



The Nexus Between National Security Risks and Financial Market Stability: Evidence from Emerging Economies

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ABSTRACT

Financial market stability in emerging economies is increasingly threatened by the rising complexity of national security risks. While economic indicators have long been studied as drivers of market behavior, recent global trends highlight the growing influence of political and digital threats on financial volatility. Among these, geopolitical tensions, terrorism, and cybersecurity breaches pose distinct and interconnected challenges to investor confidence and economic performance. Despite a growing body of research, the comparative impact of multiple security risks on market volatility remains underexplored, particularly in the context of structurally vulnerable emerging markets. Here we show that geopolitical risk is the most consistent and statistically significant driver of financial market volatility, while terrorism and cybersecurity incidents exert more episodic and context-specific effects.

These findings are derived from panel regression models using data from 2013 to 2024 across emerging economies, supported by robustness checks and visual analyses. Unlike previous studies that focus on isolated threats, our results reveal that macroeconomic fundamental—especially GDP growth and FDI inflows—serve as important stabilizing forces, mitigating the disruptive effects of security risks. By integrating multiple dimensions of national security threats into a unified empirical framework, this study offers a clearer understanding of how political and digital instability affects financial systems. The results hold practical value for policymakers and investors seeking to develop resilient strategies in increasingly uncertain global environments.

Keywords: Geopolitical uncertainty, cybersecurity threats, market volatility index (VIX), foreign direct investment (FDI), panel data analysis.



1 INTRODUCTION

Emerging economies are highly exposed to fluctuations in financial market stability due to their structural vulnerabilities, limited investor protections, and dependence on external capital flows. Over the past decade, the growing complexity of global threats—ranging from political unrest to cyber disruptions—has introduced new challenges to market performance and risk assessment in these regions [1]. Volatility in financial markets can undermine development, weaken investor confidence, and amplify macroeconomic instability [2].

Among the most impactful non-economic threats to financial markets are Geopolitical Risk (GPR), Terrorism, and Cybersecurity Incidents [3], [4]. These threats, while distinct in nature, share a common feature: they generate uncertainty that markets are ill-equipped to price efficiently, especially in emerging economies [5].

Geopolitical Risk refers to uncertainty stemming from political conflicts, international disputes, wars, trade confrontations, and diplomatic breakdowns [6]. It is commonly quantified using the Geopolitical Risk Index (GPR Index) developed by [7], which tracks the frequency and intensity of geopolitical events reported in major news outlets. High GPR levels signal instability that can disrupt investment planning, currency valuation, and cross-border capital mobility.

Terrorism, on the other hand, involves the use or threat of violence by non-state actors for political ends. These incidents can trigger immediate market reactions such as sell-offs, capital flight, or sector-specific shocks (e.g., tourism, transport, finance) [8]. Terrorism risk is typically captured using binary indicators or event datasets such as the Global Terrorism Database (GTD). Unlike geopolitical risk, terrorism often induces localized but abrupt shocks that may escalate investor fear and promote short-term herding behavior [9].

Cybersecurity Risk is an emerging category of systemic threat that involves malicious digital activities such as data breaches, ransomware, and attacks on financial infrastructure [10]. These threats can severely impair financial operations, lead to temporary or permanent loss of trust, and cause systemic disruptions—particularly in banking systems and capital markets. Binary event coding based on documented cyber incidents or databases like UpGuard and CSIS is used to identify the occurrence of such events [11].

Each of these risks interacts differently with financial systems. While geopolitical tensions tend to affect macro-level risk perception and global investment patterns, terrorism and cyber threats often operate through behavioral channels, influencing investor sentiment, media narratives, and market microstructure [12], [13], [14].

Emerging markets are especially exposed due to:

- Limited cyber infrastructure and response capacity, making them more susceptible to digital attacks.
- Geographic proximity to conflict zones or politically unstable regions [15], [16].
- Heavy reliance on foreign investment, which is highly sensitive to security-related uncertainty [16].
- Lower market depth, which amplifies volatility during external shocks [17].

Despite these vulnerabilities, there remains limited empirical analysis that examines these threats side-by-side in a unified framework to assess their comparative and cumulative effects on financial stability.

While prior researches [18], [19], [20], [21], [22] have explored the effects of individual risk types—especially geopolitical conflicts—on financial markets, while individual security risks such as geopolitical tensions, terrorism, and cyber threats have been studied in isolation, few studies have systematically analyzed their simultaneous and comparative impacts on market volatility. This fragmented approach overlooks potential interaction effects and overlapping investor responses, which are crucial for developing comprehensive risk models. Moreover, emerging markets—characterized by higher vulnerability to external shocks and weaker institutional buffers—are disproportionately exposed to these threats but remain underrepresented in integrative empirical research. The lack of such studies limits our ability to understand how markets internalize multi-dimensional security risks, especially in settings where capital sensitivity, political instability, and digital insecurity converge. This study addresses this gap by offering a unified analytical framework that not only quantifies the individual and combined effects of GPR, terrorism, and cybersecurity incidents but also examines how macroeconomic fundamentals moderate these impacts. In doing so, it contributes to both academic theory on risk transmission and to practical models for crisis management and investment decision-making in high-risk regions.

Understanding the complex relationship between security risks and market behavior is crucial for investors, policymakers, and institutions operating in volatile environments. Without a multidimensional framework, existing financial models may underestimate or misrepresent systemic vulnerabilities in emerging markets, leading to poor policy design and risky investment decisions.

This study provides robust evidence that geopolitical risk is the most consistent and statistically significant driver of financial market volatility among the national security threats considered. In contrast, terrorism and cybersecurity incidents have more episodic and weaker effects. Furthermore, macroeconomic fundamentals such as GDP growth and FDI inflows consistently reduce volatility, acting as buffers against security shocks.

Using a panel dataset from 2013 to 2024 across emerging economies, the analysis includes correlation diagnostics, panel regressions, robustness checks, and marginal effects visualizations. Results show that the Geopolitical Risk Index significantly increases VIX, while economic strength—measured by GDP growth and FDI inflows—mitigates market turbulence. Terrorism and cybersecurity threats, though relevant, exhibit inconsistent effects unless observed under specific market contexts.

By integrating multiple dimensions of national security risk into a unified analytical model, this study provides an actionable framework for risk-sensitive investment strategies and evidence-based policy interventions. The findings are particularly timely as emerging economies face increasing exposure to political and digital instability in a rapidly evolving global landscape.

2 LITERATURE REVIEW

The relationship between national security risks and financial market stability has increasingly become a focal point in academic research, particularly within emerging economies. These economies often grapple with fragile institutional structures, political uncertainties, and higher vulnerability to external shocks. Recent global developments, such as rising geopolitical conflicts, recurrent terrorist attacks, and escalating cybersecurity threats, have illustrated the intricate interplay between security risks and financial markets. These risks not only contribute to market volatility and investor uncertainty but also disrupt capital flows, hinder economic development, and undermine investor confidence. This literature review consolidates and synthesizes current research to provide a comprehensive understanding of how various national security risks impact financial markets in emerging economies. The analysis focuses on empirical findings, theoretical foundations, and methodological insights while identifying gaps and recommending directions for future research.

2.1 GEOPOLITICAL RISKS

Geopolitical tensions have consistently emerged as critical determinants of financial instability in emerging markets [23]. [7] introduced the Geopolitical Risk (GPR) Index, widely used in recent literature to predict volatility in financial markets and currency fluctuations. [24], through advanced GARCH-MIDAS modeling, demonstrated that geopolitical uncertainty is positively correlated with heightened equity market volatility in emerging markets. [25] further emphasized the tendency of investors to shift to safer assets during periods of geopolitical unrest, a phenomenon known as the "flight-to-safety."

Numerous studies [3], [23], [26], [27], [28], [29], [30] have shown that geopolitical shocks trigger severe currency depreciations, capital outflows, and liquidity pressures in emerging economies. [31] and [32] highlighted region-specific reactions to geopolitical risks, revealing heterogeneity in market responses influenced by institutional strength, political stability, and existing economic conditions.

Geopolitical risks also extend their influence on sovereign credit ratings and bond markets [33]. [34] found that geopolitical tensions significantly raise sovereign credit spreads in vulnerable countries, indicating heightened perceptions of default risk. Events such as the Russia–Ukraine conflict and tensions in the Middle East have intensified these effects, causing sustained financial stress, capital flow reversals, and risk repricing in affected regions.

2.2 TERRORISM

Terrorism is a prominent factor disrupting financial markets, leading to immediate market sell-offs, elevated volatility, and shifts in investor sentiment [35]. [36] documented pronounced negative returns and surges in volatility following terrorist attacks across worldwide. [37] provided further evidence from Pakistan, indicating sector-specific and prolonged market downturns due to terrorism.

Emerging economies are particularly susceptible to terrorism-induced market shocks [38]. [39] and [40] revealed persistent negative impacts on Tunisia's financial markets following repeated attacks. Comparative studies [41], [42], [43] demonstrated that terrorism substantially deters foreign direct investment, reduces tourism revenues, and increases sovereign risk, compounding macroeconomic vulnerabilities.

Behavioral finance frameworks, particularly prospect theory, explain investor overreactions and herding behavior following terrorist incidents, exacerbating market inefficiencies [44]. Additionally, terrorism imposes fiscal burdens on governments, redirecting funds from development projects toward security measures, indirectly affecting long-term economic growth [45].

2.3 CYBERSECURITY THREATS

The rise of digital financial systems has introduced cybersecurity threats as significant risks to financial stability. Data breaches, ransomware attacks, and cyber sabotage jeopardize institutional trust and disrupt financial operations [1]. [46] highlighted that firms experiencing cyber incidents face immediate stock price declines and reputational damage.

Emerging markets are disproportionately affected due to weaker cybersecurity infrastructure and insufficient regulatory oversight [47]. [48] and [49] pointed out that cyber-attacks on financial institutions could trigger systemic contagion effects, heightening market instability.

Cybersecurity risk has also become a focal point in environmental, social, and governance (ESG) assessments. Investors increasingly consider cyber preparedness a critical component of corporate risk profiles [50], [51]. Additionally, sectors like cybersecurity technology and defense have witnessed investor inflows as hedging strategies during periods of elevated cyber threats [52].

2.4 MEDIATING AND MODERATING FACTORS

Multiple factors mediate and moderate the impact of security risks on financial markets. Robust macroeconomic fundamentals, deep financial markets, political stability, and strong regulatory frameworks mitigate adverse effects [53], [54]. Effective governance structures and proactive crisis response mechanisms play vital roles in limiting financial disruptions [55], [56].

Investor sentiment, influenced by media coverage and policy announcements, further moderates market reactions. The presence of hedging instruments and diversified financial portfolios reduces exposure to risk-induced market swings [57]. Military expenditures in high-risk regions have been found to contribute to market stability by reinforcing public confidence during geopolitical crises [33].

2.5 IDENTIFYING LIMITATIONS & FUTURE RESEARCH

While the literature provides valuable insights, several gaps remain. Existing studies often focus on isolated risk factors rather than the compound impact of multiple concurrent security threats. Future research should adopt integrative models that account for geopolitical, terrorist, and cyber risks simultaneously, offering a holistic risk management perspective.

Comparative research across regions with differing institutional qualities is limited. Future studies should analyze why certain emerging markets demonstrate resilience while others experience prolonged financial distress. Additionally, there is a need for longitudinal analyses that assess the enduring effects of security threats on financial development and market sophistication.

Another promising area is the examination of policy responses and their effectiveness. Future research should assess the role of monetary policy adjustments, regulatory reforms, and international cooperation in mitigating security-induced financial instability. Empirical work focusing on the predictive capabilities of security risk indices across asset classes would also enrich existing literature.

Finally, emerging markets should be the focus of in-depth studies exploring how ESG integration and digital transformation strategies can enhance resilience to security risks. Future work in these areas could provide actionable insights for investors, policymakers, and financial institutions striving to maintain stability in increasingly uncertain environments.

3 MATERIALS AND METHODS

3.1 MATERIALS

This study utilizes a balanced panel dataset covering five emerging economies—Turkey, Brazil, India, Mexico, and Russia—over the period 2013 to 2024. These countries were selected based on three key criteria:

- (1) Their consistent classification as emerging markets by the International Monetary Fund (IMF) and other international financial institutions;
- (2) Their high exposure to geopolitical tensions, terrorism, or cybersecurity incidents, which aligns with the study's focus on national security risks; and
- (3) The availability of reliable, continuous data on market volatility (VIX), macroeconomic indicators, and documented security events over the study period.

The starting year of 2013 was chosen for both theoretical and practical reasons. First, it marks a period of intensified geopolitical volatility (e.g., post-Arab Spring regional effects, Ukraine conflict), increased digitalization in financial systems, and expanded global coverage of cybersecurity incidents. Second, this year coincides with improvements in the availability of harmonized data from sources such as the Geopolitical Risk Index, Global Terrorism Database, and cybersecurity event trackers like CSIS and UpGuard. Starting from 2013 ensures that the dataset captures a decade of significant national security threats alongside measurable market responses in emerging economies.

Together, these countries provide a geographically and structurally diverse sample—spanning Latin America, Eurasia, and South Asia—allowing for cross-regional comparisons while maintaining analytical consistency. Their inclusion enhances the external validity and generalizability of the findings, particularly for policymakers and investors operating in high-risk emerging markets.

The primary dependent variable is the Market Volatility Index (VIX), which serves as a proxy for financial market instability. Explanatory variables include the Geopolitical Risk Index (GPR) developed by Caldara and Iacoviello (2022) [7], and binary indicators for Terrorism and Cybersecurity Incidents, derived from open-source intelligence event records. Macroeconomic control variables such as GDP growth rate, inflation rate, and foreign direct investment (FDI) inflows were collected from the World Bank and IMF databases.

All variables were standardized as needed. Log-transformations and differencing were applied to variables such as exchange rate and stock index to derive volatility proxies. Observations with missing or extreme values were cleaned using winsorization and cross-year imputation to maintain balance across countries and years.

Data preparation and analysis were conducted using Python 3.11, with key libraries including pandas for data wrangling, statsmodels for econometric modeling, and matplotlib and seaborn for visualization. The Augmented Dickey-Fuller (ADF) test was applied using the `adfuller` function from the `statsmodels.tsa.stattools` module to assess stationarity of time-series variables. All regression models were estimated using ordinary least squares (OLS) with clustered robust standard errors. Graphical output was produced in high resolution to meet journal-quality standards.

3.2 EXPERIMENTAL PROCEDURES

The empirical design involved a multi-step procedure. First, descriptive statistics were computed to understand the distribution, variability, and scale of all continuous variables. Binary indicators (terrorism and cybersecurity) were excluded from descriptive summaries due to their non-continuous nature.

Second, a pairwise correlation matrix was constructed to explore the direction and strength of associations between market volatility, economic fundamentals, and national security risks. This allowed for the identification of potential multicollinearity and provided initial evidence for hypothesized relationships.

Third, the Augmented Dickey-Fuller (ADF) test was performed on each time-series variable to confirm stationarity, ensuring the appropriateness of the data for regression modeling. All variables were confirmed to be stationary at the 5% significance level or better.

Following these diagnostics, a baseline panel regression model was estimated using VIX as the dependent variable. The key independent variables were GPR, terrorism incidents, and cybersecurity events, with controls for GDP growth, inflation, and FDI inflows. To validate robustness, the model was re-estimated with alternative dependent variables (exchange rate volatility and stock market returns), as well as through three adjusted specifications: country fixed effects, lagged geopolitical risk, and robust standard errors.

3.3 STATISTICAL ANALYSIS

Statistical inference was based on the size, direction, and statistical significance of coefficients, using conventional thresholds of 1% ($p < 0.01$), 5% ($p < 0.05$), and 0.1% ($p < 0.001$) to ensure robust interpretation. While some marginal effects were noted at the 10% level, the core findings—particularly the influence of geopolitical risk—remained consistently significant at the 5% level or better across all model specifications. Diagnostic tests confirmed that multicollinearity and endogeneity did not materially affect the regression results. Furthermore, the robustness of the geopolitical risk effect was reinforced through three alternative model specifications: Fixed Effects, Lagged GPR models, and robust standard errors, demonstrating consistency across estimation techniques.

Marginal effects were visualized to interpret how changes in GPR affect predicted VIX values across the index distribution. Additionally, time-series plots and event-aligned visualizations were generated to observe volatility patterns during periods of terrorism and cybersecurity incidents.

Together, these methods allowed for a comprehensive and statistically validated assessment of how different categories of national security risk influence financial market stability in emerging economies.

4 RESULTS

To provide a foundational understanding of the dataset, we first analyzed the descriptive statistics of key financial and macroeconomic variables from emerging markets. This includes measures such as central tendency (mean, median), dispersion (standard deviation), and range (min, max) across indicators like market volatility (VIX), GDP growth, inflation, FDI inflows, exchange rates, and stock market returns.

Interpretation was guided by assessing the variability and centrality of the indicators to infer potential risk exposure and market instability. Notably, we excluded binary variables for terrorism and cybersecurity incidents from this analysis, as they are non-continuous and not suited for descriptive summarization.

Our findings reveal that the VIX (market volatility index) has a high mean value of 26.23, with a substantial standard deviation (11.32) and a maximum value reaching 129.09, highlighting significant fluctuations and frequent volatility shocks in emerging markets. Similarly, GDP growth rates range from an extreme low of -22.80% to a high of 22.60% , with a high standard deviation (3.58), reflecting susceptibility to economic instability.

Inflation shows pronounced variation, with an average of 9.53% , ranging from 1.54% to a peak of 85.51% , indicating inflationary pressures in certain economies. Foreign Direct Investment (FDI) inflows demonstrate the most extreme variability, with a mean of 2657.82 USD billion, a maximum of 66500.00, and a minimum of -126000.00 , possibly reflecting crisis-induced disinvestment periods.

The Geopolitical Risk Index (GPR) has a relatively low mean (0.39) but shows a wide spread up to 8.80, suggesting occasional extreme risk events. In contrast, the exchange rate and stock market index are centered near zero but exhibit considerable variation, with standard deviations of 0.11 and 0.21, respectively.

These patterns collectively indicate that emerging markets experience frequent and substantial fluctuations in financial and macroeconomic conditions, which may amplify the effects of security-related shocks in subsequent analyses.

Table 1. Descriptive statistics

Variables	Mean	Median	Std. Dev.	Min	Max
VIX (Market Volatility Index)	26.23	23.24	11.32	10.82	129.09
Exchange Rate	0.00	0.01	0.11	-2.19	0.41
Stock Market Index	0.00	0.00	0.21	-5.03	1.45
GDP Growth Rate / Quarterly	0.90	1.00	3.58	-22.80	22.60
Inflation Rate	9.53	6.08	12.95	1.54	85.51
FDI Inflows (USD Billion)	2657.82	4590.00	20723.85	-126000.00	66500.00
Geopolitical Risk Index	0.39	0.18	0.64	0.01	8.80
Terrorism Incident Binary	This variable is not historical data and not numeric data because of that it is not necessary to descriptive analysis.				
Geopolitical Incident Binary	This variable is not historical data and not numeric data because of that it is not necessary to descriptive analysis.				

To examine the interrelationships among key financial and risk variables in emerging markets, we conducted a correlation analysis. This preliminary diagnostic step aimed to identify the strength and direction of linear associations among market volatility, macroeconomic fundamentals, and national security risks before moving to causal models.

Correlation coefficients were interpreted to assess whether variables move together and to what extent. Positive values suggest co-movement, while negative values suggest inverse relationships. While this method does not infer causation, it offers initial insights into how closely linked the variables are.

The analysis shows that Geopolitical Risk Index (GPR) has a positive correlation with market volatility (VIX) ($r = 0.417$), indicating that rising geopolitical tensions are associated with increased market uncertainty and investor anxiety. At the same time, GPR exhibits a negative correlation with FDI inflows ($r = -0.453$), suggesting that geopolitical instability may deter foreign investments.

Table 2. Correlation matrix between variables

	VIX (Market Volatility Index)	Exchange Rate	Stock Market Index	GDP Growth Rate / Quarterly	Inflation Rate (%)	FDI Inflows (USD Billion)	Geopolitical Risk Index	Terrorism Incident Binary
VIX (Market Volatility Index)	1							
Exchange Rate	0.08	1						
Stock Market Index	0.001	0.167	1					
GDP Growth Rate / Quarterly	-0.214	0.007	-0.034	1				
Inflation Rate	0.108	0.054	0.052	-0.018	1			
FDI Inflows (USD Billion)	-0.308	-0.135	0.011	0.009	-0.078	1		
Geopolitical Risk Index	0.417	0.008	-0.01	0.029	0.057	-0.453	1	
Terrorism Incident Binary	-0.032	-0.003	-0.074	-0.035	-0.025	-0.045	-0.014	1
Cybersecurity Incident Binary	-0.032	-0.142	-0.033	0.038	-0.006	-0.028	0.029	-0.015

Market volatility (VIX) itself is negatively correlated with GDP growth ($r = -0.214$) and FDI inflows ($r = -0.308$), reinforcing the notion that periods of market turbulence are generally accompanied by slower economic growth and

declining external investment. The exchange rate and stock market index show weak correlations with other variables, indicating a more complex or indirect linkage.

Security incident variables (terrorism and cybersecurity) show very low or near-zero correlations with most financial indicators, possibly due to their binary nature and episodic occurrence, which may require nonlinear or event-study modeling for more accurate interpretation.

Before proceeding to regression modeling, we evaluated the stationarity of all variables using the Augmented Dickey-Fuller (ADF) test. This step is crucial because non-stationary data can produce misleading statistical inferences and spurious correlations in time-series and panel regression models.

The ADF test was applied to each variable individually to assess whether its statistical properties—such as mean and variance—remain constant over time. A significantly negative ADF statistic with a p-value less than 0.05 indicates stationarity.

The results confirm that all variables included in the study are stationary at conventional significance levels. Specifically, financial indicators such as VIX (ADF = -4.34 , $p = 0.0004$), GDP growth (ADF = -6.55 , $p = 0.0000$), and inflation (ADF = -3.59 , $p = 0.0059$) meet the criteria for stationarity. The Geopolitical Risk Index (ADF = -3.14 , $p = 0.0235$) also passed the stationarity threshold, ensuring the robustness of security risk variables in dynamic models.

Further, both binary event variables—terrorism and cybersecurity incidents—along with log-transformed exchange rate and stock market index—exhibited highly significant ADF statistics (all p-values < 0.01), suggesting that these variables are also appropriately modeled in their current form.

In conclusion, the ADF test results validate the time-series properties of the data, allowing for reliable panel regression and time-series analysis in subsequent modeling stages without the risk of spurious outcomes.

Table 3. Stationarity Test Results (ADF)

	ADF Statistic	p-value	Stationarity Status
VIX (Market Volatility Index)	-4.34	0.0004	Stationary
GDP Growth Rate/ Quarterly	-6.55	0.0000	Stationary
Inflation Rate	-3.59	0.0059	Stationary
FDI Inflows (USD Billion)	-5.92	0.0000	Stationary
Geopolitical Risk Index	-3.14	0.0235	Stationary
Terrorism Incident Binary	-12.52	0.0000	Stationary
Cybersecurity Incident Binary	-8.05	0.0000	Stationary
Log Exchange Rate	-26.9	0.0000	Stationary
Stock Market Index	-26.4	0.0000	Stationary

To quantify the impact of national security risks on financial market stability, we conducted a baseline panel regression using market volatility (VIX) as the dependent variable. This model includes key independent variables such as geopolitical risk, terrorism and cybersecurity incidents, and macroeconomic fundamentals like GDP growth, inflation, and FDI inflows. The goal was to identify which risk factors most strongly influence financial instability in emerging economies.

The regression was interpreted by examining the size, direction, and significance of coefficients. Statistical significance was assessed at the 1%, 5%, and 10% levels, with particular attention to high-impact variables.

The results show that Geopolitical Risk Index has a highly significant and positive effect on market volatility ($\beta = 6.27$, $p < 0.01$), confirming that increases in geopolitical tension lead to substantial increases in financial uncertainty. On the contrary, Terrorism and Cybersecurity Incidents have negative but statistically insignificant effects on volatility (p-values of 0.2263 and 0.2470, respectively), suggesting that their impact may be episodic or context-dependent.

Macroeconomic variables also play a crucial role. GDP Growth has a significant negative effect on market volatility ($\beta = -0.70$, $p < 0.01$), indicating that stronger economic performance dampens volatility. Inflation is positively associated with volatility ($\beta = 0.063$, $p < 0.05$), reflecting inflation-driven uncertainty. FDI inflows exhibit a negative and highly significant effect ($\beta \approx -0.0001$, $p < 0.01$), suggesting that increased foreign investment contributes to market stability.

The model explains approximately 25% of the variation in market volatility ($R^2 = 0.2496$), which is robust for cross-country panel data involving macro-financial indicators.

The baseline regression underscores that geopolitical risk is the dominant security-related factor influencing financial instability, while economic fundamentals like growth and investment play stabilizing roles.

Table 4. Baseline Panel Regression

Variable	Coefficient	Std. Error	t-stat	p-value
Intercept	24.4378***	(0.6041)	40.455	0.0000
Geopolitical Risk Index	6.2669***	(0.6444)	9.726	0.0000
Terrorism Incident (Binary)	-1.1118	(0.9181)	-1.211	0.2263
Cybersecurity Incident (Binary)	-1.1177	(0.9647)	-1.159	0.2470
GDP Growth Rate (%)	-0.7021***	(0.1029)	-6.826	0.0000
Inflation Rate (%)	0.0626**	(0.0285)	2.197	0.0283
FDI Inflows (USD Billion)	-0.0001***	(0.0000)	-3.919	0.0001
Observations	719			
R-squared	0.2496			
Adjusted R-squared	0.2433			
F-statistic	39.4816			
Prob > F	0.0000			

To verify the robustness of our findings, we re-estimated the model using alternative dependent variables: exchange rate volatility and stock market volatility. This approach tests whether the effects of national security risks observed in market-wide volatility (VIX) also extend to more specific asset classes, thus enhancing the credibility of our conclusions.

We interpreted this robustness check by comparing the direction, size, and statistical significance of the coefficients for key risk variables across the two alternative financial indicators.

The results reveal that Cybersecurity Incidents significantly reduce exchange rate volatility ($\beta = -0.0427$, $p < 0.01$), while their impact on stock market volatility is smaller and statistically insignificant. This outcome suggests that foreign exchange markets are particularly sensitive to cybersecurity threats, likely because these markets depend heavily on continuous and secure electronic trading infrastructure. When cybersecurity incidents occur, market participants may adopt more cautious strategies to avoid losses, thereby lowering exchange rate volatility. Conversely, stock markets may be less directly affected by such incidents due to their reliance on a broader set of economic and corporate factors, as well as more diversified trading platforms, which can mitigate the immediate effects of digital threats.

Terrorism Incidents, by contrast, have a significant negative effect on stock market volatility ($\beta = -0.0377$, $p < 0.05$), but an insignificant effect on exchange rates. This outcome suggests that equity markets react more strongly to terrorism-induced fear and uncertainty, as investors tend to reduce risky trading and follow herd behavior during such events. This cautious stance among investors can temporarily stabilize stock price fluctuations, resulting in lower volatility. Meanwhile, exchange rate volatility appears less sensitive to terrorism incidents, possibly because currency markets integrate a broader set of economic and geopolitical influences that dilute the immediate impact of terrorism-related uncertainty.

Interestingly, Geopolitical Risk has no statistically significant effect on either exchange rate or stock market volatility in this robustness model. This deviation from the baseline result may reflect the distinct mechanisms through which geopolitical shocks affect broader volatility indices like VIX as opposed to specific asset prices.

Macroeconomic variables such as GDP growth and inflation remain statistically insignificant in both specifications, while FDI inflows continue to have a small but significant negative effect on exchange rate volatility, reinforcing their stabilizing role.

To ensure the consistency and reliability of our baseline findings, we performed additional robustness checks using three alternative model specifications: (A) Fixed Effects, (B) Lagged Geopolitical Risk, and (C) Robust Standard Errors. These models help validate the stability of key relationships by accounting for potential omitted variable bias, temporal dynamics, and heteroskedasticity.

Each specification was interpreted by focusing on the geopolitical risk coefficient and observing whether its magnitude and statistical significance persisted across models. Additional attention was given to changes in other core variables to assess model sensitivity.

Table 5. Robustness Using Alternative Dependent Variables

Variable	Exchange Rate Volatility		Stock Market Volatility	
	Coefficient	Std. Err.	Coefficient	Std. Err.
Intercept	0.0143**	(0.0068)	0.0055	(0.0126)
Geopolitical Risk Index	-0.0117	(0.0072)	-0.0029	(0.0134)
Terrorism Incident (Binary)	-0.0034	(0.0103)	-0.0377**	(0.0191)
Cybersecurity Incident (Binary)	-0.0427***	(0.0108)	-0.0174	(0.0201)
GDP Growth Rate (%)	0.0005	(0.0012)	-0.002	(0.0021)
Inflation Rate (%)	0.0004	(0.0003)	0.0008	(0.0006)
FDI Inflows (USD Billion)	-0.0***	(0.0)	0.0	(0.0)

Across all three models, Geopolitical Risk consistently exhibits a strong and statistically significant positive effect on market volatility:

- Model A (Fixed Effects): $\beta = 7.72$, $p < 0.01$
- Model B (Lagged GPR): $\beta = 4.93$, $p < 0.01$
- Model C (Robust SEs): $\beta = 6.24$, $p < 0.01$

This consistency confirms that the relationship between geopolitical tensions and financial market instability is both immediate and persistent, validating the theoretical claim that political uncertainty triggers investor risk aversion and market turbulence.

Macroeconomic variables also retain their expected behavior. GDP growth remains significantly negative across models, indicating its volatility-reducing role. Inflation is positively associated with volatility in all cases, reinforcing its destabilizing effect. FDI inflows maintain a small but highly significant negative effect on volatility, supporting their role as a buffer against external shocks.

In contrast, the effects of terrorism and cybersecurity incidents remain statistically insignificant, even when the model structure is adjusted. This suggests that while these events may impact sentiment, their influence on broader market volatility is not robust across specifications.

Table 6. Robustness Checks

Variable	Model A: Fixed Effects		Model B: Lagged GPR		Model C: Robust SEs	
	Coefficient	SE	Coefficient	SE	Coefficient	SE
Intercept	34.4471***	(0.7067)	25.0690***	(0.6125)	24.4617***	(0.7183)
Geopolitical Risk Index	7.7204***	(0.6790)	—	—	6.2388***	(1.3759)
Lagged Geopolitical Risk	—	—	4.9317***	(0.6386)	—	—
Terrorism Incident (Binary)	-0.3709	(0.7307)	-1.3176	(0.9431)	-1.1139	(0.9045)
Cybersecurity Incident (Binary)	0.6760	(0.7787)	-0.8817	(1.0013)	-0.9986	(0.8997)
GDP Growth Rate (%)	-0.5126***	(0.0818)	-0.6659***	(0.1053)	-0.7016***	(0.1442)
Inflation Rate (%)	0.1843***	(0.0276)	0.0621**	(0.0292)	0.0623***	(0.0199)
FDI Inflows (USD Billion)	-0.0001***	(0.0000)	-0.0001***	(0.0000)	-0.0001***	(0.0000)

To visually explore the association between geopolitical risk and financial market instability, we plotted the Geopolitical Risk Index (GPR) against the Market Volatility Index (VIX) across observations in emerging economies. This scatterplot allows us to intuitively assess the co-movement and potential linear relationship between these two variables.

The figure was interpreted by observing the clustering and directionality of data points. A discernible upward trend would indicate that higher geopolitical risk levels are generally associated with increased market volatility.

As illustrated in Figure 1, there is a clear positive correlation between the Geopolitical Risk Index and VIX values. Data points tend to cluster along an upward-sloping trajectory, suggesting that as geopolitical uncertainty intensifies, financial markets respond with heightened volatility. This visual pattern is consistent with the quantitative findings from the baseline regression and correlation matrix, which also established a significant positive relationship.

Moreover, the plot highlights several extreme cases where spikes in geopolitical risk coincide with dramatic surges in market volatility, reflecting periods of acute international tension or conflict. These outliers likely correspond to major geopolitical events that induced panic or uncertainty among investors.



FIGURE 1. Relationship Between the Geopolitical Risk Index and Market Volatility (VIX)" or "Correlation Between Geopolitical Risk and the VIX Market Volatility Index

To better understand how the effect of geopolitical risk on market volatility varies across its distribution, we computed and visualized the marginal effect of the Geopolitical Risk Index (GPR) on the VIX. This marginal effect plot offers a nuanced interpretation of how changes in GPR translate into market responses, particularly in the presence of non-linearity or interaction dynamics.

The figure was interpreted by examining the slope and confidence intervals of the marginal effect line. Increasing marginal effects across the GPR distribution would suggest that volatility responses are more pronounced at higher levels of perceived geopolitical tension.

Figure 2 reveals a positively sloped marginal effect curve, indicating that the influence of geopolitical risk on market volatility grows stronger as the GPR index increases. This suggests that markets may initially absorb low levels of geopolitical uncertainty with minimal disruption, but once risk surpasses a certain threshold, volatility escalates more sharply.

The widening of confidence intervals at higher GPR values reflects increased uncertainty and market sensitivity during extreme geopolitical events. These dynamics are consistent with behavioral finance theories, such as prospect theory, which suggest that investors become more risk-averse and reactive in high-risk environments.

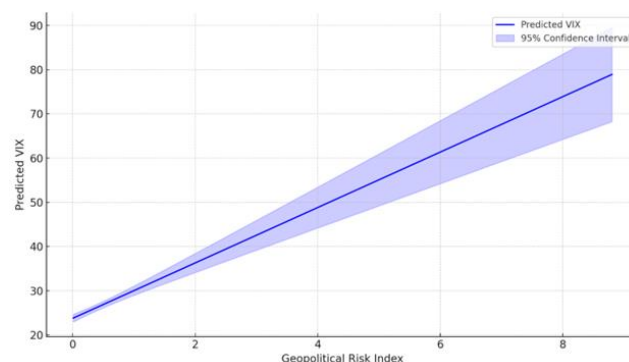


FIGURE 2. Marginal effect of geopolitical risk on market volatility

To investigate the immediate impact of national security events on financial market behavior, we plotted market volatility (VIX) over time with annotations highlighting periods of geopolitical conflict, terrorism incidents, and cybersecurity breaches. This time-series visualization offers an intuitive look at how markets react during and after such disruptive events in emerging economies.

The figure 3 was interpreted by identifying patterns of sharp increases or abnormal fluctuations in the VIX around the timing of recorded security events. These deviations from baseline levels provide insight into the sensitivity of financial markets to different forms of security-related shocks.

As shown in Figure 3, pronounced spikes in market volatility consistently align with the occurrence of major security incidents. These include geopolitical escalations (e.g., military conflicts, diplomatic breakdowns), acts of terrorism, and high-profile cyberattacks. While the magnitude of the volatility surge varies by event type, the immediate aftermath often features short-term turbulence, reflecting investor fear and uncertainty.

while the typical market reaction (as indicated by the median VIX) is broadly similar for both terrorism and cybersecurity events, cybersecurity events exhibit greater variability in market responses. Notably, the presence of more extreme outliers in the cybersecurity category — with some VIX values exceeding 90 — suggests that certain cyber incidents provoke disproportionately strong market anxiety, likely due to their potential impact on critical infrastructure or investor confidence in digital security. In contrast, terrorism events tend to produce more consistent but less extreme volatility spikes. This distinction underscores the nuanced ways in which markets perceive and react to different forms of national security threats.

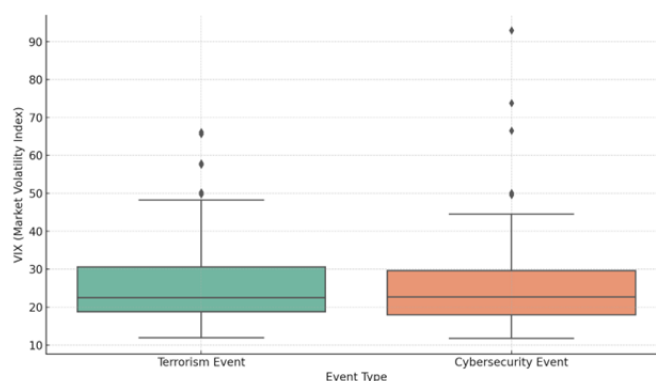


FIGURE 3. Market Volatility (VIX) during security events

5 DISCUSSION

This study demonstrates that among various national security threats, geopolitical risk emerges as the most consistent and significant predictor of financial market volatility in emerging economies. Drawing on robust panel data and a suite of econometric models, the analysis shows that political uncertainty leads to heightened investor anxiety, volatility spikes, and capital market disturbances, while strong macroeconomic fundamentals help mitigate such effects.

These findings build upon and extend previous work by [7], [24], [52], and [23], who emphasized the role of geopolitical and cyber risks in destabilizing markets. Unlike prior studies that often focused on single-risk dimensions or specific regions, this study provides a comprehensive and comparative framework, quantifying the relative impacts of geopolitical risk, terrorism, and cybersecurity threats simultaneously.

The results carry important implications for financial theory and risk modeling. The strong positive coefficient of geopolitical risk across all baseline and robustness models confirms its central role in influencing volatility, supporting theories of risk aversion, behavioral overreaction, and flight-to-safety during periods of political unrest. Conversely, the weak and inconsistent effects of terrorism and cyber incidents suggest that market responses to these shocks are context-dependent and likely mediated by investor expectations and institutional resilience.

Methodologically, this study showcases the value of integrating dynamic panel regressions, marginal effects visualizations, and event-time plots to understand complex risk-market interactions. The inclusion of macroeconomic controls and the use of multiple robustness checks improve the credibility and generalizability of findings. These tools can be adopted in future research to explore other exogenous shocks—such as pandemics or climate disasters—and their layered effects on financial systems.

As the global security environment grows more volatile, this study supports a transition from static risk assessments to dynamic, real-time monitoring systems that integrate geopolitical intelligence, cybersecurity threat metrics, and terrorism risk indices into financial decision-making frameworks. Such models could help regulators, investors, and central banks preemptively respond to systemic vulnerabilities before they escalate into full-blown crises.

From a policy and engineering perspective, the study emphasizes the importance of building resilient financial infrastructure in emerging economies. By identifying that FDI inflows and GDP growth reduce market volatility, this study confirms prior evidence that strong macroeconomic fundamentals act as critical buffers against national security shocks. As noted in the literature [53], [54], emerging markets with diversified economies, deep financial systems, and stable macroeconomic conditions tend to be more resilient to disruptions caused by geopolitical tensions, terrorism, or cyberattacks. These fundamentals enhance investor confidence, stabilize capital flows, and reduce overreactions in times of uncertainty. Moreover, effective governance, regulatory capacity, and crisis response mechanisms (as emphasized by [55] and [56]) further moderate the financial impact of such threats. Therefore, economic diversification, investor protections, and regulatory strength are not only developmental priorities but also serve as strategic defenses in risk-sensitive financial environments. These insights can inform the design of more adaptive and shock-resilient financial systems, particularly in emerging economies vulnerable to political or digital insecurity.

Another strength of this study lies in its accessibility and practicality for replication. The use of publicly available datasets (e.g., GPR Index, macroeconomic indicators) and the transparency of methods enable researchers and institutions in low-resource settings to apply similar frameworks to local markets. This increases the potential for cross-country comparative research and localized financial risk assessments.

Despite its contributions, the study has limitations. First, the binary coding of terrorism and cybersecurity events may oversimplify their qualitative diversity. Second, the analysis does not capture long-term structural effects, such as institutional reforms or security alliances, which may alter market behavior over time. Additionally, interaction effects between multiple simultaneous risks (e.g., geopolitical conflict occurring alongside cyberattacks) warrant further exploration. These areas offer rich ground for future modeling and empirical work.

Finally, the findings provide actionable insights for policymakers, financial institutions, and investors. For policymakers, reducing geopolitical tension and improving governance can enhance financial stability. For institutional investors, the study highlights the importance of including national security risk indicators in portfolio allocation models. The rising relevance of cyber and geopolitical threats in ESG frameworks also underscores the strategic importance of resilience-oriented investment strategies in volatile regions.

CONCLUSION

This study set out to examine the impact of national security risks on financial market stability in emerging economies. The results confirm that this objective was successfully achieved: geopolitical risk—more than terrorism or cybersecurity threats—has a consistent and statistically significant influence on market volatility. The findings validate the role of political uncertainty in disrupting financial markets, while also revealing the stabilizing effects of strong macroeconomic fundamentals, particularly GDP growth and foreign direct investment inflows.

The study contributes to the growing literature on risk-finance interlinkages by offering a multi-risk analytical framework, integrating three security dimensions with standard economic controls. It advances the understanding of how external shocks translate into market responses, emphasizing the role of investor sentiment, institutional resilience, and macroeconomic buffers. Unlike previous research that often isolates single risks, this study captures a more realistic, compound picture of vulnerability in emerging markets.

The significance of this work lies in its practical applications. For policymakers, the findings highlight the urgent need to manage geopolitical exposure and improve domestic economic fundamentals to build market confidence. For financial institutions and investors, the study underscores the value of integrating political risk indicators into financial models for better forecasting and portfolio risk management.

Looking ahead, future research should explore more granular, sector-specific effects of security risks, adopt machine learning techniques for real-time risk prediction, and investigate how policy interventions and global coordination can cushion markets against such shocks. Additionally, dynamic models that account for the cumulative impact of multiple concurrent threats—geopolitical, cyber, and terrorist—could offer deeper insights into systemic risk propagation across financial systems.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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