VNU Journal of Economics and Business

Journal homepage: https://jeb.ueb.edu.vn

Original Article

# The impact of geopolitical risk on financial assets: Evidence from time-varying parameter VAR

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Received: June 16, 2023
Revised: July 4, 2023; Accepted: August 25, 2023

**Abstract**: Geopolitical events are expected to affect all countries, asset classes, and sectors. Vietnam is a large open economy, actively participating in a vast network of free trade agreements. Therefore, political conflicts in some regions will have both positive and negative impacts on the Vietnamese economy. Aiming to explore the dependency structure between the geopolitical risk index and stock market returns, this study has evaluated quite in-depth using the TVP-VAR method combining the wavelet coherence phase between February 2012 and April 2022. The results show that geopolitical risk has a heterogeneous effect on the return of financial assets, and the market does not respond to geopolitical tensions in a uniform manner. Our research uncovers new and interesting implications for policymakers and investors involved in the Vietnamese stock market.

*Keywords:* Geopolitical risk, Time-Varying Parameter Vector Autoregression (TVP-VAR), return, wavelet.

## 1. Introduction

In recent years, the world's economic and political context has changed profoundly. Major countries have been adjusting their strategies and policies to increase competition and affirm their position in the international arena, leading to frictions, political conflicts and many hot spots of conflict in many regions. In this context, geopolitical risk (GPR) emerged to be a crucial factor for investors to consider as they reflect the political stability of a country.

GPR are also fluctuations related to tensions between states, threats of war, internal military-related conflicts, and acts of terrorism. For example, the conflict between Russia and Ukraine has dented the world's prosperity, but the deeper impact will be felt when it translates

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https://doi.org/10.57110/vnujeb.v3i4.202

into major changes that have reshaped the global economy. The conflict almost immediately added new uncertainties to the global economic damage in addition to the COVID-19 pandemic, which has already led to record public debt, a cost-of-living crisis caused by inflation and economic crisis and labor shortages in essential sectors.

GPR can directly affect production and business processes, as well as the operational efficiency of enterprises. In recent times, much empirical evidence has shown the strong impact of GPR on both macroeconomic and microeconomic variables. High GPR lead to a decline in real activity and lower stock returns. The adverse effects of GPR are mainly driven by the threat of adverse geopolitical events. Therefore, shocks of GPR have different effects on the financial indicators of the market.

The purpose of this study is to explore the dependency structure between GPR and stock market returns. The dependency structure in this study was evaluated quite deeply by using the TVP-VAR method combining the GPR index by Caldara and Iacoviello (2022). The period from February 2012 to April 2022 is covered to investigate the impact of political event shocks and their risks to the dependency structure in question. This period was also chosen to focus specifically on the Russia-Ukraine conflict, the series of missteps in the domestic stock and bond markets and the post-COVID-19 reopening to illustrate the disadvantage it has had for financial asset returns.

Although some studies have been done on the impact of GPR on financial assets, as far as we know, there is almost no research regarding its impact on the dynamic connectedness in returns of different industry sectors of Vietnamese stock market. Thus, the purpose of this research is to assess the influence of GPR on the financial assets connectedness of Vietnamese stock sectors over the period of from February 2012 to April 2022 in the context of sharp fluctuations due to GPR such as the Russia and Ukraine conflict, a series of mistakes in the stock and bond market, and the world reopening after the COVID-19 pandemic. To this end, our findings have important implications for policymakers and market participants in managing GPR.

## 2. Literature review

### *2.1. The concept of geopolitical risk*

GPR can be broadly defined as the exposure of one or more countries to political actions in other countries. In line with this view, Caldara and Iacoviello (2022) define GPR as "risks associated with wars, acts of terrorism, and tensions between states affecting the normal and peaceful course of international relations".

Arguably, geopolitical events are expected to affect all countries, asset classes, and sectors. GPR can directly affect the production and business processes, as well as the operational efficiency of enterprises. In recent times, much empirical evidence has shown the strong impact of GPR on both macroeconomic and microeconomic variables. Specifically, geographical and political uncertainties affect economic output and growth (Akari et al., 2019; Lee & Lee, 2020) and stock returns (Corbett et al., 2018).

### *2.2. The impact of GPR on financial assets*

Previous literature on GPR and financial assets is quite dynamic. On the one hand, GPR is documented to be positively associated with asset prices. The most prominent theory that supports this argument is the demand for a safe haven in the surge of political and economic uncertainty. While stock returns could plunge due to a rise in uncertainty, other safe assets such as bonds and gold have been empirically proven to increase (Chiang, 1988). Baur and Lucey (2010) also advocate that financial assets act as a hedge when they are not correlated or negatively correlated with alternative assets. Furthermore, when they exhibit hedging capabilities under extreme economic conditions, they are considered safe havens. Energy and natural resources markets can also benefit from GPR, as supply disruptions or changing dynamics can drive price fluctuations and offer profit opportunities. As GPR increase, users of crude oil, which are sensitive to this risk, tend to see clean energy as an alternative to traditional energy sources. This has caused growth in the share prices of new energy companies, leading to a decrease in volatility (Dutta, 2022).

Furthermore, emerging markets and frontier economies may attract capital inflows as

investors search for higher returns or diversification, potentially boosting financial asset prices. Bouri (2014) and Aslam and Kang (2015) both focus on emerging markets and find that despite war shocks and the financial crisis having disastrous consequences in most of the markets studied, the benefits of regional diversification could still be achieved. Other than traditional financial assets, there are studies trying to investigate the impact of GPR on crypto assets such as Bitcoin. These studies find that GPR has a positive and statistically significant effect on the upper quartiles of both Bitcoin returns and volatility (Aysan et al., 2019).

On the other hand, some other researches document the negative association between GPR and financial assets. Several researches explore that geopolitical risk exerts a negative effect on financial assets, especially stock markets. The stock markets reflect how companies are operating and empirical evidence shows that GPR deters companies' operations, as well as financial assets (Lee et al., 2021). This result is explained through the negative impact of GPR on the supply and demand of the market and the sentiment of consumers. In other words, uncertainty and instability caused by geopolitical events, such as conflicts, trade disputes, or political tensions, can create a sense of insecurity among investors. As a result, when GPR surges, companies would tend to spend their investment, holding up more cash, which leads to an overall economic slowdown (Lee & Wang, 2021).

Based on these impacts, a high surge in GPR would eventually translate into a bad performance of the stock market, especially in countries with a high degree of trade openness (Choi, 2022). Salisu et al., (2022) also show that the stock market is more affected by GPR (such as the threat of war and terrorism) than it actually is in advanced economies. Advanced stock markets are vulnerable to GPR and, therefore, cannot act as a good hedge against GPR. In addition, as GPR increase, there is a tendency to see clean energy as an alternative to traditional energy sources given that crude oil users are very sensitive to this risk (Dutta, 2022). Mitsas et al. (2022) also provide evidence that GPR not only impacts but also has an adverse impact on the profitability of crude oil, gold, platinum and silver.

It can be seen that, so far, there are a number of studies exploring the impacts of GPR including positive, negative and non-linear effects. Compared with previous studies, which focused on developed countries, for example, those belonging to G7 or G20, this study focuses on developing countries. As a matter of fact, studies focusing specifically on the Vietnamese stock market are still limited. Vietnam's stock market is still considered a frontier market where there are stocks with high growth potential. This study will give a better overview of the relationship between GPR and stock return's spillover in the Vietnamese stock market considering data from a variety of industries.

## 3. Methodology

### *3.1. Research methods*

In order to explore the dynamic connectedness in a time-varying manner, we employ the TVP-VAR approach introduced by Antonakakis and Gabauer (2017). The TVP-VAR methodology combines the connectedness approach of Diebold and Yilmaz (2009, 2012, 2014) and Koop and Korobilis (2014). This framework allows the variances to vary over time via a Kalman Filter estimation with forgetting factors. The TVP-VAR(p) model can be expressed as:

$$y_t = \beta_t z_{t-1} + \epsilon_t$$
$$\epsilon_t | F_{t-1} \sim N(0, S_t) \quad (1)$$
$$vec(\beta_t) = vec(\beta_{t-1}) + v_t$$
$$v_t | F_{t-1} \sim N(0, R_t) \quad (2)$$

where $y_t$ and $z_{t-1} = [y_{t-1}, \dots, y_{t-p}]'$ respectively represent $N \times 1$ and $Np \times 1$ dimensional vectors. $\beta_t$ is an $N \times Np$ dimensional time-varying coefficient matrix and $\epsilon_t$ is an $N \times 1$ dimensional vector of error disturbance with an $N \times N$ time-varying variance-covariance matrix, $S_t$. $vec(\beta_t), vec(\beta_{t-1})$ and $v_t$ are $N^2p \times 1$ dimensional vectors and $R_t$ is an $N^2p \times N^2p$ dimensional matrix.

In order to calculate the generalized impulse response functions (GIRF) and generalized forecast error variance decomposition (GFEVD) (Koop et al., 1996; Pesaran & Shin, 1998), we need to transform the TVP-VAR to a TVP-VMA using the Wold representation theorem:

$$y_t = \sum_{j=0}^{\infty} L' W_t^j L \epsilon_{t-j} \quad (3)$$

$$y_t = \sum_{j=0}^{\infty} A_{it}\epsilon_{t-j} \quad (4)$$

where $L = [I_N, \dots, 0_p]'$ is an $Np \times N$ dimensional matrix, $W = [\beta_t; I_{N(p-1)}, 0_{N(p-1)\times N}]$ is an $Np \times Np$ dimensional matrix. The GIRFs represent the responses of all variables following a shock in variable *i*. We compute the differences between a J-step-ahead forecast where once variable *i* is shocked and once where variable *i* is not shocked. The difference can be accounted to the shock in variable *i*, which is given by:

$$GIRF_t(J, \delta_{j,t}, F_{t-1}) = E(Y_{t+J}|\epsilon_{j,t} = \delta_{j,t}, F_{t-1}) - E(Y_{t+J}|F_{t-1}) \quad (5)$$

$$\varphi_{j,t}^{g}(J) = \frac{A_{J,t}S_t\epsilon_{j,t}}{\sqrt{S_{ij,t}}}\frac{\delta_{j,t}}{\sqrt{S_{ij,t}}}\ , \delta_{j,t} = \sqrt{S_{ij,t}} \quad (6)$$

$$\varphi_{j,t}^{g}(J) = S_{jj,t}^{-\frac{1}{2}}A_{J,t}S_t\epsilon_{j,t} \quad (7)$$

where $\varphi_{j,t}^{g}(J)$ is the GIRFs of variable *j*, *J* represents the forecast horizon, $\delta_{j,t}$ is the selection vector with the value of one on the *j-th* position and zero otherwise, and $F_{t-1}$ is the information set until $t-1$. Then, we compute the GFEVD that can be interpreted as the variance share one variable has on others. The calculation is as follows:

$$\tilde{\phi}_{ij,t}^{g}(J) = \frac{\sum_{t=1}^{J-1}\varphi_{ij,t}^{2,g}}{\sum_{j=1}^{N}\sum_{t=1}^{J-1}\varphi_{ij,t}^{2,g}} \quad (8)$$

with $\sum_{j=1}^{N}\tilde{\phi}_{ij,t}^{g}(J) = 1$ and $\sum_{i,j=1}^{N}\tilde{\phi}_{ij,t}^{N}(J) = N$. Based on the GFEVD, we can build the total connectedness index (TCI) as follows:

$$C_t^g(J) = \frac{\sum_{i,j=1,i\neq j}^{N}\tilde{\phi}_{ij,t}^{g}(J)}{\sum_{i,j=1}^{N}\tilde{\phi}_{ij,t}^{g}(J)} \times 100 = \frac{\sum_{i,j=1,i\neq j}^{N}\tilde{\phi}_{ij,t}^{g}(J)}{N} \times 100 \quad (9)$$

The connected approach allows us to examine how a shock in one variable spills over to other variables. First, the shock transmitted from variable *i* to all other variables j, i.e. the total directional connectedness TO others can be defined as:

$$C_{i\rightarrow j,t}^{g}(J) = \frac{\sum_{i,j=1,i\neq j}^{N}\tilde{\phi}_{ij,t}^{g}(J)}{\sum_{j=1}^{N}\tilde{\phi}_{ij,t}^{g}(J)} \times 100 \quad (10)$$

Second, the shock that variable *i* receives from all other variables *j*, i.e. the total directional connectedness FROM others can be defined as:

$$C_{i\leftarrow j,t}^{g}(J) = \frac{\sum_{i,j=1,i\neq j}^{N}\tilde{\phi}_{ij,t}^{g}(J)}{\sum_{j=1}^{N}\tilde{\phi}_{ij,t}^{g}(J)} \times 100 \quad (11)$$

Finally, the net total directional connectedness can be given by subtracting the total directional connectedness TO others from the total directional connectedness FROM others:

$$C_{i,t}^{g} = C_{i\rightarrow j,t}^{g}(J) - C_{i\leftarrow j,t}^{g}(J) \quad (12)$$

This net total directional connectedness can be interpreted as the influence of variable *i* on the analyzed network. If the net total directional connectedness of variable *i* is positive, this variable influences the network more than being influenced by it. This also means that variable *i* is a shock transmitter. On the other hand, if the net total directional connectedness is negative, variable *i* is driven by the network, meaning that it is a shock receiver.

As the net total directional connectedness is an aggregated measure and sometimes masks important underlying dynamics, we want to calculate the net pairwise directional connectedness (NPDC), which informs about the bilateral transmission process between variables *i* and *j*:

$$NPDC_{ij}(J) = \tilde{\phi}_{ji,t}(J) - \tilde{\phi}_{ij,t}(J) \quad (13)$$

A positive (negative) value of $NPDC_{ij}(J)$ indicates that variable *i* is driving (driven by) variable *j*.

In addition, the paper also applies the combined wavelet10 analysis to detect the co-movement between the GPR index with each stock's return and volatility that can develop with different frequencies and time. This is relevant and consistent with the stock data set because of stock returns and volatility.

Given that the wavelet coherency is squared, it fails to indicate the sign of co-movement between GPR and stock return (volatility). The wavelet coherence phase difference (Bloomfield et al., 2004) can address this shortcoming via the following phase measure:

$$\rho_{i,j}^{0}(u,s) = \tan^{-1}\left(\frac{lm\left\{S\left(s^{-1}W^{i,j}(u,s)\right)\right\}}{Re\left\{S\left(s^{-1}W^{i,j}(u,s)\right)\right\}}\right), \text{ with } \rho_{i,j}^{0} \in (-\pi,\pi) \quad (14)$$

where lm is the imaginary smoothed part, and Re is the real part of the smoothed cross-wavelet transform. And *s* is the scale index, *u* is the position index, and * denotes the complex conjugate (Grinsted, Moore & Jevrejeva, 2004).

Notably, the statistically significant co-movement in the time-frequency domain between GPR and stock return (volatility) is computed based on Monte Carlo simulations.

### *3.2. Data*

The GPR index developed by Caldara and Iacoviello (2022) is a useful resource for researchers and investors seeking to understand geopolitical risks. In order to measure GPR, Caldara and Iacoviello (2022) identify the keywords that are directly related to GPR, geopolitical events, military-related tensions, nuclear tensions, war, and terrorist threats published to identify articles related to GPR. The index is calculated by counting the number of articles related to adverse geopolitical events in each of the ten largest newspapers for each month (as a share of the total number of news articles). These newspapers include the Chicago Tribune, the Daily Telegraph, Financial Times, The Globe and Mail, The Guardian, the Los Angeles Times, The New York Times, USA Today, The Wall Street Journal, and The Washington Post. The search is organized into eight categories: War Threats (Category 1), Peace Threats (Category 2), Military Buildups (Category 3), Nuclear Threats (Category 4), Terror Threats (Category 5), Beginning of War (Category 6), Escalation of War (Category 7), Terror Acts (Category 8).

In terms of asset price data, this study uses secondary data on the daily stock price history and the number of shares traded of companies in 12 sectors, listed on the Vietnamese stock market from February 2020 until April 2022. This data is collected on HOSE, HNX or on websites specializing in securities investment. The companies are divided into 12 sectors according to the field of business activities. The information about the sectors is taken from Vietstock, the leading reputable stock market update website in Vietnam. Specifically, the 12 sectors studied in this research include the industrial sector, public utilities, finance, materials, banking, health service, customer service, oil, consumer goods, technology, gold, and bitcoin.

From the above historical stock price data, the sector- average stock price is computed by the following formula:

$$\frac{P_t - P_{t-1}}{P_{t-1}} \; x \; 100\% \qquad (15)$$

where $P_t$: The closing price today; $P_{t-1}$: The closing price yesterday.

## 4. Empirical results

### *4.1. The dynamic spillovers between financial assets of 12 sectors*

#### *4.2.1. Averaged dynamic connectedness*

Table 1 displays the outcomes of the average dynamic connectedness analysis. Each row of the table indicates the impact of a particular variable on the forecast error variance of all other variables in the network. Meanwhile, each column shows the forecast error variance that other variables have contributed to each variable separately. The diagonal elements represent the effects of the variable on itself, while the off-diagonal elements indicate the effect of the variable on or from others.

The Total Connectivity Index (TCI) measures the average influence that one variable has on the dynamics of other variables over time. The TCI of 12 financial assets on the stock market is 66.01/60.51, showing a moderate degree of inter-sector connectedness. Overall, all sectors have fairly low self-explanation for large stock movements, suggesting that the sectors are heavily influenced by each other. Only gold and bitcoin are the two sectors that can be self-explanatory for most large stock movements with volatility usually caused by themselves.

Table 1: Averaged dynamic connectedness

| | Industrial | Public utilities | Financial | Material | Banking | Health service | Consumer service | Oil | Consumer goods | IT | Gold | Bitcoin | FROM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industrial** | 29.49 | 6.19 | 9.85 | 10.1 | 6.79 | 5.52 | 8.3 | 6.95 | 7.27 | 7.83 | 0.99 | 0.71 | 70.51 |
| **Public utilities** | 7.33 | 32.19 | 7.82 | 7.8 | 6.67 | 3.94 | 6.09 | 13 | 6.79 | 6.56 | 0.91 | 0.91 | 67.81 |
| **Financial** | 10.03 | 6.98 | 28.99 | 9.5 | 9.31 | 4.26 | 6.63 | 7 | 7.8 | 7.78 | 0.91 | 0.8 | 71.01 |
| **Materials** | 10.09 | 6.86 | 9.36 | 29.7 | 8.51 | 4.94 | 6.73 | 7.65 | 6.62 | 7.78 | 0.85 | 0.89 | 70.3 |
| **Banking** | 7.52 | 6.37 | 10.22 | 9.2 | 32.25 | 3.54 | 6.43 | 6.78 | 6.99 | 8.58 | 1.03 | 1.09 | 67.75 |
| **Health service** | 8.32 | 5.4 | 6.18 | 7.2 | 4.8 | 42.68 | 5.51 | 5.55 | 5.85 | 5.74 | 1.35 | 1.43 | 57.32 |
| **Consumer service** | 9.59 | 5.75 | 7.49 | 7.82 | 6.86 | 4.62 | 34.71 | 6.73 | 6.6 | 7.79 | 1.01 | 1.02 | 65.29 |
| **Oil** | 7.82 | 12.75 | 7.55 | 8.45 | 6.96 | 3.96 | 6.63 | 31.63 | 5.91 | 6.39 | 0.94 | 1.02 | 68.37 |
| **Consumer goods** | 8.7 | 6.94 | 8.7 | 7.7 | 7.45 | 4.59 | 6.53 | 6.37 | 32.98 | 7.87 | 1.12 | 1.05 | 67.02 |
| **IT** | 8.85 | 6.41 | 8.45 | 8.59 | 8.59 | 4.21 | 7.05 | 6.45 | 7.58 | 32.02 | 0.81 | 0.98 | 67.98 |
| **Gold** | 2.58 | 2.13 | 2.53 | 2.52 | 2.35 | 2.64 | 2.25 | 2.32 | 2.21 | 2.12 | 73.03 | 3.32 | 26.97 |
| **Bitcoin** | 2.01 | 2.16 | 2.38 | 2.13 | 2.5 | 2.22 | 2.09 | 2.42 | 2.19 | 2.56 | 3.11 | 74.22 | 25.78 |
| **TO** | 82.85 | 67.96 | 80.54 | 81.01 | 70.79 | 44.43 | 64.23 | 71.23 | 65.83 | 71.01 | 13.03 | 13.21 | 726.12 |
| **Inc.Own** | 112.34 | 100.15 | 109.53 | 110.71 | 103.04 | 87.11 | 98.95 | 102.86 | 98.8 | 103.03 | 86.06 | 87.43 | cTCI/TCI |
| **NET** | 12.34 | 0.15 | 9.53 | 10.71 | 3.04 | -12.89 | -1.05 | 2.86 | -1.2 | 3.03 | -13.94 | -12.57 | 66.01/60.51 |
| **NPT** | 10 | 4 | 9 | 11 | 8 | 2 | 4 | 7 | 4 | 6 | 0 | 1 | |

*Notes:* Results are based on a TVP-VAR with lag length of order one (BIC) and a 20-step-ahead generalized forecast error variance decomposition, expressed as a percentage. All sectors have fluctuations and shocks from sectors are high; in which, shock from the financial sector is the highest (71.01%), followed by the industrial sector (70.51%) and materials (70.3%). Additionally, the industrial sector not only creates many shocks, but also suffers many shocks from other sectors. This sector is the one that suffers the most shocks (82.85%).

*Source*: Author's own synthesis.

This result is also reasonable – with the complications of the COVID-19 pandemic and the conflict between Ukraine and Russia, firms and households are heavily affected by high inflation and the tightening of monetary policy adopted by the banking system. The financial sector has a direct impact on the industry sectors that need to mobilize high capital every year, such as industrial and raw materials. The financial sector has a high spillover effect on other sectors due to its important contribution. This is an important sector in the economy in which companies in this sector are those with high capitalization, mostly the largest in the market. Raw materials are important inputs for companies in the industrial sector, as well as having spillover effects, positively affecting the development of many sectors, such as manufacturing industry, information technology, electronics, chemicals, high-tech industries, agriculture, forestry, fishery, and animal husbandry, etc. The material sector plays a particularly important role in manufacturing markets, which is a necessary condition for the development of a modern industry to meet the requirements of integration. This is a factor that has a strong impact on economic growth, which is the development basis for many new industries, occupations and products, creating conditions for optimal exploitation of resources for production development, and improving labor productivity, activities, product quality, competitive position and participation in globalization. With the above reasons, we also understand why these three sectors have so much spillover to others.

There are two sectors, gold and bitcoin, that do not create many shocks. They are also the two sectors that are least susceptible to shocks from others. These are the two assets that are widely used as a hedge against the impact of recession and inflation caused by geopolitical tensions.

Although Table 1 shows some interesting observations about the interdependence between the 12 sectors in the Vietnamese stock market, these results correspond to aggregate measures that consider the entire sampling period. The use of averages may mask some economic and geopolitical events occurring during the sampling period and may lead to significant deviations from the mean TCI values. Therefore, the study will proceed in a dynamic approach with the goal to identify specific periods that affect the connectivity between our variables over time.

*4.1.2. Dynamic total connectedness*

To see whether average stock market connectivity changes over time and how GPR affects it, we estimated different measures of connectivity over time. Figure 1 shows the timeline for the dynamic total connectivity index (TCI). We observed large variations in this metric over the entire sampling period. It is clear that the measure of overall connectivity changes significantly over time and it is evident during periods of economic instability, geopolitical instability, and unfavorable natural conditions and can cause shocks or disruptions and stock market turmoil.

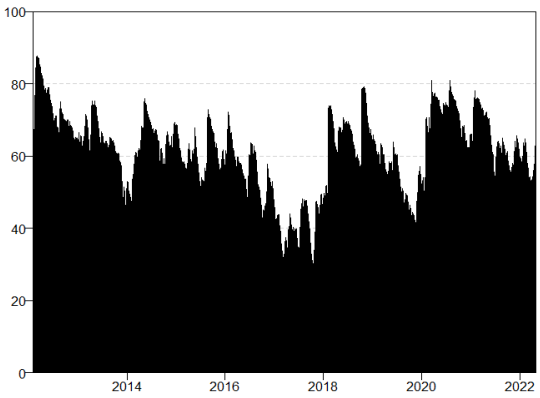


Figure 1: Dynamic total connectedness
*Notes:* Results are based on a TVP-VAR model with a lag length of order two (BIC) and a 10-step-ahead generalised forecast error variance decomposition.
*Source*: Author's own synthesis.

During the period 2012-2022, the TCI index fluctuated non-stop. TCI peaked at nearly 90% at the beginning of 2012, and fell sharply in 2017. The TCI index was always at a high level, in mid-2018, in early 2019, and high again in 2020-2021 by nearly 80%. At the beginning of 2022, this index remained above 60%. Thereby, it can be seen that in general, in the context that GPR indexes are still increasing due to political and economic events from the Russia-Ukraine conflict in 2022, the TCI index of Vietnam's stock market is still quite high. Specifically, facing latent financial turmoil as a result of the Russia-Ukraine conflict, the returns' connectedness of different industry sectors of

Vietnamese stock market were more cohesive and remained at around 50% until the end of the year. Thus, it is clear that the relationships between the variables in our network are completely governed by specific time events and developments.

*4.1.3. Summary of the results from the TVP-VAR model*

The Network Plot in Figure 2 displays blue nodes that indicate which entities transmit shocks, and yellow ones to signal net receivers. Vertices are weighted based on averaged measures of directional connectedness between pairs. The size of the nodes reflects a weighted average for all directional connectedness levels within each entity.

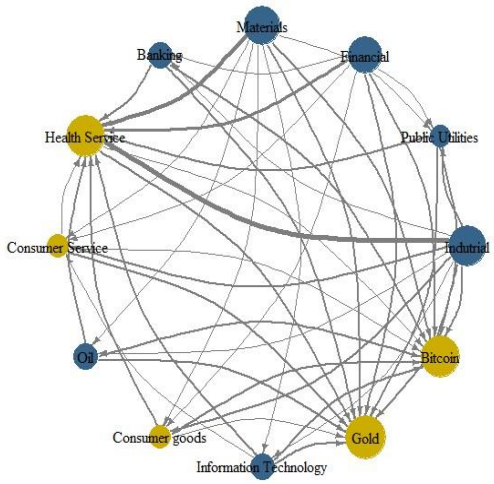


Figure 2: Network Plot
*Notes:* Results from the 10-step-ahead generalized forecast error variance decomposition, based on a TVP-VAR model with a lag length of order two (BIC), were obtained.
*Source*: Author's own synthesis.

The visual inspection of Figure 2 illustrates a clear divide between shock transmitters (colored blue) and shock receivers (colored yellow). The three main sectors in yellow – gold, bitcoin, and health services – are heavily impacted by the volatility shocks of other sectors. Consumer goods and consumer services are also affected but to a lesser extent. While the sectors with the big blue discs, like materials, finance and industrial are the main sources of influence on the stock price, the rest are banking, public utilities, oil and information technology with image sources of lower benefit. The arrows in the visual display show which industries are having an impact on others, and it is clear that the three main shockers – industry, finance and materials – have had a dramatic impact on every industry. In general, gold, bitcoin and health service are the three factors that receive the most shocks.

Firstly, the industrial sector is the most shocking of the 12 sectors here and affects the stock prices of almost all sectors. The specific impacts are represented by the arrow directions coming out from the blue circle, and the thickness of the arrow lines, most of which are darker than the arrow path from finance and materials. The industrial sector is an important sector on the stock market because this sector is less affected by the normal business cycle. Stocks of companies in this sector provide investors with greater safety for their investments when the economy falls into a recession. Most of the companies in this sector are involved in the production of fast-moving consumer goods such as food (VNM, MSM...), insurance (BVH, PVI...), pharmaceuticals (DHG), DMC...) and energy (PPC, NT2...). The sector hit hardest by the industrial sector is health service.

Like the industrial sector, the share price of the materials and financial sectors is also an important factor contributing to shocks in all other sectors. The level of shock generation of these two industries is lower than that of the industrial sector. Health services are heavily affected by fluctuations in the finance and materials sectors (shown by the thickness of the transmission line). Meanwhile, there is a milder impact transmission from banking, information technology, and public utilities to the rest of the other sectors.

Gold, bitcoin and health services suffer the most shocks and are hit hardest by others. While gold is affected by all shocks of the remaining industries, the impact is not very large (shown in thin, not very strong transmission lines), health service is not affected by the remaining sectors but this sector is strongly affected by shocks, shown by the stronger transmission lines. It proves that every time there is a change affecting other sectors, health services will be affected quite a lot.

*4.2. The impact of GPR on financial assets spillover from Wavelet coherence and phase*

In the graph below, the colors represent the degree of association or strength in the association between two variables. Blue indicates a weak correlation between the two variables, yellow indicates a moderate correlation, and red indicates a strong correlation. The direction of the arrow indicates the effect between two variables. When the arrow is pointing up, variable 1 causes variable 2, and when the arrow is pointing down it is variable 2 causing variable 1. The direction of the arrow shows a positive or negative correlation between the two variables. Arrows from right to left indicate a positive or positive relationship. From left to right, it shows that two variables have an inverse or negative relationship.

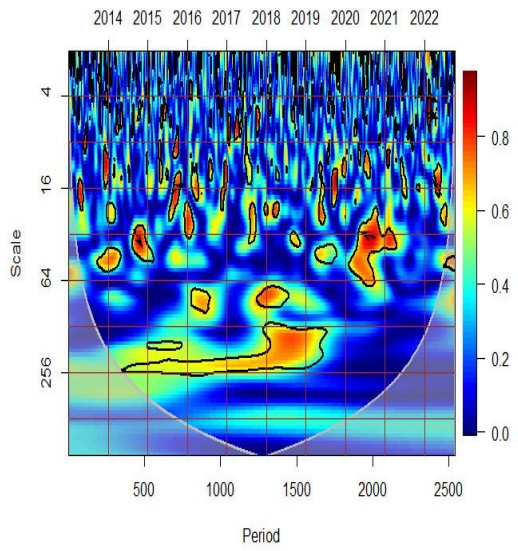


Figure 3: Wavelet Coherence: GPR and TCI
*Source*: Author's own synthesis.

As can be seen in the graph above, blue is more dominant, demonstrating a weak correlation between GPR and TCI. In 2015 and early 2022, the TCI variable causes the GPR variable. The GPR variable causes the TCI variable in 2016, 2020 and mid-2022. In 2020, the GPR variable has a positive relationship and a positive correlation with the TCI variable. The COVID-19 pandemic began to affect Vietnam's stock market from the end of January 2020, leading to an unprecedented rapid and sharp decline. The VN-Index in just two months then dropped by 33.51%, to the lowest level in three years. However, with the Government's ability to successfully control the epidemic, Vietnam's stock market recovered quickly in the remaining months of 2020. The strong recovery of the stock market and interest rates remained at a record low; cash flow has flowed strongly into the securities investment channel. The market liquidity increased sharply to a record high, showing the attractiveness of the Vietnamese market, despite being affected by the COVID-19 epidemic. The market recorded an unprecedentedly high level of new investor participation in history. Remaining in 2015, 2016 and 2022, the GPR variable has a negative relationship and a negative correlation with the TCI variable. The challenges of 2015, 2016, 2020 and 2022 significantly affected the recovery process of the world stock market. In 2015, it was extremely difficult to make a profit.

On the one hand, the market has a lot of unfavorable information, while positive information is issued and half-executed. In 2015, the stock market was affected by fluctuations from the world economy in several periods (China's economy and stock market, exchange rate issues, international capital flows, oil prices, etc.). The shock of the devaluation of the yuan led to the issuance of policies by the State Bank of Vietnam to control the exchange rate and the Fed's raising of the USD interest rate in December, which made the stock market move negatively towards the end of the year. In 2022, strong market volatility drove the MSCI global index down nearly 18% since the start of the year, with European and Asian indexes both posting fewer positive results, according to MarketWatch data.

In Vietnam, the stock market fluctuated due to the impact of the conflict between Ukraine and Russia, and the handling of a series of violations in the stock and bond markets, affecting investors' psychology. Market sentiment is further down as investments, jobs and stock yields come under pressure. More difficult economic conditions have forced investors to be more cautious and try to adapt to limit the risk of loss. The fundamental, safe-haven stocks are now a priority for many investors instead of the high-growth tech stocks that once served as the company's main growth driver. In other words, GPR exerts a miscellaneous impact on financial

assets. Overall, it suggests that GPR has a heterogeneous effect on the equity market, which implies that the market does not respond to geopolitical tensions in a uniform manner.

## 5. Conclusion

Hitherto, a great deal of research has been done to investigate the positive, negative and uncertain effects of GPR changes on the stock market. This study focuses on the marginal stock market in a developing country in contrast to most previous studies that have focused on more developed countries, such as those in the G7 or G20. In fact, there are not many studies that directly refer to the Vietnamese stock market. When there are stocks with significant growth potential, the Vietnamese stock market is still considered a frontier market. Next, the majority of the available literature focuses on only two to three important sectors in the stock market. Therefore, this study differs significantly from previous studies in that we have collected stock prices from 12 sectors, thereby providing a complete picture of the stock market. In addition, the study period covers the period from February 2012 to April 2022; a 10-year period to run the most accurate data.

As with other studies, this study has some limitations. First, this study looks at stocks across 12 sectors. Therefore, future research may explore and investigate stock price changes across a broader range of stock market sectors and sectors over a longer period of time. Second, this study uses GPR data from Caldara and Iacoviello (2022). The GPR index is built when sharing articles that address geopolitical tensions, by looking for specific words in the newspaper articles containing words related to geopolitical risk. Compared to the previous version, the following versions always have a revision index with a slight change in wording to be more relevant.

GPR cannot be completely prevented, but there are several strategies that individuals and businesses can use to mitigate their impact. Here are some solutions to hedge against GPR: Diversify investments, conduct a thorough geopolitical risk assessment, and monitor geopolitical events to reduce the potential negative impact of any particular event. In addition, political risks are creating both challenges and opportunities for global organizations. In reality, geopolitics and technology are two inextricably linked factors in today's geostrategic environment, yet many new businesses focus solely on digital transformation, paying little attention to political geography. The State and Government should promulgate appropriate policies and mechanisms to prevent and minimize fluctuations in the geographical and political environment; from there, enterprises have a safe and stable business environment, creating a basis for solid development in the future.

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