



Unravelling determinants and interconnectedness among global risks and financial stress in South and Southeast Asia

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ABSTRACT

We investigate the interconnectedness among categorical global geopolitical risk, financial stress indices for advanced and emerging markets, global economic conditions, oil and gold market uncertainty, and financial stress in South and Southeast Asian economies and explore the impact of global factors on their connectedness, employing the time-frequency time-varying parameter vector autoregressive connectivity method and monthly data from January 2008 to June 2022. Our results reveal a large degree of interconnectedness and interdependence, where short-term connectedness dominates long-term connectedness. Furthermore, geopolitical risks, global economic conditions, and financial stress in South and Southeast Asian countries are net shock receivers, while financial stress indices for advanced and emerging markets, along with oil and gold market uncertainty, are net shock transmitters. A few factors exhibit risk transmission changes in both the short and long runs. Additionally, Asian economies' financial stress is a net shock receiver of global uncertainty factors across spectral frequencies. In addition, economic policy uncertainty and global FSI external influence spillover, whereas VIX and climate policy uncertainty have no impact on spillover. These empirical findings have implications for financial institutions and policymakers.

1. Introduction

Global geopolitical risk has recently intensified since the Russia-Ukraine war (Umar et al., 2022). In addition to global political risk, South and Southeast Asia are home to several countries experiencing geopolitical tensions (Bishwakarma and Hu, 2022; Koldunova, 2023), such as India, Pakistan, China, and Myanmar, which can affect investor confidence and lead to capital outflows. This can also lead to currency depreciation and inflationary pressure in the affected economies. Financial stress, such as banking system weaknesses, high levels of debt, and financial market volatility, can lead to contagion across borders through trade and investment linkages (Chen et al., 2022; Davig & Hakkio, 2010; Yurteri Köseadağlı and Önder, 2021). Global economic conditions, such as economic growth,

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inflation, and unemployment, can affect investor sentiment and capital flows (Afonso and Blanco-Arana, 2022; Gumata et al., 2019). A slowdown in economic growth can lead to reduced investment and trade, which can have a spillover effect on the neighboring economies. These crises have highlighted the interconnectedness of financial markets and the potential for financial stress in one region to spill over and affect others (Long et al., 2021). The COVID-19 pandemic led to a sharp decline in global trade and investment, and many countries in the region, including South and Southeast Asian economies, experienced a decline in economic growth and increased financial stress (Li et al., 2023).

The interconnectedness of global financial markets has heightened the significance of understanding how fluctuations in key commodities, such as oil and gold, influence a country's level of financial stress (Fu et al., 2022; Gkillas et al., 2020). Oil and gold markets, being critical components of the world economy, often experience periods of heightened uncertainty due to geopolitical events, supply-demand imbalances, and macroeconomic shifts (Baur & McDermott, 2010; Kilian, 2009; Reboredo & Rivera-Castro, 2014). The impact of oil market uncertainty on a country's financial stress can be profound, as oil price volatility can disrupt economic stability by affecting inflation rates, trade balances, and fiscal policies (Das et al., 2022; Dornbusch, 1985; He et al., 2021; Phan et al., 2019). Similarly, gold market uncertainty can contribute to financial stress, as gold serves as a safe-haven asset in times of market turbulence, and its price fluctuations can reflect shifts in investor sentiment and global risk perceptions (Baur & McDermott, 2010; Kocaarslan et al., 2019). This interconnectedness points out the need for comprehensive analyses that evaluate the intricate relationships between oil and gold market uncertainties and their effects on country-level financial stress, giving helpful insight to policymakers and investors alike.

South and Southeast Asian¹ economies have experienced phenomenal economic growth and development over the past few decades. The combined nominal GDP (in USD) of the eight countries, as of 2021, is approximately \$6.28 trillion, which is 8.2% of the world's total nominal GDP. According to the IMF, ASEAN-5 is expected to grow at an average rate of 4.77% in the next three years, which is higher than the average global growth rate of 3.0% in the same period (International Monetary Fund, 2022). India, Pakistan, and Sri Lanka are expected to grow at the rate of 6%, 4.57%, and −3.4% respectively.² This growth has been driven by factors such as increasing trade and investment, favorable demographics, and government policies that promote economic development. However, the region's economic growth and development have also been accompanied by increased exposure to external shocks. South and Southeast Asian economies are heavily integrated into global trade networks, where combined export and import are 10% and 11% of the global export and import,³ respectively. According to UNCTAD, the COVID-19 pandemic has caused a 25% decrease in foreign direct investment (FDI) flows in ASEAN from its peak of \$182 billion in 2019 to \$137 billion in 2020, despite the region's financial markets being interconnected.⁴ As a result, the region is exposed to not only regional political, economic, and financial conditions but is also vulnerable to spillover effects from global factors and shocks.

Past studies have examined connectedness and spillover effects related to financial stress, focusing on individual factors such as geopolitical risk (Shahzad et al., 2023), oil market uncertainty (Alam and Forhad, 2025; Apostolakis et al., 2021), and gold market uncertainty (Hoque et al., 2023; Khan et al., 2025). Other studies have analyzed the connectedness between advanced and emerging economies' financial stress indexes (FSI) (Gil-Alana et al., 2021; Li et al., 2023). Additionally, some studies have examined the spillover effects between FSI and economic activity, as proxied by economic conditions (Kasal, 2023; Polat and Ozkan, 2019). However, previous studies have not explicitly combined analyses of the connectedness among the GPR, FSI, oil, and gold markets. More importantly, the existing literature has overlooked financial stress in South and Southeast Asian economies (see Dagher and Hasanov, 2023). Therefore, this study aims to investigate connectedness and spillover effects across global geopolitical uncertainty, regional financial stress, economic conditions, oil and gold market uncertainty, and the financial stress of South and Southeast Asian economies. Globalization and the rise of emerging markets have increased interdependence among nations, integrating financial and economic systems. However, this integration has also exposed economies to heightened risks from global geopolitical uncertainty, financial stress, and economic conditions that can be transmitted across borders worldwide. South and Southeast Asia have experienced rapid economic growth, driven by global trade and investment. Our theoretical framework draws on two perspectives: 1) the contagion/spillover view and 2) the interdependence view. Furthermore, different market participants and policymakers may focus on short-term versus long-term connectedness. Therefore, we employ a novel time-frequency approach to analyze the connectedness among the aforementioned global and regional factors, specifically focusing on financial stress in South and Southeast Asia. Additionally, past studies highlighted the importance of global factors like economic policy uncertainty (EPU), market volatility (VIX), global financial stress (GFSI), and climate policy uncertainty (CPU) on interconnectedness (Billah et al., 2024, 2025; Hoque et al., 2024; Elaysaed, 2025; Zhuo et al., 2025), which TVP-VAR models may not fully capture. Thus, we also examined the influence of these factors on connectedness.

Therefore, the current study contributes to the literature in the following ways. First, this study focuses on time-frequency connectedness among categorical geopolitical risk, regional financial stress, gold market uncertainty, and oil market uncertainty. Therefore, the current study extends the literature on geopolitical risk-financial stress (Shahzad et al., 2023), geopolitical risk-gold market uncertainty (Kamal et al., 2022; Li et al., 2021a), geopolitical risk-oil market uncertainty (Wang et al., 2023; Zhao, 2023), gold market uncertainty-FSI (Hoque et al., 2023), oil market uncertainty-FSI (Apostolakis et al., 2021), oil market uncertainty and gold market uncertainty (Baur and Lucey, 2010; Hamilton, 2008; Li et al., 2021b), and advanced economies FSI-Emerging FSI (Gil-Alana

¹ India, Pakistan, Sri Lanka, Philippines, Thailand, Indonesia, Malaysia, Singapore.

² Authors calculation based on the IMF Regional Outlook Asia and Pacific, October 2022.

³ Authors calculation based on WTO World Trade Statistical Review 2021.

⁴ ASEAN Investment Report 2021.

et al., 2021; Li et al., 2023; Long et al., 2021). Therefore, the current study provides a novel perspective on GPR-FSI-OIL-GOLD and bridges a gap in the literature. Additionally, the current study extends the study of Dagher and Hasanov (2023), who showed an oil price shock-financial stress nexus in Asian economies. Second, the analysis of the temporal and spectral interdependence between categorical geopolitical risk, regional financial stress, gold market uncertainty, and oil market uncertainty provides valuable insights into their interconnections across both short- and long-term horizons. Hence, policymakers and financial institutions may attain enhanced comprehension of risk dispersion across geopolitical risk, regional financial stress, gold market uncertainty, and oil market uncertainty via the evaluation of time-frequency connections. This information is significant in risk management as it facilitates the identification of potential contagion or spillover effects resulting from these interconnected interactions. Third, Hasanov (2023) focused on Asian economies' financial stress and oil price shocks, and the current study extends this by focusing on South and Southeast Asia's financial stress. Fourth, this study provides fresh evidence of the influence of global risk factors on connectedness, showing that global financial stress and economic policy uncertainty can affect the independence level.

The remainder of this paper is organized as follows. This section presents the theoretical background and a careful review of pertinent empirical research. Based on observation and experience, Section 3 examines sensible processes and data collection. The following section looks at the empirical results and their implications. The final section of the study comes upon completion.

2. Literature review

2.1. Theoretical background

This study aims to untangle the complicated connections among global geopolitical uncertainty, financial stress, economic conditions, oil market uncertainty, and gold market uncertainty, and their impact on the financial stress experienced by economies in South and Southeast Asia. Drawing on key theoretical frameworks, this research seeks to shed light on the underlying mechanisms that drive these complex dynamics. First, contagion or transmission mechanism theory highlights how global geopolitical uncertainty, characterized by unpredictable political events, diplomatic tensions, and international conflicts, has been recognized as a significant source of financial market volatility and risk aversion. This uncertainty can lead to heightened financial stress, manifested through increased market volatility, capital flight, and disruptions in currency values, trade flow, and financial institutions. Extensive research by Baker et al. (2016) and Forbes and Rigobon (2002) demonstrate how geopolitical events can trigger financial market turbulence and stress, reverberating across borders and impacting the stability of emerging economies.

Second, the concept of spillover effects highlights how disturbances in one market or region can propagate to others, creating interconnectedness. Financial markets are highly integrated, making them susceptible to transmission mechanisms that amplify or attenuate the spillover effects. Diebold and Yilmaz (2012) pioneered the network analysis framework to quantify and visualize spillovers, revealing the extent of interconnectedness and contagion across different markets. Moreover, the oil and gold markets are pivotal components of the global economic landscape. Oil market uncertainty arises from fluctuations in oil prices driven by factors like supply-demand imbalances and geopolitical tensions. Gold, often regarded as a safe-haven asset, experiences increased demand during uncertain periods. Empirical research by Hamilton (2008) and Baur and Lucey (2010) underscores the intricate links between oil price fluctuations, gold market behavior, and their impact on financial markets.

Third, economic policy frameworks accentuate the critical role of policy responses in mitigating or exacerbating the impact of these uncertainties. A country's economic conditions, encompassing indicators like GDP growth, inflation rates, unemployment, and trade balances, intricately link to its financial health. Changes in economic conditions, both globally and regionally, can influence the level of financial stress experienced by economies. Claessens et al. (2012), Kremer et al. (2016), and Balcilar et al. (2022) highlight the relationship between economic indicators and financial stress, emphasizing how economic downturns can amplify financial vulnerabilities.

2.2. Related studies

The relationship between geopolitical risk and emerging markets has garnered significant attention from researchers in the recent past. Liow et al. (2018) underlined the importance of spillovers—which account for most of the variations in policy uncertainty and financial market stress in the seven countries under analysis. Policy uncertainty in several countries causes financial market stress to spread beyond national boundaries. Recent studies by Mokni et al. (2020), Long et al. (2021), Guo et al. (2022), and Li et al. (2023) examine the interrelationships and transmission effects of FSI, EPU, and oil price shocks in various settings. Das et al. (2019) found that economic policy uncertainty had a more profound and significant impact on emerging markets compared to geopolitical risk and financial stress. Meanwhile, a study conducted by Kannadhasan and Das (2020) highlighted the negative correlation of Economic Policy Uncertainty (EPU) across all quantiles, while Geopolitical Risk (GPR) was negatively correlated in the lower quantiles and positively correlated in the intermediate and upper quantiles. Additionally, Zhang and Hamori (2022) argue that there is evidence to support the notion that US geopolitical risk shocks have a significant effect on emerging economies, and the joint connectedness value during the COVID-19 period was higher than that during the global financial crisis of 2007-2008. They argue that the geopolitical risk of BRICS nations could impact developed economies. Agyei (2023) examined the asymmetrical connectivity between global risk and the seven top emerging (E7) countries. The analysis revealed a higher degree of dependence on exceptional occurrences, such as the Russian-Ukrainian conflict and changes in financial markets. Bossman and Gubareva (2023) investigated in their paper the unequal financial effects of geopolitical risk resulting from the Russia-Ukraine conflict on the markets of the top seven emerging (E7) countries and the seven most developed (G7) nations. They discovered that GPR affects stock markets not only in terms of market-specific but

also asymmetrical influence. All E7 and G7 equities, excluding Russia and China, show positive responses to GPR under normal circumstances.

The relationship between the financial market, gold, and oil concerning geopolitical risk has been explored in several studies. While [Kamal et al. \(2022\)](#) found that the stock market illuminates an upside risk premium in the face of uncertainty, [Triki & Maatoug \(2021\)](#) found that gold works as a safe haven and diversification tool during times of increasing stress. In particular, in reaction to USEPU shocks, gold was shown to be a consistent source of protection for seeking safety during times of great stress. However, during the COVID-19 pandemic, it lost its safe-haven qualities. According to [Zhao \(2023\)](#), gold may be a safe investment to guard against the rise in geopolitical risks. [Shahzad et al. \(2023\)](#) found in their research that geopolitical risk, financial instability, and oil return are the main shocks' causes. On the other hand, the main recipients of these shocks were gold, gas, and silver. Moreover, they found that the primary route for shock communication is oil return. Additionally, [Chiang \(2022\)](#) suggested that gold may be used as a hedge against a range of uncertainties. However, [Yilanci and Kilci \(2021\)](#) found no direct link between geopolitical risk and the pricing of precious metals. [Li et al. \(2021a\)](#) found that the short-term spillover effects are the primary drivers of the overall spillover. In most scenarios, the oil market has a significant spillover linkage with the gold market. Moreover, they discovered a spillover impact from geopolitical risks on gold prices. [Zhu et al. \(2021\)](#) found that economic policy uncertainty (EPU), oil, and commodities are increasingly connected over time and impact financial markets, particularly during financial crises.

Financial stress significantly influences the real economy, according to previous studies. It is suggested that conventional monetary policy may be somewhat less successful under stressed conditions. [Ferrer et al. \(2018\)](#) discovered in their research that financial stress has a major detrimental impact on the US economy, starting with the subprime housing crisis in 2007. This tendency was particularly evident over a longer period of time. [Monin \(2019\)](#) found that the OFR FSI is a useful indicator of systemic financial stress and can forecast a decline in economic activity. [Davig and Hakkio \(2010\)](#) demonstrated that rising financial stress might progressively cause a robust economy to gradually collapse, leading to a dire scenario. [Yurteri Köseadağlı et al. \(2021\)](#) identified the determinants of financial stress and found that stress is interdependent among emerging market economies and is primarily transmitted through geographical connections. [Kasal \(2023\)](#) found that because of its relationship with rising government debt, a positive financial stress shock has negative consequences for the economic activity of emerging economies. Furthermore, the evidence shows a rise in financial stress resulting from a positive government debt shock. Overall, the literature highlights the importance of monitoring financial stress levels, as they can have significant implications in not only developed economies but also emerging economies.

Various empirical studies have extensively explored the relationship between financial stress and emerging markets. [Stolbov & Shchepeleva \(2016\)](#) observe a negative impact of financial stress on economic activity in the majority of the countries studied. [Chen and Semmler \(2018\)](#) revealed that financial shocks persistently impact the financial markets of other countries, with output shocks during high-stress periods having negative effects on other countries, and larger countries' output shocks having a more substantial impact on financial conditions than those from smaller countries. In their research, [Yurteri Köseadağlı and Önder \(2021\)](#) identified the current account balance/GDP, economic development, geopolitical risk, and global risk as major causes of financial stress. They also found that geographical ties mostly help convey the financial stress experienced in developing market economies. Using fractional integration techniques, [Gil-Alana et al. \(2021\)](#) investigated the bilateral relationships of financial stress in ten Asian countries. They discovered that, among smaller nations including Japan, the spread of financial stress moved faster than in China. [Balcilar et al. \(2023\)](#) show that financial stress co-movements and spillovers are positively associated in MENA countries, with Gulf countries exhibiting stronger financial connections among themselves. Countries with fewer capital controls and greater openness appear to play a more significant role in financial interconnectedness and risk transmission. Finally, [NguyenHuu and Örsal \(2024\)](#) conclude that GPRs seriously jeopardize the stability of the financial situation of emerging markets.

Recent studies have shed light on the relationships between financial stress, oil prices, and global macroeconomic factors. [Kocaarslan et al. \(2019\)](#) discovered dynamic conditional connections between stock markets and global macroeconomic indicators. These correlations have changed since the 2008 global financial crisis. According to the findings of [Fu et al. \(2022\)](#), improved financial stress indexes as well as higher prices for oil and gold have a considerable negative impact on the performance of clean energy companies. [Apostolakis et al. \(2021\)](#) observe that spillovers have increased significantly during the COVID-19 pandemic but have not surpassed levels seen during the Global Financial Crisis of 2007. [Lie et al. \(2022\)](#) demonstrate that the Geopolitical Risk Index (GPR) displays superior performance in predicting both long-term crude oil volatility and short-term high volatility in the crude oil market compared to other uncertainty indicators. [Huang et al. \(2022\)](#) suggest that the US plays a crucial role as a spillover transmitter compared to China, and that there is a strong interconnectedness among economic policy uncertainty, crude oil, and gold markets in terms of spillover effects. [Dagher and Hasanov \(2023\)](#) use the Financial Stress Index (FSI) to measure instability in Asian financial markets and conclude that the source of an oil price shock is a critical determinant of its impact on financial markets. [Elsayed et al. \(2024\)](#) highlighted that oil market shocks increase financial stress in MENA countries. [Shaik et al. \(2024\)](#) found that sources of volatility transmission include conventional, Islamic, and sustainable stock indices in their investigation of the dynamic volatility connection of geopolitical risk. Conversely, gold, US Treasuries, GPR, oil, and bitcoin are targets of volatility. [Soltani and Abbes \(2025\)](#) also exhibit volatility transmission among the FSI, gold, and oil markets. [Alam and Forhad \(2025\)](#) found dynamic connectedness between decomposed oil market shocks and 12 Asian countries' financial stress.

The heightened interconnectivity of global financial markets underscores the need to comprehend how fluctuations in pivotal commodities such as gold impact a nation's financial stress levels ([Fu et al., 2022](#)). Gold markets, integral components of the world economy, often undergo heightened uncertainty due to geopolitical events, supply-demand imbalances, and macroeconomic shifts ([Baur & McDermott, 2010](#); [Hoque & Low, 2022](#)). This uncertainty can contribute to financial stress, given gold's role as a safe-haven asset during market turbulence, which reflects shifts in sentiment and risk perceptions ([Baur & Lucey, 2010](#); [Kocaarslan et al., 2019](#); [Triki & Maatoug, 2021](#)). Notably, gold price volatility can impact financial stress, particularly for oil-importing countries, as gold often

serves as a payment for oil imports (Tiwari & Sahadudheen, 2015). However, Beckmann et al. (2019) emphasized the nuanced nature of gold's role as a hedge or safe haven, which varies across different periods. While economic policy uncertainty correlates positively with gold price shifts, macroeconomic and inflation uncertainties among forecasters are negatively associated (Beckmann et al., 2019). This intricate nexus underscores the exigency for comprehensive analyses that discern the multifaceted relationships between gold market uncertainties and their ramifications on national financial stress levels, presenting pivotal insights for policymakers and investors (Baur and Lucey, 2010; Beckmann et al., 2019). Hoque et al. (2024) demonstrate the dependency between the financial and gold markets.

Global factors are of paramount importance in establishing interconnections across diverse financial markets. Global factors have a substantial impact on the determination of market interconnection and the influence they have on the significance of information for market participants, as well as risk management tactics and market stability. The information provided is of substantial importance to politicians, regulatory organizations, and investors. The study conducted by Mensi et al. (2021) revealed that many factors, including Citi Macro Risk, the financial circumstances of the United States and Europe, and treasury bills, substantially influence the dynamic efficiency of green bonds. According to the study conducted by Ji et al. (2019), the occurrence of spillovers in cryptocurrency markets is impacted by two key factors: trading volume and global financial uncertainty. Karim and Naeem (2022) and Billah et al. (2023, 2024), Elsayed (2024b), and Zhou et al. (2025) emphasized that implied volatility in the stock, oil, gold, currency, and bond markets influences the amount of financial interconnectedness. Billah et al. (2024) and Naeem et al. (2024) look at global uncertainty factors. Billah et al. (2025) and Elsayed et al. (2025) show climate risk factors also can shape the connectedness of financial markets. Therefore, we consider economic policy uncertainty (EPU), implied volatility (VIX), global financial stress (GFSI), and climate policy uncertainty (CPU).

After extensively reviewing existing studies, it is evident that none of the aforementioned studies have examined the complex connection between the financial stress of South and Southeast Asian economies, the categorical global geopolitical risk, and the financial stress of advanced and emerging economies. Similarly, researchers have not documented the connectedness of oil market uncertainty and gold market uncertainty with the financial stress of South and Southeast Asian economies. Therefore, addressing the gaps, the current study examines the connectedness and spillover across global geopolitical uncertainty, financial stress, economic conditions, oil market uncertainty, gold market uncertainty, and South and Southeast Asian economies' financial stress.

3. Data and empirical methods

3.1. Data and preliminary analysis

The present study focuses especially on the data from the 2018 Caldara and Iacoviello's constructed categorical geopolitical risk index. This score is strongly related to potential risks largely resulting from armed confrontations, acts of terrorism, and geopolitical tensions between two countries and mostly reflects these factors. Therefore, we use two indices of Geopolitical risk as Geopolitical Threats and Geopolitical Acts,⁵ which are obtained from Matteo Iacoviello's website. The global economic condition indicator is obtained from Baumeister's et al (2020) Google site.⁶ We consider three regional financial stress indices as Emerging market Financial Stress, Other advanced markets Financial Stress, and US market Financial Stress, which are extracted from the OFR FSI Website.⁷ Oil market Volatility (OVX) and Gold Market Volatility (GVX) indices are proxies for oil and gold market stress, which were obtained from Investing.com. Financial stress indices for India (IND), Pakistan (PAK), Sri Lanka (SL), Indonesia (INDO), Malaysia (MY), Philippines (PH), Singapore (SG), and Thailand (TH). Financial stress indices of South and Southeast Economies' Financial Stress are extracted from Asia Regional Integration Center.⁸ Further details on the variables are presented in Appendix A1. The global economic condition indicator facilitated the choice of the data frequency and the study span covers monthly data from Jan 2008 to Jun 2022.

Fig. 1 presents index movements of geopolitical risk along with global economic conditions (OVX, GVX) and financial stress in emerging and advanced countries. We note that GPRA and GPRT increased with global geopolitics, instilling heightened concerns regarding terrorism, international security, and regional stability. The ongoing Russia-Ukraine war has primarily resurrected geopolitical risk. Seemingly, geopolitical acts have exhibited a similar trend during the study period. Global economic conditions have been marked by two significant downturns, one occurring in 2008-2009 (the GFC) and the other in 2020 (the Covid-19 pandemic). Throughout the study period, the financial stress experienced by both advanced and emerging economies has exhibited volatility, except for notable spikes during the global financial crisis (GFC) of 2008-2009, the 2013 taper tantrum episode, the 2014 Russian financial crisis, oil price shocks of 2014-15, the 2015 Greek debt crisis, the China crisis of 2015, the Covid-19 pandemic, and the 2022 Russian-Ukrainian war.

The study employs the difference-in-natural logarithm of time series for generating series of GPRT, GPRA, GEC, and financial stress of advanced and emerging countries. Based on descriptive statistics, Table 1 depicts the characteristics of the variables.

The analysis of geopolitical risk reveals that both GPRT and GPRA have means of 0.036 and 0.035, indicating a slight average positivity in geopolitical risk perceptions. Notably, GPRT displays a skewness of 1.184, while GPRA is skewed by 1.408, suggesting a rightward tail in the distribution and implying that there are more extreme increased risks (see Hoque et al., 2024b; Wang et al., 2024).

⁵ <https://www.matteoiacoviello.com/gpr.htm>.

⁶ <https://sites.google.com/site/cjsbaumeister/datasets>.

⁷ <https://www.financialresearch.gov/financial-stress-index/>.

⁸ <https://aric.adb.org/database/fsi>.

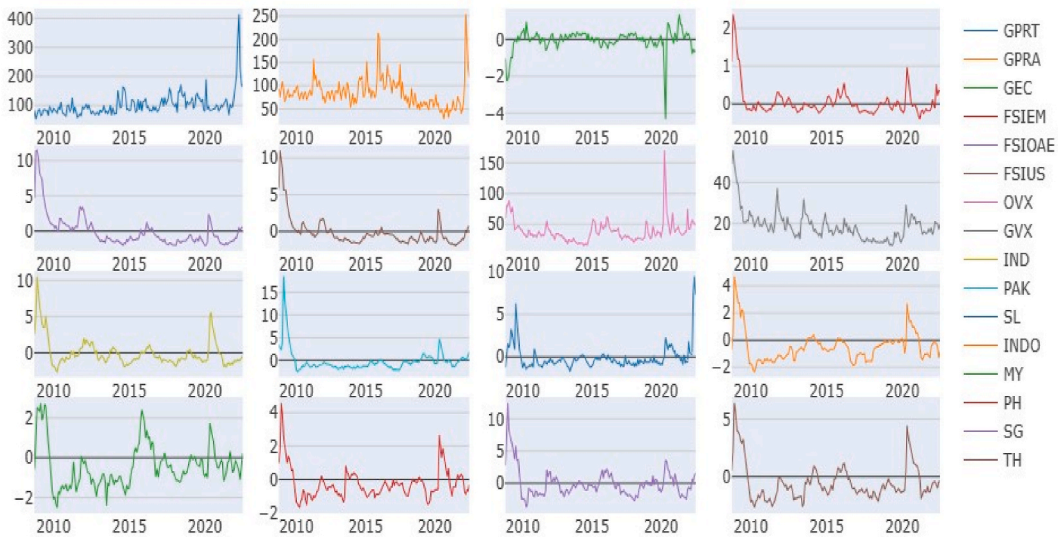


Fig. 1. Index movements of geopolitical risk along with global economic conditions, OVX, GVX, and financial stress in emerging and advanced countries.

GEC shows a mean of -0.093 , reflecting generally adverse economic conditions. The high standard deviation of 10.387 indicates considerable variability, highlighting the unpredictability of economic conditions. With a skewness of 6.804 and a kurtosis of 73.51 , the distribution of GEC exhibits a heavy right tail, suggesting the presence of better economic conditions.

In examining regional financial stress, FSIEM shows a negative mean of -0.168 , while FSIOAE has a positive mean of 0.363 . This contrast signifies differing stress levels between emerging and advanced markets. Both indices exhibit positive skewness, with FSIOAE showing a more pronounced effect, suggesting that larger spikes in financial stress are more frequent. The studies by [Hoque et al. \(2024a, 2024c\)](#) and [Khan et al. \(2025\)](#) show similar findings.

The analysis of oil and gold market uncertainty shows that OVX and GVX have low means of 0.024 and 0.008 , respectively, indicating mild average uncertainty in these markets. Both variables demonstrate positive skewness and heavy-tailed distribution, suggesting a propensity for larger volatility spikes. Among these markets, the gold market shows more stability than the oil market, which is in line with [Hoque \(2024b\)](#) and [Soltani and Abbes \(2025\)](#).

The financial stress indices for South and Southeast Asian countries exhibit a wide range of means, with SL showing the highest mean of 2.606 , while IND presents the lowest at -1.019 . This variation signifies differing levels of financial stress across the region. Several countries, particularly PAK and SL, exhibit high skewness and kurtosis, indicating the presence of extreme values. Furthermore, among the ASEAN markets, TH shows a higher mean of 0.441 , suggesting increased financial stress, while SG presents a negative mean of -0.048 , reflecting a generally stable economic environment. In terms of standard deviation, TH and SG show the highest variability among the four, indicating a greater possibility for extreme financial stress events, which are confirmed with higher positive skewness values and kurtosis values. Henceforth, we capture the divergence of financial stress level and characteristics among Asian countries' FSI, which are in line with past studies ([Gil-Alana et al., 2021](#); [Valerio Roncagliolo and Villamonte Blas, 2022](#); [Dagher et al., 2023](#); [Alam & Forhad, 2025](#)).

The [Jarque and Bera \(1980\)](#) test shows that none of the variables conform to a Gaussian distribution, and they do not fit a normal distribution. As recommended by [Elsayed et al. \(2024b\)](#), at a 1% significance level, the ERS unit root test shows these components to have statistical stationarity. Additionally, a correlation matrix is presented in [Appendix A2](#). The weighted portmanteau test of [Fisher and Gallagher \(2012\)](#) shows a link between returns and squared returns. This provides compelling evidence that a TVP-VAR method with a time-varying variance-covariance structure should estimate the interlinkages between many financial markets.

3.2. Empirical methods

The TVP-VAR connectedness technique, as introduced by [Chatziantoniou et al. \(2023\)](#), was utilized to examine the interconnectedness and transmission of effects among global geopolitical uncertainty, financial stress, economic conditions, oil market uncertainty, gold market uncertainty, and the financial stress of South and Southeast Asian economies. The method integrates both the [Antonakakis et al. \(2020\)](#) TVP-VAR connectivity technique and the [Baruník and Křehlík \(2018\)](#) technique. In the following, we have written the time-varying parameter vector autoregression (TVP-VAR) of order p :

$$y_t = \gamma_{1t} y_{t-1} + \gamma_{2t} y_{t-2} + \dots + \gamma_{pt} y_{t-p} + \varepsilon_t \quad \varepsilon_t \sim N(0, \Sigma_t) \quad (1)$$

where y_t and y_{t-1} are $K \times 1$ dimension vectors. Σ_t and γ_{it} are $K \times K$ dimensional matrices which represent the time-varying variance-

Table 1

Descriptive statistics.

Variable Name	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	ERS	Q(10)	Q2(10)
Panel A: Geopolitical risk											
GPRT	0.036	0.006	1.394	−0.509	0.283	1.184	5.879	95.529	−2.69***	8.97	26.964***
GPRA	0.035	0.02	1.382	−0.543	0.271	1.408	7.417	188.632	−2.800***	13.968***	8.755
Panel B: Global economic Conditions											
GEC	−0.093	−0.399	107.733	−36.981	10.387	6.804	73.51	35453.21	−1.348	20.799***	24.394***
Panel C: Regional Financial Stress											
FSIEM	−0.168	−0.142	50.553	−31.177	5.218	4.344	63.332	25543.89	−0.613	8.212	5.19
FSIOAE	0.363	−0.014	86.074	−37.188	7.718	7.952	97.827	63560.61	−0.544	6.753	2.345
FSIUS	−0.403	−0.032	9.202	−34.834	3.015	−9.056	105.249	74132.38	−0.694	6.753	8.737
Panel D: Oil and Gold Market Uncertainty											
OVX	0.024	−0.016	2.328	−0.433	0.273	4.175	33.276	6781.127	−1.937*	10.715**	15.340***
GVX	0.008	−0.019	0.78	−0.265	0.173	1.392	5.999	115.154	−1.563	4.684	26.234***
Panel E: Financial Stress in South and Southeast Asia											
IND	−1.019	−0.117	14.873	−135.158	10.889	−11.499	141.566	135639.6	−1.144	13.648**	17.322***
PAK	1.452	−0.055	173.692	−23.888	14.741	10.296	117.031	92311.2	−4.173***	4.222	2.922
SL	2.606	−0.148	402.2	−63.867	32.053	11.809	148.311	149002.1	−1.444	12.416**	4.519
INDO	0.645	−0.029	89.267	−8.865	7.36	10.819	129.459	113163.9	−1.198	8.188	1.565
MY	0.153	−0.056	29.663	−17.714	3.148	4.472	56.35	20117.47	−1.156	12.404**	19.383***
PH	0.156	−0.052	29.589	−8.551	2.88	6.787	70.664	32743.61	−1.642*	5.452	2.03
SG	−0.048	−0.097	58.647	−18.311	5.461	7.306	83.898	46461.75	−0.926	2.034	67.990***
TH	0.441	−0.063	57.439	−6.115	4.655	11.267	138.048	128877.7	−1.235	12.157**	6.604

GPRT-Geopolitical Threats, GPRA—Geopolitical Acts, GEC—Global Economic Conditions, FSIEM- Emerging market Financial Stress, FSIOAE-other advanced markets' financial stress, FSIUS-US market financial stress, OVX- Oil market volatility, and GVX Gold Market Volatility. IND, PAK, SL, INDO, MY, PH, SG, and TH are Country Wise Financial Stress indices. Under the null hypothesis of no autocorrelation, the Ljung-Box Q(10) and Q2(10) statistical tests indicate whether there is any autocorrelation present in a given series and in its squared series, respectively. The Elliott-Rothenberg-Stock unit root test is ERS. Statistical significance at the 1% level is denoted by ***; at the 5% level by **; at the 10% level by *.

covariance matrix and the time-varying VAR coefficient, respectively. More precisely, we use the lag-polynomial $\gamma(L) = [I_N - \gamma_{it} L - \dots - \gamma_{pt} L^p]$ from the K by K matrix in tandem with the I_N Identity matrix. This is the case hence we will now propose the model in the following way:

$$\gamma(L)y_t = \varepsilon_t \quad (2)$$

One may convert the TVP-VAR (p) to its TVP-VMA (∞), in line with [Chatziantoniou et al. \(2023\)](#), and the TVP-Vector Moving Average of equation exhibits the following form:

$$y_t = \psi(L)\varepsilon_t \quad (3)$$

We therefore build infinite lag polynomials of coefficients iteratively from $(L) = [\psi(L)]^{-1}$. Once again, $\psi(L)$ consists of an unlimited number of lags; consequently, we approximated it by ψ_h , which projected $h = 1, \dots, H$ horizons.

Using the TVP-VMA coefficients, ψ_h , we estimate the generalized forecast error variance decomposition (GFEVD), which is fundamental in the connectedness method. With the effect of a shock in series j on series i underlined, the generalized forecast-error variance decomposition function follows.

$$\theta_{ijt}(H) = \frac{\sum_{t=1}^{T-1} \sum_{h=0}^H (\psi_h \Sigma_t)_{ijt}^2}{\sum_{h=0}^H (\psi_h \Sigma_t \psi_h')_{ii}} \quad (4)$$

$$\tilde{\theta}_{ijt}(H) = \frac{\sum_{t=1}^{T-1} \sum_{h=0}^H (\psi_h \Sigma_t)_{ijt}^2}{\sum_{k=1}^K \theta_{ikt}(H)} \quad (5)$$

Under this framework, $\tilde{\theta}_{ijt}(H)$ denotes the degree of j th variable contribution to the variance of the prediction error of the i th variable at a given time horizon H . It is required to normalise the rows of $\tilde{\theta}_{ijt}(H)$ as their total is not one. This produces $\tilde{\theta}_{ijt}(H)$. Henceforth, normalisation helps us to acquire the following identities: $\sum_i^K \tilde{\theta}_{ijt}(H) = 1$ and $\sum_{i=1}^K \sum_{j=1}^K \tilde{\theta}_{ijt}(H) = K$. Subsequently, it is possible to calculate all metrics of connectivity. The net pairwise directional link demonstrates the reciprocal power dynamic between series i and j , as seen below:

$$NPDC_{ijt}(H) = \tilde{\theta}_{ijt}(H) - \tilde{\theta}_{jit}(H) \quad (6)$$

If $NPDC_{ijt}(H) > 0$, variable j has on influences more variable i . Similarly, if $NPDC_{ijt}(H) < 0$, the variable i has higher influences on variable j .

The following equation may be employed to produce the estimate of directional spillover to all other series and the estimate of spillover to the i series from all other series:

$$TO_{it}(H) = \sum_{i=1, i \neq j}^K \tilde{\theta}_{ijt}(H) \quad (7)$$

$$FROM_{it}(H) = \sum_{j=1, i \neq j}^K \tilde{\theta}_{jit}(H) \quad (8)$$

The subsequent analysis involves the difference between Equations (7) and (8) in terms of the net contribution to the system.

$$NET_{it}(H) = TO_{it}(H) - FROM_{it}(H) \quad (9)$$

In the framework that has been given, the i series might be considered either the transmitter or the receiver of shocks based on its overall contribution: positive or negative. The Total Connectedness Index (TCI) aims to determine the degree of connection and spillover among many networks. Apart from the spillover effect found about series i from all other series, it is feasible to define it mathematically as the mean value of the directional spillover influence detected about all other series. Stated otherwise, it is the total of every other series's results. As such, it is expressed in the manner that is detailed below:

$$TCI_t(H) = \frac{1}{K} \sum_{i=1}^K TO_{it}(H) = \frac{1}{K} \sum_{i=1}^K FROM_{it}(H) \quad (10)$$

where, Low (high) TCI denotes low (high) risk and connection level.

The examination of the connection of connectivity in the frequency domain may be extended by the use of [Stiassny's \(1996\)](#) spectral decomposition approach. We start our analysis by contemplating the frequency response function.

By expressing the equation $\psi(e^{-i\omega})$ as the sum of $e^{-i\omega} \psi_h$ from $h = 0$ to infinity, one may state the equation properly. It is the sign ψ_h that stands for the imaginary unit, i , which is equivalent to the square root of -1 . ω is a symbol that signifies the frequency at which we

will conduct the analysis of the spectral density of y_t . Based on the TVP-VMA (∞) model, this spectral density may be described as the Fourier transformation of the model.

$$S_y(\omega) = \sum_{h=-\infty}^{\infty} E(y_t y'_{t-h}) e^{-i\omega h} = \Psi(e^{-i\omega h}) \Sigma_t \Psi(e^{+i\omega h}) \quad (11)$$

$$\theta_{ijt}(\omega) = \frac{\Sigma_{tij}^{-1} \left| \sum_{h=0}^{\infty} (\Psi(e^{-i\omega h}) \Sigma_t)_{ijt} \right|^2}{\sum_{h=0}^{\infty} \Psi(e^{-i\omega h}) \Sigma_t)_{ii}} \quad (12)$$

$$\tilde{\theta}_{ijt}(\omega) = \frac{\theta_{ijt}(\omega)}{\sum_{k=1}^K \theta_{ijt}(\omega)} \quad (13)$$

The exact fraction of the frequency spectrum ω of the i th variable that may be ascribed to a shock in the j th variable is represented by the variable $\tilde{\theta}_{ijt}(\omega)$. One reasonable theory is that the observed phenomena might be a sign of interactions falling within a certain frequency band. We integrate all frequencies falling within a certain range to provide a full picture of both short and long-term linkages, $d = (a, b)$, $a, b \in (-\pi, \pi)$, a rather than assessing connectivity at a single frequency.

$$\tilde{\theta}_{ijt}(d) = \int_a^b \tilde{\theta}_{ijt}(\omega) d\omega \quad (14)$$

The present study examines the associations between DY time-domain connectivity measures proposed by [Diebold and Yilmaz \(2012, 2014\)](#) and BK frequency-domain connectedness measures introduced by Barunik and Krehlik (2018).

$$TO_{it}(H) = \sum_d TO_{it}(d) = \sum_d \left(\sum_{i=1, i \neq j}^K \tilde{\theta}_{ijt}(d) \right) \quad (15)$$

$$FROM_{it}(H) = \sum_d FROM_{it}(d) = \sum_d \left(\sum_{j=1, j \neq i}^K \tilde{\theta}_{ijt}(d) \right) \quad (16)$$

$$NET_{it}(H) = \sum_d NET_{it}(d) = \sum_d \left[\left(\sum_{i=1, i \neq j}^K \tilde{\theta}_{ijt}(d) \right) - \left(\sum_{j=1, j \neq i}^K \tilde{\theta}_{ijt}(d) \right) \right] \quad (17)$$

$$NPDC_{ijt}(H) = \sum_d NPDC_{ijt}(d) = \sum_d [\tilde{\theta}_{ijt}(d) - \tilde{\theta}_{jji}(d)] \quad (18)$$

$$TCI_t(H) = \sum_d TCI_t(d) = \sum_d \frac{1}{K} \sum_{i=1}^K TO_{it}(d) = \sum_d \frac{1}{K} \sum_{i=1}^K FROM_{it}(d) \quad (19)$$

Following an evaluation of the magnitude of the return spillover issue, a subsequent inquiry was conducted to identify the main causes of spillover. We employ a customized gravity model, commonly utilized in international trade, to analyze market returns. We expect significant changes in spillover effects in higher-priority markets. Global concerns are commonly considered significant forces. Hence, this study examines the influence of global risk factors, including equity market uncertainty (VIX), global economic policy (EPU), global financial stress (GFSI), and climate policy uncertainty, on the impact of connectedness in both short and long spillovers.

The fundamental gravity model provides the foundation for using the following regression in this case. Still, it is sufficiently adaptable to include variables connected to global indices, seeing them as significant factors.

$$TCI(i) = \alpha_0 + \alpha_1 X_{it} + \varepsilon_{it} \quad (20)$$

The dependent variable $TCI(i)$ is constructed using the following approaches: total, short-term, and long-term spillovers between categorical geopolitical risk, global economic conditions, categorical FSI, regional FSI, gold, and crude oil volatility. The analysis specifically emphasizes the financial stress experienced by economies in South Asia and South-East Asia. All the pertinent data is obtained from Renfitive-Eikon. Several of the factors influencing connection are included in the term X_{it} , which are EPU_{ij} , VIX_{ij} , $GFSI_{ij}$, CPU_{ij} .

4. Empirical results

In our investigation of connectedness and spillover effects, we employ the novel TVP-VAR connectedness technique introduced by [Chatziantoniou et al. \(2023\)](#). This approach allows us to estimate a dynamic time-frequency-based pattern of connectedness and volatility spillover, capturing the joint behavior of different asset classes. We focus on the total connectedness index (TCI) in this

section, which provides a measure of overall connectedness. Before presenting the TCI, we calculate the average value of TCI for the entire study period, allowing us to assess the average connectedness.

Additionally, we explore the changing patterns of TCI during periods of uncertainty or crises, aiming to gain insights into the net total connectedness (NTC) and net total directional connectedness (NTDC) among the variables. By analyzing evidence of NTC and NTDC, we can understand the role played by each market - whether it acts as a net receiver or net transmitter of shocks. This analysis provides valuable insights into the behavior of the proposed variables or markets.

4.1. Averaged connectedness

Tables 2–4 report the connectedness and spillover results among categorical geopolitical risk, global economic conditions, categorical FSI, regional FSI, gold, and crude oil volatility. The volatility of a particular market is observed by the diagonal element, while the off-diagonal element represents the volatility that is a contribution of this market to others' or pay of others to this market's volatility. For instance, although the columns show the effect that a certain kind of market has on all of the other markets individually at the individual level, we sketch the outline for each individual market's contribution to the prediction error variance of a specific market in the row.

Table 2 shows the average value of the Total Connectedness Index (TCI), 61.94%. Of this, Table 3 shows 38.96% allocated to the short-term, while Table 4 shows 22.98% ascribed to the long-term. The distribution shows that the variables within the system might be responsible for a significant portion of the variance in the prediction error variance, namely 61.94%. The idiosyncratic component of every variable explains the residual variation. Notably, the short-term connectedness outweighs that of the long-term, indicating stronger interactions in the short run. These findings underscore the presence of intricate interactions and interdependencies among the variables under examination. Li et al. (2021b) discovered that short-term spillover effects primarily drive the overall spillover. In many scenarios, the oil market demonstrates a substantial spillover linkage with the gold market. Furthermore, the study identified a spillover impact from geopolitical risks to gold prices. In a similar vein, Zhu et al. (2021) established that economic policy uncertainty (EPU), oil, and commodities are increasingly interconnected over time, exerting an influence on financial markets, particularly during periods of financial crises.

Furthermore, Table 3 and Fig. 2 provide insight into the direction of connectedness, representing the net contribution of each variable to the entire system. Notably, global risk indicators and FSI categories exhibit specific behaviors. Variables such as global political risk threat (−6.5%), global political acts (GPRA) (−5.57%), global economic conditions (−5.23%), and the financial stress of South and South-East Asian countries act as net shock receivers. Among them, the Philippines (−41.4%) stands as the most significant shock receiver, followed by Indonesia (−33.13%), Malaysia (−29.27%), and Thailand (−24.45%). In the realm of South Asian countries, Sri Lankan FSI emerges as the primary net shock receiver, trailed by India (−18.99%) and Pakistan (−15.83%). Contrarily, the financial stress of the United States emerges as the foremost net shock transmitter, constituting 64.89%, followed by the financial stress of advanced economies (58.47%), oil price volatility (35.92%), the financial stress of emerging markets (29.5%), and gold price volatility (16.03%).

The findings underscore that geopolitical risk experiences greater shock reception from global and categorical financial stress than it transmits. However, Li et al. (2022) found that the Geopolitical Risk Index (GPR) is superior to other uncertainty indicators in predicting both long-term variations and short-term spikes in crude oil prices. Shahzad et al. (2023) have shown that geopolitical risk, financial instability, and oil returns act as conduits for conveying shocks, whereas gold, gas, and silver act as receivers of these shocks. In contrast, Yilanci & Kilci (2021) discovered no causal relationship between geopolitical risk and precious metal prices. Interestingly, it is noteworthy that global economic conditions emerge as shock receivers rather than transmitters. Notably, Southeast Asian countries exhibit higher vulnerability to global and regional financial stress due to their deeper integration with the global and regional economy, except for India. As anticipated, financial stress originating from the US and advanced economies significantly impacts both emerging and developing nations. Strikingly, oil volatility demonstrates a stronger net transmission effect compared to gold volatility, underlining the significance of oil in both developed and developing countries. This implies that the financial stress of a country is likely to be more affected if it is a net importer or exporter.

While we initially anticipated a stronger linkage of geopolitical risk, passing through oil and gold price volatility, to financial stress, no such evidence has been identified for the South and Southeast Asian countries. Zhang & Hamori (2022) posit that evidence supports the idea that US geopolitical risk shocks exert a significant impact on emerging economies. Interestingly, despite the significant rise in global political risk in recent times, we have observed a comparatively lower degree of connectedness with the financial stress of advanced, emerging, and South and Southeast Asian developing countries. This phenomenon could potentially be attributed to the fact that geopolitical risks have largely emanated from the Middle East and have recently intensified in Europe due to events like the Russia-Ukraine war. Yurteri Köseadağlı et al. (2021) have identified the determinants of financial stress, revealing its interdependence among emerging market economies, predominantly transmitted through geographical connections. As proximity increases, so does the associated risk and its impact on the economy. Consistent with our study, Das et al. (2019) have also found that economic policy uncertainty has a more profound and significant impact on emerging markets compared to geopolitical risk and financial stress.

A closer examination of the connectedness reveals even more detailed insights. Interestingly, in addition to its own volatility, GPRA (10.5%) exhibits a dominant spillover effect on GPRT. This trend is reciprocated, with GPRT also displaying a similar spillover effect on GPRA. Global Economic Conditions (GEC) are primarily influenced by oil price volatility, followed by US FSI, advanced economies FSI, and emerging markets FSI. It is noteworthy that the financial stress of Singapore contributes modestly (3.98%) to GEC, which stands as the highest value within South and South-East Asia. This illustrates the importance of Singapore as a regional trade hub, not only for ASEAN countries but also for South Asian nations such as India and Sri Lanka. Financial stress originating from the US and advanced

Table 2

Total connectedness and spillover across global geopolitical uncertainty, regional financial stress, economic conditions, oil and gold market uncertainty, and South and Southeast Asian economies' financial stress.

	GPRT	GPRA	GEC	FSIEM	FSIOAE	FSIUS	OVX	GVX	IND	PAK	SL	INDO	MY	PH	SG	TH	FROM
GPRT	71.79	10.95	1.31	2.58	0.85	0.84	1.19	0.88	0.48	0.69	5.82	0.57	0.36	0.51	0.78	0.41	28.21
GPRA	12.57	76.38	0.69	0.86	0.42	0.58	0.64	0.22	1.16	2.37	1.4	0.31	0.49	0.77	0.17	0.99	23.62
GEC	0.38	0.43	28.64	7.8	12.45	14	16.97	6.07	1.47	0.3	0.57	2.64	1.35	0.8	3.98	2.17	71.36
FSIEM	0.79	0.49	6.69	25.69	16.86	19.66	12.31	7.95	0.91	0.31	0.26	1.39	1.38	0.63	4.12	0.56	74.31
FSIOAE	0.42	0.26	7.09	15.78	24.81	20.77	9.88	10.79	0.94	0.15	0.33	0.96	0.78	0.23	5.95	0.88	75.19
FSIUS	0.36	0.17	7.5	16.14	19.91	25.28	11.86	8.44	0.94	0.73	0.56	1.16	0.83	0.32	5.2	0.6	74.72
OVX	0.71	0.13	11.24	10.88	13.24	14.79	34.3	6.54	0.44	0.64	0.21	1.1	0.76	1.26	3.4	0.34	65.7
GVX	0.09	0.12	4.87	6.93	14.01	9.2	6.96	47.85	1.07	0.45	1.08	2.32	1.51	0.59	2.19	0.75	52.15
IND	0.37	0.36	4.25	7.52	9.22	10.33	6.34	4.29	22	0.77	4.78	5.84	3.77	4.08	9.37	6.7	78
PAK	0.39	1.48	2.48	1.23	1.47	2.74	5.03	0.7	3.7	69.69	0.69	1.22	1.25	3.22	3.91	0.81	30.31
SL	3.09	1.22	2.9	1.38	2.65	1.55	3.1	1.19	10.42	1.77	47.67	2.01	3.27	3.46	7.44	6.89	52.33
INDO	0.34	0.21	4.18	7.5	8.64	10.18	5.59	3.84	7.22	0.9	1.65	22.29	5.43	6.67	6.73	8.64	77.71
MY	0.49	0.68	2.23	5.35	5.6	5.3	4.85	2.03	5.69	3.4	2.16	4.61	39.96	3.53	3.33	10.79	60.04
PH	0.64	0.78	3.62	6.84	8.96	10.88	6.52	4.63	6.46	0.87	2.19	7.58	2.68	23.43	5.21	8.72	76.57
SG	0.31	0.12	3.49	5.77	10.45	9.4	4.44	6.56	11.11	0.62	4.46	5.59	1.8	2.73	28.04	5.1	71.96
TH	0.76	0.66	3.58	7.27	8.93	9.39	5.97	4.05	7.01	0.52	3.12	7.28	5.12	6.36	8.79	21.18	78.82
TO	21.71	18.05	66.13	103.81	133.66	139.6	101.62	68.18	59.01	14.49	29.27	44.57	30.78	35.17	70.58	54.38	991
Inc.Own	93.5	94.43	94.77	129.5	158.47	164.89	135.92	116.03	81.01	84.17	76.94	66.87	70.73	58.6	98.62	75.55	TCI
Net	-6.5	-5.57	-5.23	29.5	58.47	64.89	35.92	16.03	-18.99	-15.83	-23.06	-33.13	-29.27	-41.4	-1.38	-24.45	61.94
NPDC	4	2	9	11	14	15	13	12	9	4	2	5	2	3	9	6	

Note: The variable Lag is set to 1. We are using a Bayes Prior and the variable forgetting factor for VAR is set to 0.99. Similarly, the forgetting factor for EWMA is also set to 0.99. The size of the Bayes prior is 200, and the frequency partition is 4. GPRT- Geopolitical Threats, GPRA -Geopolitical Acts, GEC- Global Economic Conditions, FSIEM- Emerging market Financial Stress, FSIOAE- Other advanced markets financial Stress, FSIUS- US market Financial Stress, OVX- Oil market Volatility, GVX- Gold Market Volatility. IND, PAK, SL, INDO, MY, PH, SG, and TH are country-wise financial stress indices.

Table 3

Short-term connectedness and spillover across global geopolitical uncertainty, regional financial stress, economic conditions, oil and gold market uncertainty, and South and Southeast Asian economies' financial stress.

	GPRT	GPRA	GEC	FSIEM	FSIOAE	FSIUS	OVX	GVX	IND	PAK	SL	INDO	MY	PH	SG	TH	FROM
GPRT	52.71	8.83	1.2	2.5	0.74	0.48	0.99	0.7	0.45	0.5	3.59	0.26	0.33	0.41	0.7	0.31	21.99
GPRA	8.47	57.29	0.64	0.71	0.36	0.45	0.59	0.2	1.09	1.33	0.71	0.26	0.38	0.62	0.13	0.8	16.75
GEC	0.37	0.32	20.73	5.52	8.33	9.62	11.97	3.49	1.24	0.22	0.53	2.48	1.16	0.76	2.79	1.83	50.63
FSIEM	0.71	0.42	3.69	15.4	9.65	10.68	6.66	3.75	0.81	0.17	0.24	0.47	0.36	0.3	2.57	0.32	40.8
FSIOAE	0.37	0.21	4.09	8.68	14.18	11.14	5.19	4.84	0.78	0.1	0.28	0.53	0.44	0.14	3.41	0.7	40.9
FSIUS	0.32	0.15	4.54	10.3	12.41	15.14	6.86	4.28	0.82	0.46	0.46	0.51	0.35	0.17	3.46	0.5	45.6
OVX	0.63	0.11	8.81	7.97	9.43	11.02	26.22	3.85	0.42	0.57	0.2	0.72	0.36	0.96	2.33	0.28	47.66
GVX	0.07	0.11	3.99	5.4	10.82	7.01	5.4	34.16	0.58	0.37	0.57	1.74	0.73	0.42	1.83	0.31	39.35
IND	0.14	0.18	1.85	4.39	4.7	5.08	3.32	2.08	14.38	0.7	3.47	4.77	2.65	3.2	4.18	4.26	44.95
PAK	0.28	1.32	1.65	0.51	0.54	2.02	3.02	0.51	3.15	47.75	0.58	1.15	0.72	2.89	3.43	0.63	22.39
SL	2.22	1.1	2.19	0.88	1.35	0.91	2.42	0.96	7.38	1.37	34.31	1.46	1.7	2.68	4.63	4.51	35.76
INDO	0.25	0.16	1.45	5.13	4.62	5.85	2.8	1.7	4.02	0.82	1.08	16.73	3.41	5.25	2.41	4.99	43.94
MY	0.36	0.58	0.77	3.61	3.1	2.76	2.5	1.05	3.46	1.86	1.79	3.68	26.81	3.12	1.21	6.17	36.02
PH	0.24	0.36	1.47	5.13	5.57	6.66	4.83	2.47	3.71	0.62	1.3	6.13	2.11	16.46	2	5.65	48.27
SG	0.26	0.08	1.58	2.7	4.83	4.1	1.56	2.9	7.94	0.54	3.37	4.88	1.37	2.35	17.86	3.62	42.07
TH	0.42	0.35	1.25	4.58	4.43	4.81	2.98	2.39	4.26	0.37	1.89	5.86	3.58	5.25	3.85	13.79	46.24
TO	15.09	14.29	39.18	68.01	80.86	82.58	61.09	35.15	40.12	10	20.05	34.89	19.65	28.54	38.94	34.88	623.32
Inc.Own	67.8	71.58	59.91	83.42	95.04	97.71	87.3	69.31	54.5	57.75	54.36	51.62	46.46	45	56.81	48.67	TCI
Net	-6.9	-2.46	-11.45	27.21	39.96	36.97	13.43	-4.2	-4.83	-12.39	-15.71	-9.04	-16.37	-19.73	-3.13	-11.36	38.96
NPDC	2	3	7	13	15	14	11	9	8	4	2	11	2	6	7	6	

Note: The variable Lag is set to 1. We are using a Bayes prior, and the variable forgetting factor for VAR is set to 0.99. Similarly, the forgetting factor for EWMA is also set to 0.99. The size of the Bayes prior is 200, and the frequency partition is 4. GPRT- Geopolitical Threats, GPRA -Geopolitical Acts, GEC- Global Economic Conditions, FSIEM- Emerging market Financial Stress, FSIOAE- Other advanced markets financial Stress, FSIUS- US market Financial Stress, OVX- Oil market Volatility, GVX- Gold Market Volatility. IND, PAK, SL, INDO, MY, PH, SG, and TH are country-wise financial stress indices.

Table 4

Long-term frequency spillover across global geopolitical uncertainty, regional financial stress, economic conditions, oil and gold market uncertainty, and South and Southeast Asian economies' financial stress.

	GPRT	GPRA	GEC	FSIEM	FSIOAE	FSIUS	OVX	GVX	IND	PAK	SL	INDO	MY	PH	SG	TH	FROM
GPRT	19.08	2.11	0.11	0.08	0.11	0.36	0.2	0.17	0.03	0.18	2.23	0.31	0.03	0.1	0.08	0.1	6.22
GPRA	4.1	19.08	0.05	0.15	0.06	0.12	0.04	0.02	0.07	1.05	0.69	0.05	0.1	0.14	0.03	0.19	6.87
GEC	0.01	0.11	7.91	2.28	4.11	4.39	5	2.58	0.22	0.08	0.04	0.15	0.19	0.03	1.19	0.34	20.72
FSIEM	0.08	0.06	3	10.29	7.21	8.98	5.65	4.2	0.1	0.13	0.03	0.92	1.02	0.33	1.55	0.24	33.51
FSIOAE	0.05	0.05	2.99	7.1	10.63	9.62	4.69	5.95	0.16	0.05	0.05	0.43	0.33	0.09	2.54	0.18	34.29
FSIUS	0.04	0.03	2.96	5.83	7.5	10.15	5	4.16	0.11	0.26	0.1	0.64	0.48	0.14	1.74	0.11	29.11
OVX	0.08	0.02	2.43	2.91	3.81	3.77	8.09	2.7	0.03	0.07	0.01	0.38	0.4	0.3	1.08	0.06	18.04
GVX	0.02	0.01	0.88	1.53	3.19	2.19	1.56	13.69	0.49	0.08	0.52	0.58	0.78	0.18	0.35	0.45	12.8
IND	0.23	0.18	2.4	3.13	4.53	5.25	3.02	2.21	7.62	0.08	1.31	1.07	1.12	0.88	5.19	2.44	33.05
PAK	0.11	0.16	0.83	0.72	0.93	0.73	2.01	0.19	0.55	21.93	0.11	0.07	0.53	0.33	0.48	0.18	7.93
SL	0.87	0.12	0.7	0.49	1.3	0.64	0.68	0.23	3.04	0.4	13.36	0.56	1.57	0.78	2.81	2.38	16.57
INDO	0.1	0.05	2.73	2.36	4.02	4.33	2.79	2.14	3.2	0.08	0.57	5.56	2.02	1.42	4.32	3.65	33.77
MY	0.13	0.1	1.46	1.74	2.5	2.55	2.35	0.99	2.22	1.53	0.36	0.93	13.15	0.41	2.12	4.63	24.02
PH	0.41	0.42	2.15	1.71	3.38	4.21	1.68	2.16	2.74	0.25	0.89	1.45	0.56	6.97	3.2	3.07	28.3
SG	0.05	0.04	1.91	3.06	5.63	5.3	2.88	3.66	3.17	0.08	1.09	0.72	0.44	0.38	10.18	1.49	29.89
TH	0.34	0.31	2.33	2.69	4.51	4.58	2.99	1.66	2.75	0.16	1.23	1.42	1.55	1.11	4.94	7.39	32.58
TO	6.62	3.76	26.95	35.79	52.79	57.03	40.53	33.03	18.89	4.49	9.22	9.68	11.13	6.63	31.63	19.5	367.68
Inc.Own	25.7	22.85	34.86	46.09	63.43	67.17	48.62	46.72	26.51	26.42	22.58	15.25	24.28	13.6	41.81	26.89	TCI
Net	0.4	-3.11	6.23	2.29	18.5	27.91	22.5	20.23	-14.16	-3.44	-7.35	-24.09	-12.9	-21.67	1.74	-13.08	22.98
NPDC	5	5	10	10	12	13	14	14	6	5	5	3	4	1	8	5	

Note: The variable Lag is set to 1. We are using a Bayes prior, and the variable forgetting factor for VAR is set to 0.99. Similarly, the forgetting factor for EWMA is also set to 0.99. The size of the Bayes prior is 200, and the frequency partition is 4: GPRT—Geopolitical Threats, GPRA -Geopolitical Acts, GEC- Global Economic Conditions, FSIEM- Emerging market Financial Stress, FSIOAE- Other advanced markets financial Stress, FSIUS- US market Financial Stress, OVX- Oil market Volatility, GVX- Gold Market Volatility. IND, PAK, SL, INDO, MY, PH, SG, and TH are country-wise financial stress indices.

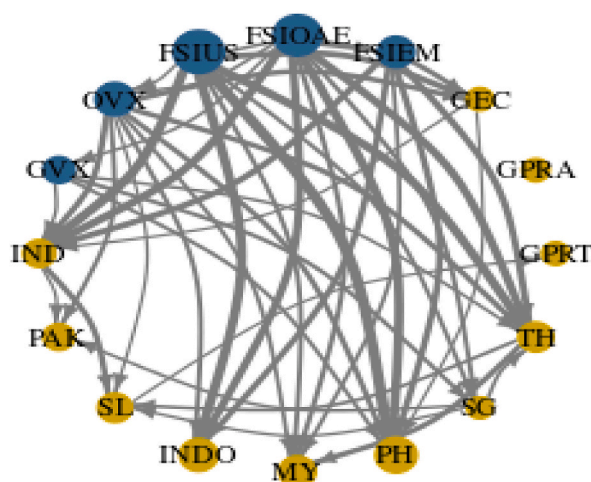


Fig. 2a. Total Connectedness and Spillover Network Plot Blue (yellow) nodes illustrate the net transmitter (receiver) of shocks.

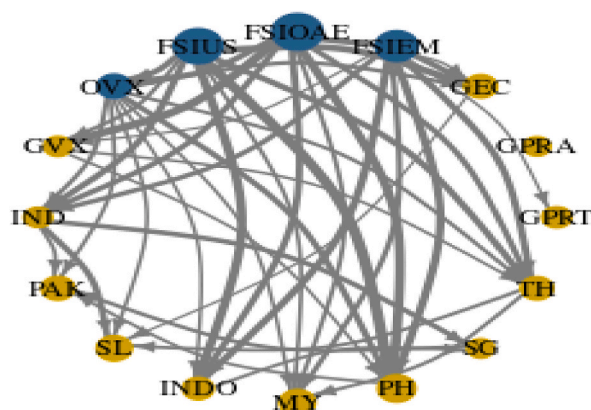


Fig. 2b. Short-term Connectedness and Spillover Network Plot Blue (yellow) nodes illustrate the net transmitter (receiver) of shocks.

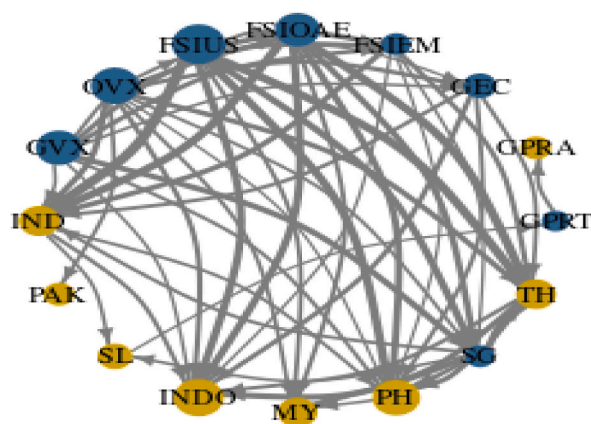


Fig. 2c. Long-term Connectedness and Spillover Network Plot Blue (yellow) nodes illustrate the net transmitter (receiver) of shocks.

economies significantly contributes to the financial stress of emerging markets, accounting for 19.66% and 16.86%, respectively. Once again, Singapore emerges as the primary spillover transmitter for the financial stress of emerging markets, highlighting its pivotal role within the region.

US FSI (20.77%) significantly contributes to the financial stress of other advanced economies, followed by emerging markets FSI (15.78%). Both oil price volatility (9.88%) and gold price volatility (10.79%) exhibit a similar impact on advanced economies' FSI. Along similar lines, aside from financial stress from emerging countries, Singaporean financial stress (5.95%) emerges as the most significant spillover contributor to the financial stress of advanced economies. This underscores the interconnectedness between developed countries and the Singaporean economy through financial markets and trade. Additionally, apart from its own shock, the financial stress of the US predominantly receives shocks from the FSI of advanced economies (19.91%), followed by the FSI of emerging markets (16.14%). Simultaneously, oil price volatility contributes 11.86% to US FSI, while gold volatility's impact is measured at 8.44%. With regard to financial stress from South and Southeast Asian countries, it has limited spillover effects on US financial stress, except for Singaporean FSI, which constitutes 5.2%. This reaffirms the dominant influence of financial stress originating from the US across both developed and developing nations. While financial stress from emerging markets is noteworthy for the US, the role of financial stress from South and Southeast Asian countries appears less influential. As anticipated, financial stress from developed economies and global economic conditions play a significant role in driving oil price volatility. Notably, Singaporean FSI contributes only 3.4% to OVX volatility. However, financial stress from developed economies holds a greater influence on gold price volatility (GVX) compared to financial stress from South and South-East Asian countries. Triki & Maatoug (2021) have affirmed that gold functions as a safe haven and diversifier during times of heightened tension. Zhao (2023) supports this perspective, highlighting gold's potential as a safe-haven asset for hedging against escalating geopolitical risks. Furthermore, Chiang (2022) suggests that gold can act as a hedge against various uncertainties. Lastly, Dagher & Hasanov (2023) employ the Financial Stress Index (FSI) to assess instability in Asian financial markets and determine that the source of an oil price shock is a critical determinant of its impact on financial markets.

As we analyze the regional FSI, intriguing findings come to light. For instance, US FSI (10.3%) exhibits the most significant spillover effect on Indian financial stress, which measures 9.37% for FSI Singapore and 9.22% for FSI advanced economies. Interestingly, emerging markets FSI appears to exert a stronger spillover effect on Indian FSI, underscoring robust regional financial integration within South and South-East Asia. Notably, FSI volatility in Pakistan relies on its own conditions by 70%, reflecting a lesser degree of regional and global economic integration for the nation. For Sri Lanka, FSI India emerges as the primary shock transmitter, followed by Singapore and Thailand. This trend is unsurprising given Sri Lanka's substantial financial and trade connections with these countries. FSI Indonesia showcases a balanced impact from both regional and global financial stress. However, FSI stemming from emerging markets in Southeast Asia holds more prominence than that of South Asian countries. Remarkably, FSI Malaysia experiences the predominant shock from FSI Thailand, contributing 10.79%. Furthermore, Malaysian FSI receives a very similar spillover effect from both advanced and emerging economies. In the case of the Philippines, financial stress originating from advanced and emerging economies demonstrates a comparable pattern. Notably, FSI from South-East Asian economies holds greater dominance than that from South Asian economies, except for FSI India. Interestingly, FSI Singapore receives the greatest shock from FSI India, accounting for 11.11%, followed by FSI in advanced economies (10.45%) and the US (9.4%). Similarly, for FSI Thailand, both advanced and emerging economies exhibit a similar shock pattern. These findings confirm that Southeast Asian countries maintain stronger financial and trade connections with both global and ASEAN countries in comparison to South Asian nations. The ASEAN union appears to be more vibrant and active than SAARC. Gil-Alana et al. (2021) report a faster transmission of financial stress between Japan and smaller economies compared to China. Similarly, Balçilar et al. (2023) reveal that financial stress co-movements and spillovers are positively associated in MENA countries, with Gulf nations demonstrating stronger financial connections among themselves. Countries with fewer capital controls and higher openness appear to play a more substantial role in financial interconnectedness and risk transmission.

To gain more profound insights into the connectedness, we have segmented our findings into short-run and long-run analyses. In the short-run analysis, as anticipated, advanced economies FSI (39.96%), followed by US FSI (36.97%), emerge as the most significant net shock transmitters. Conversely, FSI Philippines (−19.73%) stands out as the largest net shock receiver. Interestingly, Geopolitical Risk and Geopolitical Threats demonstrate no substantial spillover effect on the financial stress of developed and emerging economies. Furthermore, their contributions to oil and gold price volatility remain minimal. Notably, Singapore experiences the least shock from others in the short run, highlighting the robustness of the Singaporean economy, which exerts significant influence in the South and South-East Asian region. Moreover, our findings suggest that geopolitical risks hold little spillover effect on the financial stress of advanced and emerging countries. As expected, the FSI US (11.02%) contributes to Global Economic Conditions (GEC), followed by the FSI of advanced economies (9.43%) and the Oil Volatility Index (OVX) at 8.81%. Notably, the FSI of both advanced and emerging economies exhibits a similar pattern. These results align with the findings of Li et al., 2021b, who established that short-term spillover effects primarily drive the overall spillover.

In the short run, gold functions as a net shock receiver, but interestingly, it transitions into a net shock transmitter in the long run (as shown in Table 4). However, Shahzad et al. (2023) contradict this, asserting that gold serves as a net receiver of financial stress shocks. Notably, the dual role of gold and oil as net shock transmitters suggests that various financial stress categories experience spillover effects from these commodities. This underscores that both gold and oil respond to multiple categories of financial stress. Of note, oil volatility significantly contributes (5.4%) to gold volatility in the short run (as indicated in Table 3). Furthermore, the varying levels of gold's exposure to global political risk and categorical FSI highlight heterogeneous impacts on these assets. This means that gold might possibly act as a hedge or diversifier asset amid periods of financial stress, especially when stress arises from sources like global political risk and global economic circumstances. These findings parallel the conclusions drawn by Hoque and Low (2022) regarding the diverse response of gold to categorical FSI. Our present results, however, differ somewhat from those of Zhang and Wang (2021), who empirically reported that gold has lost its safe-haven value versus U.S. FSI and China FSI. Captivatingly, we observe that gold causes more spillover to others than it absorbs from other FSI categories and geopolitical concerns. In the long term, the spillover effect on gold from all other factors is negligible (as shown in Table 4), suggesting evidence of gold's safe-haven properties. In

alignment with our findings, [Zhao \(2023\)](#) underscores that gold can indeed function as a safe-haven asset, offering hedging potential against the escalation of geopolitical risks.

In line with previous results of [Zhang and Wang \(2021\)](#), our study also emphasizes the important function of US FSI as a major net shock producer. The notion that financial stress originating from the US plays a pivotal role in triggering global financial stress is intuitive and well-founded. However, recent studies have argued that China's influence has grown more pronounced in South and Southeast Asian countries compared to the US and other advanced economies ([Zhang and Hamori, 2022](#)). Although we cannot directly confirm this hypothesis, as we have not utilized Chinese FSI in our analysis, it's important to note that China is included within the broader category of Emerging Market FSI. Therefore, the function of emerging countries as net transmitters of financial shocks suggests that they might be pathways of amplification for the financial stress from the US and other advanced markets to the gold and oil markets.

As already pointed out, the results highlight how mostly connectivity and shock spillover are shown in the shorter time horizon, accounting for 38.96% of the overall impact when compared to 22.98% in the long term. This may suggest that both global political risk and the financial stress market require less time to absorb and assimilate information. Significantly, these outcomes align with the findings of [Zhang and Wang \(2021\)](#), which highlight that spillover effects predominantly manifest within a shorter time frame. Furthermore, in the short run, emerging markets' financial stress exerts a more considerable shock on the financial stress of South and Southeast Asian countries compared to the long run. This reinforces the dynamic nature of spillover effects and the shifting impacts over different time periods.

In the long run, a notable reduction in connectedness has been observed between regional financial stresses and geopolitical risks as well as commodity risks. While global geopolitical risk remains a net shock receiver, global economic activities transition into net transmitters, albeit with a minimal magnitude. FSI US (27.91%) emerges as the most dominant net shock transmitter, closely followed by oil volatility (22.5%) and gold volatility (20.23%). The once-significant dominance of FSI from emerging markets has notably diminished to 2.29% in the long run. Within this context, Indonesian FSI transforms into a prominent net shock receiver (−24.09%), trailed by the Philippines (−21.67%) and India (−14.16%). Once again, our study reaffirms that regional financial stress yields a greater spillover effect on South-East Asian countries compared to financial stress emanating from advanced economies. Additionally, apart from the financial stress stemming from the US and advanced economies, the FSI of regional countries significantly contributes to Indonesia's financial stress. Similarly, India, as an emerging economy in South Asia, is notably susceptible to a financial strain originating from the US (5.25%) and Singapore (5.19%). These findings demonstrate the need for both greater regional and global financial integration. Furthermore, it is evident that financial stress from the US and Singapore plays a pivotal role in shaping financial stress within South and South-East Asian contexts. [Huang et al. \(2022\)](#) suggest that the US plays a crucial role as a spillover transmitter compared to China, and that there is a strong interconnectedness among economic policy uncertainty, crude oil, and gold markets in terms of spillover effects. Conversely, the financial stress of Pakistan experiences the least impact from global and regional financial

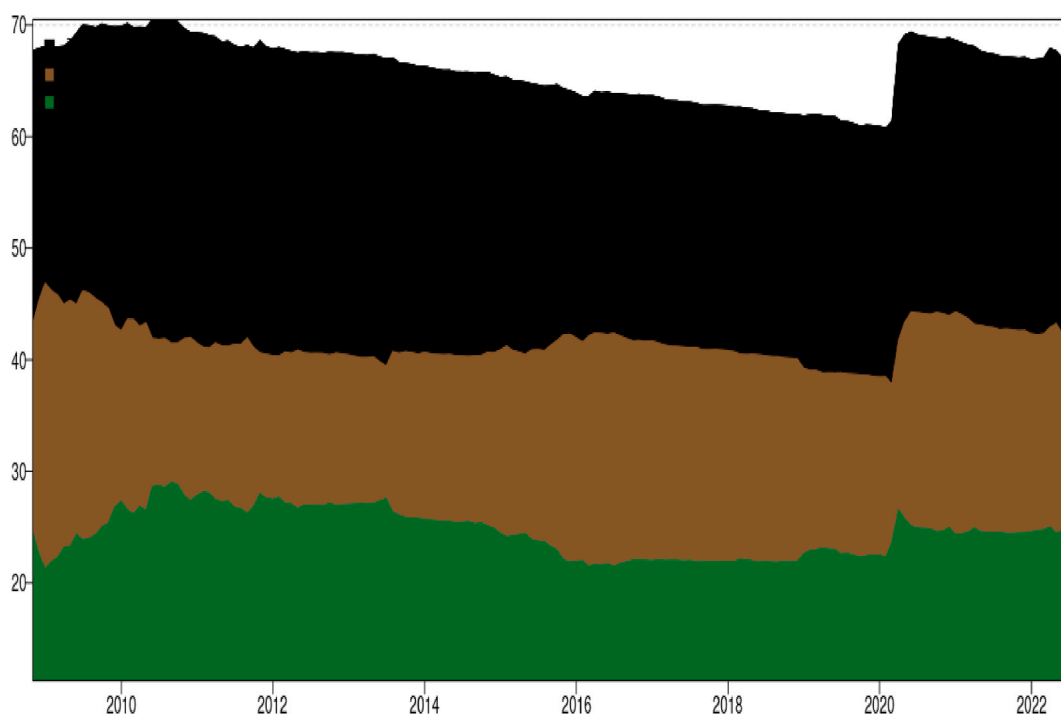


Fig. 3. Dynamic connectedness among global geopolitical uncertainty, regional financial stress, economic conditions, oil and gold market uncertainty, and South and Southeast Asian economies' financial stress.

stress, except for oil volatility. This can be attributed to the country's lesser degree of regional and global economic integration. Notably, our findings align with those of Yurteri Köseadağlı et al. (2021) and Long et al. (2021).

4.2. Time-varying dynamic total connectedness

Fig. 3 shows the overall dynamic interconnectedness of categorical geopolitical risk, global economic conditions, categorical FSI, regional FSI, gold, and crude oil volatility, as well as the breakdown of short-term and long-term connections. The figure depicts three distinct areas of interconnectedness, with the green shaded region representing long-term interconnectedness, the brown shaded region representing short-term interconnectedness, and the black region representing total interconnectedness.

In particular, it is observed that the total connectedness index (TCI) is high in some periods and low in others. This confirms that the relationships among the variables are time-varying. Short-term and long-term connectedness also exhibit this time-varying nature. However, these TCI values tend to remain stable but increase significantly during the last GFC and then remain stable until the COVID-19 pandemic and the Russia-Ukraine war, when they reached the highest peak. Previous research also indicates that various commodities markets' connections increased during difficult periods like the global financial crisis (2007–2009); see, for example, Balcilar et al. (2022) and Zhang and Broadstock (2020). Although these high TCI values only occur in a relatively brief time after the initial incidence of the COVID-19 epidemic, mean contagions across the many kinds of variables imply more when these values are greater. Balcilar et al. (2023) and Hoque et al. (2024) also provide similar findings wherein the COVID-19 epidemic causes overall connectivity levels to reach a new amazing high.

These high values then extend towards the end of our sample period. Our results and those of previous studies agree that the time-variant of the TCI is sensitive to shocks from the Global Financial Crisis and COVID-19 and that interlinkages rise with an increasing degree of uncertainty. Apostolakis et al. (2021) investigate the relationship between non-financial Brent oil markets and prices as well as the elements causing financial stress and concern regarding economic policy. Though the spillover has not yet surpassed the levels seen during the Global Financial Crisis of 2007, they conclude that spillovers have considerably increased during the COVID-19 outbreak. Similarly, Kocaarslan et al. (2019) demonstrate that the 2008 global financial crisis affected the relationship between dynamic conditional correlations between stock markets and global macroeconomic variables such as financial stress, oil prices, and gold prices.

South and Southeast Asian economies are closely linked, primarily through trade. Singapore, one of the world's most open economies, is a regional trade hub for both ASEAN and South Asian countries. The region benefits from a relatively stable network intensity and financial integration in the world, which allows shocks to be absorbed effectively rather than amplified throughout the system. However, global economic uncertainty, oil shocks, and financial stress in the region were more volatile in the 2020–2022 period due to both regional and global events, such as the trade war, COVID-19 pandemic, oil price shock, and Russia-Ukraine war (Li et al., 2023; Umar et al., 2022).

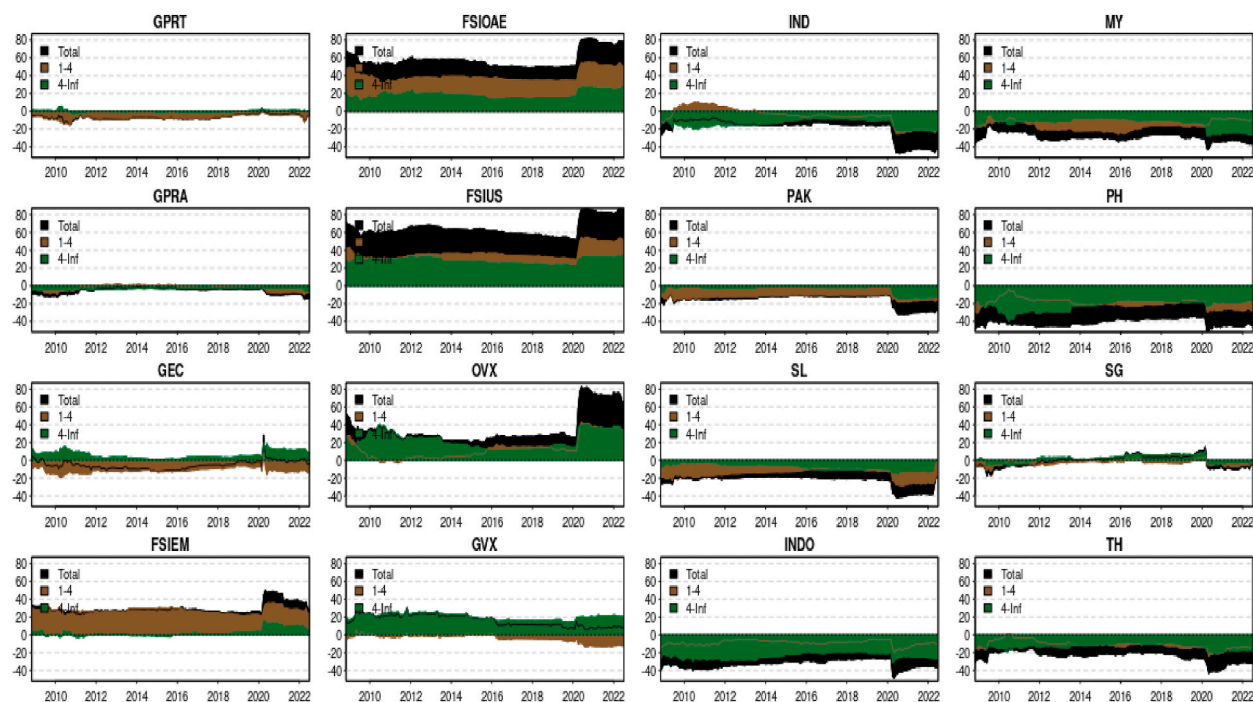


Fig. 4. Net total directional connectedness of global geopolitical uncertainty, regional financial stress, economic conditions, oil and gold market uncertainty, and South and Southeast Asian economies' financial stress.

4.2.1. Time-varying net total connectedness

In this analysis, we concentrate on this study's net connectivity findings, which will enable us to determine if a variable is a net shock generator or a net shock receiver. This approach differs from previous methods, as it allows us to track how the roles of different markets change over time. In other words, the roles of a market as a net shock receiver or a net shock transmitter can vary depending on the time period and the types of series being analyzed.

Our study begins by examining the net total connectedness of each series. This metric helps us identify any changes in the role of a series over time. Next, we look at the net total directional connectedness of each variable. This analysis allows us to see how the variables have changed over time. Fig. 4 plots the results of our analysis. It is important to note that positive values represent the net transmitting role, while negative values represent the net receiving role.

In line with our previous findings, we show that global economic conditions consistently transmit shocks to other markets. Interestingly, the transmission of shocks has intensified since the COVID-19 pandemic and the subsequent Russia-Ukraine war (Li et al., 2023; Umar et al., 2022). In addition to those geopolitical acts, gold volatility and crude oil volatility have been consistently net shock transmitters. The financial stress of advanced economies is a net shock receiver throughout the study period, and the intensity has increased significantly since the pandemic. At the same time, the finances of emerging economies have acted as net shock transmitters, although their impact has diminished over the period. The role of US financial stress has changed over the period. Similarly, the roles of Malaysian, Thai, and Indonesian financial stress have changed over time. Malaysia and Indonesia have been net receivers of shocks till 2018-19, but later they acted as net shock transmitters to the system. Singapore has been a consistent net transmitter of shocks, but the magnitude of these shocks has increased since 2018. Our findings contradict those of Zhang & Hamori (2022) but align with the conclusions of Yurteri Köseadağı et al. (2021), which state that financial stress in ASEAN countries is interdependent among emerging market economies and is primarily transmitted through geographical connections. Some earlier studies, like Monin (2019), found that financial stress was at its lowest in 2018 since the 2007-09 global financial crisis. Our findings are supported by Long et al. (2021), who confirm shocks from advanced economies have a significant impact on other economies, but shocks from emerging economies are becoming increasingly important. Gold and oil volatility transmitted more shocks during the COVID-19 pandemic.

4.3. Determinants of connectedness

In this analysis, we explore the effects of EPU, VIX, GFSI, and CPU total dynamic connectedness, which are presented in Table 5. Models 1 and 3 show that EPU and GFSI have a negative relationship with the total dynamic connectedness, and in both cases, the results are statistically significant at the 1% level. The results also align with the multivariate model. However, there is a discrepancy between how the CPU influences the dependent variable in the single model versus the multivariate model. In Model 5, the CPU harms the total dynamic connectedness, whereas it affects the dependent variable positively in Model 6. Neither of the results is statistically significant. The overall R^2 of the multivariate model is 15.33%, showing some ability to predict total connectedness among global geopolitical uncertainty, regional financial stress, economic conditions, oil market uncertainty, gold market uncertainty, and the financial stress of South and Southeast Asian economies.

In Table 6, we presented an estimated model for the influence of EPU, VIX, GFSI, and CPU on the short-term dynamic connectedness. In Model 1, EPU negatively influences the short-term dynamic connectedness, which is statistically significant at the 5% level. In Model 3, the effect of GFSI on the dependent variable is also negative but statistically significant at the 1% level. The signs of all the coefficients of the independent variables are the same in Model 5 with multiple independent variables. The overall R^2 of Model 4 is 11.66%, showing some forecasting power to predict short-term connectedness. The role of EPU and GFSI short-term connectedness appears to be consistent with total spillover.

In Table 7, we demonstrated an estimated model for the influence of EPU, VIX, GFSI, and CPU on long-term dynamic connectedness. Here, EPU and VIX affect long-term dynamic connectedness negatively in both the single and multivariate models. The results are statistically significant at the 10% level. GFSI influences the dependent variable positively, but the result is not statistically significant. The effect of CPU on the dependent variable is negative in the single model but is positive in the multivariate model, which is

Table 5
Determinants of total dynamic connectedness.

Coefficient	Model 1	Model 2	Model 3	Model 5	Model 6
EPU	−0.011*** (0.002)				−0.010*** (0.004)
VIX		−0.003 (0.258)			−0.003 (0.288)
GFSI			−0.0021*** (0.000)		−0.0021*** (0.000)
CPU				−0.001 (0.379)	0.0001 (0.938)
Adj R^2 (%)	5.35	0.70	9.00	0.13	13.22
N	165	165	165	165	165
Average VIF					1.057

Note: P-values are indicated within parentheses. At the 10%, 5%, and 1% levels correspondingly, *, **, and ***** indicate if the relevant coefficient is significant. Model 6 has an average VIF of 1.057 and a maximum VIF of 1.110.

Table 6

Determinants of short-term dynamic connectedness.

Coefficient	Model 1	Model 2	Model 3	Model 5	Model 6
EPU	−0.0088742* (0.076)				−0.00738 (0.141)
VIX		0.0017283 (0.638)			0.0021664 (0.537)
GFSI			−0.0031759*** (0.000)		−0.0031*** (0.000)
CPU				−0.0016139 (0.489)	−0.0007454 (0.749)
Adj R ² (%)	1.32	0.11	9.33	0.21	9.39
N	165	165	165	165	165
Average VIF					1.057

Note: See Table 5.

Table 7

Determinants of long-term dynamic connectedness.

Coefficient	Model 1	Model 2	Model 3	Model 5	Model 6
EPU	−0.0143** (0.049)				−0.0147** (0.073)
VIX		−0.0103* (0.066)			−0.010* (0.072)
GFSI			0.0001 (0.938)		0.0002 (0.842)
CPU				−0.001 (0.758)	0.0016 (0.676)
Adj R ² (%)	1.37	1.46	0.00	0.05	2.81
N	165	165	165	165	165
Average VIF					1.057

Note: see Table 5.

misaligned. The overall R² of the model is only 4%.

Overall, we capture that economic policy uncertainty, EPU impacts both total and long connectedness, and the global financial stress index influences short- and long-term spillover. The VIX and CPU do not exhibit influences. The moderating effects of EPU and GFSI are consistent with [Hoque \(2024c\)](#), [Billah \(2025\)](#), and [Elsyaed \(2025\)](#).

5. Conclusion

The current study examines the connectedness and spillover among global geopolitical risk, global financial stress, global economic conditions, oil market uncertainty, gold market uncertainty, and financial stress of South and Southeast Asian economies using a novel time-varying parameter vector autoregressive (TVP-VAR) connectedness approach in the time-frequency domain. We also examine the role of other global uncertainty factors in connectedness. Our sample period covers monthly data from January 2008 to June 2022.

We found a high level of interconnectedness and interdependence among categorical GPR, advanced and emerging markets' FSI, oil market uncertainty, gold market uncertainty, and the financial stress of South and Southeast Asian economies. Short-term connectedness dominates long-term connectedness. We revealed that the GPR indicators, global economic conditions, and FSI of South and Southeast Asian countries are net shock receivers. On the other hand, FSIEM, FSIOAE, FSIUS, OVX, and GVX are net shock transmitters, with FSIUS being the largest influencer in the network of GPR-FSI-OIL-GOLD. However, in terms of short-term connectedness, gold market uncertainty becomes a net shock recipient, while the roles of the other factors remain consistent with total connectedness. Similarly, there are changes in net roles where FSIEM and FSIOAE transition from net transmitters to receivers, while the roles of others remain the same as in total connectedness. Additionally, across different spectral frequencies, the financial stress of South and Southeast Asian economies is a net shock receiver of global uncertainty factors. Furthermore, the dynamics of connectedness and net spillover follow global economic events and conditions and are time-varying. Network analysis of total, short-term, and long-term connectedness highlights that GPRA is isolated from the network. Moreover, the empirical results indicate that economic policy uncertainty (EPU) has an impact on total and long-term spillover connectedness and the global financial stress index has an influence on total and long-term spillover. The VIX and CPU do not exhibit influences.

5.1. Practical implications

The above-presented empirical findings have practical implications. Firstly, the high interdependence of global geopolitical risk, country-level financial stress indices, and the volatility of the oil and gold markets means that shocks that occur in one area or market

may have a big impact on other areas via network transmission. Coordination of policy measures might aid in spillover and external shock management. Particularly, the economies of South and South-East Asia often receive net shocks from external uncertainty sources. Hence, the main goal of policy should be to increase resistance to the transmission of exogenous shocks. This might include expanding export markets, balancing trade, and accumulating foreign reserves. Similarly, central banks and financial regulators in South and Southeast Asia should also work together more closely to monitor spillover risks and conduct cross-border macroprudential surveillance. Information exchange on capital flow patterns, risk exposures, financial situations, etc. falls under this category. Additionally, countries facing substantial external shocks and capital outflows could potentially gain advantages from short-term liquidity support through regional financial mechanisms like currency swap lines and bilateral or regional repo facilities. This measure prevents the spread of instability to neighboring areas. Furthermore, enforcing reserve requirements on short-term capital inflows and implementing debt-to-equity requirements are effective policies for reducing the impact of unpredictable capital flows resulting from external uncertainties. These policies also support the goal of countering adverse effects. This reduces the propagation of shock. Moreover, it is essential to prioritize the sustainability of debt levels and the control of fiscal deficits in the fiscal policies of large advanced countries. Unsustainable budgetary trajectories might result in prolonged unpredictability and worldwide financial strain.

Secondly, the gold and oil markets have net shock-transmitting roles in the transmission of short-term shocks. Given that oil market uncertainty is a transmitter, oil importers should concentrate on diversifying their energy sources and executing energy transition plans to gradually decrease their dependency on imports. This reduces the spread of oil price fluctuations. Similarly, gold is a safe-haven transmitter; other secure assets may also transmit during risk-off occurrences. Creating local currency investment opportunities may provide choices. Furthermore, the net role of gold and oil markets has implications for investors: they can use gold and oil commodities as a safe haven and hedging instrument against the financial stress of South and Southeast Asian economies.

Thirdly, given that GFSI has an impact on both the long-term and short-term transmission of effects, it is important for global monitoring of financial conditions to include the accumulation of weaknesses across markets and sectors that might intensify pressure. This enables prompt intervention. Additionally, implementing macroprudential instruments, such as countercyclical capital buffers, helps decrease the tendency of the financial system to transmit stress in the short term due to fluctuations in the Global Financial Stress Index (GFSI). Similarly, regularly monitoring and evaluating the ever-growing network of connections can provide valuable insights into the evolving dynamics of financial stress, thereby facilitating the implementation of timely risk management measures.

5.2. Future research direction

The current study only covers the South and Southeast Asian economies, which may not allow us to generalize our results. Hence, future studies may focus on other regions, such as the GCC, Africa, and the Eurozone. Additionally, our study only captures the time-varying nature of the connectedness. This connectedness may vary the economic and financial conditions. Thus, future studies may employ methods that capture connectedness dependent on different states and conditions. Furthermore, future studies might investigate how specific global events (such as financial crises, pandemics, or geopolitical tensions) affect connectedness among economies, potentially leading to different patterns of interdependence.

Author contributions

Conceptualization: [M.E.Hoque, A. Uddin, F. Bilgili, S. B. Tariq]; Methodology: [M.E.Hoque, A. Uddin, F. Bilgili, S. B. Tariq]; Formal analysis and investigation: [M.E.Hoque, A. Uddin, F. Bilgili, S. B. Tariq]; Writing - original draft preparation: [M.E.Hoque, A. Uddin, F. Bilgili, S. B. Tariq]; Writing - review and editing: [M.E.Hoque, F. Bilgili, A. Uddin, S. B. Tariq]; Resources: [M.E.Hoque, A. Uddin, F. Bilgili, S. B. Tariq]; Supervision: [F. Bilgili, M.E.Hoque].

Submission declaration and verification

We, the authors, verify that this work has not been published previously.

Declaration of generative AI in scientific writing

We, the authors, have not used AI tools to analyze and draw insights from data as part of the research process.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.iref.2026.105013>.

Data availability

I have shared the data and codes at the Attach File step.

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