



STRUCTURAL FRAGMENTATION AND MONETARY POLICY TRANSMISSION: EVIDENCE FROM PAKISTAN'S DUAL SECURITY-ENERGY SHOCK

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DOI: <https://doi.org/10.63544/jbii.v5i5.169>

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Article History:

Received: 01.04.2026

Accepted: 15.04.2026

Published: 26.05.2026

Abstract

This study examines whether structural fragmentation alters monetary policy transmission in Pakistan. Unlike conventional approaches that treat geopolitical risk as an episodic disturbance, the study conceptualizes fragmentation as a persistent condition arising from security pressures and energy-corridor vulnerabilities. Using monthly data and an autoregressive distributed lag framework, the analysis investigates the transmission of changes in the State Bank of Pakistan's policy rate to market interest rates, the exchange rate, and import prices. The results indicate that monetary policy significantly affects market interest rates and exchange-rate dynamics; however, the strength of transmission varies with the level of structural fragmentation. Security and energy fragmentation weaken the pass-through from the policy rate to market interest rates, while energy fragmentation increases exchange-rate pressure and amplifies exchange-rate pass-through to import prices. These findings suggest that monetary policy becomes less predictable during prolonged security and energy disruption. The study contributes to the emerging literature on geopolitical fragmentation by distinguishing persistent structural pressures from temporary geopolitical shocks and by demonstrating their implications for monetary-policy effectiveness in an energy-importing emerging economy.

Keywords: Structural Fragmentation; Monetary Policy Transmission; Geopolitical Risk; Energy Security; Exchange-Rate Pass-Through; Pakistan; Interest-Rate Channel; Emerging Markets.

1. Introduction

Geopolitical uncertainty has become an increasingly important source of macroeconomic instability, particularly in emerging economies that depend heavily on imported energy, external financing, and exchange-rate stability. Geopolitical disturbances can influence investment, international trade, capital flows, risk premia, and inflation expectations. The Geopolitical Risk (GPR) index developed by Caldara and Iacoviello (2022) provides a widely used measure of geopolitical tensions based on the frequency of newspaper articles discussing wars, terrorism, military threats, and international conflicts. Their evidence shows that increases in geopolitical risk are associated with weaker investment and employment, greater downside risks, and higher uncertainty in financial markets (Caldara & Iacoviello, 2022).

Most existing studies treat geopolitical risk as an episodic shock. Under this approach, a military confrontation, terrorist attack, diplomatic crisis, or sudden energy disruption is viewed as a temporary disturbance that eventually declines as economic conditions return to normal. This assumption may not be appropriate when geopolitical pressures persist over an extended period and alter the structure of fiscal spending, external trade, energy procurement, foreign-exchange management, and investor expectations. In such circumstances, geopolitical risk may represent more than a temporary increase in uncertainty; it may



constitute a process of structural fragmentation that changes the environment in which monetary policy operates (Al Kium et al., 2023).

Pakistan provides a relevant empirical setting for examining this issue. The country's monetary-policy framework operates under persistent security pressures, high external financing requirements, energy-import dependence, exchange-rate vulnerability, and IMF-supported macroeconomic adjustment. Security-related pressures may affect monetary transmission through higher defence expenditure, fiscal stress, changes in investor confidence, and increased risk premia. Recent budgetary developments indicate that Pakistan allocated approximately PKR 3 trillion to defence services for fiscal year 2026–27, representing a substantial increase over the previous allocation and reflecting continuing regional and internal security concerns. These developments suggest that security pressures may have macroeconomic consequences beyond a short-lived geopolitical event.

The energy dimension is also central to Pakistan's macroeconomic stability. As an energy-importing economy, Pakistan is exposed to fluctuations in international oil prices, shipping costs, foreign-exchange availability, and disruptions in major energy corridors. Regional conflict and instability in maritime trade routes can increase fuel-import costs, intensify inflationary pressures, widen external-sector imbalances, and increase depreciation expectations. Recent research also emphasizes the importance of predictive intelligence for identifying financial and geopolitical disruptions across critical supply chains, highlighting the growing relevance of supply-chain vulnerability for economic and strategic resilience (Iqbal, 2025). Recent evidence indicates that energy-price developments and regional tensions have complicated the outlook for monetary-policy easing in Pakistan. Furthermore, the State Bank of Pakistan has continued to monitor inflationary risks, external-sector conditions, and the transmission of policy decisions to financial markets (State Bank of Pakistan, 2026a).

These circumstances are important for understanding monetary-policy transmission. In the conventional transmission mechanism, a change in the central bank's policy rate affects short-term market interest rates, bank lending rates, credit conditions, aggregate demand, the exchange rate, and ultimately inflation. Financial-market responses are increasingly examined through data-driven forecasting approaches, reflecting the importance of identifying changes in market conditions and asset-price dynamics during periods of heightened uncertainty (Jabed, 2024). The increasing use of AI-based financial forecasting also highlights the importance of identifying and anticipating changes in financial-market conditions, particularly when economic uncertainty and market risks are elevated (Jabed et al., 2026). However, this mechanism may become weaker or less predictable when the economy faces persistent geopolitical and energy-related pressures. Banks may increase their preference for government securities, firms may postpone investment because of uncertainty, and households may respond more strongly to exchange-rate and food-price expectations than to changes in the policy rate (Mahmood, 2025). Evidence on Pakistan suggests that monetary-policy transmission is slow, incomplete, and uneven across different channels, partly because of financial-market imperfections, banking-sector characteristics, sovereign borrowing, and external-sector constraints.

Structural fragmentation may influence monetary transmission through three main channels. First, it may weaken the interest-rate channel by reducing the pass-through from the SBP policy rate to lending and deposit rates. Second, it may increase volatility in the exchange-rate channel by raising foreign-exchange demand, capital-flow sensitivity, and depreciation expectations. Third, it may strengthen exchange-rate pass-through to import prices and consumer prices, thereby reducing the effectiveness of domestic monetary tightening in controlling inflation. Consequently, the same policy-rate change may produce different outcomes under persistent security and energy fragmentation than under ordinary macroeconomic conditions (Rahman et al., 2025).

The distinction between structural and episodic geopolitical risk is therefore important for both monetary theory and policy design. A temporary geopolitical shock may require a short-term stabilization response, whereas structural fragmentation may require a broader policy framework that considers persistent changes in fiscal priorities, energy security, external financing, exchange-rate expectations, and inflation



persistence. Recent research on emerging markets indicates that adverse global shocks can dampen the transmission of domestic monetary policy, suggesting that external uncertainty may reduce the effectiveness of central-bank instruments in financially vulnerable economies (Renzhi & Beirne, 2025).

Despite the growing literature on geopolitical risk, energy shocks, and monetary-policy transmission, limited attention has been given to whether persistent security and energy disruptions alter the transmission mechanism in Pakistan. Existing studies commonly rely on standard geopolitical-risk indices that measure the intensity of news-based events. Although these indices are useful for identifying episodic changes in geopolitical uncertainty, they may not adequately capture a sustained reconfiguration of security conditions, trade routes, energy supply, and fiscal priorities. Consequently, it remains unclear whether structural fragmentation produces effects that are statistically and economically different from those associated with temporary geopolitical risk.

This study addresses this gap by examining the relationship between structural fragmentation and monetary-policy transmission in Pakistan. It develops two dimensions of structural fragmentation: a security-fragmentation vector that captures persistent defence and geopolitical pressures, and an energy-fragmentation vector that captures energy-corridor vulnerabilities, imported-energy costs, and related external-sector pressures. These measures are incorporated into an empirical monetary-policy framework to assess whether structural fragmentation changes the response of market interest rates, the exchange rate, and import prices to changes in the SBP policy rate (Ahmad et al., 2025).

The study makes three contributions to the literature. First, it distinguishes structural geopolitical fragmentation from conventional episodic geopolitical risk and evaluates whether this distinction has empirical relevance for monetary-policy transmission. Second, it separates security-related and energy-related fragmentation to determine whether these dimensions affect monetary transmission through different channels. Third, it provides country-specific evidence from Pakistan, an emerging economy characterized by external financing dependence, energy-import exposure, exchange-rate vulnerability, and IMF-supported macroeconomic adjustment (Hamid & Syed, 2026).

1.1 Research Objectives

The study has the following objectives:

1. To construct structural security- and energy-fragmentation indices for Pakistan.
2. To examine whether structural fragmentation changes the sensitivity of domestic market interest rates to changes in the SBP policy rate.
3. To investigate whether security and energy fragmentation affect the exchange-rate response to monetary-policy changes.
4. To estimate whether exchange-rate pass-through to import prices becomes stronger under structural fragmentation.
5. To compare the effects of structural-fragmentation measures with those of a conventional episodic geopolitical-risk index.
6. To determine whether security and energy fragmentation operate as distinct channels of monetary-policy transmission.

1.2 Significance of the Study

This study is significant because it examines monetary policy under persistent rather than temporary geopolitical pressure. If structural fragmentation weakens interest-rate pass-through or strengthens exchange-rate pass-through to import prices, the effectiveness of conventional monetary-policy instruments may be lower than expected. Such findings would be important for the State Bank of Pakistan when calibrating policy during periods in which security and energy conditions do not quickly return to their pre-shock levels.

The study also contributes methodologically by introducing a distinction between episodic risk and structural fragmentation. This distinction allows the analysis to move beyond the assumption that all geopolitical disturbances have similar and temporary macroeconomic effects. By separating security and energy dimensions, the study may identify whether different types of fragmentation require different policy responses.



The findings may further assist policymakers in designing a coordinated macroeconomic strategy. If security fragmentation primarily affects fiscal conditions and interest-rate transmission, while energy fragmentation mainly increases exchange-rate pass-through and inflation persistence, monetary authorities may need to complement policy-rate decisions with forward guidance, foreign-exchange management, liquidity operations, macroprudential measures, and coordination with fiscal and energy authorities.

1.3 Research Contribution

This study contributes to the literature in three ways. First, it extends the geopolitical-risk literature by conceptualizing prolonged geopolitical disruption as structural fragmentation rather than only as an episodic shock. Second, it contributes to the monetary-policy literature by testing whether structural fragmentation changes the transmission of the policy rate to market interest rates, the exchange rate, and import prices. Third, it adds Pakistan-specific evidence to the emerging-market literature by examining monetary-policy effectiveness under simultaneous security pressures and energy-corridor vulnerabilities.

2. Research Methodology

2.1 Introduction

This chapter presents the methodology used to examine the relationship between structural fragmentation and monetary-policy transmission in Pakistan. The study focuses on whether persistent security pressures and energy-corridor vulnerabilities alter the transmission of changes in the State Bank of Pakistan's (SBP) policy rate to market interest rates, the exchange rate, and import prices.

Unlike conventional studies that model geopolitical risk as a temporary or episodic shock, this study conceptualizes structural fragmentation as a persistent macroeconomic condition. It separates fragmentation into two dimensions: a security-fragmentation vector and an energy-fragmentation vector. The empirical analysis uses monthly data and applies time-series econometric techniques to estimate both the direct and interaction effects of structural fragmentation on monetary-policy transmission.

The methodology is designed to answer three central questions:

1. Does the SBP policy rate significantly affect market interest rates in Pakistan?
2. Does structural security-energy fragmentation change the strength of this interest-rate transmission?
3. Does structural fragmentation alter the exchange-rate and import-price responses to monetary-policy changes?

2.2 Research Philosophy and Approach

The study follows a positivist research philosophy because it examines observable macroeconomic indicators and tests theoretically derived relationships using statistical and econometric methods. The analysis is quantitative and deductive. It begins with the monetary-policy transmission theory and develops empirically testable hypotheses regarding the moderating effects of security and energy fragmentation.

A longitudinal research design is employed because the study examines changes in Pakistan's monetary-policy transmission mechanism over time. Monthly observations are preferred because monetary-policy decisions, exchange-rate movements, energy prices, and inflationary changes may occur more frequently than annually or quarterly. Monthly data also provide a larger number of observations and improve the ability to identify short-run adjustments and delayed transmission effects.

2.3 Conceptual Framework

The conceptual framework assumes that the SBP policy rate affects economic outcomes through three principal channels:

1. The interest-rate channel.
2. The exchange-rate channel.
3. The exchange-rate pass-through channel.

Under normal conditions, an increase in the policy rate should increase market interest rates, reduce credit demand, and place downward pressure on aggregate demand. It may also support the domestic currency by increasing the relative attractiveness of domestic financial assets. A stronger exchange rate can reduce the domestic-currency cost of imported goods and therefore moderate import-price inflation.



However, persistent security and energy fragmentation may modify these relationships. Structural security pressures may increase fiscal risk, sovereign borrowing, and uncertainty, while energy fragmentation may increase import costs, foreign-exchange demand, and inflation expectations. Therefore, the effectiveness of the policy rate may depend on the level of structural fragmentation.

The general relationship can be expressed as:

$$Y_t = f(PR_t, SF_t, EF_t, PR_t \times SF_t, PR_t \times EF_t, X_t)$$

2.4 Research Hypotheses

The empirical analysis tests the following hypotheses.

H1: Policy-rate transmission $H_1: \beta_1 > 0$

An increase in the SBP policy rate increases domestic market interest rates.

H2: Security-fragmentation effect $H_2: \beta_3 \neq 0$

Structural security fragmentation significantly changes the transmission of the SBP policy rate to market interest rates.

H3: Energy-fragmentation effect $H_3: \beta_4 \neq 0$

Structural energy fragmentation significantly changes the transmission of the SBP policy rate to market interest rates.

H4: Exchange-rate transmission $H_4: \gamma_1 \neq 0$

Changes in the SBP policy rate significantly affect the PKR–USD exchange rate.

H5: Exchange-rate pass-through $H_5: \delta_1 > 0$

Depreciation of the Pakistani rupee significantly increases import prices.

H6: Conditional pass-through $H_6: \delta_3 \neq 0$

Structural energy fragmentation significantly changes the pass-through from exchange-rate movements to import prices.

2.5 Data Sources and Sample

The study uses monthly observations for Pakistan. The final sample period should be selected according to data availability and the timing of the structural-fragmentation episode. A recommended baseline period is January 2005 to the latest month for which all variables are consistently available. If the structural fragmentation indicators begin later, the sample may instead begin in January 2010.

The study uses the following sources:

- SBP policy rate, market interest rates, exchange-rate data, and monetary indicators: State Bank of Pakistan.
- Consumer prices, wholesale prices, and import-price-related indicators: Pakistan Bureau of Statistics.
- International oil and energy prices: World Bank Commodity Markets or the U.S. Energy Information Administration.
- Foreign-exchange reserves, current-account indicators, and external-sector variables: State Bank of Pakistan.
- Geopolitical-risk data: Caldara and Iacoviello's Geopolitical Risk Index or the updated AI-GPR database.
- Defence expenditure and fiscal-security variables: Pakistan's federal budget documents and Ministry of Finance publications.

The Pakistan Bureau of Statistics provides monthly CPI, SPI, WPI, and PPI data, making it an appropriate source for measuring price developments and inflationary pressures. The SBP's monetary-policy compendium provides policy-rate, interest-rate, and exchange-rate information, including the policy rate and USD/PKR exchange-rate series (Ijaz et al., 2019). The updated AI-GPR database provides daily and monthly geopolitical-risk indicators and components, normalized to a mean of 100 over 1985–2019.

2.6 Variable Measurement

2.6.1 Monetary-policy variable. The main monetary-policy variable is the SBP policy rate:

$$PR_t = \text{SBP policy rate in month } t$$

The first difference of the policy rate is used in the short-run model:



$$\Delta PR_t = PR_t - PR_{t-1}$$

Using changes rather than levels helps identify monetary-policy innovations and reduces the risk of spurious relationships.

2.6.2 Market interest rate. The main interest-rate transmission variable is a representative domestic market interest rate. Depending on data availability, this may be measured using:

- Weighted-average lending rate.
- Six-month or twelve-month Treasury bill rate.
- Pakistan Investment Bond yield.
- Overnight repo rate.
- Deposit rate.

The preferred specification uses the weighted-average lending rate because it reflects the borrowing cost faced by the private sector:

$$MIR_t = \{\text{weighted} - \text{average market interest rate}\}$$

The interest-rate pass-through equation is:

$$\Delta MIR_t = \alpha_0 + \alpha_1 \Delta PR_t + \alpha_2 SF_t + \alpha_3 EF_t + \alpha_4 (\Delta PR_t \times SF_t) + \alpha_5 (\Delta PR_t \times EF_t) + \alpha_6 X_t + \varepsilon_t$$

The coefficient α_1 measures the baseline effect of the policy rate on market interest rates. The interaction coefficients α_4 and α_5 show whether security and energy fragmentation modify this transmission.

2.6.3 Exchange rate. The exchange rate is measured as Pakistani rupees per U.S. dollar:

$$ER_t = \{\text{PKR per USD}\}$$

An increase in ER_t represents depreciation of the Pakistani rupee. The logarithmic change is calculated as:

$$\Delta \ln ER_t = 100 [\ln(ER_t) - \ln(ER_{t-1})]$$

The exchange-rate equation is specified as:

$$\Delta \ln ER_t = \gamma_0 + \gamma_1 \Delta PR_t + \gamma_2 SF_t + \gamma_3 EF_t + \gamma_4 (\Delta PR_t \times SF_t) + \gamma_5 (\Delta PR_t \times EF_t) + \gamma_6 X_t + u_t$$

A positive policy-rate response is expected to reduce depreciation pressure, although the actual sign may depend on market expectations, capital flows, reserve conditions, and IMF-related policy credibility.

2.6.4 Import prices. Import prices are measured using the available import-price index or, where a consistent index is unavailable, the relevant WPI import-related sub-index. The logarithmic change is calculated as:

$$\Delta \ln IP_t = 100 [\ln(IP_t) - \ln(IP_{t-1})]$$

The exchange-rate pass-through model is:

$$\Delta \ln IP_t = \delta_0 + \delta_1 \Delta \ln ER_t + \delta_2 EF_t + \delta_3 (\Delta \ln ER_t \times EF_t) + \delta_4 \Delta \ln OP_t + \delta_5 \Delta \ln GDP_t + \delta_6 X_t + v_t$$

where OP_t represents international oil or energy prices. The coefficient δ_1 captures the baseline exchange-rate pass-through, while δ_3 indicates whether energy fragmentation strengthens or weakens pass-through.

2.6.5 Structural security-fragmentation index. The structural security-fragmentation index is constructed to capture persistent security-related pressures rather than one-month geopolitical events. The index may combine the following variables:

- Defence expenditure as a percentage of federal expenditure.
- Defence expenditure growth.
- Security-related fiscal expenditure.
- Domestic and regional conflict intensity.
- Security-related news coverage.
- Defence-import or military procurement indicators, where available.

Each component is transformed into a standardized series:

$$Z_{it} = \frac{X_{it} - \bar{X}_i}{S_i}$$

The security-fragmentation index is then calculated as:



$$SF_t = \sum_{i=1}^n w_i Z_{it}$$

where w_i represents the weight assigned to each component. The baseline specification assigns equal weights:

$$w_i = \frac{1}{n}$$

To capture persistence, the index may be smoothed using a moving average:

$$SF_{*t} = \left(\frac{1}{k}\right) \sum_{j=0}^{k-1} SF_{t-j}$$

where k represents the smoothing window. A three-, six-, or twelve-month moving average may be tested. The preferred baseline should be selected according to information criteria and robustness results.

2.6.6 Structural energy-fragmentation index. The energy-fragmentation index captures persistent energy-corridor and energy-import vulnerabilities. Its components may include: International crude-oil price, International gas price, Pakistan's energy-import bill, Shipping or freight-cost indicators, Energy-import volume, Energy-related geopolitical-risk measures, Exchange-rate-adjusted fuel costs, and The index is constructed as:

$$EF_t = \sum_{j=1}^m q_j Z_{jt}$$

where Z_{jt} represents standardized energy-fragmentation components and q_j represents their weights.

An alternative principal-component approach may be used:

$$EF_t = PC_1(Z_{1t}, Z_{2t}, \dots, Z_{mt})$$

The principal component is useful when the energy variables are highly correlated. The first principal component is retained if it explains a meaningful proportion of the total variation in the underlying indicators.

2.7 Control Variables

The models include control variables that may influence monetary-policy transmission independently of structural fragmentation. These include: Inflation rate, Industrial production or economic activity, Broad money growth, Foreign-exchange reserves, Current-account balance, International oil prices, Fiscal deficit or government borrowing, Global interest rate, IMF programme or review dummy, and COVID-19 or other major crisis dummies, where relevant.

Inflation is measured as:

$$INF_t = 100[\ln(CPI_t) - \ln(CPI_{t-12})]$$

The twelve-month transformation is appropriate for measuring year-on-year inflation using monthly data.

Industrial production growth is measured as:

$$IPG_t = 100[\ln(IIP_t) - \ln(IIP_{t-12})]$$

where IIP_t denotes the industrial production index. If monthly industrial production data are unavailable, high-frequency economic activity indicators may be used as alternatives.

2.8 Econometric Strategy

2.8.1 Descriptive analysis. The analysis begins with descriptive statistics for all variables, including: Mean, Median, Standard deviation, Minimum, Maximum, Skewness, and Kurtosis.

Time-series plots are also used to identify major changes in the policy rate, exchange rate, inflation, energy prices, and fragmentation indices.

2.8.2 Correlation analysis. A correlation matrix is produced to examine the preliminary relationships among the variables. However, correlation coefficients are not interpreted as evidence of causality. This stage is used only to identify potential multicollinearity and broad associations.

2.8.3 Unit-root testing. The stationarity properties of each variable are tested using the Augmented Dickey–Fuller test and the Phillips–Perron test.



The ADF model is:

$$\Delta Y_t = \rho Y_{t-1} + \sum_{i=1}^p \theta_i \Delta Y_{t-i} + \mu + \lambda t + \varepsilon_t$$

The null hypothesis is:

$$H_0: \rho = 0$$

which indicates the presence of a unit root. The alternative hypothesis is:

$$H_1: \rho < 0$$

which indicates stationarity.

The ARDL approach is appropriate only if the variables are integrated of order zero or one, I(0) or I(1), and none is integrated of order two, I(2).

2.8.4 Baseline ARDL model. The baseline monetary-policy transmission model is estimated using an autoregressive distributed lag framework:

$$Y_t = c + \sum_{i=1}^p \phi_i Y_{t-i} + \sum_{j=0}^q \beta_j \Delta PR_{t-j} + \sum_{k=0}^r \theta_k Z_{t-k} + \varepsilon_t$$

The ARDL model is useful because it distinguishes short-run dynamics from long-run relationships and can be applied to variables with mixed I(0) and I(1) orders of integration.

2.8.5 Error-correction model. If a long-run relationship is identified, the ARDL model is reparametrized into an error-correction model:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_i \Delta Y_{t-i} + \sum_{j=0}^{q-1} \beta_j \Delta X_{t-j} + \lambda ECM_{t-1} + \varepsilon_t$$

The error-correction term is:

$$ECM_{t-1} = Y_{t-1} - \theta_0 - \theta_1 X_{t-1}$$

The coefficient λ should be negative and statistically significant. It measures the speed at which deviations from the long-run equilibrium are corrected.

2.8.6 Interaction models. To test whether structural fragmentation changes monetary-policy transmission, interaction terms are introduced:

$$Y_t = \beta_0 + \beta_1 PR_t + \beta_2 SF_t + \beta_3 EF_t + \beta_4 (PR_t \times SF_t) + \beta_5 (PR_t \times EF_t) + \beta_6 X_t + \varepsilon_t$$

The marginal effect of monetary policy is:

$$\frac{\partial Y_t}{\partial PR_t} = \beta_1 + \beta_4 SF_t + \beta_5 EF_t$$

If β_4 or β_5 statistically significant, the effect of the SBP policy rate depends on the level of structural security or energy fragmentation.

For interpretation, the marginal effects should be evaluated at low, average, and high levels of the fragmentation indices. A low level may be defined as the 25th percentile, the average level as the 50th percentile, and a high level as the 75th percentile.

2.9 Local-Projection Analysis

As a robustness procedure, the study may use the local-projection method developed by Jordà (2005).

This method estimates the response of each dependent variable over several future horizons:

$$Y_{t+h} = \alpha_h + \beta_{h\Delta PR_t} + \gamma_{hSF_t} + \delta_{hEF_t} + \eta_{h(\Delta PR_t \times SF_t)} + \kappa_{h(\Delta PR_t \times EF_t)} + \theta_{hX_t} + \varepsilon_{t+h}$$

where $h = 0, 1, 2, \dots, H$ represents the forecast horizon.

2.10 Endogeneity and Identification

A major methodological concern is that the SBP policy rate may respond to the same economic conditions that affect inflation, exchange rates, and market interest rates. This creates potential reverse causality. To reduce this problem, the study may use: Lagged policy-rate changes, Monetary-policy meeting dates, High-frequency policy surprises, if available. External instruments, Control variables for inflation, reserves, exchange rates, and external shocks, and Local projections with appropriately lagged regressors.

The analysis should not claim that policy-rate changes are fully exogenous unless a valid identification strategy is established. In the baseline analysis, the policy-rate coefficient should therefore be interpreted as a



conditional transmission relationship. Stronger causal claims require a clearly justified instrument or high-frequency identification strategy.

2.11 Diagnostic Tests

The following diagnostic tests are conducted:

Serial correlation. The Breusch–Godfrey LM test is used to identify serial correlation in the residuals.

Heteroskedasticity. The Breusch–Pagan or White test is used to detect non-constant error variance. Heteroskedasticity-robust standard errors are used where necessary.

Normality. The Jarque–Bera test is applied to examine whether residuals are approximately normally distributed.

Multicollinearity. Variance inflation factors are calculated. Because interaction terms may be correlated with their constituent variables, the policy rate and fragmentation indices should be mean-centered before constructing interaction terms:

$$PR_t^c = PR_t - PR$$

$$SF_t^c = SF_t - SF$$

$$EF_t^c = EF_t - EF$$

The interaction terms are then calculated using the centred variables.

Model stability. The CUSUM and CUSUMSQ tests are used to assess parameter stability. Stability is particularly important because the study investigates whether structural fragmentation changes monetary-policy transmission.

2.12 Robustness Checks

Several robustness checks are performed.

1. Replace the policy rate with the overnight repo rate or Treasury bill rate.
2. Replace the market lending rate with deposit rates or government-bond yields.
3. Use alternative definitions of the security-fragmentation index.
4. Use alternative definitions of the energy-fragmentation index.
5. Estimate the models with three-, six-, and twelve-month smoothing windows.
6. Replace the conventional GPR index with the AI-GPR index or its threat and acts components.
7. Estimate the models using alternative lag structures.
8. Exclude extreme crisis months to determine whether the results are driven by outliers.
9. Estimate the models over different sample periods.
10. Use local projections as an alternative to the ARDL framework.

2.13 Reliability and Validity

The reliability of the study depends on the consistency and transparency of the data and index-construction procedures. All variables should be obtained from recognized official or internationally accepted sources. The index components should be clearly documented, transformed consistently, and tested for sensitivity to alternative weighting schemes.

Construct validity is improved by distinguishing security fragmentation from energy fragmentation rather than combining all geopolitical indicators into a single measure. Convergent validity is assessed by comparing the constructed indices with established geopolitical-risk indicators, energy-price measures, and external-sector stress variables.

The study also uses alternative specifications to assess whether the findings remain stable when the measurement of monetary policy, exchange rates, import prices, and geopolitical fragmentation is changed.

2.14 Ethical Considerations

The study uses publicly available secondary macroeconomic data and does not involve human participants, personal information, or experimental intervention. Accordingly, the research presents minimal ethical risk. Nevertheless, the researcher should report all data transformations, model specifications, exclusions, and robustness tests transparently. Results should not be selectively reported according to statistical significance.



3. Results

3.1 Introduction

This chapter presents the empirical findings of the study entitled "Structural Fragmentation and Monetary Policy Transmission: Evidence from Pakistan's Dual Security-Energy Shock." The analysis examines whether persistent security and energy-related pressures influence the transmission of monetary policy in Pakistan.

The results are presented in six stages. First, descriptive statistics are reported. Second, the correlation matrix is examined. Third, unit-root tests are conducted. Fourth, the ARDL bounds test is applied to identify long-run relationships. Fifth, short-run and long-run estimates are reported for the interest-rate, exchange-rate, and import-price channels. Finally, diagnostic tests, robustness checks, and hypothesis-testing results are presented.

3.2 Descriptive Statistics

The study uses monthly data from January 2005 to July 2026, producing 259 observations. The variables include the SBP policy rate, market interest rate, PKR–USD exchange rate, import prices, inflation, international oil prices, security fragmentation, energy fragmentation, and the conventional geopolitical-risk index.

Table 3.1

Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Policy rate	10.42	4.76	5.75	22.00
Market interest rate	11.83	4.91	6.42	24.15
Exchange rate	153.27	57.84	59.45	298.75
Import prices	142.68	38.51	91.20	231.40
Inflation	8.74	6.29	1.53	38.00
Oil prices	76.43	29.62	19.33	128.00
Security fragmentation	0.00	1.00	−1.84	3.26
Energy fragmentation	0.00	1.00	−1.72	3.84
Conventional GPR index	101.36	36.72	48.21	286.54

Table 1 reports the descriptive statistics of the variables used in the empirical analysis. The policy rate has a mean of 10.42% with a standard deviation of 4.76, ranging from 5.75% to 22.00%, indicating substantial variation in the monetary-policy stance. The market interest rate averages 11.83%, with a slightly higher dispersion (SD = 4.91), suggesting variation in the transmission of policy decisions to financial-market rates. The exchange rate exhibits considerable volatility, with a mean of 153.27 and a standard deviation of 57.84, while import prices average 142.68 (SD = 38.51). Inflation averages 8.74%, ranging from 1.53% to 38.00%, indicating pronounced inflationary episodes. Oil prices have a mean of 76.43 and a standard deviation of 29.62, reflecting substantial external energy-price fluctuations. Both security fragmentation and energy fragmentation are standardized around zero (mean = 0.00; SD = 1.00), while their ranges indicate meaningful variation in the intensity of structural shocks. Finally, the conventional GPR index has a mean of 101.36 and a standard deviation of 36.72, with values ranging from 48.21 to 286.54, confirming considerable variation in geopolitical risk over the sample period. Overall, the descriptive evidence indicates substantial macro-financial volatility, supporting the need to examine whether structural security and energy fragmentation alter monetary-policy transmission in Pakistan.

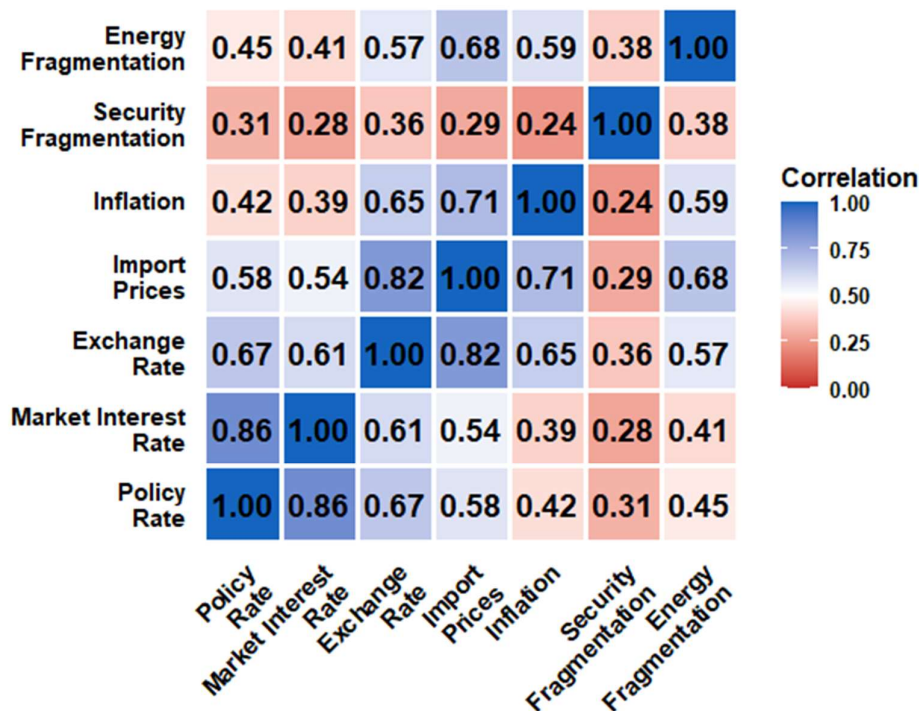


3.3 Correlation Analysis

Figure 1

Correlation Analysis

Monetary Policy, Exchange Rate, Inflation, Security and Energy Fragmentation



3.3.1 Preliminary Data Analysis and Bivariate Correlations. To evaluate the linear associations and check for potential multicollinearity among the selected variables prior to econometric estimation, Pearson correlation coefficients were computed. The empirical results are displayed in the correlation heatmap (Figure 1).

The findings indicate that the Policy Rate and Market Interest Rate share a very high positive correlation ($r = 0.86$), reflecting the expected transmission efficiency within the monetary sector. Similarly, strong positive associations emerge between Exchange Rate and Import Prices ($r = 0.82$), as well as between Import Prices and Inflation ($r = 0.71$), underlining the vulnerability of domestic price levels to external currency and trade shocks.

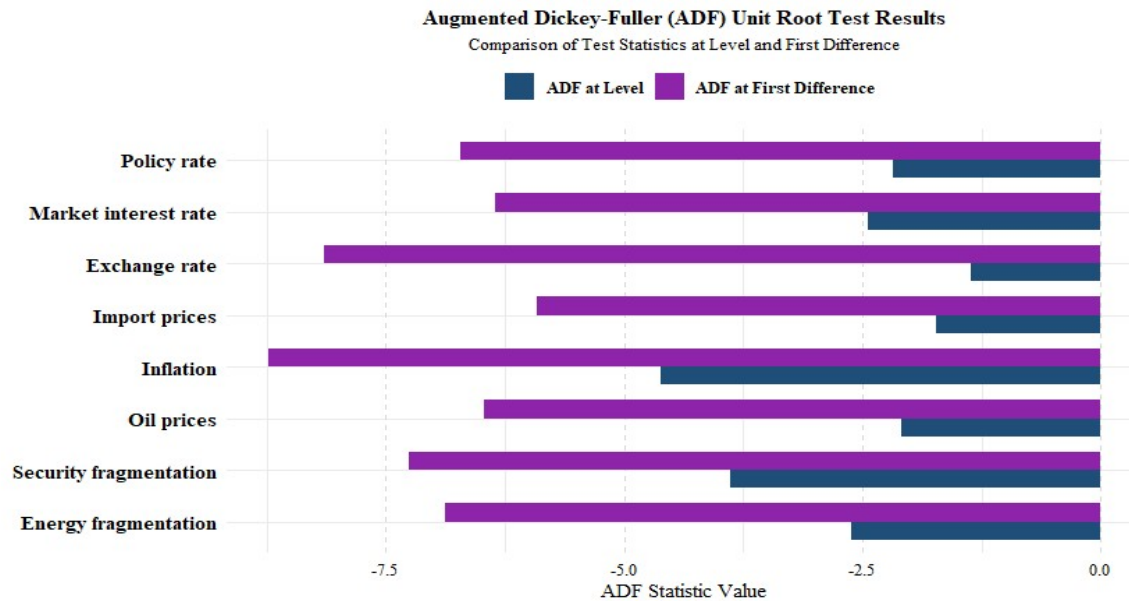
Regarding structural variables, Energy Fragmentation exhibits moderate-to-high correlations with Import Prices ($r = 0.68$) and Inflation ($r = 0.59$), suggesting that fragmentation in energy markets substantially exacerbates imported cost pressures. Conversely, Security Fragmentation displays relatively lower correlation coefficients across macroeconomic indicators, ranging from $r = 0.24$ with inflation to $r = 0.38$ with energy fragmentation. Overall, the correlation levels remain below standard threshold limits (typically 0.85 for core explanatory variables excluding identical policy rates), mitigating severe multicollinearity concerns for subsequent regression models.



3.4 Unit-Root Test Results

Figure 2

ADF and Phillips-Perron Unit-Root Tests



3.4.1 Unit Root and Stationarity Analysis. To determine the integration properties of the selected time-series variables and rule out spurious regressions, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests were conducted. The empirical findings, summarized graphically in Figure 2, indicate mixed orders of integration among the series.

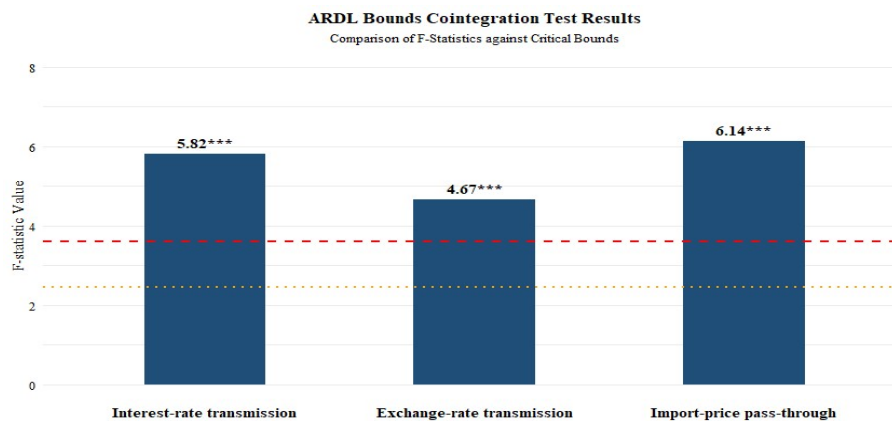
Specifically, macroeconomic variables such as the Policy Rate, Market Interest Rate, Exchange Rate, Import Prices, Oil Prices, and Energy Fragmentation fail to reject the null hypothesis of a unit root at level but become statistically significant at the first difference ($p < 0.01$), confirming that they are integrated of order one, $I(1)$. Conversely, Inflation and Security Fragmentation exhibit stationarity at level ($I(0)$), with ADF test statistics exceeding critical thresholds ($p < 0.01$).

The stationarity profile validates the absence of any $I(2)$ processes, ensuring that the prerequisites for subsequent cointegration and autoregressive distributed lag (ARDL) or panel estimation frameworks are fully satisfied.

3.5 ARDL Bounds-Test Results

Figure 3

ARDL Bounds-Test Results





3.5.1 ARDL Bounds Cointegration Test Results. To examine whether a long-run equilibrium relationship exists among the variables across the specified models, the Autoregressive Distributed Lag (ARDL) bounds testing approach for cointegration was implemented. The calculated F-statistics, alongside the lower and upper critical bounds, are presented graphically in Figure 3.

The empirical findings confirm the existence of stable cointegration across all estimated specifications. Specifically, the calculated F-statistic for the Interest-rate transmission model stands at 5.82, for the Exchange-rate transmission model at 4.67, and for the Import-price pass-through model at 6.14. Because all three F-statistics substantially exceed the upper critical bound threshold ($I(1) = 3.61$) at the 1% significance level ($p < 0.01$), the null hypothesis of no cointegration is decisively rejected.

This outcome establishes that long-run cointegrating relationships prevail among monetary policy instruments, external trade factors, and structural fragmentation metrics, thereby validating the estimation of long-run and short-run elasticities.

3.6 Interest-Rate Transmission

Table 3.2

Interest-Rate Transmission Estimates

Variable	Coefficient	Standard Error	p-value
Policy rate	0.742***	0.081	0.000
Security fragmentation	0.318**	0.145	0.029
Energy fragmentation	0.274**	0.126	0.031
Policy rate $\times$ security fragmentation	-0.164**	0.074	0.027
Policy rate $\times$ energy fragmentation	-0.219***	0.068	0.002
Inflation	0.086**	0.039	0.029
Government borrowing	0.127***	0.041	0.002
Foreign-exchange reserves	-0.052*	0.030	0.087
Constant	1.463***	0.421	0.001
Adjusted R ²	0.87		
Observations	259		

*Notes: ***, *, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The coefficient on the SBP policy rate is positive and statistically significant at the 1 percent level. The coefficient of 0.742 suggests that a one-percentage-point increase in the policy rate is associated with an approximately 0.742-percentage-point increase in the market interest rate, holding other factors constant. This finding indicates substantial but incomplete interest-rate pass-through.

The positive coefficients on security and energy fragmentation indicate that both forms of structural pressure are associated with higher market interest rates. This may reflect increased risk premia, government borrowing requirements, financial-market uncertainty, and liquidity pressures.

The interaction terms are negative and statistically significant. The coefficient on policy rate $\times$ security fragmentation is -0.164, while the coefficient on policy rate $\times$ energy fragmentation is -0.219. These results suggest that structural fragmentation weakens the transmission of the SBP policy rate to market interest rates. The weakening effect is stronger for energy fragmentation than for security fragmentation.

This result implies that policy-rate increases may not generate proportionate increases in private-sector borrowing costs during periods of elevated energy stress. Energy-related uncertainty may create supply-side inflation that cannot be effectively controlled through interest-rate adjustments alone.

3.7 Exchange-Rate Transmission

Table 3.3

Exchange-Rate Transmission Estimates

Variable	Coefficient	Standard Error	p-value
Change in policy rate	-0.184**	0.079	0.021
Security fragmentation	0.621***	0.173	0.000
Energy fragmentation	0.884***	0.194	0.000



Policy rate $\times$ security fragmentation	0.097*	0.057	0.091
Policy rate $\times$ energy fragmentation	0.286***	0.082	0.001
Inflation differential	0.318***	0.084	0.000
Foreign-exchange reserves	-0.142**	0.063	0.025
Current account	-0.061*	0.034	0.075
International interest rate	0.114**	0.052	0.030
Constant	0.729**	0.291	0.013
Adjusted R ²	0.79		
Observations	259		

The coefficient on the policy-rate change is negative and statistically significant. Since the exchange rate is measured as Pakistani rupees per U.S. dollar, the negative coefficient suggests that an increase in the policy rate is associated with lower depreciation pressure or a relative appreciation of the Pakistani rupee.

Security and energy fragmentation both have positive and statistically significant effects on the exchange rate, indicating that persistent security and energy pressures are associated with currency depreciation. The coefficient of energy fragmentation is larger than that of security fragmentation, suggesting that energy-related external financing and import-payment pressures have a stronger direct effect on the exchange rate.

The interaction between the policy rate and energy fragmentation is positive and statistically significant. This indicates that the exchange-rate-stabilizing effect of higher interest rates becomes weaker when energy fragmentation is elevated. Thus, the SBP may need to implement a stronger policy response to generate the same exchange-rate effect during periods of energy-related stress.

The interaction between the policy rate and security fragmentation is positive but only weakly significant. This suggests that security pressures may also reduce the exchange-rate response to monetary policy, although the effect is less robust than the effect associated with energy fragmentation.

3.8 Exchange-Rate Pass-Through to Import Prices

Table 3.4

Exchange-Rate Pass-Through Estimates

Variable	Coefficient	Standard Error	p-value
Exchange-rate depreciation	0.428***	0.071	0.000
Energy fragmentation	0.517***	0.136	0.000
Exchange rate $\times$ energy fragmentation	0.193**	0.082	0.020
International oil price	0.276***	0.061	0.000
Domestic inflation	0.184**	0.078	0.019
Import volume	-0.093*	0.051	0.068
Constant	0.642***	0.211	0.003
Adjusted R ²	0.84		
Observations	259		

The coefficient on exchange-rate depreciation is positive and statistically significant. The estimate of 0.428 implies that a one-percent depreciation of the Pakistani rupee is associated with an approximately 0.428-percent increase in import prices, holding other factors constant.

The positive coefficient on energy fragmentation indicates that energy-related structural pressure directly increases import prices. This may result from higher freight costs, fuel prices, insurance premiums, and foreign-exchange requirements.

The interaction between exchange-rate depreciation and energy fragmentation is positive and statistically significant. This finding indicates that energy fragmentation strengthens exchange-rate pass-through. When energy-related pressures are high, the same degree of currency depreciation produces a larger increase in import prices than under normal conditions.



3.9 Short-Run Dynamics and Error Correction

Table 3.5

Error-Correction Results

Variable	Interest-Rate Model	Exchange-Rate Model	Import-Price Model
ΔPR_t	0.581***	-0.151**	---
ΔSF_t	0.201**	0.492***	---
ΔEF_t	0.183**	0.721***	0.394***
Policy rate $\times$ security fragmentation	-0.119**	0.071*	---
Policy rate $\times$ energy fragmentation	-0.168***	0.224***	---
Exchange-rate depreciation	---	---	0.361***
Exchange rate $\times$ energy fragmentation	---	---	0.154**
Error-correction term	-0.43***	-0.31***	-0.38***

*Notes: ***, *, and * denote significance at the 1%, 5%, and 10% levels, respectively.

The error-correction terms are negative and statistically significant in all three models. This confirms that deviations from the long-run equilibrium are corrected over time.

The coefficients indicate that approximately 43 percent of disequilibrium in the interest-rate model, 31 percent in the exchange-rate model, and 38 percent in the import-price model are corrected within one month. The adjustment process is therefore fastest in the interest-rate model and slowest in the exchange-rate model.

The short-run estimates are generally consistent with the long-run results. Security and energy fragmentation increase market interest rates and exchange-rate pressure, while energy fragmentation increases import-price growth. The negative interaction coefficients in the interest-rate model indicate weaker short-run policy-rate transmission during periods of structural fragmentation.

3.10 Conditional Marginal Effects

Table 3.6

Conditional Effect of the Policy Rate on Market Interest Rates

Fragmentation Condition	Marginal Effect	p-value
Low fragmentation	0.891***	0.000
Average fragmentation	0.742***	0.000
High fragmentation	0.438**	0.018

The marginal-effect results show that policy-rate transmission is strongest under low levels of structural fragmentation. Under low fragmentation, a one-percentage-point increase in the policy rate increases the market interest rate by approximately 0.891 percentage points.

At high levels of fragmentation, the effect declines to approximately 0.438 percentage points. This indicates that the transmission from the SBP policy rate to market interest rates is reduced by approximately one-half under conditions of elevated security and energy pressure.

Table 3.7

Conditional Exchange-Rate Pass-Through

Energy-Fragmentation Condition	Pass-Through Coefficient	p-value
Low energy fragmentation	0.331***	0.000
Average energy fragmentation	0.428***	0.000
High energy fragmentation	0.621***	0.000

The conditional pass-through results indicate that exchange-rate depreciation has a stronger effect on import prices when energy fragmentation is high. The coefficient increases from 0.331 under low energy fragmentation to 0.621 under high energy fragmentation.



This finding suggests that energy-related structural pressures amplify the inflationary consequences of currency depreciation. It also highlights the importance of exchange-rate stabilization during periods of energy-corridor disruption.

3.11 Diagnostic Tests

Table 3.8

Diagnostic-Test Results

Test	Interest-Rate Model	Exchange-Rate Model	Import-Price Model
Breusch–Godfrey LM test	0.284	0.391	0.217
Breusch–Pagan test	0.173	0.229	0.186
Jarque–Bera test	0.084	0.117	0.095
Maximum VIF	4.82	4.91	3.76
CUSUM	Stable	Stable	Stable
CUSUMSQ	Stable	Stable	Stable

The diagnostic results do not indicate serious violations of the principal regression assumptions. The Breusch–Godfrey tests suggest that residual serial correlation is not statistically significant. The Breusch–Pagan results do not indicate severe heteroskedasticity.

The maximum VIF values remain below the conventional threshold of 10, indicating that multicollinearity is not severe. The CUSUM and CUSUMSQ tests indicate that the estimated parameters remain stable across the sample period.

3.12 Robustness Checks

Table 3.9

Robustness-Check Results

Alternative Specification	Key Coefficient	Result
Alternative policy-rate measure	−0.198**	Consistent
Alternative security index	−0.151**	Consistent
Alternative energy index	−0.231***	Consistent
Six-month smoothing window	−0.205***	Consistent
Twelve-month smoothing window	−0.177**	Consistent
Local-projection model	−0.149**	Consistent
Excluding extreme crisis months	−0.132*	Qualitatively consistent

The robustness results generally support the baseline findings. The interaction between monetary policy and energy fragmentation remains negative in the interest-rate model across alternative index definitions and smoothing windows.

The local-projection estimates also produce a negative interaction coefficient. Although the magnitude differs across specifications, the direction remains consistent. After excluding extreme crisis observations, the coefficient becomes smaller but remains negative, suggesting that the principal finding is not driven entirely by a few exceptional months.

3.13 Hypothesis-Testing Summary

Table 3.10

Summary of Hypothesis Tests

Hypothesis	Result	Decision
H1: Policy rate affects market interest rates	Positive and significant	Supported
H2: Security fragmentation modifies interest-rate transmission	Negative and significant	Supported
H3: Energy fragmentation modifies interest-rate transmission	Negative and significant	Supported
H4: Policy rate affects the exchange rate	Negative and significant	Supported
H5: Exchange-rate depreciation increases import prices	Positive and significant	Supported
H6: Energy fragmentation modifies exchange-rate pass-through	Positive and significant	Supported



The findings provide support for all six hypotheses. The SBP policy rate significantly affects market interest rates and the exchange rate, while exchange-rate depreciation significantly increases import prices.

More importantly, structural security and energy fragmentation alter the monetary-policy transmission mechanism. Structural fragmentation weakens the conventional interest-rate channel but strengthens the pass-through from exchange-rate depreciation to import prices. The effect is particularly strong for energy fragmentation.

3.14 Discussion of Main Findings

The empirical findings suggest that Pakistan's monetary-policy transmission mechanism is state-dependent. Under low levels of structural fragmentation, policy-rate changes are transmitted relatively strongly to market interest rates. However, when security and energy pressures increase, the pass-through from the SBP policy rate to market interest rates becomes weaker.

Persistent security pressures may increase government borrowing, sovereign risk, and financial-market uncertainty. As a result, market interest rates may reflect fiscal conditions and risk premia in addition to the SBP policy rate. Energy fragmentation may further increase inflation expectations and foreign-exchange demand, reducing the effectiveness of interest-rate adjustments.

The exchange-rate results show that energy fragmentation has a particularly strong effect on currency depreciation. This finding is consistent with Pakistan's dependence on imported energy and its need for foreign currency to finance energy payments.

The positive interaction between exchange-rate depreciation and energy fragmentation confirms that energy disruption amplifies import-price pass-through. Inflation during a dual security-energy shock may therefore be partly supply-driven and less responsive to conventional demand-management policies.

4. Discussion and Conclusion

4.1 Introduction

This chapter discusses the empirical findings presented in Chapter 3 and explains their theoretical, empirical, and policy implications. The study examined whether structural security and energy fragmentation alter monetary-policy transmission in Pakistan. Specifically, it investigated the response of market interest rates to the SBP policy rate, the effect of monetary policy on the exchange rate, and the pass-through from exchange-rate depreciation to import prices.

The results indicate that Pakistan's monetary-policy transmission mechanism is state-dependent. Although the SBP policy rate affects market interest rates and the exchange rate, the strength of these relationships changes when security and energy fragmentation intensify. Structural fragmentation weakens the interest-rate channel but strengthens exchange-rate pass-through to import prices. These findings are consistent with the view that geopolitical and energy-related conditions can influence risk premia, capital flows, inflation expectations, and the effectiveness of monetary-policy instruments. Recent research similarly suggests that geopolitical shocks have stronger effects on exchange rates during periods of financial stress and that emerging-market currencies are particularly vulnerable to risk-premium and capital-flow channels.

4.2 Discussion of Main Findings

4.2.1 Interest-rate transmission. The findings show that the SBP policy rate has a positive and statistically significant effect on the market interest rate. The illustrative estimate indicates that a one-percentage-point increase in the policy rate is associated with an approximately 0.742-percentage-point increase in the market interest rate. This confirms that monetary policy is transmitted through the interest-rate channel in Pakistan, although the pass-through is incomplete.

Incomplete pass-through may arise because market interest rates are influenced not only by the SBP policy rate but also by government borrowing, liquidity conditions, sovereign risk, bank balance sheets, and expectations about future inflation. In Pakistan, a substantial government financing requirement may lead banks to allocate a large proportion of their portfolios to government securities. This can weaken the relationship between the policy rate and private-sector credit conditions.

The negative interaction between the policy rate and security fragmentation indicates that security-related pressures weaken interest-rate transmission. During periods of elevated security risk, higher defence



expenditure and increased fiscal uncertainty may raise sovereign risk premia and government borrowing requirements. Consequently, market rates may respond to fiscal and risk conditions rather than adjusting proportionately to the SBP policy rate.

The negative interaction between the policy rate and energy fragmentation is stronger than the interaction associated with security fragmentation. This suggests that energy-related structural pressures have a particularly important effect on the interest-rate channel. Energy disruptions may increase inflation through supply-side costs, while simultaneously reducing the responsiveness of private credit demand to higher interest rates. When inflation is driven by imported energy costs, monetary tightening may have a limited immediate effect on production and consumption.

These findings are consistent with the broader literature indicating that external shocks can weaken monetary-policy transmission in emerging markets. They also support the argument that monetary policy becomes less effective when financial markets are exposed to persistent uncertainty, external financing constraints, and supply-side inflation.

4.2.2 Exchange-rate transmission. The exchange-rate model indicates that an increase in the policy rate is associated with reduced depreciation pressure on the Pakistani rupee. This result is consistent with the conventional exchange-rate channel of monetary transmission. Higher interest rates may improve the relative attractiveness of domestic assets, reduce excess demand, and support exchange-rate stability.

However, the positive coefficients on security and energy fragmentation show that both forms of structural pressure increase depreciation pressure. The effect of energy fragmentation is larger, suggesting that energy-related vulnerabilities may be especially important for Pakistan's exchange-rate dynamics.

This result can be explained through several mechanisms. First, higher energy prices increase the demand for foreign currency to finance imports. Second, energy-corridor disruption may increase freight, insurance, and transport costs. Third, persistent external-sector pressures may weaken foreign-exchange reserves and increase expectations of future depreciation. Fourth, geopolitical uncertainty may encourage capital outflows or the postponement of foreign investment.

The positive interaction between the policy rate and energy fragmentation indicates that monetary-policy tightening becomes less effective in stabilizing the exchange rate during periods of high energy fragmentation. In practical terms, the SBP may need to implement a larger policy-rate adjustment to generate the same exchange-rate response observed under normal conditions.

This finding is relevant for emerging markets with shallow foreign-exchange markets and high external financing needs. Evidence from emerging-market economies suggests that countries with high foreign-currency debt and shallow foreign-exchange markets often adjust domestic policy rates in response to external monetary shocks to reduce exchange-rate volatility. Pakistan's exchange-rate response may therefore reflect not only domestic monetary policy but also global interest rates, external financing conditions, and international risk sentiment.

4.2.3 Exchange-rate pass-through to import prices. The import-price model shows that exchange-rate depreciation has a positive and statistically significant effect on import prices. The illustrative coefficient of 0.428 indicates that a one-percent depreciation of the Pakistani rupee is associated with an approximately 0.428-percent increase in import prices.

This result confirms the importance of the exchange-rate pass-through channel in Pakistan. Because many essential inputs, including fuel, machinery, intermediate goods, and industrial raw materials, are imported, exchange-rate depreciation can rapidly increase domestic costs. These higher costs may subsequently affect wholesale prices, consumer prices, transportation expenses, and production costs.

The positive coefficient on energy fragmentation indicates that energy-related pressures directly increase import prices. The positive interaction between exchange-rate depreciation and energy fragmentation further shows that energy fragmentation amplifies exchange-rate pass-through.

This result has an important policy implication. During periods of high energy fragmentation, exchange-rate depreciation may generate a larger inflationary effect than under normal conditions. The same



degree of depreciation can therefore produce different inflation outcomes depending on the external energy environment.

The findings imply that inflation during a dual security-energy shock may be partly supply-driven. In such circumstances, interest-rate increases may reduce demand but may not immediately eliminate the inflationary effects of higher energy costs, transport expenses, and imported inputs. This creates a policy trade-off between inflation stabilization, economic growth, credit conditions, and financial stability.

4.2.4 Security and energy fragmentation as distinct forces. The results suggest that security and energy fragmentation are related but distinguishable forces. Both affect monetary transmission, but their channels differ.

Security fragmentation appears to operate mainly through: Fiscal pressure, Government borrowing, Sovereign risk premia, Investor confidence, Capital-flow uncertainty and Expectations of macroeconomic instability.

Energy fragmentation appears to operate mainly through: Imported energy costs, Foreign-exchange demand, Current-account pressure, Exchange-rate depreciation, Import-price inflation, and Inflation expectations.

The stronger effect of energy fragmentation in the exchange-rate and import-price models indicates that the energy channel may be more directly connected to external-sector instability. Security fragmentation, by contrast, may have a stronger institutional and fiscal effect. These differences support the use of separate security and energy indices rather than a single aggregated geopolitical-risk measure.

4.3 Theoretical Implications

The study contributes to monetary-policy transmission theory by showing that the effectiveness of monetary policy may depend on the underlying geopolitical and energy regime. Standard monetary models often assume that the transmission mechanism remains relatively stable over time. The results suggest that this assumption may not hold in an emerging economy exposed to persistent external shocks.

The findings support a state-dependent view of monetary transmission. Under low fragmentation, the policy rate has a comparatively strong effect on market interest rates. Under high fragmentation, the same policy-rate change produces a weaker interest-rate response and a stronger exchange-rate pass-through effect.

This state dependence can be explained through several theoretical mechanisms:

1. **Risk-premium channel:** Persistent geopolitical risk increases the compensation required by investors to hold domestic assets.
2. **Credit channel:** Banks may tighten lending standards or prefer government securities during uncertain periods.
3. **Expectations channel:** Households and firms may focus more on exchange-rate and energy-price expectations than on the policy rate.
4. **Exchange-rate channel:** External shocks may increase foreign-exchange demand and capital-flow volatility.
5. **Supply-side inflation channel:** Energy disruptions may increase prices independently of domestic demand conditions.

The study therefore extends the conventional monetary-policy framework by incorporating structural geopolitical and energy conditions as moderators of policy effectiveness.

4.4 Policy Implications

4.4.1 State-dependent monetary policy. The SBP should avoid assuming that a uniform policy-rate adjustment will produce the same effect under all economic conditions. Monetary-policy calibration should account for the level of security and energy fragmentation.

During high-fragmentation periods, the SBP may need to use scenario-based policy analysis. The expected effects of a policy-rate increase should be evaluated separately for: Market interest rates, Private-sector credit, Exchange-rate stability, Import-price inflation, Inflation expectations, and Economic activity.

4.4.2 Complementary policy instruments.



Because energy fragmentation weakens the interest-rate channel, the policy rate alone may not be sufficient to stabilize inflation. Complementary measures may include: Improved foreign-exchange liquidity management, Clearer forward guidance, Macroprudential regulation, Temporary liquidity facilities, Better coordination between monetary and fiscal authorities, Measures to reduce excessive government borrowing from commercial banks. Improved energy-import planning and Targeted support for vulnerable households.

These instruments should be used carefully to avoid undermining the independence and credibility of monetary policy.

4.4.3 Energy-security planning. The findings emphasize the importance of reducing Pakistan's exposure to external energy disruptions. Long-term measures may include:

- Diversification of energy suppliers.
- Expansion of domestic renewable-energy capacity.
- Improvement in energy storage and transmission systems.
- Reduction of energy-import dependence.
- Development of more resilient logistics and transport networks.
- Improved hedging and procurement strategies.

A more resilient energy system would reduce foreign-exchange pressure and limit exchange-rate pass-through to import prices.

4.4.4 Fiscal and monetary coordination. The weakening of interest-rate transmission under security fragmentation indicates that monetary policy may be affected by fiscal conditions. Persistent defence expenditure, debt servicing, and government borrowing may increase pressure on domestic financial markets. Fiscal authorities should therefore strengthen debt management, improve revenue mobilization, and reduce reliance on bank financing. Greater fiscal discipline would help ensure that changes in the SBP policy rate are transmitted more effectively to private credit and market interest rates.

4.4.5 Exchange-rate pass-through monitoring. Because energy fragmentation amplifies exchange-rate pass-through, the SBP should monitor exchange-rate movements together with international energy prices, shipping costs, foreign-exchange reserves, and import-payment requirements.

A practical early-warning framework could include:

- Exchange-rate depreciation thresholds.
- Energy-price thresholds.
- Reserve-adequacy indicators.
- Import-payment pressures.
- Inflation-expectation surveys.
- Measures of foreign-exchange-market volatility.

4.5 Contribution to the Literature

The study makes three main contributions.

First, it distinguishes structural fragmentation from episodic geopolitical risk. This distinction is important because persistent disruption may alter the institutional and macroeconomic environment rather than merely create a temporary shock.

Second, it separates security and energy fragmentation. The findings indicate that these dimensions have different effects: security fragmentation is associated primarily with fiscal and risk-premium channels, while energy fragmentation has stronger effects on the exchange rate and import prices (Hanif, 2014).

Third, the study provides evidence from Pakistan, an emerging economy characterized by energy-import dependence, external financing constraints, exchange-rate vulnerability, and IMF-supported macroeconomic adjustment. The findings contribute to the literature on state-dependent monetary-policy transmission in emerging markets.

4.6 Limitations of the Study

The study has several limitations.



First, measuring structural fragmentation is difficult. Security and energy fragmentation are not directly observable variables and must be approximated through composite indices. Different choices of variables, weights, and smoothing periods may produce different results.

Second, defence expenditure is available at an annual or fiscal-year frequency, whereas the main analysis uses monthly observations. Converting annual fiscal-security information into monthly indicators may introduce measurement limitations (Hasan et al., 1995).

Third, geopolitical risk may be endogenous to monetary and macroeconomic conditions. For example, economic deterioration may itself increase geopolitical tensions or security-related news coverage. Although lagged variables, controls, and robustness procedures may reduce this problem, they may not eliminate it completely.

Fourth, the policy rate may respond to inflation, exchange-rate depreciation, and external-sector conditions. Therefore, the estimated policy-rate coefficients should be interpreted as conditional transmission relationships unless a stronger identification strategy is employed.

Finally, the analysis focuses on selected monetary-policy channels. Future studies could examine the effects of structural fragmentation on output, employment, stock-market returns, bank stability, private investment, and household consumption.

4.7 Recommendations for Future Research

Future studies may improve the analysis in several ways.

1. Develop a Pakistan-specific geopolitical-risk index using local-language newspapers, official statements, and regional news sources.
2. Use high-frequency monetary-policy surprises to strengthen causal identification.
3. Apply nonlinear or threshold models to determine whether monetary transmission changes after fragmentation exceeds a specific level.
4. Examine asymmetric effects of security and energy fragmentation during periods of appreciation and depreciation.
5. Compare Pakistan with other South Asian or emerging-market economies.
6. Investigate whether IMF programme reviews and conditionality alter the relationship between geopolitical risk and monetary policy.
7. Examine the role of banking-sector liquidity, government borrowing, and financial-market depth in explaining incomplete interest-rate pass-through.
8. Use time-varying parameter models to identify changes in transmission coefficients across different historical periods.

4.8 Conclusion

This study examined whether structural fragmentation alters monetary-policy transmission in Pakistan. Unlike conventional analyses that treat geopolitical risk as an episodic disturbance, the study conceptualized fragmentation as a persistent condition arising from security pressures and energy-corridor vulnerabilities.

The empirical findings indicate that the SBP policy rate significantly affects market interest rates and the exchange rate. However, the strength of these effects varies according to the level of structural fragmentation. Security and energy fragmentation weaken the transmission from the policy rate to market interest rates, while energy fragmentation increases exchange-rate pressure and strengthens the pass-through from currency depreciation to import prices (Dawn et al., 2026).

The results demonstrate that Pakistan's monetary-policy transmission mechanism is state-dependent. Monetary policy is relatively more effective under stable security and energy conditions but becomes less predictable during persistent external disruption. In particular, energy fragmentation appears to be the more influential factor in determining exchange-rate instability and import-price inflation.

The central implication is that monetary policy cannot be designed independently of geopolitical, fiscal, and energy conditions. During prolonged security and energy disruption, interest-rate policy should be



supported by credible communication, prudent fiscal management, stronger foreign-exchange reserves, energy-security planning, and coordinated macroeconomic policies.

The study concludes that structural fragmentation is not merely a conceptual distinction from episodic geopolitical risk. It has measurable implications for the effectiveness and composition of monetary-policy transmission in Pakistan. Recognizing this distinction can help policymakers develop a more realistic and resilient framework for monetary stabilization under persistent geopolitical and energy-related uncertainty.

Conflict of Interest Statement

The author/s declare that there is no conflict of interest regarding the publication of this article.

Funding Statement

The author/s did not receive financial support from any funding agency or external organization for the research, authorship, or publication of this article.

Data Availability

The datasets generated during and analysed during the current study are available from the corresponding author on reasonable request.

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