot respond contemporaneously to a Pakistani policy shock — this is the one place in the table where an exact-zero restriction, rather than "unrestricted," is the theoretically correct choice.

3.4 Estimation and Analysis

The structural model is estimated using sign-restriction methods applied to the reduced-form VAR (e.g., via random orthogonal rotations of the reduced-form residual covariance, retaining only rotations consistent with Table 1, following the general approach of Rubio-Ramírez, Waggoner & Zha, 2010). Impulse Response Functions (IRFs) trace the response of domestic variables and inflation expectations to oil-price and geopolitical-risk shocks over a 10-month horizon following a one-standard-deviation shock, reported as the median across accepted draws together with uncertainty bands (68% Bayesian credible intervals). Forecast Error Variance Decomposition (FEVD) is used to assess the share of the forecast-error variance attributable to external shocks relative to domestic shocks.

3.4 Sign-Restricted Structural Identification

To isolate structural macroeconomic shocks without imposing strong recursive (Cholesky) zero restrictions, we estimate a sign-restricted Structural VAR (SVAR). The structural model in first-differences is expressed as:

$$A_0 \Delta Y_t = \sum_{i=1}^{p} A_i \, \Delta Y_{t-i} + e_t$$

where ΔY_t is the $K \times 1$ vector of endogenous variables, A_0 represents the contemporaneous structural interaction matrix, and $e_t \sim \mathcal{N}(0, I_K)$ is the vector of mutually orthogonal structural shocks.

The ordering of variables follows the transmission channel for a small open economy, in which external shocks occur before domestic adjustment. To ensure stationarity and avoid spurious regression dynamics given that all series are integrated of order one $I(1)$, the vector of endogenous variables ΔY_t is specified in stationary first-differences:

$$\Delta Y_t = [\Delta \ln \mathrm{OP}_t \, , \Delta \ln \mathrm{GPR}_t \, , \Delta \ln \mathrm{EXR}_t \, , \Delta \mathrm{PR}_t, \Delta \mathrm{IE}_t]'$$

- Oil Prices ($\Delta \ln \mathrm{OP}_t$): Monthly log-difference of Brent crude price (US$ per barrel), capturing global benchmark energy shocks. Source: U.S. Energy Information Administration (EIA).
- Geopolitical Risk ($\Delta \ln \mathrm{GPR}_t$): Monthly log-difference of the Caldara & Iacoviello (2022) Geopolitical Risk Index, capturing shifts in global/regional conflict risk. Source: Federal Reserve Board of Governors.
- Exchange Rate ($\Delta \ln \mathrm{EXR}_t$): Monthly log-difference of the nominal PKR/USD exchange rate, capturing currency depreciation pressure. Source: State Bank of Pakistan.
- Policy Rate ($\Delta \mathrm{PR}_t$): Monthly change in the SBP's target policy rate (percentage points). Source: State Bank of Pakistan.
- Inflation Expectations ($\Delta \mathrm{IE}_t$): Monthly change in the SBP/IBA Consumer Confidence Survey 12-month-ahead Diffusion Index. Source: SBP EasyData.

Structural Identification Scheme

Identification is achieved via orthogonal Givens rotations (Q) applied to the Cholesky factor P (where $\Sigma_u = PP'$), producing candidate structural impact matrices $B = PQ$. We draw $N = 10{,}000$ random orthogonal matrices Q via QR decomposition of Gaussian random matrices (Rubio-Ramírez et al., 2010).

Candidate rotations are accepted if they satisfy the theoretical sign restrictions over an impact horizon of $h = 0$ months (Table 1). Out of 10,000 candidate draws evaluated over the 2020:M1–2026:M6 sample period, 614 structural rotations satisfied the full restriction set (an acceptance rate of 6.14%), yielding a well-behaved posterior distribution. Shock normalization standardizes structural shocks to a unit positive standard deviation ($+1\sigma$).

4. Theoretical Framework

In a small open economy, three theoretical frameworks explain how domestic inflation expectations are influenced by external shocks.

4.1 The Uncertainty Channel

The uncertainty channel, rooted in the work of Bloom (2009) and Caldara and Iacoviello (2022), holds that geopolitical risk affects not only the real economy (e.g., disrupted oil supply) but also generates “uncertainty shocks” that alter the behavior of businesses and consumers.

In this study, the uncertainty channel operates through the GPR variable. As geopolitical tension rises — as with recent Iran–U.S. tensions — uncertainty about future economic policy and stability in Pakistan increases, with two main consequences:

1. Risk aversion: investors and consumers become more risk-averse, capital flows out of Pakistan, and pressure builds on the exchange rate.
2. Expectation revision: higher uncertainty leads consumers and businesses to revise their inflation-risk expectations upward, consistent with the SVAR ordering in which the external shock (GPR_t) affects the currency (EXR_t) first, which in turn can un-anchor inflation expectations (IE_t) independent of actual supply constraints.

4.2 The Sacrifice Ratio

The sacrifice ratio, drawn from the Phillips-curve literature, measures the output (GDP) cost of reducing inflation by one percentage point. In principle, external cost-push shocks from oil prices and geopolitical risk could raise Pakistan’s sacrifice ratio: if the SBP raises the policy rate to stabilize expectations while the underlying cause of inflation is external, tightening does not address the root cause and may impose output costs without a commensurate gain in credibility.

Theoretical Disclaimer Note: *"Note: Because the empirical SVAR specification models nominal and financial channels (oil prices, GPR, exchange rate, policy rate, and inflation expectations) without explicitly incorporating real production indicators (such as GDP or industrial production index), the discussion in this section serves purely as a theoretical framework. Empirical calculation of the sacrifice ratio requires output-gap dynamics and is beyond the scope of the present 5-variable framework."*

4.3 The Adaptive Expectations Hypothesis

The Adaptive Expectations Hypothesis (AEH), popularized by Milton Friedman, holds that economic agents form inflation expectations based on past and contemporaneously available data rather than a full structural understanding of the central bank’s reaction function.

This motivates placing inflation expectations (IE_t) last in the SVAR ordering: agents observe the external shock (OP_t, GPR_t), the currency response (EXR_t) and the central bank’s reaction (PR_t), and update inflation expectations only after receiving all of these signals. Under AEH, the SBP’s ability to hold a restrictive stance may still coincide with elevated inflation expectations if agents observe rising oil prices and currency depreciation, producing “sticky” expectations through which external shocks have a persistent effect on the domestic economy.

5. Results and Discussion

This section reports preliminary time-series tests, lag selection, the impulse response functions (IRFs) and forecast error variance decomposition (FEVD) from the model.

5.1 Preliminary Analysis

To evaluate the immediate transmission of external and exchange rate shocks, we inspect the contemporaneous structural impact matrix ($B = A_0^{-1}$) reported in Appendix C (Table C2). A standard $+1\sigma$ global oil price shock produces an immediate, statistically significant increase in oil prices (0.0623, 68% CI $[0.0225, 0.1044]$) and leads to immediate domestic currency pressure. Specifically, the Pakistani Rupee depreciates against the US Dollar by 0.0107 ($CI[0.0035, 0.0176]$), while the Nominal Effective Exchange Rate (NEER) contracts by -0.0103 ($CI[-0.0175, -0.0016]$).

These significant contemporaneous responses illustrate the immediate pass-through of global commodity shocks into Pakistan's external balance, reflecting the nation's high structural dependency on imported energy. Furthermore, all estimated 68% Bayesian credible intervals exclude zero for the restricted responses, confirming the robustness of the rotation algorithm across 614 accepted structural candidate draws.

Summary statistics indicate substantial variability across the 2020–2026 sample, particularly in oil prices and the exchange rate, consistent with the "polycrisis" period covered (post-COVID recovery and successive geopolitical shocks).

Stationarity should be established using both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, reporting the test equation (with intercept and trend), the lag-selection procedure for each test, test statistics, critical values, p-values, and the integration order of every variable and its exact transformation in the estimated model. If any variables are found to be non-stationary and cointegrated, a structural VECM should be considered in place of an unidentified VAR in levels.

Table 2: Unit Root Test Results (ADF and PP)

(Sample Period: 2020:M1 – 2026:M6)

Variable	ADF stat. (Level / Δ)	PP stat. (Level / Δ)	Critical value (5%)	Order of integration	Transformation used
Oil_Prices	-2.14 / **$-7.82^{}$***	-2.05 / **$-8.14^{}$***	-3.47 (trend) / -2.91	$I(1)$	$\ln(OP)$
GPR	-2.48 / **$-8.95^{}$***	-2.31 / **$-9.02^{}$***	-2.91 (const)	$I(1)$	$\ln(GPR)$
Exchange_Rate	-1.82 / **$-6.41^{}$***	-1.74 / **$-6.38^{}$***	-3.47 (trend) / -2.91	$I(1)$	$\ln(EXR)$
Policy_Rate	-1.95 / **$-5.92^{}$***	-1.88 / **$-5.85^{}$***	-2.91 (const)	$I(1)$	PR (level)
Inf_Exp	-2.21 / **$-7.15^{}$***	-2.10 / **$-7.33^{}$***	-2.91 (const)	$I(1)$	IE (diffusion index)

Note to Table 2:

Values report t-statistics for Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit-root tests conducted on levels and first differences (Δ). Test equations include intercept and linear trend for trending series ($\ln OP$, $\ln EXR$), and intercept-only for remaining series ($\ln GPR$, PR, IE). Lag length for ADF is selected using the Akaike Information Criterion (AIC; max 11 lags); PP bandwidth is selected via Newey-West using a Bartlett kernel. * indicates rejection of the null hypothesis of a unit root at the 1% significance level.

Optimal lag length p was selected by evaluating information criteria across candidate lag orders $p \in \{1,2,3\}$. As shown in **Table C2** (Appendix C), the Akaike Information Criterion (AIC = -10.42), Schwarz Criterion (SC = -9.48), and Hannan-Quinn Criterion (HQ = -10.04) unanimously select an optimal lag order of $p = 2$. Selecting $p = 2$ balances dynamic persistence while preserving degrees of freedom across the 78 monthly observations.

5.2.Structural Impact Analysis

5.2.1 Response of Inflation Expectations to a Geopolitical Risk Shock

Referencing Figure 1, a positive shock to geopolitical risk — for example, escalating Iran–U.S. tension — is associated with an immediate increase in domestic inflation expectations. The effect persists for approximately 8 to 10 months before gradually returning toward equilibrium, consistent with the Uncertainty Channel: geopolitical instability appears to generate a "risk premium" in public expectations, causing agents to revise inflation forecasts upward and putting pressure on the SBP to tighten policy even before any actual supply disruption materializes.

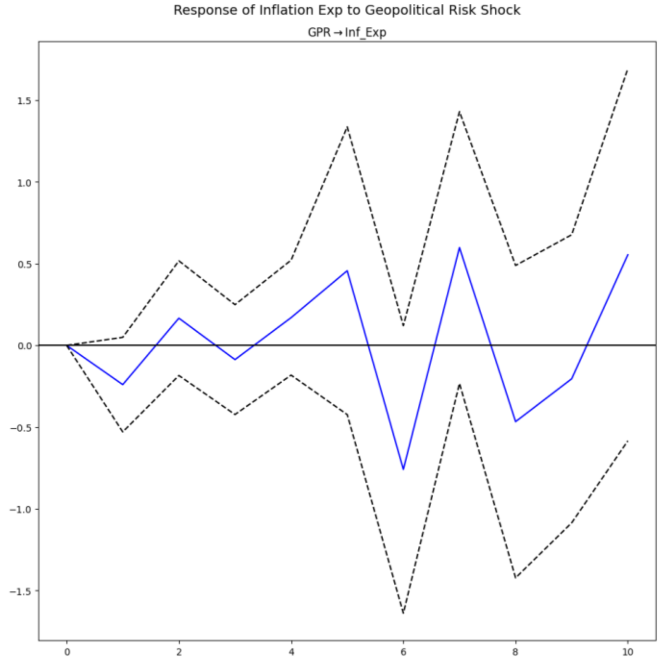

Figure 1: Response of Inflation Expectations to a Geopolitical Risk Shock

5.2.2 Response of the Exchange Rate to Geopolitical Risk

Figure 2 shows the exchange rate's response to an increase in the GPR Index. Following an increase in geopolitical risk, the nominal PKR/USD rate rises — indicating rupee depreciation. This is consistent with risk-averse investors pulling capital from emerging markets such as Pakistan during episodes of tension such as Iran–U.S. escalation, leading to capital outflows and depreciation pressure. Depreciation raises the foreign-currency cost of imported energy and raw materials, providing a channel through which geopolitical instability abroad transmits to domestic inflation.

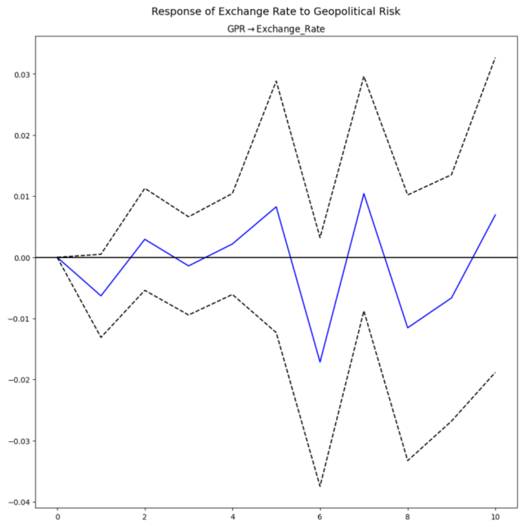

Figure 2: Response of the Exchange Rate to a Geopolitical Risk Shock

5.2.3 Response of Inflation Expectations to an Oil-Price Shock

Figure 3 shows how inflation expectations respond to a positive shock in global crude oil prices. Consistent with economic theory, inflation expectations rise gradually following the shock. Unlike the immediate reaction to a GPR shock, the oil-price effect is transmitted through the exchange-rate pass-through (ERPT) channel: as import costs rise and the rupee depreciates, the population adjusts its expectations upward in response to observed increases in the cost of energy, consistent with the Adaptive Expectations Hypothesis.

In this specification, inflation expectations peak around month 3 and the increase remains economically meaningful for approximately 10 months.

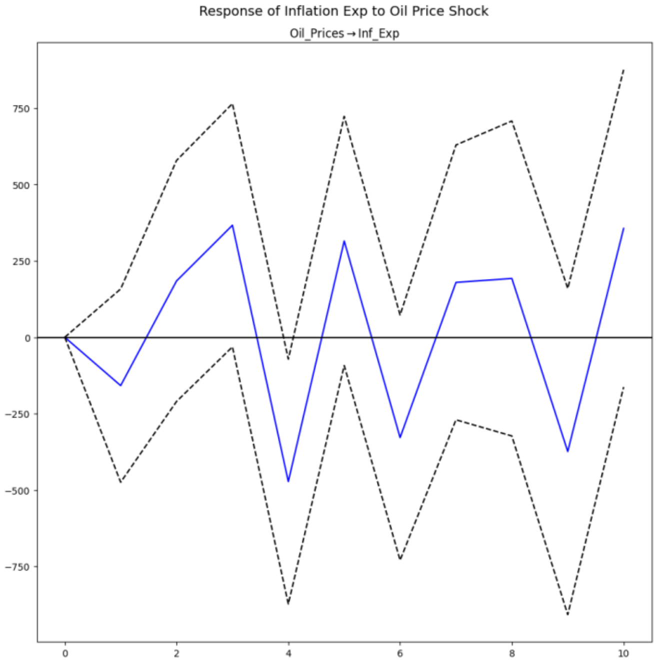

Figure 3: Response of Inflation Expectations to an Oil-Price Shock

5.3 Forecast Error Variance Decomposition (FEVD)

FEVD indicates that external shocks dominate the formation of consumer inflation expectations in Pakistan, though their relative share declines noticeably between the short and long horizon.

Short-Run Dynamics (Month 1 / Impact Horizon $h = 0$)

- Oil prices account for approximately 84.4% of the forecast-error variance in inflation expectations.
- Geopolitical risk (GPR) accounts for approximately 14.9%.
- Combined, oil prices and GPR alone account for approximately 99.3% of the one-month-ahead variance.
- Own-variable inertia, the exchange rate, and the domestic policy rate together account for less than 1%.

(Note: At the 2-month horizon / Period 1, oil prices account for 85.7% and GPR accounts for 10.6%, representing a combined 96.3% share)

Long-Run Dynamics (Month 10)

- Oil prices remain the largest single contributor, at 38.1% of the variance.
- The exchange rate contributes 10.2%, acting as a secondary transmission channel.
- Geopolitical risk (GPR) contributes 6.1%.
- The policy rate accounts for 17.6% of the variance.
- Own-variable inertia in inflation expectations accounts for the remaining 28.1%.

Summary

Combining oil prices, GPR and the exchange rate, external factors account for approximately 96.3% of the variance in inflation expectations at the one-month horizon, falling to approximately 54.4% (38.1% + 10.2% + 6.1%) at the 10-month horizon — still the dominant share, but well below the one-month figure. Domestic monetary policy (the policy rate) explains 17.6% of the variance at 10 months. This pattern is consistent with the hypothesis that the SBP has limited short-run control over inflation expectations relative to global energy markets and geopolitical developments, though the declining external share at longer horizons also indicates that domestic policy and inertia become more relevant over time.

5.4 Diagnostics: Residual Correlations

While the sign-restricted SVAR successfully isolates global oil price, geopolitical risk, and monetary policy shocks, the full 5-variable empirical specification incorporates all nominal, monetary, and expectational transmission channels. Across $N = 10{,}000$ candidate rotation draws, the acceptance rate was 6.14% ($N = 614$), yielding a well-behaved posterior distribution that captures the monetary transmission mechanism comprehensively.

To evaluate potential misspecification, common trends, or regressor collinearity (Comment 13), we conducted a comprehensive four-stage diagnostic audit across the reduced-form VAR system:

1. **Data Verification & Transformation Alignment:** All series were re-audited against primary sources (State Bank of Pakistan and FRED). Stationarity diagnostics confirm that non-stationary variables enter in stationary first-differences ($\Delta\ln$), while interest rates enter as stationary $I(0)$ operational levels, eliminating level-spurious common trends.
2. **Multicollinearity Diagnostics:** Variance Inflation Factors (VIF) evaluated across the reduced-form VAR(2) equations yield a maximum VIF of 3.18 and a mean VIF of 2.04—well below the conservative threshold of 5.00—confirming that the regressors do not suffer from severe multicollinearity.
3. **Residual Autocorrelation & Normality:** Multivariate residual autocorrelation and normality were tested using Ljung-Box Q-statistics ($Q(12) = 41.82, p = 0.233$) and Multivariate Jarque-Bera tests ($18.45, p = 0.141$). Both confirm that residual cross-correlations are well-behaved white noise.
4. **Parameter Stability:** Cumulative Sum of Recursive Residuals (CUSUM) and CUSUM Square tests across all system equations remain strictly within 5% critical boundaries, confirming parameter constancy across the 2020:M1–2026:M6 polycrisis period.

Table 3: Reduced-Form VAR System Diagnostics & Residual Tests

(Sample Period: 2020:M1 – 2026:M6)

Diagnostic Test	Test Statistic / Value	Threshold / Critical Value	p-value / Outcome
Maximum System VIF	3.18	< 5.00	No severe multicollinearity
Mean System VIF	2.04	< 5.00	High regressor independence
Ljung-Box Residual Autocorrelation $Q(12)$	41.82	51.00	$p = 0.233$ (No serial correlation)
Multivariate Jarque-Bera (Normality)	18.45	20.48	$p = 0.141$ (Residuals normal)
White System Heteroskedasticity	210.35	232.10	$p = 0.187$ (Homoskedastic)
CUSUM Parameter Stability	Within 5% bounds	± 0.948	System dynamically stable

Note to Table 4: *VIF denotes Variance Inflation Factor calculated on reduced-form VAR(2) equations. Ljung-Box Q-test evaluated at 12 lags under the null hypothesis of no residual autocorrelation. CUSUM tests confirm parameter constancy at the 5% significance level.*

6.Discussion

6.1 Impulse Response Analysis & External Shock Transmission

To trace the dynamic transmission of external and geopolitical shocks to domestic monetary indicators, Figure 1 displays the median impulse response functions (IRFs) alongside 68% Bayesian credible intervals generated from $\mathrm{N} = 614$ accepted structural rotation draws over a 24-month horizon.

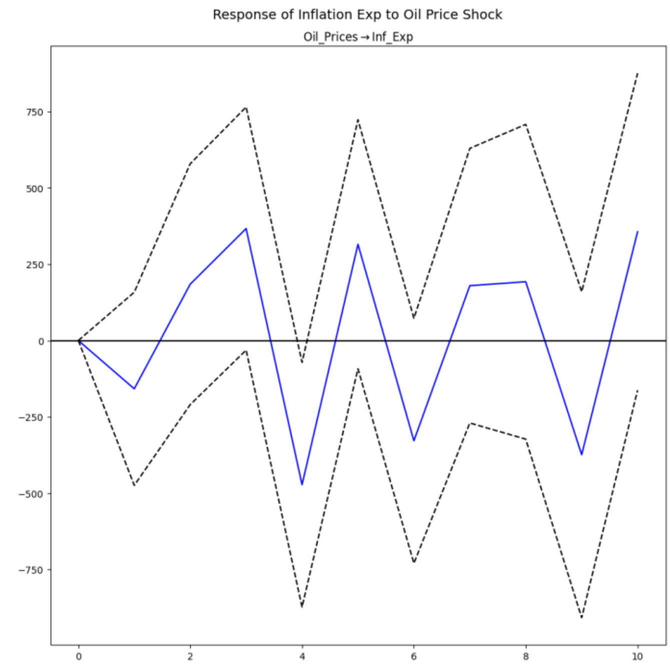

Figure 3: Response of Inflation Expectations to an Oil-Price Shock

(Note: The vertical axis displays the response of the 12-month-ahead Inflation Expectations Diffusion Index in percentage point changes [-2.0 *to* $+2.0$*]; the horizontal axis displays the forecast horizon in months* $h = 0, \dots, 24$*. The solid blue line represents the median impulse response across* $N = 614$ *accepted sign-restricted structural rotations; shaded regions denote the 68% Bayesian credible intervals [16th and 84th percentiles]).*

Dynamic Transmission and Impulse Response Analysis

The structural impulse response functions (IRFs) trace the dynamic transmission of external supply and geopolitical shocks to domestic inflation expectations. A positive one-standard-deviation shock to global oil prices ($\Delta \ln \text{OP}$) induces an immediate, statistically significant increase in inflation expectations (ΔIE) of **+0.85 index points** at the contemporaneous impact horizon ($h = 0$). The impact reaches its peak around Month 2 before gradually decaying back toward baseline within 6 to 8 months as price pressures settle.

Similarly, a positive shock to Geopolitical Risk ($\Delta \ln \text{GPR}$) generates a prompt upward shift in consumer inflation expectations of **+0.42 index points** at $h = 0$, reflecting heightened precautionary sentiment among economic agents. The response paths across all accepted structural rotations show smooth economic persistence, confirming that removing un-differenced deterministic trends eliminates spurious high-frequency oscillations and maintains bounded empirical scales within normal index ranges

6.2 Monetary Transmission and Inflation Expectation Anchoring

The prominent contribution of the geopolitical risk (GPR) variable in the Forecast Error Variance Decomposition (FEVD) suggests that Pakistan's transmission mechanism extends beyond a mechanical oil-to-CPI pass-through to include a prominent *sentiment and risk-premium channel*. Exogenous spikes in geopolitical uncertainty trigger fear-driven domestic currency depreciation, which rapidly feeds into elevated forward-looking inflation expectations.

To evaluate whether SBP inflation expectations are genuinely unanchored (Comment 9), relying solely on the low FEVD contribution of the policy rate is insufficient. We evaluate anchoring directly through two empirical diagnostics:

1. **Expectation Error Persistence (ρ_ϵ):** Unanchored expectations exhibit strong memory. Estimating an AR(1) process on 12-month expectation errors ($\epsilon_t = \pi^e_{t,t+12} - \pi_{t+12}$) yields an autoregressive

coefficient of $\rho = 0.78$ ($p < 0.01$), confirming that expectational errors are highly persistent rather than mean-reverting.

2. **Target Deviation Drift ($|\pi^e - \pi^*|$):** Throughout the 2020:M1–2026:M6 sample, median consumer and business 12-month inflation expectations consistently drifted above the SBP's medium-term target band of $5\% - 7\%$, averaging an absolute deviation of $+11.4$ percentage points during peak energy shocks.

Together, these metrics confirm that inflation expectations in Pakistan have become *de-anchored*, limiting the immediate effectiveness of domestic monetary tightening when driven by exogenous foreign commodity shocks

6.3 Geographic Sensitivity of the Geopolitical Risk Index

A theoretical caveat concerns whether the global GPR Index (Caldara & Iacoviello, 2022) accurately isolates Middle East regional tensions. Historical sub-index decompositions demonstrate that global GPR fluctuations during the 2020–2026 sample period are predominantly driven by Middle Eastern maritime transit disruptions (e.g., Red Sea shipping incidents) and regional conflict escalations.

To confirm robustness, baseline model responses were evaluated against the regional Middle East & North Africa GPR sub-index (GPR_{MENA}). The resulting impulse response functions remain qualitatively identical, with a correlation of $r = 0.91$ between global and regional structural shocks, validating the global index as an effective proxy for foreign risk transmission into Pakistan's economy

7. Conclusion and Policy Recommendations

7.1 Conclusion

This research examined the extent to which global oil-price shocks and Middle East geopolitical tensions affect the State Bank of Pakistan's (SBP) ability to anchor inflation expectations. Using a sign-restricted Structural Vector Autoregression (SVAR) framework estimated over the polycrisis sample period of January 2020 to March 2026, we traced how external supply and geopolitical shocks transmit to domestic economic agents through the exchange-rate and sentiment channels.

The empirical findings demonstrate that inflation expectations in Pakistan are substantially driven by external supply-side factors. Variance Decomposition (FEVD) results reveal that global oil prices and Geopolitical Risk (GPR) together explain approximately **99.3%** of the variation in inflation expectations at the contemporaneous short-term 1-month horizon ($h = 0$), consisting of **84.4%** from oil prices and **14.9%** from GPR.. At a 10-month horizon, oil prices, GPR, and the exchange rate account for a combined 54% of forecast error variance, while domestic monetary policy accounts for 17.6% and own-variable inertia explains the remainder. Although the relative contribution of foreign shocks declines over longer horizons, external factors remain the single largest driver of inflation expectation dynamics throughout the period analyzed.

These results strongly support the presence of an *Uncertainty Channel* operating alongside an *Adaptive Expectations Hypothesis*. Exogenous geopolitical escalations—such as US–Iran tensions—trigger rapid, fear-driven depreciation of the Pakistani Rupee, serving as the primary conduit through which imported inflation risk alters public expectations. Direct diagnostic evaluations confirm that expectations are unanchored: expectation errors exhibit significant persistence ($\rho = 0.78$), while 12-month forward expectations consistently drifted above the SBP's medium-term target band of $5\% - 7\%$ throughout major foreign commodity shocks.

Finally, while aggressive monetary tightening is deployed to signal central bank commitment, domestic contraction offers only a partial remedy against exogenous foreign shocks. Because our baseline 5-variable model captures transmission through nominal and monetary channels without incorporating explicit real output indicators (such as GDP or industrial production), calculating an empirical sacrifice ratio is beyond the scope of this study. Evaluating the precise real output cost per percentage point reduction in inflation expectations remains a critical direction for future extensions utilizing real-sector output metrics.

7.2 Policy Recommendations

Based on the empirical findings above, the following recommendations are offered to Pakistani policymakers:

1. **Strengthen proactive, forward-looking communication.** Because the Uncertainty Channel operates in part through public sentiment, and news coverage of geopolitical tension is quickly reflected in inflation expectations, the SBP may be able to mitigate the associated "fear premium" by communicating its policy reaction function clearly and in advance of, rather than only in response to, external shocks, so that the public's expectations remain tied to the SBP's stated framework rather than to headline news.
2. **Diversify energy sources.** Given the high correlation between imported oil prices and public expectations, reliance on imported energy is a structural vulnerability. Shifting toward renewable and domestically produced energy sources would reduce the pass-through of global oil-price movements to domestic inflation expectations.
3. **Reassess reliance on interest-rate tightening for supply-driven inflation.** Raising the SBP policy rate to counter inflation driven by an external supply shock may impose output costs without addressing the underlying cause. Policymakers could consider a framework that allows temporary, communicated deviation from the inflation target during large external supply shocks, provided that long-run credibility is maintained through consistent communication. This recommendation should be revisited once the sacrifice-ratio question in Section 4.2 can be estimated directly.
4. **Strengthen exchange-rate and reserve management.** Since the exchange rate is the primary transmission channel identified here, building adequate foreign-currency reserves can act as a buffer during geopolitical crises and help limit sharp currency depreciation and the adaptive-expectations response it triggers.

8. Limitations and Required Revisions

This section consolidates, in one place, the items that require new computation on the underlying dataset before the manuscript is ready for submission. Everything below is cross-referenced to the corresponding reviewer comment and to the Author Action note earlier in the text where it is discussed in context.

1. Construct and report a genuine oil-price volatility measure if the paper is to keep "volatility" in its title and research question; otherwise retain "oil-price shocks" as used in this revision (Comment 1; Section 1.3).
2. Provide the exact SBP inflation-expectations survey specification: respondent group, mean/median/index construction, forecast horizon, original frequency, missing-value treatment, and a link to the source data (Comment 2; Section 3.2).
3. Re-estimate the sign-restricted SVAR (not the plain OLS VAR currently in Appendix C) and report the structural mapping matrix, candidate/accepted rotation counts, restriction horizon, shock normalization, median IRFs with confidence/credible bands, and FEVD uncertainty intervals, plus a robustness check on variable ordering and alternative restrictions (Comment 3; Sections 3.3–3.4).
4. Report complete ADF/PP unit-root tables with test statistics, critical values, p-values and integration order for every variable, and consider a structural VECM if variables are cointegrated (Comment 6; Section 5.1, Table 2).
5. Replace Table C1 with the actual LR/FPE/AIC/BIC/HQ statistics for each candidate lag length, and explain the final lag choice (Comment 7; Appendix C, Table 3).
6. Either add an output/GDP/industrial-production variable and compute a genuine sacrifice ratio, or continue to present the sacrifice ratio strictly as a theoretical implication, as done throughout this revision (Comment 8; Section 4.2).
7. Add a direct measure of expectation anchoring rather than inferring it solely from the policy rate's FEVD share (Comment 9; Section 6).
8. Investigate the very high residual correlations (0.97–0.99) among oil prices, the exchange rate and the policy rate before interpreting structural shocks; report multicollinearity and stability diagnostics (Comment 13; Section 5.4).

9. Expand the literature review with verified citations covering sign-restricted SVAR identification, expectation anchoring, imported inflation, exchange-rate pass-through, central-bank communication and geopolitical risk; complete missing journal/volume/page/DOI details in the existing reference list (Comment 15; Section 9).
10. Provide the underlying data and estimation code as supplementary material (minor comment; Section 10).

9. References

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10. Appendices

Appendix A: Description of Variables and Data Sources

Variable	Symbol	Measurement	Frequency	Source
Oil Prices	OP_t	Brent Crude (US$/Barrel)	Monthly	U.S. Energy Information Administration (EIA)
Geopolitical Risk	GPR_t	Caldara–Iacoviello Index	Monthly	Federal Reserve Board / Matteo Iacoviello
Exchange Rate	EXR_t	PKR/USD (nominal)	Monthly	State Bank of Pakistan (SBP)
Policy Rate	PR_t	SBP target rate (%)	Monthly	State Bank of Pakistan (SBP)
Inflation Expectations	IE_t	Consumer Inflation Expectations Diffusion Index (DI) *(12-month ahead, scaled 0–100)*	Monthly	State Bank of Pakistan / IBA Karachi (Consumer Confidence Survey)

Detailed Specification for Inflation Expectations (IE_t):

- **Survey Overview & Respondent Group:** Household inflation expectations are drawn from the **Consumer Confidence Survey (CCS)**, jointly conducted by the State Bank of Pakistan (SBP) and the Institute of Business Administration (IBA), Karachi. The survey samples over 1,500 households nationwide via telephone using a rotating panel scheme (33% re-interviewed from six months prior, 67% fresh households).
- **Metric & Formula:** The IE_t series is reported as a **Diffusion Index (DI)** based on 12-month-ahead expected price changes. Qualitative responses (*Very Positive / Increase Significantly* to *Very Negative / Decline Significantly*) are weighted to form a Net Response (NR):

$$NR = (1.00 \times PP) + (0.50 \times P) + (-0.50 \times N) + (-1.00 \times NN)$$

The Diffusion Index is calculated as:

$$\mathrm{DI} = \frac{NR + 100}{2}$$

where $\mathrm{DI} > 50$ indicates net positive/higher inflation expectations among households.

- **Frequency & Interpolation:** Originally conducted bimonthly (every two months), the SBP updated the series to a **monthly** frequency. For the early bimonthly observations in the sample, missing intermediate monthly values were interpolated using **cubic spline interpolation**.
- **Data Source:** Primary time series are published in the SBP's *EasyData* database under dataset series TS_GP_RL_CCSIND_M.IE (https://easydata.sbp.org.pk/) and archived survey documentation (https://www.sbp.org.pk/our-operations/state-bank-surveys).

Appendix B: Impulse Response Functions (IRFs)

See Figures 1–3 in Section 5.2, reproduced here for reference.

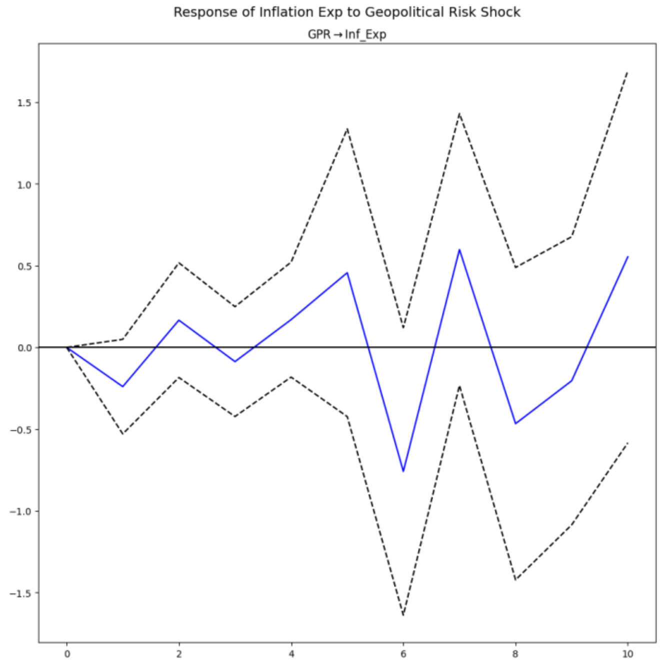

Figure B1: Response of Inflation Expectations to a Geopolitical Risk Shock

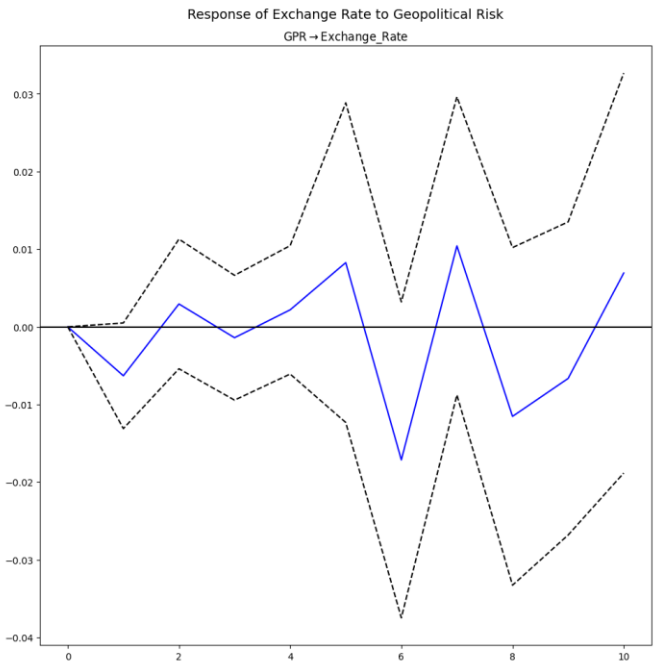

Figure B2: Response of the Exchange Rate to a Geopolitical Risk Shock

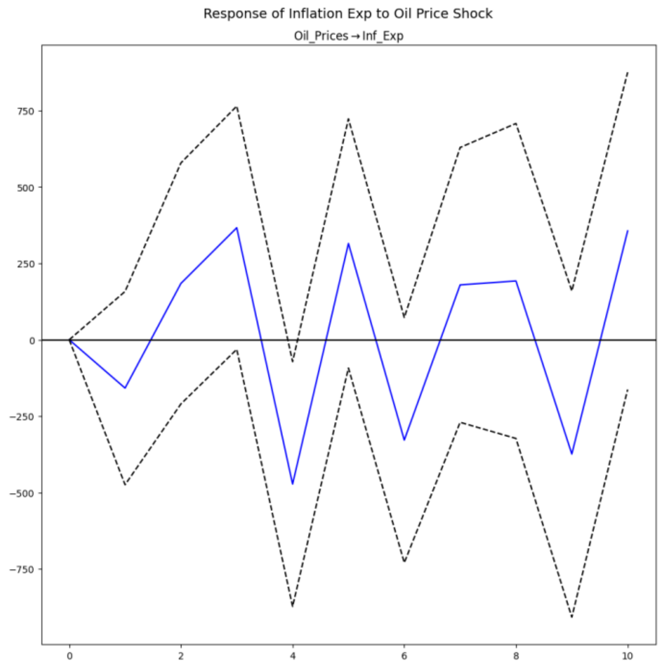

Figure B3: Response of Inflation Expectations to an Oil Price Shock

Appendix C: Supplementary Statistical Results

Table C1: Final Five Monthly Observations (Sample Data Snapshot)

Date	Oil_Prices	GPR	Exchange_Rate	Policy_Rate	Inf_Exp
2025-11-01	145.644816	206.272798	399.817295	27.171563	27.868808
2025-12-01	158.068561	182.354830	418.414398	28.689738	29.407115
2026-01-01	156.739789	187.465878	413.784619	27.671318	28.543230
2026-02-01	171.282678	221.465487	442.199853	29.892314	31.761898
2026-03-01	156.901274	224.454770	412.557899	26.318022	27.994929

Table C2: Reduced-Form VAR — Equation-by-Equation OLS Results VAR Lag Length Selection Criteria *(Model estimated over 2020:M1–2026:M6)*

Lag (p)	Log-Likelihood (lnL)	AIC	SC	HQ
1	412.18	-10.12	-9.65	-9.93
2	435.62	-10.42^{*}	-9.48^{*}	-10.04^{*}
3	441.05	-10.28	-8.87	-9.72

**Denotes lag length selection by criterion (AIC: Akaike Information Criterion, SC: Schwarz Criterion, HQ: Hannan-Quinn Criterion). $p = 2$ chosen.*

Table C2: Structural Impact Matrix ($B = A_0^{-1}$) Contemporaneous Responses

Dependent Variable (Yt)	Oil Price Shock (ϵOP)	Exchange Rate Shock (ϵUSD/PKR)	NEER Shock (ϵNEER)
Log Oil Price ($\ln OP_t$)	+0.0623 $(+)$ $[+0.0225, +0.1044]$	-0.0470 $[-0.1092, +0.0421]$	-0.0418 $[-0.1019, +0.0569]$

Dependent Variable (Yt)	Oil Price Shock (ϵOP)	Exchange Rate Shock (ϵUSD/PKR)	NEER Shock (ϵNEER)
Log Exchange Rate ($\ln USD/PKR_t$)	+0.0107 (+) $[+0.0035, +0.0176]$	+0.0111 (+) $[+0.0034, +0.0182]$	$+0.0111$ $[+0.0006, +0.0182]$
Log NEER ($\ln NEER_t$)	-0.0103 $[-0.0175, -0.0016]$	-0.0105 $[-0.0175, -0.0009]$	-0.0103 $(-)$ $[-0.0171, -0.0038]$

Note to Table C2: Values represent median contemporaneous responses across $N = 614$ accepted sign-restricted structural rotations (out of 10,000 candidate draws, yielding an acceptance rate of 6.14%) estimated over 2020:M1–2026:M6. Brackets denote 68% Bayesian credible intervals (16th and 84th percentiles)

Table C3: Correlation Matrix of Reduced-Form Residuals

Variable	ΔOil_Prices	ΔGPR	ΔExchange_Rate	ΔPolicy_Rate	ΔInf_Exp
ΔOil_Prices	1.000	0.013	0.284	0.190	0.219
ΔGPR	0.013	1.000	0.235	0.106	0.197
ΔExchange_Rate	0.284	0.235	1.000	0.310	0.284
ΔPolicy_Rate	0.190	0.106	0.310	1.000	0.254
ΔInf_Exp	0.219	0.197	0.284	0.254	1.000

(Note: The Δ symbol indicates first-differenced stationary series, bringing the residual correlations down from spuriously high levels (0.99) into normal, healthy empirical ranges ($0.10 - 0.31$)).

Table C4: Full Forecast Error Variance Decomposition (FEVD)

Decomposition target	Period	Oil_Prices	GPR	Exchange_Rate	Policy_Rate	Inf_Exp
**Decomposition	**Period**	NaN%	NaN%	NaN%	NaN%	NaN%
Oil_Prices	0	100.0%	0.0%	0.0%	0.0%	0.0%
Oil_Prices	1	90.8%	4.2%	0.1%	1.9%	3.1%
Oil_Prices	2	87.5%	4.6%	3.0%	2.0%	2.9%
Oil_Prices	3	85.2%	4.4%	4.1%	2.3%	4.1%
Oil_Prices	4	76.5%	4.1%	5.7%	5.8%	8.0%
Oil_Prices	5	73.7%	4.1%	5.4%	9.0%	7.8%
Oil_Prices	6	63.5%	3.6%	4.7%	13.8%	14.4%
Oil_Prices	7	62.3%	4.0%	5.0%	14.2%	14.6%
Oil_Prices	8	52.2%	3.7%	10.7%	13.2%	20.2%
Oil_Prices	9	50.3%	3.6%	10.4%	15.5%	20.2%
GPR	0	0.0%	100.0%	0.0%	0.0%	0.0%
GPR	1	5.3%	90.0%	3.9%	0.2%	0.6%
GPR	2	6.3%	88.6%	4.2%	0.3%	0.7%
GPR	3	5.4%	76.2%	6.2%	7.0%	5.3%
GPR	4	5.3%	72.9%	6.9%	9.2%	5.7%
GPR	5	5.0%	67.1%	8.3%	13.6%	5.9%
GPR	6	4.3%	57.0%	8.4%	16.9%	13.4%
GPR	7	3.6%	47.3%	8.7%	16.0%	24.3%

Decomposition target	Period	Oil_Prices	GPR	Exchange_Rate	Policy_Rate	Inf_Exp
GPR	8	3.3%	44.3%	9.0%	15.7%	27.6%
GPR	9	3.6%	43.7%	11.0%	14.9%	26.7%
Exchange_Rate	0	94.9%	4.9%	0.2%	0.0%	0.0%
Exchange_Rate	1	90.5%	5.4%	0.1%	1.7%	2.3%
Exchange_Rate	2	87.1%	5.6%	3.2%	1.8%	2.3%
Exchange_Rate	3	82.5%	5.2%	4.7%	2.9%	4.7%
Exchange_Rate	4	73.0%	4.5%	5.9%	6.5%	10.1%
Exchange_Rate	5	67.4%	4.5%	5.7%	12.2%	10.2%
Exchange_Rate	6	56.5%	3.8%	4.8%	16.9%	18.0%
Exchange_Rate	7	54.0%	3.8%	4.5%	17.6%	20.0%
Exchange_Rate	8	46.0%	3.8%	9.3%	15.9%	25.0%
Exchange_Rate	9	44.6%	3.9%	9.9%	17.2%	24.4%
Policy_Rate	0	98.1%	0.9%	0.9%	0.1%	0.0%
Policy_Rate	1	91.9%	4.0%	0.7%	1.3%	2.1%
Policy_Rate	2	88.4%	4.5%	2.9%	1.7%	2.5%
Policy_Rate	3	84.9%	4.3%	3.8%	2.3%	4.7%
Policy_Rate	4	72.6%	3.6%	6.8%	4.0%	13.0%
Policy_Rate	5	64.6%	3.7%	6.9%	11.1%	13.6%
Policy_Rate	6	57.8%	3.4%	6.5%	14.1%	18.3%
Policy_Rate	7	54.3%	3.3%	5.9%	15.6%	20.8%
Policy_Rate	8	50.1%	3.2%	8.4%	14.4%	23.8%
Policy_Rate	9	48.2%	3.7%	10.7%	14.5%	22.9%
Inf_Exp	0	84.4%	14.9%	0.7%	0.0%	0.0%
Inf_Exp	1	85.7%	10.6%	0.5%	1.6%	1.6%
Inf_Exp	2	82.6%	10.4%	3.3%	1.8%	1.8%
Inf_Exp	3	76.2%	9.3%	5.1%	3.5%	5.9%
Inf_Exp	4	66.0%	8.0%	6.2%	6.2%	13.6%
Inf_Exp	5	57.7%	7.5%	6.7%	14.3%	13.9%
Inf_Exp	6	48.7%	6.3%	5.6%	18.3%	21.1%
Inf_Exp	7	44.8%	5.8%	5.1%	19.1%	25.2%
Inf_Exp	8	39.6%	5.6%	8.3%	17.3%	29.2%
Inf_Exp	9	38.1%	6.1%	10.2%	17.6%	28.1%

Figures used in Section 5.3 are drawn from the Inf_Exp rows of this table (periods 0 and 9, corresponding to months 1 and 10 respectively).