A TVP-VAR assessment of the spillover effects of geopolitical risk shocks on macroeconomic variability: a study of the Ghanaian economy

Kwame Ofori Asomaning[1], Shah Hamayoon[2] and Emmanuel Uche[3]*

Abstract

Our study verified the implications of the spillover of geopolitical risk (GPR) shocks to the economic crisis in Ghana. Our analysis employed the VAR-based spillover models by Diebold and Yilmaz (Int J Forecast 28:57–66, 2012; J Econ 182:119–134, 2014) and the Time-Varying Parameter Vector Autoregressive (TVP-VAR) connectedness approach by Gabauer and Antonakakis (Munich personal RePEc archive refined measures of dynamic connectedness based on TVP-VAR refined measures of dynamic connectedness based on TVP-VAR*, 2017). We scrutinized the interconnections and transmission mechanisms among key macro-financial variables spanning from 2000 to 2022. Our findings indicate that GPR is a fundamental source of shocks to the foreign exchange reserve (FXI), real exchange rate (REER), consumer price index (CPI), and debt. Other significant contributors include export (EXP) and import (IMP), with EXP standing out as the main shock transmitter. On the receiving end, CPI is most impacted by transmissions from IMP and GPR. Our study demonstrates that EXP and IMP are the top shock contributors, while FXI and CPI are the major recipients of these shocks. Such findings provide policymakers with valuable insights into the ramifications of geopolitical risk on the macroeconomic environment. Hence, policymakers are expected to provide necessary buffers to curb the influence of geopolitical risks on the economy.

Keywords Geopolitical risks, Macroeconomic crisis, TVP-VAR, Ghana

Introduction

Academic studies have recently emphasized how financial crises propagate across the economy, particularly in the wake of the global financial crisis of 2007–2009. Notably, economic crises are mostly intrinsically transmitted; some studies [32] highlighted certain commonalities in the transmission channels linked to financial turmoil. During this milestone, researchers have put a lot of time and effort into studying these transmission mechanisms and their spillover effects on real economic issues. Efforts to enhance our understanding of financial crisis dynamics have led to a crucial focus on capturing and studying transmission mechanisms and their connections to such events. However, based on our knowledge, very little has been said about the transmission of geopolitical risks to financial crises, particularly in the case of emerging economies.

According to some prior evaluations [7, 24, 34], geopolitical risk (GPR) has an asymmetric influence on the overall economy through its impacts on trade, fiscal, and monetary policies, as well as the commodities markets. Geopolitical events may also engender information asymmetries and disrupt the supply chain, thereby causing shortages of essential goods and seriously impacting national security [11]. The 2023 IMF report by Kristalina Georgieva highlights the far-reaching consequences of

*Correspondence:
Emmanuel Uche
euche@uj.ac.za
[1] Sacred Heart University, Fairfield, CT, USA
[2] Lahore University of Management Science (LUMS), Lahore, Punjab, Pakistan
[3] School of Economics, College of Business & Economics, University of Johannesburg, Johannesburg, South Africa

Russia's invasion of Ukraine. Despite Africa's limited direct trade and financial affiliations with Russia and Ukraine, the war has greatly impacted the continent's economic landscapes. This has resulted in higher commodity prices, increased food shortages, volatile energy prices, and headline inflation.

Geopolitical conflicts can exert both direct and indirect influences on economic stability. Prior investigations [8] emphasized that geopolitical risk (GPR) transmits shock to macro-financial variables, thereby adversely impacting the economic stability in developing countries. Geopolitical risk events, such as in Ukraine, can negatively impact developing countries' foreign reserves, trigger foreign debt default, and cause overall macro-financial instability.

Most emerging countries like Ghana lack sufficient foreign reserves to cover essential imports. Thus, their economic woes are heightened by volatile foreign exchange markets, high commodity prices, and other economic challenges. Particularly, Ghana's import dependency, its weak financial system, and insufficient foreign reserves have made it highly susceptible to the adverse impacts of geopolitical shocks. The country's inability to effectively absorb supply-side crises has resulted in economic instability, heightened inflationary pressures, and currency depreciation. Moreover, Ghana's higher external debt and sluggish economic growth have left it in a precarious position, grappling with escalating debt burdens and the looming risk of default. The country's limited foreign reserves pose significant challenges in meeting its dollar-denominated obligations. Besides, the country's excessive political expenditures could be another factor influencing prevailing economic woes.

A press release from the IMF in 2023 claims that Ghana's fiscal and debt vulnerabilities have worsened recently due to significant external shocks, thereby reducing domestic financing and increasing reliance on monetary financing. As a result, the nation no longer has access to foreign markets. The economic difficulties became more severe owing to the dwindling foreign reserves, the depreciation of the local currency (Cedi), inflationary pressures, excessive political expenditures, and dwindling investor confidence. Ghana's economy was already on the path to recovery from the epidemic when it was struck by the worldwide rise in food and energy prices occasioned by the crisis in Ukraine. This crisis also affected other African countries directly or indirectly given the interconnections of global economies.

The Ghanaian Cedi experienced a significant 57% decline in 2023, making it the poorest performer among currencies tracked by Bloomberg. Based on insights from data from the [20], Ghana's inflation rate has surged to almost 52.8%. The World Bank reported a continuous acceleration of inflation throughout the year, with the average CPI inflation reaching 31.5% in 2022 (up from 10% in 2021) and peaking at 54.1% in December year-on-year. In response to these economic challenges, the Bank of Ghana (BOG) recently raised its monetary policy rate from 14.5 to 28%.

However, the government's extensive use of its overdraft facility with BOG, estimated at 6.7% of gross domestic product (GDP) in 2022, hindered the effectiveness of these efforts. The soaring fuel prices and large debt payments that consumed over half of the government's revenues have pushed Ghana into one of its most severe economic crises in decades. Ghana's finance ministry reported that the currency's depreciation has significantly increased the government's debt burden by 93.9 billion Cedi ($6.5 billion). The country's debt has reached a worrying level of 90% of its annual economic value as of March 2023, resulting in substantial interest payments. Consequently, the government defaulted on loan payments and other financial obligations. Likewise, the Ghanaian banking sector's vulnerabilities have heightened owing to Cedi's depreciation and the aftermath of a domestic debt exchange (DDE) policy executed in February 2023. The DDE implementation has significantly impacted the country's financial sector, particularly due to the substantial exposure of banks, insurance companies, and pension funds to government debt. These entities currently hold approximately 42.1% of the government's domestic debt.

Moreover, Ghana's foreign reserves have significantly depleted, posing challenges in meeting import payment obligations predominantly denominated in the US dollars. As a result, international reserves dwindled to $5.6 billion in December 2022, equivalent to 2.5 months of import coverage, down from $9.1 billion (4.2 months of import) in the previous year. Given the prevailing economic challenges, growth prospects for Ghana are expected to slow further, with a projected growth rate of 1.6% in 2023 and little improvement anticipated in 2024.

The COVID-19 global epidemic and the Russia–Ukraine conflict are cited by the current administration as among the causes of Ghana's economic challenges. On the other hand, analysts, specialists, and the Ghanaian populace emphasized that the country's economic problems are mostly the result of excessive political expenditures that predate the pandemic. Notably, the contributions of geopolitical risks to these crises are utterly neglected. It is imperative to note that this study interrogates the effects of geopolitical shocks and statistically investigates how macro-financial factors interact with one another. Its objective is not to weigh in on the argument over whether the conflict in Ukraine contributed to Ghana's economic problems, as some analysts and professionals have indicated. Rather, the study is

dedicated to unraveling how this global issue has predicted Ghana's economic woes.

Ghana's governmental finances have reached unsustainable levels due to uncontrolled borrowing. Other factors such as external shocks and the effects of several factors such as the decline in natural resource prices and the COVID-19 outbreak may be influencing the economic crises. In March 2022, the nation lost access to the financial markets, and in December 2022, it stopped making payments on its foreign obligations. The markets reacted favorably to a recent local debt swap arrangement, but there is still uncertainty about an IMF agreement and the ability to access financing. The value of Ghana's money has considerably declined, and the country's foreign exchange reserves have been exhausted. Concerned about the G20 Common Framework's poor progress in treating debt, Ghana may consider having bilateral discussions with China and holders of Eurobonds. The economy could suffer greatly if investments and capital inflows were absent. Finding long-term sustainable funding options is difficult, which increases liquidity strain and lowers Ghana's political risk rating.

This study adds significantly to the corpus of the literature by first analyzing the dynamic relationship between geopolitical risk and Ghana's economic problems. Additionally, it examines the measurement of connectedness among macro-financial variables during geopolitical shocks. It also investigates the relationship between negative feedback loops between the real and financial channels of transmission during geopolitical shocks and determines if these channels reinforce one another.

In a bid to extend the depth of empirical literature, this investigation utilizes the dynamic connectedness approach, a methodology developed by Gabauer and Antonakakis [19]. This novel technique inculcates the time-varying VAR (TVP-VAR) model with Diebold and Yilmaz's [16] widely used procedure. With this methodology, we measure the extent of the change in real and monetary due to shocks originating from geopolitical risks. Rather than the inherently symmetric (hence non-directional) measures, such as correlation, the TVP-VAR framework is used because it allows for asymmetries in the pairwise linkages across macro-financial variables. By estimating forecast error variance decompositions derived from a VAR model, this approach allows us to examine the individual impact (own influence) as well as the influence from other variables (network influence). It provides a comprehensive framework for analyzing interdependence, including aggregate, directional, and net interdependencies, enabling a more thorough data analysis.

In addition to advancing our knowledge of how global risk spillover networks change as the economic crisis in Ghana develops, our analysis quantifies the dynamic consequences of various routes of transmissions in the face of geopolitical shocks. Our research also provides insightful information that will assist policymakers in developing effective strategies to restore financial stability and help investors make informed investment decisions. Particularly, the analyses on the size and direction of net transmission effects during economic crises are plausible [10, 22]. This is crucial, especially in light of the exceptional geopolitical shocks that hurt the world's economies and financial systems by depleting reserves, triggering debt defaults, and causing significant volatility in the oil and financial markets.

Other components of the study are outlined as follows. Section "Literature review" unveils the related literature. Section "Methodology" depicts the adopted methodology. The penultimate section presents the data analysis and result discussion, while the last section reports the concluding remarks.

Literature review
Theoretical literature
The research on the spillover of geopolitical risks emphasizes how connected the world economy is and how crucial it is to understand how these risks are transmitted. This study has connections to geopolitical risk and economic interconnectedness. In economic theory, the idea of financial and economic interconnectedness is relatively recent. According to Diebold and Yilmaz [16], the interconnectedness of real-world activity across sectors within a nation or across countries is intimately tied to the continuing debate of concepts such as globalization, synchronization, decoupling, and recoupling. Many aspects of systemic risk thinking also include actual actions since many individuals assume that a financial firm's systemic risk is tied to the likelihood that its failure would affect the real economy.

In their study, Asomaning and Hamayoon [8] utilized the Time-Varying Parameter Vector Autoregressive (TVP-VAR) connectedness approach to uncover connections and transmission mechanisms among key macro-financial components. The research specifically delves into the impact of geopolitical risk (GPR) shocks and their transmission channels during the Pakistan economic crisis spanning from 2000 to 2022. Notably, geopolitical risk (GPR) and foreign direct investment (FDI) emerge as primary drivers, propagating shocks across most variables. This highlights Pakistan's vulnerability to external influences, contributing to economic instability.

The second strand of the literature stresses geopolitical risk spillover. According to research by Berkman et al. [9], Pástor and Veronesi [31], and Uche et al. [35], geopolitical risk directly affects the global economy. It has

Asomaning *et al. Future Business Journal*   (2024) 10:55

Page 4 of 13

a significant role in investment decisions. Trade, money flows, and business cycles are just a few of how geopolitical risk may spread its effects. Studies have demonstrated that it can slow down economic development, domestic loans to the private sector, and foreign direct investment [1, 38]. Inflation dynamics, currency rates, and the prognosis for the government's budgetary position are impacted by geopolitical risk [25, 33].

Wang et al. [36] emphasized that geopolitical risk spillover transmits political and security uncertainties from one country or region to others with the potential to impact economic and financial conditions. This concept has garnered significant attention in academic literature due to its implications for global economic stability and financial market performance.

On the empirical front, Zhang and Hamori [37] studied the spillover effects of geopolitical risk in the BRICS countries on various macroeconomic variables. They found that geopolitical risk directly affects macroeconomic variables, indicating the interconnectedness between geopolitical events and economic outcomes. Civil unrest, armed conflicts, and violent incidents, including terrorist attacks, generate high levels of risk and uncertainty. These events have profound impacts on stock markets and financial markets, leading to significant fluctuations [12, 17, 21, 26]. Geopolitical shocks occur frequently, affecting economic conditions and financial markets. One particular area of impact is the volatility of crude oil prices, which can be influenced by geopolitical events [28].

Furthermore, Asomaning [7] explored the relationship between GPR and foreign reserves. It was found that geopolitical risk has an asymmetric relationship with foreign reserves. Countries with inadequate levels of reserves may face a higher risk of economic crises. This highlights the vulnerability of countries with limited reserves to geopolitical shocks and the potential for such shocks to trigger economic instability. Similarly, Naifar and Aljarba [30] reported a positive interaction between GPR and sovereign credit risk. Hence, their intricate interaction affected funding costs substantially.

Cheng and Chiu [13] studied the impact of global geopolitical threats on underdeveloped and emerging economies. They found that 38 of these economies experienced significant economic declines due to increased geopolitical threats on a global scale. Moreover, they observed that geopolitical risk shocks contributed substantially to changes in business cycles in these countries, accounting for approximately 22% of the overall variance in production.

Alam et al. [2] emphasized the role of geopolitical events as external shocks that generate economic and political uncertainty, leading to a reduction in corporate investment. These events disrupt the economic landscape, impeding development and progress. In a related study, Feng et al. [18] examined the effects of heightened geopolitical risk on capital flows in 45 major economies. They discovered that as geopolitical risks increased, capital flows decreased, indicating a decline in financial and investment activities within these economies.

Research gaps
The empirical review of extant literature revealed that studies have explored the subject of geopolitical risk and its spillover effects. However, none specifically examined the extent of its impact and the transmission dynamics of macro-financial variables in response to unprecedented geopolitical risks in Ghana. Our study fills this gap by investigating the dynamic interconnections between geopolitical shocks and the economic crisis in Ghana. We analyzed the propagation of shocks and identified variables acting as net transmitters and receivers of these shocks within the macro-financial network.

Methodology
Data description
The recently introduced TVP-VAR connectedness approach of Diebold and Yilmaz [14] is consistent with Diebold and Yılmaz [16]. These econometrics algorithms are based on the variance decompositions of a typical VAR process. The TVP-VAR is a novel technique that has attracted several interests. Among such studies are He and Hamori [23] and Mensi et al. [29]. TVP-VAR offers a significant improvement over the Diebold and Yilmaz connectedness approach [16] for analyzing relationships between assets in a system. Unlike rolling-window VAR models, TVP-VAR eliminates the need to subjectively choose a window size, thereby avoiding data loss and improving efficiency [6]. Furthermore, TVP-VAR retains the strengths of the Diebold and Yilmaz approach, allowing for the measurement of both the direction and intensity of connectedness between assets [14]. This makes TVP-VAR a more robust and flexible method for analyzing dynamic connectedness in complex systems. Data from the Census and Economic Information Center (CEIC) were used in this investigation. The Ghana Central Bank website's domestic official publication filled up any gaps in the data. The data sample consists of monthly observations from January 2000 to December 2022. The geopolitical risk index (GPR), which assesses the danger of terrorist attacks, conflicts, and tensions between nations that influence the regular and peaceful development of international relations, was one source of information used. Assets held by Ghana's central bank that is denominated in foreign currencies are known as foreign exchange reserves (RES) as a percentage of GDP. Foreign

direct investment (FDI) is external capital inflows to the Ghanaian economy expressed as a share of GDP.

Other factors include Ghana's external debt to its external development partners, which is expressed as a percentage of its GDP (DEBT). The quantity of money in circulation in an economy is measured by M2, which is broad money as a proportion of GDP, and the GDP per capita (GDPC) measures economic activity. While the Treasury bill rate (INT) gauges the short-term interest rate, the consumer price index (CPI) measures the level of prices. Real effective exchange rate and domestic lending to the private sector as a proportion of GDP, which gauges financial development activity, are additional factors. Market capitalization is expressed as a proportion of GDP. In contrast, exports are a percentage of GDP. Additionally, imports are expressed as a percentage of GDP. These variables are used to measure both the real and financial sectors of the economy.

Estimation techniques
TVP-VAR connectedness approach
We adopted a comprehensive analytical approach, drawing on the methodologies devised by Gabauer and Antonakakis [19] and Antonakakis et al. [5]. This approach seamlessly integrates Diebold and Yilmaz's [16] connectedness technique with Koop and Korobilis's [27] TVP-VAR methodology. We followed Asomaning and Hamayoon [8] and delved into the dynamic and evolving interplay between geopolitical risk and Ghana's macrofinancial variables.

Accordingly, Diebold and Yilmaz [14] introduced the Diebold–Yilmaz spillover index, which measures the volatility spillovers across asset classes and countries. Their framework has been widely used to quantify and analyze the interconnectedness and transmission of risks in financial markets. Gabauer and Antonakakis [19] further enhanced the measurement of spillover effects by developing the Time-Varying Parameters Vector Autoregression (TVP-VAR) methodology, which captures the changing dynamics of spillovers over time.

VAR and FEVD
At the heart of Diebold and Yilmaz's pioneering work on spillover dynamics, notably, the DY index introduced in 2009, lies the forecast error variance decomposition (FEVD) within VAR models. This index, often referred to as the DY index, acts as a valuable metric, unveiling the extent to which a response to an external shock—such as the impact of geopolitical risk—can be attributed to changes in one variable as influenced by another.

The VAR (p) process with K variables is expressed in Eq. (1):

$$Y_t = C + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \varepsilon_t \tag{1}$$

Equation (1) encapsulates the VAR (p) process, where Y_t represents a K-dimensional column vector denoting a stable covariance process, and $_{\varepsilon t}$ is a vector representing independent and identically distributed (i.i.d.) disturbances following N (0, Σ) distribution. The VAR (p) process is illustrated through a moving average (MA) framework, providing insights into the interactions among various components of the process. Forecasting Y_t in a forward-looking H-step manner involves deconstructing the forecast error into individual shocks from each variable using Cholesky factorization. However, the outcome of this factorization depends on the variable order. To address this, Diebold and Yilmaz [15] introduced the generalized forecast error variance decomposition (GFEVD) method. The GFEVD procedure considers correlated shocks and provides a clearer understanding of each variable's contribution to the forecast error [15].

Accordingly, Eq. 2 explains the KPPS H-step FEVD procedure.

$$d_{ij}(H) = \frac{\sigma_{ii}^{-1} \sum_{h=0}^{H} \left(e_i' A_h e_j \right)^2}{\sum_{h=0}^{H} \left(e_i' A_h \Sigma A_h' e_j \right)} \tag{2}$$

We further explored the estimation of $d_{ij}(H)$, representing the percentage of the H-step forecast error variance of Y_i attributable to Y_j. This estimate is derived by dividing the portion of the forecast error variance of Y_i explained by Y_j by the total forecast error variance, denoted by Σ—the variance–covariance matrix of the error term, denoted as $\in t$. Additionally, σ_{ii} signifies the diagonal element in Σ corresponding to the ith variable. To differentiate variables, we use a selection vector, *ei*, where *ei* equals 1 for the ith element and 0 otherwise.

Diebold and Yilmaz [15] emphasized that the sum of $\sum_{(j=1)}^{K} d_{ij}(H)$ for all j may not equate to 1. To address this, we normalize the elements within each entry of the variance decomposition matrix. This normalization enables us to compute the spillover index, offering a relative measure of the spillover effect from one variable to another.

$$\hat{d}_{ij}(H) = \frac{d_{ij}(H)}{\sum_{j=1}^{K} d_{ij}(H)}.$$

Measuring the spillover
The total spillover measures the extent a shock in one variable affects the overall forecast error. It indicates the degree to which the changes that occur in a particular variable are caused by the influences of other variables.

$$S(H) = \frac{\sum_{i,j=1(i \neq j)}^{K} \hat{d}_{ij}(H)}{\sum_{i,j=1}^{K} \hat{d}_{ij}(H)} \times 100 = \frac{\sum_{i,j=1(i \neq j)}^{K} \hat{d}_{ij}(H)}{K} \times 100$$

Academic researchers have a keen interest in exploring the relationships between different factors. One way to assess these relationships is through the value dij(H), which signifies the directional connection between variable j and variable i, known as SHij. Conversely, SHij = dji(H) represents the directional spillover from variable i to variable j. To gain a clearer understanding of how geopolitical shock effects propagate, it is essential to consider the net pairwise spillover. This involves multiplying the pairwise spillovers: SHij = dij(H) * dji(H), with the stipulation that Sij equals 0 when *i* and *j* are identical. The net pairwise spillover analysis allows us to identify instances where a net spillover impact is significant.

Furthermore, the directional spillover from variable *j* to variable *i*, referred to as SHi←j, indicates the influence from *j* to *i*. Conversely, SHi→j represents the directional spillover from variable i to variable j. To gain deeper insights into how geopolitical shocks are transmitted, we factor in the net pairwise spillover. This is calculated by taking the difference between the spillover from *i* to *j* and the spillover from *j* to *i*. When i and j are the same, Sij is set to 0, resulting in SHij = dij(H)—dji(H). A positive value indicates that i serves as a net transmitter of spillover to j, while a negative value suggests that *i* functions as a net receiver of spillover.

Results and discussion

Figure 1 displays a heatmap of the correlation matrix in which the coefficient values along the P-values are provided. Given our primary focus on geopolitical risk (GPR) as the central variable of interest, we observe that it exhibits a notably stronger negative correlation with FDI and DCP. Conversely, it demonstrates a robust positive correlation between M2 and debt. The negative correlation between GPR and FDI suggests that during volatile geopolitical events, capital tends to flow away from developing countries, and Ghana is no exception. Similarly, the strong negative correlation with DCP implies that financial institutions become hesitant to extend loans during periods of uncertainty. On the positive side, GPR displays a strong positive correlation with M2 and debt. This is attributable to government actions such as increased currency printing and raising more foreign loans during turbulent times, which could explain the positive correlation observed. Some prior studies [25, 33] emphasized the negative implications of GPR on macroeconomic variables. Related inferences are available in submissions of Alshubiri [3, 4] in the case studies of western European, G7, and GCC countries.

In the case of other pairs exhibiting strong negative correlations, we observe the following patterns: GDPC displays a significant negative correlation with REER, debt, and INT; FDI exhibits a strong negative correlation with debt and IMP; and debt demonstrates a robust negative correlation with EXP. Conversely, on the strong positive side, we find the following strong correlations. FDI shows a strong correlation with DCP, EXP, and debt with INT, CPI, and M2, while INT displays a strong correlation with CPI. Based on these highlighted scenarios, policymakers are encouraged to pay careful attention to these variables to forestall their negative effects on the macroeconomy.

Figure 2 illustrates the pairwise connectedness between the variables. Given our primary focus on GPR, it serves as a net transmitter, as indicated by the blue shade. However, the extent of its net transmission is not particularly high, as evident from the circumference of the circle. GPR primarily transmits shocks to FXI, REER, CPI, and debt. Other net transmitters include EXP and IMP, with EXP showing the highest net transmission. On the receiver side, CPI receives the highest transmission from IMP and GPR. Similarly, REER, DCP, FXI, and debt are also exhibiting the role of net receivers.

Figure 3 presents the dynamic total connectedness index spanning a 22-year timeframe. The highest total connectedness index was recorded in 2012, coinciding with an election year in Ghana. This period was marked by considerable uncertainty, as government expenditure tends to rise significantly during elections, leading to disruptions in macroeconomic indicators and increased economic fragility. It was a time when the country reached out to the IMF for the bailout.

In contrast, the year 2000, when the TCI reached its minimum value, also occurred during an election year. However, during that time, there were a coalition government and reconciliation efforts among all stakeholders, resulting in a smoother transition of power and a less disruptive impact on the economy.

Figure 4 illustrates the spillover from the system to each variable. Notably, the year 2012 stands out as a critical juncture when the system transmitted significantly higher shocks to most variables. This aligns with a period of political turmoil in the country, marked by intense political polarization among the various parties regarding controversial election results. The nation faced a heightened level of instability, to the point where civil war seemed imminent, until the intervention of the Supreme Court, which allowed the incumbent government to continue.

Figure 5 illustrates the spillover of shocks from each variable into the system. Notably, GPR emerges as a prominent transmitter of shocks into the system. This
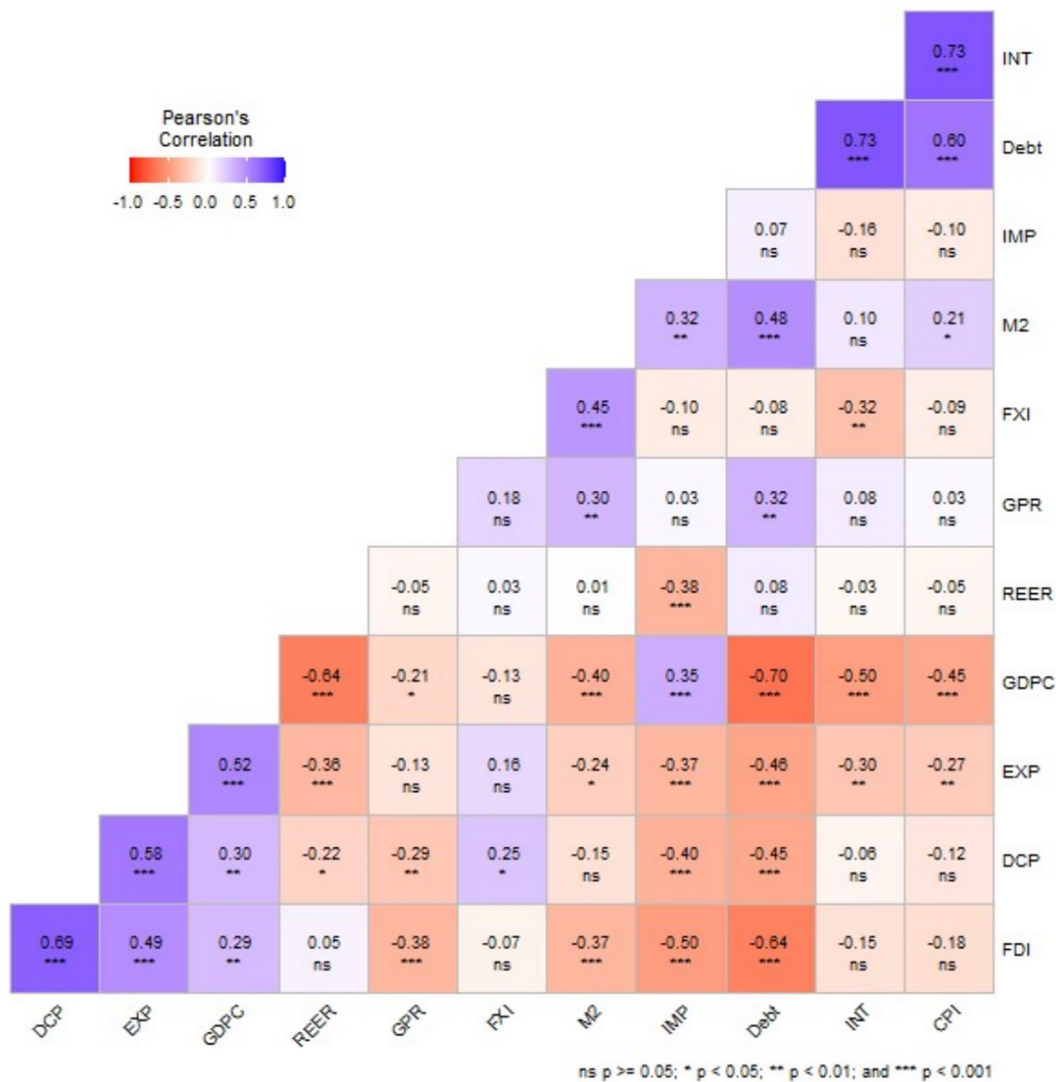
Fig. 1 Heatmap of correlation matrix

trend is particularly pronounced after 2002, as it consistently exhibits higher levels of transmission with minimal fluctuations. In contrast, all the other variables either display very low transmission or exhibit highly fluctuating spillover into the system.

Figure 6 displays the net dynamic spillover among the variables over 20 years. FXI, debt, and CPI consistently acted as the net recipients of shocks throughout this entire timeframe. Notably, there has been a marked increase in shock reception since 2012. DCP, FDI, and INT also predominantly served as net receivers, although there were instances where they functioned as transmitters. Conversely, EXP, IMP, and GPR stood out as the primary net transmitters of shocks most of the time. On the other hand, REER, M2, and GDPC exhibited more balanced roles, with their net transmitter and receiver roles showing roughly equal occurrences.

Table 1 presents the results from the well-known Diebold–Yilmaz connectedness table. The "From" column displays the spillover from the system into specific variables, while the "To" row showcases the spillover from each variable into the system. In the "From" column, debt, M2, INT, and GDPC emerge as the top recipients of shocks from the system, with values of 86.58, 81.04, 80.02, and 79.64, respectively. Conversely, in the "To" row, EXP, IMP, GPR, and M2 stand out as the primary transmitters of shocks into the system, with values of 123, 109, 84, and 80, respectively. The "NET" row represents the net transmission or reception of shocks, revealing that EXP and IMP serve as the highest shock transmitters,
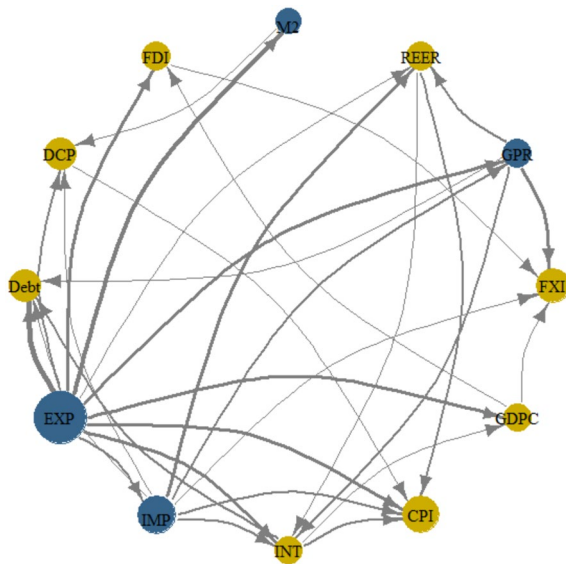
Fig. 2 Network pairwise connectedness

with values of 84.8 and 39.32, respectively. Similarly, CPI and FXI are the most significant net recipients of shocks, with values of −35.9 and −27.4, respectively.

Conclusion

This research focused on exploring how the shocks of geopolitical risk (GPR) spillover and impact the economic crisis in Ghana. It is imperative to reemphasize the absence of such narrative in prior studies. To perform the analysis, this study utilized spillover models based on VAR (vector autoregressive) proposed by Diebold and Yilmaz in 2012 and 2014. Additionally, the study employed the novel Time-Varying Parameter Vector Autoregressive (TVP-VAR) connectedness approach developed by Gabauer and Antonakakis in 2017. The investigation involved a detailed examination of the interconnections and transmission mechanisms among crucial macro-financial variables, covering the period from 2000 to 2022.

Recent research has looked into how financial and economic crises spread among countries. We highlight the importance of studying how these crises are transmitted into Ghana's economic crisis from 2022 to 2023. The study also considered the global geopolitical risks from the Russia–Ukraine war with increasing challenges such as high food, gas, and oil prices. Particularly, Ghana's borrowings raised worries about the country not being able to pay, causing the currency to lose value and import
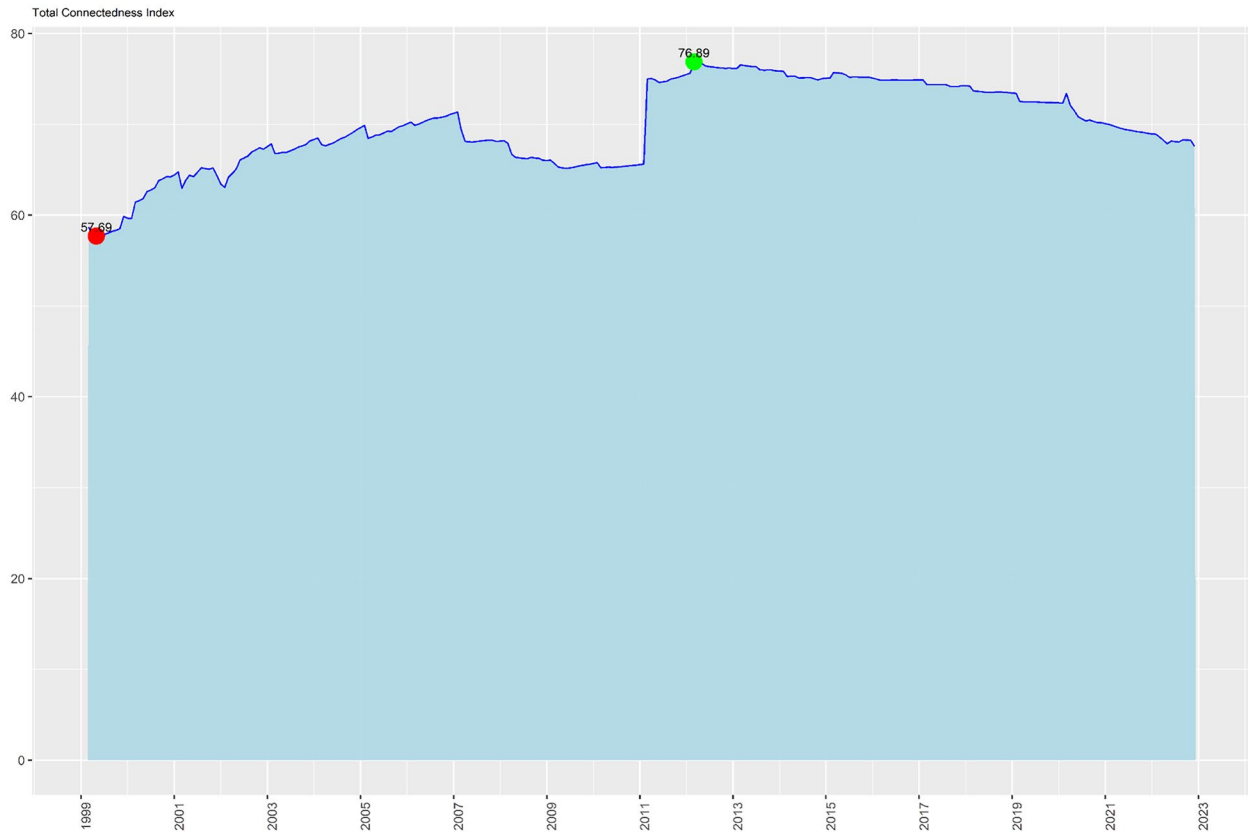

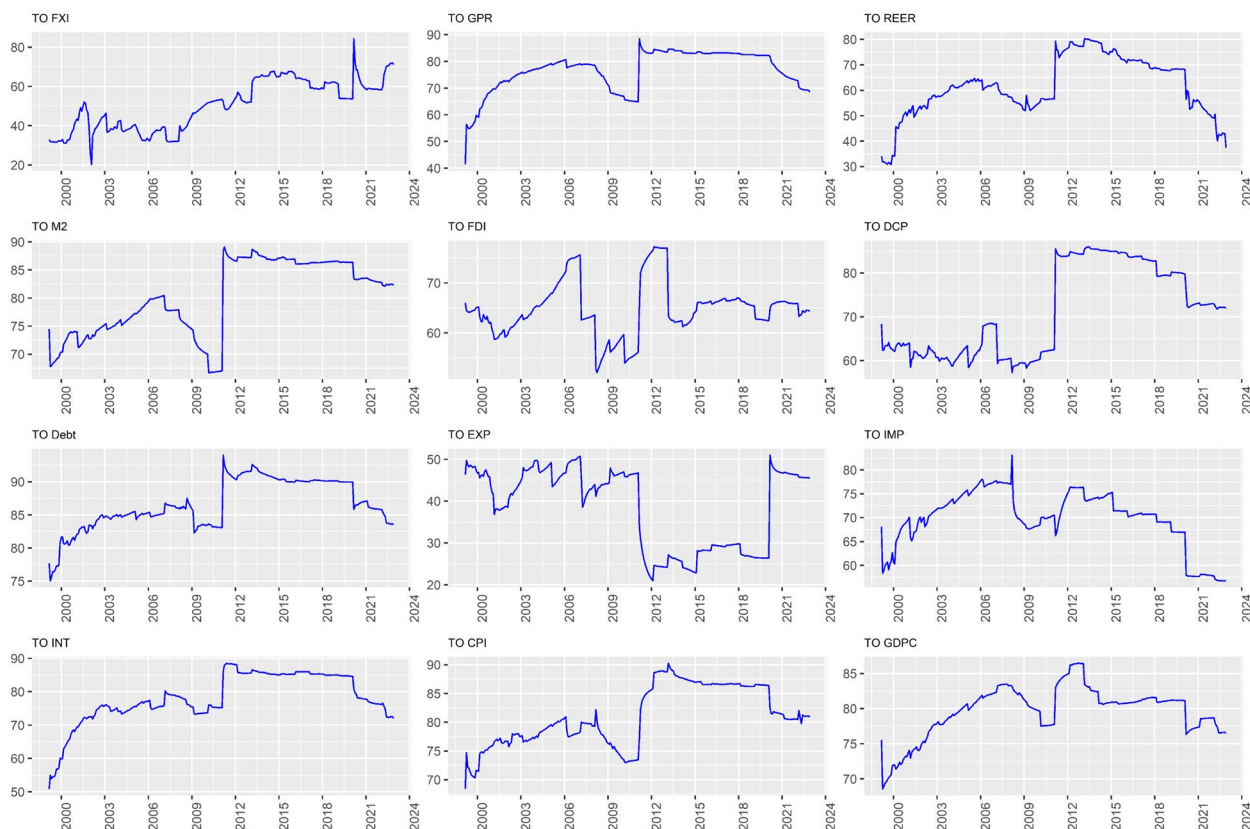**Fig. 3** The total connectedness index

Fig. 4 From the system to each variable

costs to rise. By August 2022, Ghana's foreign reserves hit a record low, and inflation shot up, making life harder for people and showing how serious the crisis was. These outcomes were triggered by lots of factors, including geopolitical risks.

Our study of Ghana's economy points to geopolitical risk (GPR) as a major factor, thereby confirming Asomaning and Hamayoon's [8] inferences. Using graphs, correlation matrices, and connection models, we discovered the wide-ranging relationships GPR has with other factors. Constant negative links show its connection to global uncertainty and economic cycles. We also find positive connections between GPR, debt, and exports, highlighting how outside influences shape the country's economic path. These factors contributed to Ghana's economic crises.

Our research reveals that geopolitical risk (GPR) plays a crucial role in transmitting shocks to FXI, REER, CPI, and debt. Additionally, notable contributors to these shocks include EXP and IMP, with EXP being the primary transmitter of shocks. On the receiving end, CPI is most affected by transmissions from IMP and GPR. Our study emphasizes that EXP and IMP are the primary sources of shocks, while FXI and CPI are the primary recipients

of these impacts. Besides, the study underpins the need to provide other economic buffers to curtail the negative effects of geopolitical factors on other macroeconomic variables. As an extension, it is recommended that the government of Ghana should outline a sustainable fiscal policy system that reflects its economic capabilities. They should discourage excessive political expenditures by aligning with global best practices. When these steps are taken, the Ghana economy is expected to perform better and yield the expected positive results. Likewise, the economy could withstand the negative repercussions of external shocks like geopolitical risks.

In conclusion, our findings empower policymakers to address geopolitical risk challenges proactively. By strategically guiding Ghana's economic trajectory toward stability and resilience, they can mitigate the adverse effects of economic shocks. This objective could be achieved by reducing external dependency and controls. In this context, an inward-looking economic system with less external incursion will help the Ghanaians withstand the negative influence of GPR. Particularly, cutting down on excessive political expenditures could help shore up the domestic financial capacities for improved domestic investments.
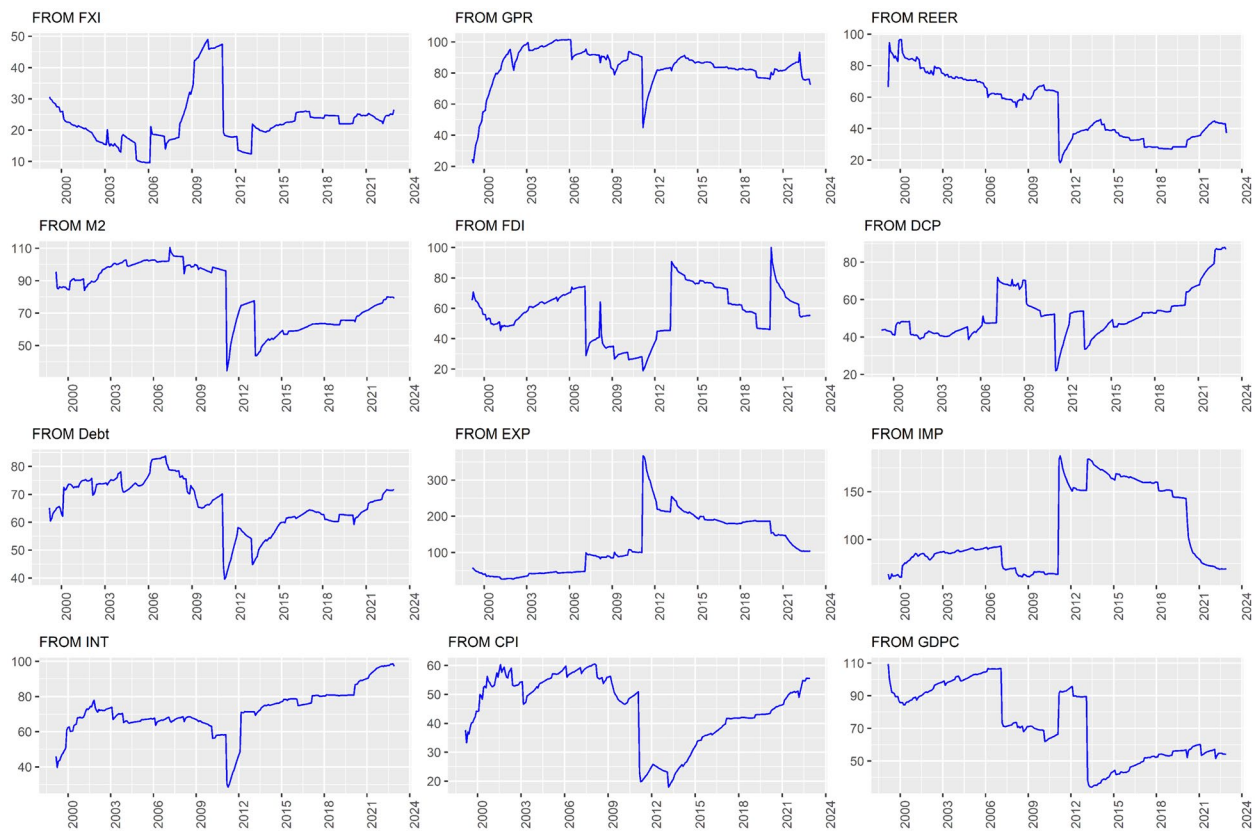
Fig. 5 From each variable to system

Admittedly, other essential factors could trigger a macroeconomic crisis. However, the current study restrains itself to its specified objectives. Therefore, the current investigation may not be entirely inclusive, given that it neglected certain factors. Hence, this is obvious; future studies are encouraged to explore other factors with the potential to trigger a macroeconomic crisis in Ghana. Moreover, a study that considers the peculiarities of other developing countries vis-à-vis geopolitical risks—macroeconomic performance nexus—is needed for a broad understanding of the dynamics.
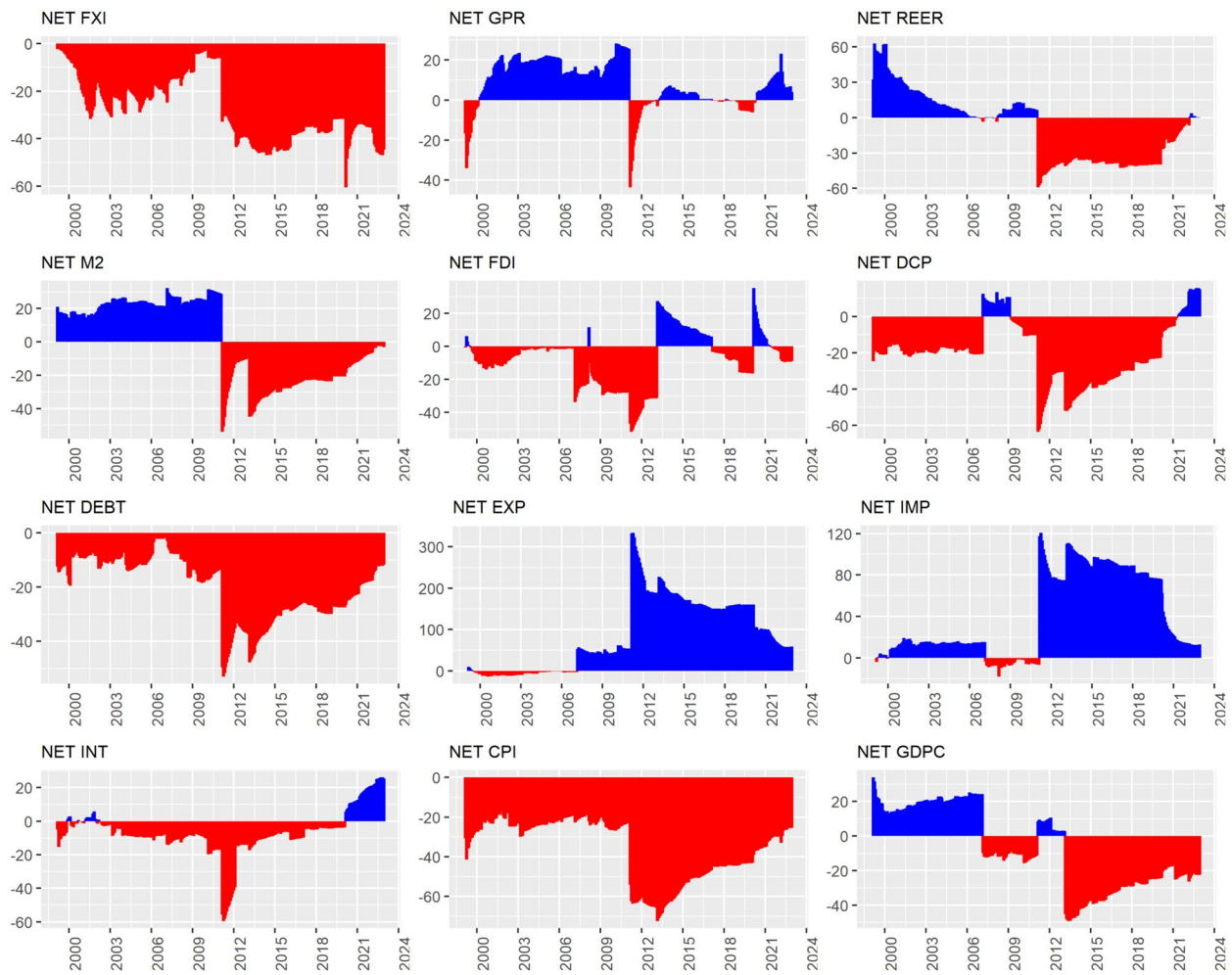
Fig. 6 Net spillover by each variable

Table 1 Diebold–Yilmaz connectedness table using the TVP-VAR methodology

	FXI	GPR	REER	M2	FDI	DCP	Debt	EXP	IMP	INT	CPI	GDPC	FROM
FXI	49.71	10.10	1.31	2.38	6.57	4.95	3.86	3.19	4.71	2.98	2.91	7.31	50.29
GPR	0.7	23.39	5.96	9.84	7.02	5.25	3.65	11.43	14.26	7.75	6.13	4.61	76.61
REER	2.29	11.54	38.62	5.65	3.39	2.7	3.06	7.1	14.77	5.32	3.09	2.47	61.38
M2	1.85	7.54	4.51	19.98	8.72	8.21	10	12.16	8.6	5.34	3.24	9.86	80.02
FDI	2.65	4.12	0.84	10.82	35.23	2.17	6.61	14.1	8.56	2.75	2.27	9.87	64.77
DCP	4.71	5.92	5.14	11.64	3.35	28.78	7.05	8.14	8.88	5.23	2.41	8.76	71.22
Debt	1.46	7.84	5.8	9.84	4.88	5.27	13.42	13.42	9.87	12.81	5.97	9.41	86.58
EXP	2.56	2.29	2.12	2.06	5.35	1.84	0.92	61.55	12.22	1.48	1.17	6.44	38.45
IMP	1.35	8.33	6.53	6.95	6.23	4.95	5.82	18.4	30.25	3.3	2.83	5.06	69.75
INT	0.84	13.22	8.74	5.8	3.55	3.52	6.11	11.33	10.31	21.86	10.65	4.07	78.14
CPI	1.14	9.17	9.57	5.11	2.4	5.69	8	9.27	9.92	16.28	18.96	4.49	81.04
GDPC	3.3	4.31	2.38	10.66	5.67	7.4	11.47	14.73	6.97	8.31	4.46	20.36	79.64
TO	22.87	84.39	52.88	80.76	57.14	51.95	66.55	123.25	109.07	71.56	45.14	72.35	cTCI/TCI
NET	−27.43	7.77	−8.5	0.74	−7.63	−19.28	−20.03	84.8	39.32	−6.58	−35.9	−7.29	76.17/69.83

The connectedness table using the TVP-VAR methodology. The variables FXI, GPR, M2, FDI, DCP, debt, EXP, IMP, INT, CPI, and GDPC show the foreign exchange reserves, geopolitical risk, real effective exchange rate, money supply, foreign direct investment, domestic credit to private sector, foreign debt, exports, imports, interest rate, consumer price index, and gross domestic per capita, and the column From represents the spillover from the system toward each variable while the row TO represents the spillover from each variable into the system

Abbreviations

TVP-VAR	Time-varying parameter vector autoregression
GPR	Geopolitical risks
FXI	Foreign exchange reserve
REER	Real exchange rate
CPI	Consumer price index
EXP	Export
IMP	Import
IMF	International Monetary Fund
BOG	Bank of Ghana
GDP	Gross domestic product
DDE	Domestic debt exchange
FDI	Foreign direct investment
BRICS	Brazil, Russia, India, China, and South Africa
FEVD	Forecast error variance decomposition
VAR	Vector autoregression
MA	Moving average
GFEVD	Generalized forecast error variance decomposition
INT	Interest rate
TCI	Total connectedness index
DCPS	Domestic credit to private sector
GDPC	Gross domestic product per capita

Declarations

References
1. Afşar M, Doğan E, Özarslan DB (2021) Does higher geopolitical risk limits Turkish foreign direct investments? Mehmet Akif Ersoy Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi 8(3):1456–1475. https://doi.org/10.30798/makuiibf.859137
2. Alam AW, Houston R, Farjana A (2023) Geopolitical risk and corporate investment: how do politically connected firms respond? https://papers.ssrn.com/abstract=4486678
3. Alshubiri F (2022) The impact of the real interest rate, the exchange rate and political stability on foreign direct investment inflows: a comparative analysis of G7 and GCC countries. Asia-Pac Finance Markets 29:569–603
4. Alshubiri F (2022) The stock market capitalisation and financial growth nexus: an empirical study of western European countries. Fut Bus J 7(1):46
5. Antonakakis N, Gabauer D, Gupta R (2019) International monetary policy spillovers: evidence from a time-varying parameter vector autoregression. Int Rev Financ Anal 65:101382
6. Antonakakis N, Chatziantoniou I, Gabauer D (2020) Refined measures of dynamic connectedness based on time-varying parameter vector autoregressions. J Risk Finan Manag 13(4):84
7. Asomaning K (2023) Asymmetric Effects in geopolitical risk and foreign reserves accumulation among BRICS countries. Doctoral Dissertations (DBA). https://digitalcommons.sacredheart.edu/wcob_theses/31
8. Asomaning K, Hamayoon S (2023) Geopolitical risk spillover and Pakistan economic crisis. A TVP-VAR connectedness approach (October 23, 2023).

Available at SSRN: https://ssrn.com/abstract=4610204 or https://doi.org/10.2139/ssrn.4610204

9. Berkman H, Jacobsen B, Lee JB (2011) Time-varying rare disaster risk and stock returns. J Financ Econ 101(2):313–332. https://doi.org/10.1016/j.jfineco.2011.02.019

10. Bouri E, Cepni O, Gupta R, Jalkh N (2021) Geopolitical risks and stock market volatility in the G7 countries: a century of evidence from a time-varying nonparametric panel data model. Working Papers 202029, University of Pretoria, Department of Economics

11. Cáceres BS, Ear S (2012) The geopolitics of china's global resources quest. Geopolitics 17:47–79

12. Choudhry T (2010) World War II events and the Dow Jones industrial index. J Bank Finance 34(5):1022–1031. https://doi.org/10.1016/j.jbankfin.2009.11.004

13. Cheng CHJ, Chiu CWJ (2018) How important are global geopolitical risks to emerging countries? Int Econ 156(1):305–325. https://doi.org/10.1016/j.inteco.2018.05.002

14. Diebold FX, Yilmaz K (2009) Measuring financial asset return and volatility spillovers with application to global equity markets. Econ J 119(534):158–171. https://doi.org/10.1111/J.1468-0297.2008.02208.X

15. Diebold FX, Yilmaz K (2012) Better to give than to receive: predictive directional measurement of volatility spillovers. Int J Forecast 28(1):57–66. https://doi.org/10.1016/j.ijforecast.2011.02.006

16. Diebold FX, Yilmaz K (2014) On the network topology of variance decompositions: measuring the connectedness of financial firms. J Econ 182(1):119–134. https://doi.org/10.1016/j.jeconom.2014.04.012

17. Elsayed AH, Yarovaya L (2019) Financial stress dynamics in the MENA region: evidence from the Arab Spring. J Int Finan Markets Inst Money 62:20–34. https://doi.org/10.1016/j.intfin.2019.05.004

18. Feng C, Han L, Vigne S, Xu Y (2023) Geopolitical risk and the dynamics of international capital flows. J Int Finan Markets Inst Money 82:101693. https://doi.org/10.1016/J.INTFIN.2022.101693

19. Gabauer D, Antonakakis N (2017) Munich personal RePEc archive refined measures of dynamic connectedness based on TVP-VAR refined measures of dynamic connectedness based on TVP-VAR*

20. Ghana Statistical Service (2023) https://www.statsghana.gov.gh/gssmain/fileUpload/Price%20Indices/Bulletin_%20CPI%20Febuary%20%202023.pdf?ref=mariblock.com

21. Guidolin M, La Ferrara E (2010) The economic effects of violent conflict: evidence from asset market reactions. J Peace Res 47(6):671–684. https://doi.org/10.1177/0022343310381853

22. Haddad HB, Mezghani I, Gouider A (2021) The dynamic spillover effects of macroeconomic and financial uncertainty on commodity markets uncertainties. Economies 9(91):1–22

23. He X, Hamori S (2021) Is volatility spillover enough for investor decisions? A new viewpoint from higher moments. J Int Money Financ 116:102412

24. IMF. (2023). World Economic Outlook. https://www.imf.org/-/media/Files/Publications/CR/2023/English/1GHAEA2023001.ashx

25. Jeanne O, Rose AK (2002) Noise trading and exchange rate regimes. Q J Econ 117(2):537–569. https://doi.org/10.1162/003355302753650328

26. Kollias C, Kyrtsou C, Papadamou S (2013) The effects of terrorism and war on the oil price–stock index relationship. Energy Econ 40:743–752

27. Koop G, Korobilis D (2014) A new index of financial conditions. Eur Econ Rev 71:101–116

28. Liu J, Ma F, Tang Y, Zhang Y (2019) Geopolitical risk and oil volatility: a new insight. Energy Econ 84:104548

29. Mensi W, Hernandez JA, Yoon SM, Vo XV, Kang SH (2021) Spillovers and connectedness between major precious metals and major currency markets: The role of frequency factor. Int Rev Financ Anal 74:101672

30. Naifar N, Aljarba S (2023) Does geopolitical risk matter for sovereign credit risk? Fresh evidence from nonlinear analysis. J Risk Finan Manag 16(3):148. https://doi.org/10.3390/jrfm16030148

31. Pástor Ľ, Veronesi P (2012) Political uncertainty and risk premia. J Financ Econ 110(3):520–545. https://doi.org/10.1016/J.JFINECO.2013.08.007

32. Reinhart C, Rogoff K (2008) this time is different: a panoramic view of eight centuries of financial crises. NBER Working Papers 13882, National Bureau of Economic Research, Inc

33. Salisu AA, Cuñado J, Gupta R (2022) Geopolitical risks and historical exchange rate volatility of the BRICS. Int Rev Econ Financ 77:179–190. https://doi.org/10.1016/J.IREF.2021.09.017

34. Sohag K, Islam MM, Tomas Žiković I, Mansour H (2022) Food inflation and geopolitical risks: analyzing European regions amid the Russia-Ukraine war. British Food J 125(7):2368–2391. https://doi.org/10.1108/BFJ-09-2022-0793

35. Uche E, Nwaeze NC, Obiakor RT (2022) Do geopolitical risk factors and economic policy uncertainties stimulate capital outflows: an updated evidence. Stud Appl Econ. https://doi.org/10.25115/eea.v40i3.6971

36. Wang X, Wu Y, Xu W (2019) Geopolitical risk and investment. J Money, Credit Bank, Forthcom. https://doi.org/10.2139/SSRN.3305739

37. Zhang Y, Hamori S (2022) A connectedness analysis among BRICS's geopolitical risks and the US macroeconomy. Econ Anal Policy 76:182–203. https://doi.org/10.1016/J.EAP.2022.08.004

38. Zhou L, Gozgor G, Huang M, Lau MCK (2020) The impact of geopolitical risks on financial development: evidence from emerging markets. J Competit 12(1):93–107

Publisher's Note