Economic Policy Uncertainty, Financial Stress, and Cross-Country Risk Spillovers: Evidence from Global Stock Markets

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ABSTRACT This study examines how economic policy uncertainty intensifies cross-country financial risk spillovers by amplifying pressures within the financial system. Using daily stock market data from 15 economies, we estimate a high-dimensional time-varying parameter vector autoregression model and construct a dynamic directional risk-spillover network that measures time-varying risk outflows, inflows, and net spillovers across markets. Economic policy uncertainty and financial stress are then incorporated into a two-way fixed-effects panel model, followed by bootstrap mediation tests of the transmission pathway from policy uncertainty through financial stress to risk spillovers. The global equity spillover network displays a pronounced peak-heavy-tail pattern: the mean total spillover index is 70.97%, and the index frequently exceeds 85% during extreme shocks. Benchmark regressions show that domestic economic policy uncertainty significantly increases a country's risk outflows, whereas global financial stress primarily amplifies external risk inflows. The mediation tests further establish financial stress as a pivotal intermediary in the uncertainty-transmission mechanism. These findings support the development of cross-country risk early-warning systems that monitor financial stress and strengthen international coordination of macroprudential policy under heightened global uncertainty.

INDEX TERMS Economic policy uncertainty, financial stress, mediation effect, risk spillovers

I. INTRODUCTION

The deep integration of global financial markets has enhanced resource allocation efficiency while simultaneously diversifying risk transmission channels and accelerating their speed to unprecedented levels. The 2008 global financial crisis, the 2011 European debt crisis, and the market turmoil triggered by the 2020 pandemic have repeatedly demonstrated that localized risks can rapidly evolve into global systemic crises through complex financial networks. In the post-crisis era, major economies' frequent macroeconomic policy adjustments to counter sluggish growth and inflationary pressures, compounded by persistently tense geopolitical dynamics in recent years, have collectively fostered a prolonged environment of heightened uncertainty. This uncertainty not only directly impacts the real economy but also alters market expectations and risk preferences, generating and accumulating pressures within the financial system. Ultimately, it may function as an amplifier for cross-country risk contagion.

Existing research has addressed core aspects of this study from various angles. Regarding risk spillover measurement, Diebold and Yilmaz [1] pioneered the spillover index method based on vector autoregressive forecast error variance decomposition, enabling quantification of spillover intensity, direction, and net contribution. Antonakakis et al. [2] further introduced the time-varying parameter vector autoregression model (TVP-VAR), revealing the dynamic evolution and crisis-driven characteristics of risk spillovers. This model has been widely adopted in subsequent studies for analyzing dynamic correlations in financial markets [3]. Regarding the financial effects of economic policy uncertainty, the Economic Policy Uncertainty Index (EPU) developed by Baker et al. [4] has become a benchmark indicator in this field. Research has found that policy uncertainty intensifies stock market volatility through real option effects and risk premium channels. The dynamic risk spillover characteristics between policy uncertainty and the crude oil market, as well as the financial sector, have also been empirically tested [5]. Regarding financial stress, the Financial Stress Index (FSI) developed by Balakrishnan et al. [6] confirms that financial stress can transmit across borders through trade channels, financial channels, and investor sentiment channels. Financial crises in developed economies can rapidly spread to emerging economies.

However, existing research has yet to examine these three key dimensions–economic policy uncertainty as a source of risk, the financial system as an internal stress state, and cross-country risk spillovers as the ultimate manifestation–within a unified, coherent empirical framework. Most studies treat the domestic impact of economic policy uncertainty on financial markets and the cross-country transmission of risk as relatively independent processes, lacking a comprehensive chain analysis linking the two. A few attempts to bridge this gap often treat variables like financial stress as ordinary control variables, failing to rigorously test their potential mediating mechanisms. How exactly does economic policy uncertainty "cross" national borders to affect foreign markets? Is financial system stress merely a contemporaneous variable in this process, or does it play an indispensable mediating role in transmission? Neglecting this "black box" mechanism limits our understanding of the nature of cross-country risk transmission and constrains the precise design of relevant macroprudential policies.

To address this, this paper systematically seeks to answer the following core questions: Does economic policy uncertainty at the global and national levels ultimately exacerbate cross-country risk spillovers by amplifying financial system stress? Does this transmission mechanism exhibit significant variations across different types of economies and market conditions? The potential contributions of this paper are as follows: First, theoretically, it empirically establishes–through rigorous mediation effect testing–the pivotal role of financial stress (FSI) in the transmission chain "economic policy uncertainty $\rightarrow$ cross-country risk spillover," marking a leap from "correlation analysis" to "mechanism identification." Second, in methodology, it constructs a more refined and robust analytical framework by integrating high-frequency TVP-VAR dynamic spillover indices, mixed-frequency data synthesis, and panel Bootstrap mediation tests, offering methodological guidance for addressing similar complex transmission issues. Third, in policy implications, the findings explicitly suggest that cross-country risk prevention requires establishing a comprehensive monitoring and intervention system covering the entire chain: "source (uncertainty) $\rightarrow$ node (financial stress) $\rightarrow$ outcome (spillover)" monitoring and intervention system, offering a new perspective for advancing macroprudential policy from domestic stability to transnational coordination.

The structure of the subsequent sections is as follows: Chapter 2 presents theoretical hypotheses; Chapter 3 details the research design; Chapter 4 reports empirical results and conducts in-depth analysis; Chapter 5 summarizes conclusions and elaborates on policy implications.

II. THEORETICAL HYPOTHESES

Based on a literature review, this paper constructs the theoretical transmission framework illustrated in Fig. 1. The core argument posits that economic policy uncertainty, as an exogenous shock, first impacts the domestic financial system. Specifically, rising uncertainty prompts firms to postpone investments, financial institutions to tighten credit, and investors to shift toward safe-haven assets. Collectively, these behaviors lead to interbank liquidity tightening, increased asset price volatility, and widening credit spreads–thereby elevating the financial stress index. When the financial system operates under high stress, its inherent vulnerability sharply increases, impairing market functionality. Within highly interconnected global financial networks, this fragility rapidly spills over to other countries and regions through cross-border capital flows, multinational risk exposures of financial institutions, and resonance in global investor sentiment. This ultimately manifests as a tightening of the transnational risk spillover network and an intensification of spillover strength. Based on this, the study proposes the following hypotheses for testing:

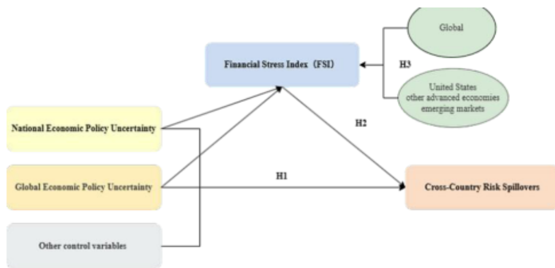

FIGURE 1. Theoretical transmission framework.

Hypothesis H1: Rising economic policy uncertainty significantly exacerbates transnational financial risk spillovers.
Hypothesis H2: The financial stress index plays a crucial mediating role in the transmission of economic policy uncertainty to transnational risk spillovers, with uncertainty primarily exerting its cross-country contagion effects by amplifying financial system stress.
Hypothesis H3: Heterogeneity exists in the aforementioned transmission mechanism. Emerging markets exhibit greater sensitivity to uncertainty shocks and faster transmission compared to developed economies. Furthermore, transmission effects are significantly stronger during periods of elevated financial stress than during calm periods.

III. EMPIRICAL MODEL SPECIFICATION

A. VARIABLE DEFINITIONS AND DATA SOURCES

1) Dependent Variable: Dynamic Directional Risk Spillover Index

This study utilizes daily return series of benchmark stock indices from 15 sample countries (regions). Employing a high-dimensional time-varying parameter vector autoregression (HD-TVP-VAR) model combined with generalized prediction error variance decomposition, it calculates rolling directional spillover values between any two markets. Ultimately, three core dependent variables are constructed for each market i on each trading day t: (a) Total Outflow Index $To_{i,t}$: Measures the sum of risk shocks transmitted by market i to all other markets on that day; (b) Total Inflow Index $From_{i,t}$: Measures the sum of risk shocks received by market i from all other markets on that day;

(c) Net Outflow Index $Net_{i,t}$: Measures the difference between market i's outward risk transmission and inward risk absorption. Additionally, the mean of all markets' daily total outflow indices is calculated as the Total Risk Outflow TCI_t. Major economies and their representative benchmark indices are introduced in Table I below, with data sourced from the Wind database.

2) Core Explanatory Variables, Mediating Variables, and Control Variables

The Economic Policy Uncertainty Index (EPU) utilizes the monthly EPU index published by Baker et al. [4], categorized into global and country-specific indices. Monthly values are assigned to all trading days within the month to generate daily time series. The Financial Stress Index (FSI) utilizes the "OFR Financial Stress Index" published by the U.S. Department of the Treasury's Office of Financial Research (OFR), updated daily. Two types of proxies are employed: (a) global FSI; (b) U.S. FSI, emerging market FSI, and other developed economies FSI. To control for other factors, annual macroeconomic variables are introduced and converted into daily series: level of financial development (private credit as a percentage of GDP), claims on the central government (government claims held by the central bank as a percentage of GDP), annual GDP growth rate, annual CPI growth rate, and youth unemployment rate (unemployment rate for the 15–24 age group).

TABLE I. Major Economies and Their Stock Market Metrics

Country or Region	Stock Market Metric	Variable Name
USA	S&P 500 Index	SPX
CAN	S&P/TSX Composite Index	SPTSX
BRA	Indice Bovespa Index	IBOV
CHN	CSI 300 Index	CSI300
HKG	Hang Seng Index	HSI
GER	FTSE 100 Index	FTSE100
FRA	CAC 40 Index	CAC40
DEU	DAX Performance Index	DAX
ITA	FTSE MIB Index	FTSEMIB
JPN	Nikkei 225 Index	NKY
RUS	RTS Index	RTSI
KOR	KOSPI Composite Index	KOSPI
AUS	S&P/ASX 200 Index	ASX200
IND	S&P BSE Sensex 30 Index	SENSEX
MEX	Indice de Precios y Cotizaciones (IPC/MXX)	MXX

3) Data Frequency Integration

The daily volatility of the dynamic directional risk spillover index–calculated via the HD-TVP-VAR-DY model and serving as the dependent variable in this study–is crucial for capturing the instantaneous dynamics of risk contagion. To maximize retention of this high-frequency information while maintaining synchronization with the daily Financial Stress Index (FSI), this study standardizes lower-frequency variables to a daily frequency. Specifically, for the monthly Economic Policy Uncertainty Index (EPU), we employ a common academic approach to similar issues: assigning the monthly observation for month m to all trading days l within that month, thereby generating a constant daily sequence within the month. This method implicitly assumes that economic policy uncertainty shocks persist throughout the month, functioning as a background risk factor for daily financial markets. Annual control variables (e.g., GDP growth rate) are treated according to similar principles.

This upward-frequency conversion inevitably introduces serial autocorrelation in monthly and annual variables within the daily panel. To ensure the validity of subsequent statistical inferences, this study employs dual-clustered robust standard errors for both "country" and "month-year" in all regression models. This corrects for potential cross-sectional and time-series correlations in the error terms, thereby safeguarding the validity of statistical inferences.

B. RISK SPILLOVER MEASUREMENT MODEL

To precisely capture the dynamic risk correlations among stock markets in major global economies, this paper employs a High-Dimensional Time-Varying Parameter Vector Autoregression (HD-TVP-VAR) model combined with generalized forecast error variance decomposition to construct a directional risk spillover network. Building upon the spillover index framework of Diebold and Yilmaz [1], this model incorporates time-varying parameters and high-dimensional constraints to effectively depict the nonlinear jumps in risk contagion and the dynamic evolution of network structures during crises. The specific construction process is as follows.

Definition 1 (Basic VAR(p) Model)

Let $\mathbf{Y}_t = (y_{1t}, y_{2t}, \ldots, y_{nt})'$ denote an n dimensional time series vector. The standard VAR(p) model can be expressed as:

$$\mathbf{Y}_t = \sum_{j=1}^{p} \mathbf{\Phi}_j \mathbf{Y}_{t-j} + \boldsymbol{\varepsilon}_t, \quad \boldsymbol{\varepsilon}_t \sim N(0, \mathbf{\Sigma}_t), \tag{1}$$

where $\mathbf{\Phi}_j \in \mathbb{R}^{n\times n}$ denotes the coefficient matrix, and $\mathbf{\Sigma}_t$ represents the time-varying error covariance matrix. This specification allows the variance of disturbance terms to change over time, thereby capturing volatility clustering in financial markets.

Definition 2 (Time-Varying Parameter Extension)

To reflect structural changes in economic-financial relationships, the TVP-VAR model extends the coefficient matrix to a time-varying form:

$$\mathbf{Y}_t = \sum_{j=1}^{p} \mathbf{\Phi}_{j,t} \mathbf{Y}_{t-j} + \boldsymbol{\varepsilon}_t, \tag{2}$$

where $\mathrm{vec}(\mathbf{\Phi}_{j,t})$ follows a random walk process:

$$\mathrm{vec}(\mathbf{\Phi}_{j,t}) = \mathrm{vec}(\mathbf{\Phi}_{j,t-1}) + \boldsymbol{\nu}_t, \quad \boldsymbol{\nu}_t \sim N(0, \mathbf{Q}). \tag{3}$$

This specification permits smooth evolution of coefficients, capturing gradual shifts in economic relationships.

Definition 3 (High-Dimensional Constraints and Elastic Network Estimation)

When the number of variables (n) approaches or exceeds the time dimension (T) (i.e., $n \gg T$), directly estimating

n^2p time-varying parameters triggers severe dimensionality catastrophe. To address this, Elastic Net regularization is employed for equation-independent estimation. For the i equation, the objective function is:

$$\min_{\boldsymbol{\beta}_i}\left\{\frac{1}{T}\left\|\mathbf{y}_i-\mathbf{X}\boldsymbol{\beta}_i\right\|^2 + \lambda\left[\alpha\left\|\boldsymbol{\beta}_i\right\|_1+\frac{1-\alpha}{2}\left\|\boldsymbol{\beta}_i\right\|_2^2\right]\right\}, \tag{4}$$

where $\mathbf{y}_i$ is the observation vector for the i variable, $\mathbf{X}$ is the lagged design matrix containing all lagged terms, $\boldsymbol{\beta}_i = \mathrm{vec}(\boldsymbol{\Phi}_{\cdot,i,t})$ is the coefficient vector for the i equation, where λ is the regularization parameter, and $\alpha \in [0,1]$ controls the weight between L1 and L2 penalties. λ is automatically selected via cross-validation to avoid subjective settings. This strategy satisfies: 1) Computational feasibility is maintained with complexity $O(n \cdot np)$; 2) Variable selection is achieved through the penalty term, automatically addressing high-dimensionality issues; 3) Network structure information between variables is preserved.

After obtaining coefficient estimates, the time-varying covariance matrix $\boldsymbol{\Sigma}_t$ is updated using Exponentially Weighted Moving Average (EWMA):

$$\widehat{\boldsymbol{\Sigma}}_t = (1-\kappa)\widehat{\boldsymbol{\Sigma}}_{t-1} + \kappa\boldsymbol{\varepsilon}_t\widehat{\boldsymbol{\varepsilon}}_t', \tag{5}$$

where $\kappa \in (0,1)$ is the smoothing parameter, typically set to 0.06 (corresponding to a half-life of approximately 20 days), and $\boldsymbol{\varepsilon}_t = \mathbf{Y}_t - \widehat{\mathbf{Y}}_t$ denotes the forecast residual. This updating method captures the time-varying volatility characteristics while avoiding the need to re-estimate the covariance matrix at each time point, thereby improving computational efficiency.

Definition 4 (Generalized Variance Decomposition)

Based on the estimated time-varying coefficients and covariance matrix, the generalized forecast error variance decomposition (GFEVD) is used to calculate the spillover contributions between variables. The contribution ratio of variable j to variable i in the hth step forecast error variance is:

$$\widetilde{\theta}_{ij}(h) = \frac{\sum_{l=0}^{h-1}\left(\mathbf{e}_i'\boldsymbol{\Theta}_l\boldsymbol{\Sigma}\mathbf{e}_j\right)^2}{\sum_{l=0}^{h-1}\left(\mathbf{e}_i'\boldsymbol{\Theta}_l\boldsymbol{\Sigma}\boldsymbol{\Theta}_l'\mathbf{e}_i\right)}, \tag{6}$$

where $\boldsymbol{\Theta}_l$ denotes the impulse response coefficient matrix of the prediction error (derived recursively from VAR coefficients), $\mathbf{e}_i$ is a selection vector with the i element equal to 1 and all others zero, and $\boldsymbol{\Sigma}$ represents the error covariance matrix. (Here, $\widehat{\boldsymbol{\Sigma}}_t$ at time point t may be used to preserve time-varying properties). Generalized factorization avoids the influence of variable order on results, making it suitable for high-frequency interconnectivity analysis in financial markets.

Definition 5 (Connectivity Metrics)

Based on GFEVD results, a series of network connectivity metrics are defined:

Total Connectedness To others: $To_i = \sum_{j\neq i}\widetilde{\theta}_{ij}(H) \times 100$, measuring the total risk spillover intensity from market i to all other markets.

Total Connectedness from Others: $From_i = \sum_{j\neq i}\widetilde{\theta}_{ji}(H) \times 100$, measuring the total intensity of risk inflows received by market i from all other markets.

Net Connectedness Index: $Net_i = To_i - From_i$, reflecting whether market i is a net risk exporter (positive value) or a net risk importer (negative value).

Total Connectedness Index: $TCI = (1/N)\sum_{i=1}^{N} To_i = (1/N)\sum_{i=1}^{N} From_i$, measuring the average risk spillover level across the entire network, i.e., the overall interconnectedness of global financial markets.

This study employs a forecast horizon of 10 trading days (two weeks) and a variable count of 15 major economies. Through rolling estimation (with a rolling window length of 120 trading days), we obtain a dynamic connectivity indicator sequence for each trading day (t), providing high-frequency dependent variables for subsequent panel regression. This measurement system captures both the directionality and intensity of risk spillovers while depicting the time-varying characteristics of network structures, laying the foundation for analyzing the transmission channels of economic policy uncertainty shocks.

C. BENCHMARK PANEL REGRESSION MODEL

To preliminarily explore the relationship among uncertainty shocks, financial stress, and cross-country risk spillovers while controlling for unobservable individual heterogeneity and common time trends, this paper constructs the following two-way fixed-effects panel model as the benchmark analytical framework:

$$\begin{aligned} Spillover_{i,t} = \alpha &+ \beta_1 Domestic\_EPU_{i,t} \\ &+ \beta_2 Global\_EPU_t + \gamma_1 Global\_FSI_t \\ &+ \delta Controls_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}, \end{aligned} \tag{7}$$

where the dependent variable $Spillover_{i,t}$ represents the external risk spillover index or net risk spillover index for market i on day t. The core explanatory variables incorporate both global and country-specific dimensions to distinguish systemic shocks from idiosyncratic shocks: $Domestic\_EPU_{i,t}$ denotes the country-level economic policy uncertainty index, $Global\_EPU_t$ represents the global economic policy uncertainty index, and $Global\_FSI_t$ signifies the global financial stress index. The control variable vector $Controls_{i,t}$ comprises annual macroeconomic variables (converted to daily levels), including financial development level, government debt-to-GDP ratio, GDP growth rate, CPI growth rate, and youth unemployment rate. μ_i represents country-specific fixed effects to capture country characteristics that do not vary over time; λ_t denotes time fixed effects to capture common daily shocks affecting all countries; $\varepsilon_{i,t}$ is the random error term, employing robust standard errors with dual clustering by country and month to correct for potential cross-sectional and serial correlation.

This baseline model aims to preliminarily observe the "net effects" of each core variable. Specifically, coefficients β_1 and β_2 reflect the "residual" direct effect of economic policy uncertainty on risk spillovers after controlling for the current state of financial stress; coefficient γ_1 measures the direct contagion effect of financial stress after controlling for uncertainty factors.

Considering that simultaneously including global and country-level variables may induce multicollinearity issues, this paper adopts a dual treatment strategy. First, the variance inflation factor (VIF) for explanatory variables in the full model is calculated. If the mean VIF for all variables is well below the critical threshold of 10, it indicates that severe multicollinearity does not exist. Second, a stepwise regression strategy is employed to sequentially estimate model combinations containing only country-level variables, only global variables, and both global and country-level variables, with control variables introduced for comparison, as shown in Table II. Specifically: Model (1) includes only country-level EPU variables; Model (2) includes only global EPU and global FSI variables; Model (3) includes both global and country-level variables; Model (4) adds control variables to Model (1); Model (5) adds control variables to Model (2); Model (6) is the full model incorporating all core and control variables. If the sign and significance of key variables remain highly stable across the full model, this enhances the robustness of the conclusions and establishes a reliable foundation for subsequent mediation effect analysis.

TABLE II. Model Definitions and Included Variables

Model	Variables
Model (1)	$(Domestic\_EPU_{i,t})$
Model (2)	$(Global\_EPU_t)$, $(Global\_FSI_t)$
Model (3)	$(Domestic\_EPU_{i,t})$, $(Global\_EPU_t)$, $(Global\_FSI_t)$
Model (4)	$(Domestic\_EPU_{i,t})$, $(Controls_{i,t})$
Model (5)	$(Global\_EPU_t)$, $(Global\_FSI_t)$, $(Controls_{i,t})$
Model (6)	$(Domestic\_EPU_{i,t})$, $(Global\_EPU_t)$, $(Global\_FSI_t)$, $(Controls_{i,t})$

D. MEDIATING EFFECT TEST

To rigorously test Hypothesis H2–that financial stress (FSI) mediates the relationship between economic policy uncertainty and risk spillover–this study employs stepwise regression combined with nonparametric Bootstrap techniques for mediating effect analysis. This method demonstrates strong adaptability within a panel data framework and provides precise confidence intervals for mediating effects (indirect effects). The testing process follows these three progressive equations:

Step 1 (Total Effect): Test the total effect of economic policy uncertainty on risk spillover (c).

$$Spillover_{i,t} = c_0 + c \cdot Uncertainty_{i,t} + \mathbf{\Gamma X}_{i,t} + \mu_i + \lambda_t + e_{1,i,t}, \tag{8}$$

where $Spillover_{i,t}$ denotes the risk spillover indicator, $Uncertainty_{i,t}$ represents various economic policy uncertainty variables (including country-specific EPU, global EPU, etc.), and $\mathbf{X}_{i,t}$ is the vector of control variables. μ_i and λ_t denote individual and time fixed effects, respectively, and $e_{1,i,t}$ is the random error term.

Step 2 (First mediating effect segment): Test the effect of economic policy uncertainty on the mediating variable, the Financial Stress Index (FSI) (a).

$$FSI_{i,t} = a_0 + a \cdot Uncertainty_{i,t} + \mathbf{\Phi X}_{i,t} + \mu_i + \lambda_t + e_{2,i,t}. \tag{9}$$

Here, the mediating variable may be country-specific FSI or global FSI, depending on the analysis level. Coefficient (a) measures the direction and strength of uncertainty's impact on financial stress.

Step 3 (Direct and Mediating Effects): Test the mediating variable's effect on risk spillover (b) and uncertainty's direct effect (c') while controlling for economic policy uncertainty.

$$Spillover_{i,t} = c_0' + c' \cdot Uncertainty_{i,t} + b \cdot FSI_{i,t} + \mathbf{\Psi X}_{i,t} + \mu_i + \lambda_t + e_{3,i,t}. \tag{10}$$

where coefficient (b) measures the marginal effect of financial stress on risk spillover after controlling for uncertainty, while (c') represents the direct effect of uncertainty.

The magnitude of the mediating (indirect) effect is ($a \times b$), and the total effect satisfies ($c = a \times b + c'$). To overcome the non-normality of coefficient product distributions in stepwise regression, this study employs a bias-corrected percentile bootstrap method for significance testing. Specifically, 5000 resampled samples are drawn with replacement from the original dataset. After each sampling, the three equations are estimated, and the estimated value of ($a \times b$) is recorded to construct the 95% confidence interval for the indirect effect. If this confidence interval does not contain zero, it indicates that the mediating effect is statistically significant. This method does not rely on the assumption of normality and is suitable for panel data that may exhibit asymmetric and non-normal disturbances, providing more robust statistical inference.

E. ESTIMATION DETAILS AND TESTS

To ensure the reliability of estimation results and the validity of statistical inferences, all panel regressions were estimated using the PanelOLS function from Python's linearmodels library, specifying a covariance matrix of individual-time bidirectional clustering. This configuration effectively controls potential cross-sectional correlation (interdependence among countries at the same time point) and time-series correlation (autocorrelation within countries across time points), thereby correcting standard error biases and enhancing the accuracy of hypothesis tests. Bootstrap mediation tests were automated using the statsmodels and pandas libraries for resampling and coefficient estimation loops: In each sample, the three sequential equations for the mediating effect were successively estimated, recording the indirect effect estimate ($a \times b$). After 5000 resamples, a bias-corrected percentile method constructs the 95% confidence interval for the indirect effect to assess the statistical significance of the mediation effect. This method does not rely on the assumption of normality and is suitable for panel data that may exhibit asymmetric and non-normal disturbances.

To validate the robustness of the findings and further reveal the heterogeneity of transmission mechanisms, this study conducts systematic tests across the following dimensions. First, by altering the measurement of the dependent variable, the net spillover index replaces the total spillover index to re-estimate the benchmark model and mediation effect, examining whether the results depend on the specific measure of risk spillover. The net spillover index comprehensively reflects the net difference between a market's external risk output and intake, capturing its role within risk networks from multiple perspectives. Second, to mitigate potential reverse causality, all core explanatory variables (including country-level and global economic policy uncertainty indices and financial stress indices) are lagged by one period before re-running the regression analysis. Since economic policy uncertainty and financial stress may be influenced by feedback from contemporaneous risk spillovers, this lagging treatment helps identify the exogenous shock effects of the former. Third, to test the heterogeneity of transmission mechanisms in Hypothesis H3, this study conducts grouped tests across two dimensions. First, based on the sources and nature of financial stress, the financial stress index is categorized into three groups: the United States, other developed economies, and emerging market economies. Each group is incorporated into the mediation effect model to examine the differentiated roles of financial stress from different sources within the transmission pathway. Second, based on the values of the global financial stress index, the sample is divided into "high-stress periods" (above the upper quartile) and "normal periods" (below the upper quartile). The study compares the magnitude of uncertainty variable coefficients and the strength of mediation effects across these two groups. This test aims to reveal the nonlinear moderating effect of financial stress states on the transmission mechanism: whether uncertainty shocks are dramatically amplified when the financial system is already under high stress. Through these multidimensional robustness and heterogeneity tests, this study strives to balance methodological rigor with robust conclusions, providing reliable empirical support for theoretical hypotheses.

IV. EMPIRICAL ANALYSIS AND RESULTS

A. DYNAMIC CHARACTERISTICS OF THE RISK SPILLOVER NETWORK

Based on dynamic calculations using the HD-TVP-VAR-DY model, the average total risk spillover index across 15 major global stock markets reached 70.968% during the sample period. This figure confirms that cross-country risk transmission is not an isolated occurrence in financial integration but rather a structural norm in global financial markets. As shown in Fig. 2 depicting the temporal evolution of total risk spillover, the index fluctuated within a range of 40% to 90%, exhibiting a typical "peak-heavy tail" distribution. Its dynamic trajectory was highly correlated with major global risk events.

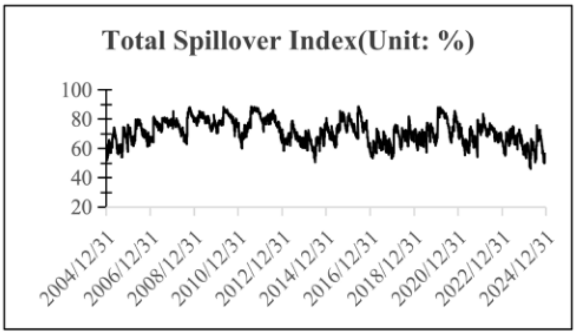

FIGURE 2. Time-series evolution of total risk spillover.

During the 2008 global financial crisis, U.S. subprime mortgage risks rapidly spread through the dollar-denominated system and cross-border banking networks. The total spillover index surpassed 85% in the second half of 2008, approaching the peak of the sample period, profoundly reflecting the "resonance effect" within global financial markets during crises. Following the 2011 European debt crisis, cross-border transmission of eurozone sovereign debt risks triggered global market turbulence, pushing the index above 80% once more and highlighting Europe's systemic role within the global risk network. Although China's 2015 stock market volatility remained largely localized, its "ripple effect" through global supply chains and cross-border capital flows still caused a pulse-like surge in the index. The intensified Sino-US trade friction in 2018 heightened policy uncertainty, with declining investor risk appetite amplifying index volatility. The economic shutdown and liquidity crisis triggered by the 2020 global COVID-19 pandemic enabled risks to achieve "instantaneous resonance" across the global financial network, rapidly pushing the index above 85%. This confirmed the synchronized and severe nature of risk contagion under extreme shocks. This "peak-heavy tail" distribution further supports the procyclical contagion theory in financial networks: extreme risk events not only elevate risk spillover levels but also prolong high-spillover states through the dual effects of market panic and liquidity tightening, highlighting the nonlinear amplification effect of global financial interconnectedness.

Correspondingly, the three-dimensional spillover index decomposition in Table III further reveals divergent risk roles across global financial markets. Examining total outward spillover (To), total inward spillover (From), and net spillover (Net), economies like Italy, Germany, Brazil, and China consistently emerged as net risk exporters during the sample period. Italy and Germany recorded total outward spillover indices of 128.161% and 103.865% respectively, significantly exceeding their total inward spillover levels. This reflects the "risk source" attributes of core Eurozone economies: the region's financial integration substantially amplifies sovereign debt risk spillovers, while Germany's role as the Eurozone's "anchor economy" magnifies the transmission of its monetary policy and financial market volatility across the region and globally. Brazil's net outflow characteristic stems from its reliance on commodity exports and the high volatility of emerging markets, while China's net outflow is closely linked to the expansion of its capital market scale and the deepening of cross-border capital flows, reflecting the increasingly systemic role of emerging economies within the global risk network.

TABLE III. Three-Dimensional Spillover Index

Country or Region	To	From	Net
USA	74.905	78.973	-4.068
CAN	48.923	83.785	-34.862
BRA	113.504	52.161	61.343
CHN	49.781	43.266	6.515
HKG	63.295	71.408	-8.113
GER	62.833	85.862	-23.029
FRA	108.132	81.577	26.555
DEU	103.865	80.100	23.765
ITA	128.161	72.429	55.732
JPN	40.704	71.329	-30.625
RUS	109.072	46.058	63.013
KOR	38.135	75.616	-37.481
AUS	16.966	85.644	-68.677
IND	40.718	65.544	-24.826
MEX	65.532	70.774	-5.242

Note: (To: Total Outbound Spillover, From: Total Inbound Spillover, Net: Net Spillover)

In contrast, economies such as South Korea, Russia, Canada, and Australia have long been net risk importers. South Korea's total exposure to spillovers (85.644%) significantly exceeds its total external spillover level (38.135%), reflecting heightened sensitivity of its highly open capital markets to global risk shocks. Russia's net import characteristic is closely tied to its reliance on energy exports and the transmission of geopolitical risks, where external shocks rapidly permeate domestic markets through commodity prices and capital flows. Canada and Australia's net import attributes stem from their resource-based economic structures, making them passive recipients of global risks through fluctuations in global commodity prices and cross-border capital flows.

Notably, the United States' net spillover index stands at -4.068%, indicating it functions as a mild net importer on average during the sample period. However, examining temporal patterns reveals that the U.S. became a core risk exporter during extreme events like the 2008 financial crisis. This divergence between "normal-state importer-crisis exporter" reveals the time-varying nature of leading economies' risk roles: under normal conditions, the depth and liquidity of U.S. financial markets make it a "safe haven" for global capital; during crises, the transmission effects of the dollar system transform it into the core of risk spillover. This finding confirms the dual nature of U.S. financial markets' "systemic importance" and risk transmission.

B. BENCHMARK REGRESSION RESULTS

Prior to conducting formal regression analysis, this study first performed multicollinearity diagnostics on the core explanatory variables and control variables. After trimming and standardizing the core explanatory variables to eliminate dimensional effects, the variance inflation factor (VIF) test revealed that all variables' VIF values were well below the critical threshold of 10. The maximum VIF was 3.45 (corresponding to youth unemployment rate), with an average of only 1.98. The Pearson correlation coefficients between variables did not exceed 0.7. This indicates no severe multicollinearity issues in the model, providing a reliable statistical basis for estimating and inferring regression coefficients.

Table IV reports the benchmark panel regression results with the total risk spillover index ($Spillover$), representing the risk exported by each country's market, as the dependent variable. Through a stepwise model specification, the driving logic of risk contagion exhibits significant bidirectional heterogeneity. In Model (1), which includes only domestic-level variables, controlling for country-specific and time fixed effects, the coefficient for domestic economic policy uncertainty (Domestic_EPU) is highly significant at the 1% level ($\beta = 7.4282$, $p = 0.0067$). This indicates that increased domestic economic policy uncertainty significantly enhances a country's risk spillover capacity: Domestic policy fluctuations transmit risk to global markets through channels such as cross-border capital flows and asset price linkages. This result preliminarily reveals the driving role of domestic uncertainty in transnational risk spillovers. In Model (2), which incorporates only global-level variables, the coefficient for the global financial stress index (Global_FSI) is significantly positive at the 5% level ($\beta = 3.9555$, $p = 0.0171$), while the coefficient for global economic policy uncertainty (Global_EPU) is insignificant. This indicates that global financial stress exerts a weaker driving force on risk export than on risk import. Global systemic shocks primarily function as an "amplifier" intensifying external risks borne by countries, rather than directly driving domestic risk export.

In Model (3), which simultaneously incorporates domestic and global core variables, the coefficient for (Domestic_EPU) remains highly significant at the 1% level ($\beta = 7.1467$, $p = 0.0027$), while the coefficient for (Global_FSI) is significant at the 10% level ($\beta = 3.1680$, $p = 0.0615$). This indicates that the driving effect of domestic economic policy uncertainty on risk exportation remains robust, while the influence of global financial pressure has weakened. After incorporating macroeconomic control variables, Model (4) includes domestic variables and control variables under a dual fixed-effects model. The coefficient for (Domestic_EPU) is significantly positive at the 5% level ($\beta = 6.2143$, $p = 0.0248$) under the dual fixed-effects model. In Model (5), after incorporating global variables and controls, all global variable coefficients become insignificant, indicating that the impact of global financial pressures on risk output is fully absorbed after controlling for macroeconomic fundamentals. In Model (6), the full variable model, the coefficient of (Domestic_EPU) remains highly significant at the 1% level ($\beta = 6.0081$, $p = 0.0083$). This further validates that domestic economic policy uncertainty is the core driver of a country's outward risk transmission–heightened domestic policy volatility significantly amplifies a country's capacity to transmit risk to global markets, while the influence of global factors remains relatively limited.

TABLE IV. Benchmark Panel Regression Results (Dependent Variable: Spillover)

	Model (1)	Model (2)	Model (3)
Domestic_EPU	7.4282***		7.1467***
Global_EPU		-0.0694	-1.5249
Global_FSI		3.9555**	3.1680*
Controls	NO	NO	NO
Country FE	YES	YES	YES
Time FE	YES	NO	NO
Obs.	74,715	74,715	74,715
R^2	0.1713	0.1042	0.2716

TABLE IV. (Continued)

	Model (4)	Model (5)	Model (6)
Domestic_EPU	6.2143**		6.0081***
Global_EPU		-1.0100	-1.1930
Global_FSI		2.9114	2.4399
Controls	YES	YES	YES
Country FE	YES	YES	YES
Time FE	YES	NO	NO
Obs.	74,715	74,715	74,715
R^2	0.3184	0.3075	0.4201

Note: ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors adjusted for dual clustering by country and year. FE: Fixed Effects. Controls included but not reported.

In summary, regression results with risk spillover as the dependent variable indicate that domestic economic policy uncertainty is the core driver of a country's outward risk transmission. Its coefficient remains significantly positive across all models, while the impact of global financial stress is comparatively weaker. This divergence profoundly reveals the bidirectional heterogeneity of risk contagion within global stock market networks: global financial stress primarily functions as an "amplifier" intensifying external risk inflows to countries, while domestic uncertainty primarily acts as a "driver" enhancing a country's risk outflows. This finding provides crucial empirical evidence for understanding the asymmetry of risk contagion in global stock markets and lays the groundwork for subsequent analysis of the mediating effects of risk contagion.

C. MEDIATING EFFECT TEST RESULTS

Building upon the benchmark regression revealing the association between uncertainty and risk spillover, this study further examines the mediating role of financial stress (FSI) in the transmission process from economic policy uncertainty (EPU) to risk spillover ($Spillover$) through a mediating effect test. Employing stepwise regression combined with 5,000 Bootstrap samples to control potential estimation biases and enhance robustness, this study focuses on two core transmission pathways: domestic economic policy uncertainty → domestic financial stress → risk spillover (Domestic_EPU → Domestic_FSI → $Spillover$) and global economic policy uncertainty → global financial stress → risk spillover (Global_EPU → Global_FSI → $Spillover$). Table V reports the Bootstrap test results for the mediating effects across these two transmission channels.

TABLE V. Summary of Mediating-Effect Analysis and Test Results

	Domestic	Global
Path A	0.0372	-0.0216
Path B	18.6257	2.9829
Indirect Effect ($a \times b$)	0.6936	-0.0644
Direct Effect (c')	5.4249	-0.8345
Total Effect (c)	6.1185	-0.8989
Mediation proportion	11.34%	7.17%
Standard error	0.0377	0.0099
95% Confidence interval (lower bound)	0.6207	-0.0842
95% Confidence interval (upper bound)	0.7684	-0.0461
P-value	0.0000	0.0000
Conclusion	Significant	Significant

Regarding the transmission channels of domestic economic policy uncertainty, path A (Domestic_EPU → Domestic_FSI) has a coefficient of 0.0372 and is significant at the 1% level, indicating that increased domestic economic policy uncertainty significantly elevates domestic financial stress levels; Path B (Domestic_FSI → $Spillover$), controlling for (Domestic_EPU) has a coefficient of 18.6257 and is significant, meaning increased domestic financial stress significantly enhances a country's risk spillover capacity. The product of these two paths constitutes the indirect effect, valued at 0.6936. Its Bootstrap 95% confidence interval 0.6207, 0.7684 does not contain zero, confirming the significance of the mediating effect. The direct effect (c') is 5.4249 and significant, while the total effect (c) is 6.1185. The mediation proportion is 11.34%, indicating that approximately 11.34% of the total positive driving effect of domestic economic policy uncertainty on risk spillover is achieved through the mediating channel: "increased domestic policy uncertainty → increased domestic financial pressure → enhanced risk spillover."

Shifting to the global transmission pathway: Path A (Global_EPU → Global_FSI) for global economic policy uncertainty (Global_EPU) has a coefficient of -0.0216 and is significant, indicating that rising global EPU significantly reduces global financial stress. Path B (Global_FSI → $Spillover$), controlling for (Global_EPU) has a coefficient of 2.9829 and is significant, meaning increased global financial pressure amplifies risk spillover. The indirect effect is -0.0644, with a Bootstrap 95% confidence interval -0.0842, -0.0461 that does not include zero, confirming a significant mediating effect. The direct effect (c') is -0.8345 and significant, while the total effect (c) is -0.8989. The mediation proportion is 7.17%, indicating that approximately 7.17% of the total negative effect of global EPU on risk spillover is achieved through the mediating channel: "increased global

EPU → decreased global financial stress → weakened risk spillover."

Combining the test results from both pathways, the Bootstrap 95% confidence intervals for all indirect effects do not include zero. This confirms the pervasive mediating role of financial stress (FSI) in the transmission from economic policy uncertainty (EPU) to risk spillover ($Spillover$), strongly supporting hypothesis H2. Simultaneously, the direction and magnitude of mediating effects differ significantly between domestic and global pathways: the domestic pathway primarily exhibits positive driving effects, where domestic uncertainty amplifies risk spillovers through financial stress channels; while the global path exhibits a negative buffering effect, where global uncertainty weakens risk spillovers through the financial stress channel. This divergence further reveals heterogeneous mechanisms in the cross-border transmission of uncertainty, providing deeper empirical evidence for understanding the complexity of risk contagion within global financial networks.

D. HETEROGENEITY ANALYSIS AND ROBUSTNESS TESTS

To more clearly identify structural differences in the impact of uncertainty and financial stress on risk spillovers, this paper conducts heterogeneity analysis based on a benchmark regression framework with the total risk spillover index ($Spillover$) as the dependent variable. This analysis examines two dimensions–different periods of financial stress and different sources of financial stress–to further test the conditional validity of the conclusions. Simultaneously, to ensure the reliability of the findings, robustness tests are conducted from multiple angles, including variable substitution, endogeneity treatment, and estimation method transformations. All tests focus on the full-variable benchmark Model (6), with results presented uniformly in a single table for comparative analysis.

1) Heterogeneity Analysis Across Financial Stress Periods

Using the upper quartile of the global financial stress index (Global_FSI) as the cutoff point, the full sample is divided into two subsamples: periods of high financial stress and periods of normal financial stress. Separate regressions are conducted for each. Table VI presents the results of the heterogeneity analysis. Empirical results reveal a pronounced asymmetric effect of uncertainty and financial stress on risk spillover. Within the high-stress subsample, the coefficient for domestic economic policy uncertainty (Domestic_EPU) is significantly higher than in the full sample and normal period, reaching 8.7219 and significant at the 1% level. In contrast, the normal period coefficient is 4.1563 with significance dropping to the 5% level. The coefficient for global financial stress (Global_FSI) was 4.1072 and significant during high-stress periods, whereas it was only 1.5804 and less significant during normal periods. Furthermore, the model fit (R^2 = 0.0715) was significantly higher during high-stress periods than during normal periods (R^2 = 0.0268), indicating that the model explains risk spillover more effectively under financial strain. This finding reveals that when the global financial system itself is under strain, market resilience weakens and investor sentiment becomes more sensitive. Economic policy uncertainties and geopolitical risks are amplified, significantly intensifying a country's outward risk transmission. Under extreme financial conditions, risk contagion exhibits pronounced acceleration and amplification characteristics.

TABLE VI. Heterogeneity Analysis Results

	Full Sample	Financial Stress Period	
		High	Normal
Domestic_EPU	6.0081***	8.7219***	4.1563**
Global_EPU	-1.1930	-1.8246*	-0.7614
Global_FSI	2.4399	4.1072**	1.5804*
Controls	YES	YES	YES
Country FE	YES	YES	YES
Time FE	NO	NO	NO
Obs.	74,715	18,679	56,036
R^2	0.0420	0.0715	0.0268

TABLE VI. (Continued)

	Financial Stress Source		
	US_FSI	AE_FSI	EM_FSI
Domestic_EPU	6.1145***	5.8722***	5.6109**
Global_EPU	-1.2271*	-1.1409	-1.0726
Global_FSI	3.6918**	1.9145*	1.3268*
Controls	YES	YES	YES
Country FE	YES	YES	YES
Time FE	NO	NO	NO
Obs.	74,715	74,715	74,715
R^2	0.0517	0.0374	0.0293

Note: ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors adjusted for dual clustering by country and year. FE: Fixed Effects. Controls included but not reported.

2) Heterogeneity Analysis of Financial Stress Sources

This study sequentially replaces the global financial stress index (Global_FSI) in the benchmark model with the U.S. financial stress index (US_FSI), the financial stress index of other developed economies (AE_FSI), and the financial stress index of emerging market economies (EM_FSI) to identify the differentiated roles of various financial centers within the risk network. The regression results, as shown in Table VI, reveal that the coefficient for the U.S. Financial Stress Index is the largest (3.6918) and most statistically significant (at the 5% level) among the three groups. Its marginal contribution to risk spillover across countries is significantly stronger than that of emerging markets (1.3268, 10% level) and other developed economies (1.9145, 10% level). This finding confirms the current center-periphery structure of the global financial system: As the core anchor for global liquidity and pricing, fluctuations in U.S. financial stress exert dominant influence on the global risk spillover network through channels such as dollar circulation, cross-border capital flows, and asset pricing. In contrast, the spillover effects of financial stress from emerging markets and other developed economies remain relatively limited.

3) Robustness Checks

To ensure the benchmark findings remain unaffected by variable specification, endogeneity, and estimation methods, this study conducts multidimensional robustness checks around Model (6), specifically including: replacing the dependent variable with the Net Risk Premium Index (NET); lagging the core explanatory variables by one period to mitigate reverse causality concerns; Employing instrumental variables (IV-2SLS) to address potential endogeneity, using lagged second- to fourth-order terms of core explanatory variables as instruments; applying System Generalized Method of Moments (System GMM) to control for dynamic path dependence; and re-regressing after excluding samples from the extreme crisis periods of the 2008 global financial crisis and the 2020 COVID-19 pandemic. Table VII summarizes the results of these robustness tests.

TABLE VII. Robustness Test Results

	Full Sample	Dependent Variable (NET)	Core Explanatory Variable (1st Lag)
Domestic_EPU	6.0081***	5.7834***	
Global_EPU	-1.1930	-1.1509	
Global_FSI	2.4399	2.3711	
L.(Domestic_EPU)			5.5126***
L.(Global_EPU)			-1.0843*
L.(Global_FSI)			2.2607*
Controls	YES	YES	YES
Country FE	YES	YES	YES
Time FE	NO	NO	NO
Obs.	74,715	74,715	73,968
R^2	0.0420	0.0462	0.0395

TABLE VII. (Continued)

	IV-2SLS Estimation	System GMM Estimation	Excluding Crisis Periods
Domestic_EPU	6.2417***	5.8904***	5.3176***
Global_EPU	-1.2685*	-1.1672	-1.0144*
Global_FSI	2.5163**	2.4058	2.1476*
L.(Domestic_EPU)			
L.(Global_EPU)			
L.(Global_FSI)			
Controls	YES	YES	YES
Country FE	YES	YES	YES
Time FE	NO	NO	NO
Obs.	74,715	74,715	67,412
R^2	–	–	0.0341

Note: ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors adjusted for dual clustering by country and year. L. denotes the first lag. FE: Fixed Effects. Controls included but not reported. R^2 is not reported in IV-2SLS Estimation and System GMM Estimation.

Across all tests, the coefficient sign, magnitude, and statistical significance of domestic economic policy uncertainty (Domestic_EPU) remained highly consistent with the benchmark regression. The coefficient consistently ranged between 5.3 and 6.2, achieving significance at the 1% or 5% level. Although the significance of the global financial stress (Global_FSI) coefficient fluctuated slightly across tests, its direction remained positive and was mostly significant at the 10% level. In tests substituting the core explanatory variables with one-period lagged versions, the coefficient for (Domestic_EPU) was 5.5126 and significant at the 1% level, while the coefficient for (Global_FSI) was 2.2607 and significant at the 10% level, broadly matching the benchmark results. Results from instrumental variables and system GMM estimations similarly support the benchmark conclusions, indicating endogenous issues do not pose a serious threat to core findings. After excluding extreme crisis periods, the coefficient for (Domestic_EPU) remains at 5.3176 and is significant at the 1% level, while (Global_FSI)'s coefficient is 2.1476 and significant at the 10% level. This demonstrates that conclusions are not driven by extreme events and possess general applicability. None of the above robustness tests altered the sign or significance of the core variables, fully demonstrating the high reliability and robustness of this paper's conclusion that economic policy uncertainty affects cross-border risk spillovers through the financial stress channel.

V. CONCLUSION

A. KEY FINDINGS

By integrating high-frequency risk spillover networks, mixed-frequency data, and rigorous mediation effect tests, this study systematically examines the dynamic mechanism through which economic policy uncertainty catalyzes cross-border risk spillovers via financial stress. The following key conclusions emerge:

First, economic policy uncertainty at both global and national levels constitutes the fundamental macroeconomic driver of cross-border financial risk spillovers. Dynamic estimations based on the HD-TVP-VAR model reveal that the global equity risk spillover network exhibited a pronounced "peak-heavy tail" distribution during the sample period, with the total spillover index averaging 70.97% and repeatedly exceeding 85% during extreme event shocks. Benchmark regression results reveal that domestic economic policy uncertainty exerts a significant positive driving effect on a country's risk exports, with its coefficient remaining robustly significant across all models. Meanwhile, global financial stress primarily functions as an "amplifier," intensifying the external risk inputs faced by nations. Among these, policy and geopolitical risks originating from shared global challenges–particularly those stemming from core economies like the United States–exert the most widespread and profound influence.

Second, financial system pressures play a crucial mediating role in this transmission process. Mediating effect tests confirm that economic policy uncertainty catalyzes cross-border risk spillovers by influencing financial pressures. Specifically: Global economic policy uncertainty, conversely, exerts a negative buffering effect through the pathway: "increased global EPU → reduced global financial stress → weakened risk transmission," accounting for approximately 7.17% of the mediating effect. The Bootstrap confidence intervals for both pathways do not contain zero, confirming the significant mediation effect. This indicates that the state of financial stress acts as an "accelerator" and "amplifier" for cross-border risk contagion, with a substantial portion of uncertainty shocks transmitting their cross-border effects through this channel.

Third, this transmission mechanism exhibits significant heterogeneity. By economy type, emerging markets are more sensitive to uncertainty shocks, exhibiting more pronounced reactions in financial stress and risk spillovers. By financial stress state, transmission effects intensify sharply and non-linearly when the global financial system faces high stress, creating a vicious "stress-spillover" cycle. Heterogeneity analysis further reveals that fluctuations in the U.S. financial stress index exert the most pronounced influence on the global risk spillover network, with coefficients significantly stronger than those of other developed economies and emerging markets. This underscores the systemic importance of the U.S. as a core node in the global financial system. Robustness tests consistently uphold the core findings, confirming the reliability of the research conclusions.

B. RESEARCH LIMITATIONS AND FUTURE DIRECTIONS

This study has certain limitations, which also point to directions for future research. First, while this paper primarily focuses on risk spillovers between stock markets, financial market contagion involves complex interactions across multiple asset classes such as bonds, foreign exchange, and derivatives. Future research could expand the analysis to multidimensional contagion networks encompassing multiple asset classes, thereby more comprehensively capturing the interconnectedness of the financial system. Second, the analysis of transmission channels warrants further refinement. While this study primarily examines the mediating role of financial stress, more micro-level channel variables–such as investor sentiment, cross-border capital flows, and financial institutions' cross-border risk exposures–may also play significant roles. Future research could incorporate these variables into mediation analysis frameworks to uncover deeper insights into the underlying logic of transmission mechanisms. Finally, as climate change becomes increasingly prominent, uncertainties stemming from climate-related policy adjustments are emerging as a new source of risk. Future research could incorporate a climate policy uncertainty index into the analytical framework, comparing its transmission mechanisms with those of traditional policy uncertainty to provide theoretical support for more comprehensive macroprudential policy design.

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