The Impact of Geopolitical Risk on Risk Contagion across Major Asset Classes

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Abstract. In recent years, geopolitical risk has been rising. Numerous studies discuss the impact of geopolitical risk on individual asset classes or risk contagion in different asset classes through external shocks such as COVID-19 and financial crises. Motivated by these, this paper adopts the Granger causality test to explore how geopolitical risk can impact the pattern of risk contagion across asset classes including stock, bond, foreign exchange, and commodities from a global perspective. The outcome implies that geopolitical risk has little impact on the pattern of risk contagion across the asset classes. However, an intrinsic connection exists between asset classes, which is visually presented. First, the crude oil market is relatively independent, so systemic risk can be reduced for portfolios by taking crude oil futures. Second, the safe-haven effect may diminish because risk transmits from the bond market to the foreign exchange market and gold market. Third, the stock is the most important in transmitting contagion among the selected asset classes, so the stock market should be prioritized for monitoring and stimulation.

Keywords: geopolitical risk, risk contagion, stock, bond, foreign exchange, commodities

1 Introduction

With the deepening of globalization, financial markets have become increasingly interconnected, making them susceptible to various external shocks. Among these, geopolitical risk is vital in influencing market dynamics, which stems from wars, trade disputes, political instability, etc. This risk can trigger significant volatility, impacting not just localized regions but also rippling through global financial markets.

Geopolitical risk's impact on global financial markets has been examined in many empirical studies. The stock market is usually the first to be adversely affected by rising geopolitical risks in terms of stock return and volatility. In addition, commodities such as crude oil and gold are also impacted due to supply and safety concerns. Furthermore, bond and foreign exchange markets may encounter shocks because market conditions shift during times of increased geopolitical risk as well. The prolonged Russia-Ukraine war, persisting for years, along with the intensification of the Israel-Palestine conflict, suggests a notable increase in geopolitical risks globally. These conflicts contribute to

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the emergence of short-term shocks in global financial markets, undermining financial stability.

Moreover, the escalation of such geopolitical tensions can potentially suppress economic activity and elevate global inflation, especially if there are sustained disruptions to supply chains and interruptions in production. Due to the uncertainty around the development of geopolitical events, it is crucial to understand the contagion of risk across major asset classes in response to geopolitical events, especially for investors and policymakers. As geopolitical risk rises, it becomes necessary for investors to construct a resilient portfolio and rebalance it accordingly to withstand potential higher market volatility. In the meantime, governments and regulatory bodies should monitor other risks that may increase with geopolitical risk such as interest rate risk and credit risk, and take appropriate measures to mitigate those risks and maintain financial stability.

This paper aims to explore the multifaceted relationship between geopolitical risk and the contagion of risk across major asset classes such as stock, bond, commodities, and foreign exchange. By analyzing historical data and utilizing econometric models, the research seeks to reveal patterns and mechanisms through which geopolitical shocks transmit across different financial instruments and markets. The findings can provide practical insights for constructing and rebalancing a diversified portfolio and managing the complex risks associated with geopolitical events in an interconnected global market.

The remainder of this paper is structured as follows. The second section will review the relevant literature and outline the innovations of this research. The third section will introduce the methodology, along with the dataset and indicators used in this study. The fourth section will explore the pattern of risk contagion across major asset classes under the impact of geopolitical risk. Finally, the last section will present the conclusions and suggestions.

2 Literature Review

There is a vast amount of literature examining the impact of geopolitical risks on particular asset classes' return and risk. Umar et al. (2022) [1] applied the quantile-on-quantile regression approach to the geopolitical risk index and financial asset returns and argued that geopolitical risk has both positive and negative impacts on most assets, affects asset returns during normal market conditions, and varies in its effects depending on the market type and conditions. Choi (2022) [2] conducted partial and multiple wavelet coherence analysis and stated that a strong short-term relationship exists between geopolitical risk and stock market volatility in North-East Asian countries, namely South Korea, China, and Japan. Furthermore, Hossian et al. (2024) [3] believed that foreign exchange rates were significantly negatively affected in countries with high reliance on Russian energy, countries with a high level of economic policy uncertainty, countries with proximity to Russia and Ukraine, and those with a high degree of political rights during Russia-Ukraine conflict. Mandaci et al. (2023) [4] found that there is a high connectedness among natural resource commodities, and the extreme return shocks in metals tend to spill over to energy commodities during extreme geopolitical events by implementing a quantile vector autoregressive connectedness estimation approach.

Additionally, many studies focus on risk contagion across different financial markets. Bei et al. (2024) [5] examined contagion, safe-haven, and diversification effects across stocks, gold, and oil by using multivariate downside-to-upside and downside-to-downside CoVaR measures, and argued that the diversification benefit of gold investment still existed in the form of reduced downside risk and upside potential in the early COVID-19, however, it diminished because of pandemic-related fear after the worldwide pandemic was declared on March 11, 2020. Xue et al. (2024) [6] employed six distinct second- and higher-order co-moment contagion tests and argued that during the pandemic, Brent oil played a more prominent role in transmitting contagion across different stock markets, while natural gas served as the primary transmitter for the Russian-Ukraine war. Liu et al. (2024) [7] constructed a tail event-driven network to investigate risk spillover effects among stock, foreign exchange, gold, and oil markets and argued that stock markets make a predominant contribution to the aggregate risk level, while oil, gold, and specific currencies such as JPY, USD, and CNY contribute to diversifying systemic risk. Guidolin et al. (2019) [8] found that during a financial crisis, contagion mainly occurs through flight-to-liquidity, risk premium, and correlated information channels using dynamic time series models estimated with Bayesian methods.

Although lots of studies have been conducted, they concentrate on either how geopolitical risk individually impacts a single kind of asset class, or the spillover effect between asset classes resulting from exogenous shocks. There are limited studies to discuss how the pattern of risk contagion across asset classes is impacted by geopolitical risk. Hence, this paper seeks to fill the research gap by introducing geopolitical risk as an endogenous variable along with the returns of different asset classes and exploring how these variables are connected.

3 Methodology and Data

3.1 Methodology

The Granger causality test was pioneered by Clive W.J. Granger in 1969 to analyze the causality between economic variables [9]. Compared to traditional quantitative modeling methods, it is robust when there is a large number of variables. However, the Granger causality test can be effective only when the time-series data is stationary, otherwise, false regression problems may occur. Therefore, in practice, some techniques like differencing are often used to ensure stationarity of data before fitting the model.

For two sets of time series data x and y, the Granger causality between them is defined as follows - if the addition of the past value of variable x leads to a better prediction of variable y than the prediction of y made solely by the past value of y, variable x is deemed as the Granger cause of variable y, and vice versa. Assuming the information needed to predict variables x and y is entirely contained in the time series of these variables, the test requires estimating the following regressions.

$$y_t = \sum_{i-1}^{q} \alpha_t x_{t-i} + \sum_{j-1}^{q} \beta_j y_{t-j} + \varepsilon_{1t} \quad (1)$$

$$x_t = \sum_{i-1}^{s} \lambda_t x_{t-i} + \sum_{j-1}^{s} \delta_j y_{t-j} + \varepsilon_{2t} \quad (2)$$

Equation (1) assumes that the current y is not only related to the past value of y itself but that of x, while equation (2) assumes a similar pattern for the current x. ε_{1t} and ε_{2t} are two uncorrelated error terms.

For equation (1), the null hypothesis is $H_0: \alpha_1 = \alpha_2 = \alpha_3 = \ldots = \alpha_q = 0$. For equation (2), the null hypothesis is $H_0: \delta_1 = \delta_2 = \delta_3 = \ldots = \delta_s = 0$. The result is classified into three scenarios.

First, there is a one-way causal relationship between x and y. This can be further divided into two conditions. If x is the Granger cause of y but y doesn't Granger cause x, the coefficient estimate of the lagging x in equation (1) is statistically significantly different from zero and that of the lagging y in equation (2) is insignificantly different from zero. On the contrary, If y is the Granger cause of x but x doesn't Granger cause y, the coefficient estimate of the lagging y in equation (2) is statistically significantly different from zero and that of the lagging x in equation (1) is insignificantly different from zero.

Second, x and y are mutually casual, indicating a feedback relationship or two-way causality exists between x and y. In this case, the coefficient estimates of the lagging x in equation (1) and the lagging y in equation (2) are both statistically significantly different from zero.

Third, x and y are independent, meaning there is no causal relationship between x and y. This is the case where the coefficient estimate of the lagging x in equation (1) and that of the lagging y in equation (2) are both statistically insignificantly different from zero.

3.2 Data

This paper incorporates four types of asset classes: stock, bond, foreign exchange, and commodities. MSCI ACWI, an index that includes both developed and emerging market countries and covers approximately 85% of the global investable equity opportunity set, is used as a proxy for the global stock market. Additionally, the yield of the 10-year US Treasury bond is adopted to proxy the performance of the global bond market since the 10-year US Treasury bond is often considered a benchmark for the risk-free rate, and it provides a straightforward and easily accessible measure. Furthermore, as US dollar index futures are highly liquid and actively traded on major exchanges, it is used as a proxy for the global foreign exchange market. The commodities are divided into two sub-classes, gold and crude oil. Gold futures, as a publicly traded instrument for gold, are used as a proxy for the global gold market. What's more, Brent crude oil is one of the three main global oil benchmarks and is widely used as a pricing standard for oil around the world, therefore, it is chosen as a proxy for the global oil market. To analyze the impact of geopolitical risk, the geopolitical risk index is used to provide a quantitative measure of the level of geopolitical risk globally. All the data are collected from 09/07/2012 to 08/07/2024.

All the data excluding the yield of the 10-year US Treasury bond are converted to the form of daily percentage change. Subsequently, all the data are tested for stationarity by the augmented Dickey-Fuller test. The result implies that the yield of the 10-year US Treasury bond is the only non-stationary variable, so its first difference should be taken. Table 1 exhibits the statistics of the six variables. There are positive average values for all the variables during the period selected. Moreover, among the assets, the greatest return can be found in OIL, and the smallest loss can be found in YTM. Concerning standard deviation, YTM appears to be the least volatile, while GPR seems much more volatile than the asset returns. Furthermore, though all the assets have a slightly higher probability of ending up with a loss, OIL, GOLD, and MSCI are more likely to experience extreme values than USDX as well as YTM.

Table 1. Summary of Statistics for The Variables.

	OIL	GOLD	MSCI	USDX	YTM	GPR
Mean	0.000467	0.000180	0.000384	0.000066	0.000009	0.100884
Median	0.001100	0.000200	0.000600	0.000000	0.000000	0.069100
Maximum	0.210200	0.059500	0.083900	0.022400	0.003290	2.736160
Minimum	-0.244000	-0.093400	-0.095100	-0.023900	-0.002880	-2.995883
Std. Dev.	0.023213	0.009687	0.008637	0.004261	0.000519	0.494460
Skewness	-0.319518	-0.329391	-0.905920	-0.039620	-0.041378	0.501360
Kurtosis	16.961950	9.291799	19.630470	5.023201	5.344383	5.326872
ADF-P_Value	0.000100	0.000100	0.000000	0.000100	0.000100	0.000000
Observations	3010	3010	3010	3010	3010	3010

Note: Variable OIL, GOLD, MSCI, USDX, and GPR respectively represent the daily percentage changes of Brent crude oil futures, gold futures, MSCI ACWI, US dollar index futures, and geopolitical risk index. Variable YTM represents the yield of the 10-year US Treasury bond after taking the first difference.

4 Empirical Test

The Schwarz criterion suggests that the optimal order of lag should be 1 for the VAR model. Hence, the Granger causality test is established through the VAR model with a lag of 1. Table 2 shows the results of the Granger causality test for each pair of variables. There are five sets of one-way causal relationships and two sets of feedback relationships in total. All the asset returns but GOLD don't Granger cause GPR. In the meanwhile, GPR isn't the Granger cause of any asset returns, which was unexpected. OIL and YTM are the Granger causes of USDX. Moreover, USDX and YTM are the

Granger causes of GOLD. There is a two-way causal relationship between USDX and MSCI. The same pattern can be detected between MSCI and YTM as well.

Table 2. Results of the Granger Causality Test.

Null Hypothesis:	F-Statistic	Prob.
GOLD does not Granger Cause OIL	0.2982	0.5851
OIL does not Granger Cause GOLD	1.5124	0.2189
GPR does not Granger Cause OIL	1.02921	0.3104
OIL does not Granger Cause GPR	0.80048	0.371
MSCI does not Granger Cause OIL	0.05751	0.8105
OIL does not Granger Cause MSCI	0.00481	0.9447
USDX does not Granger Cause OIL	1.43182	0.2316
OIL does not Granger Cause USDX	5.68197	0.0172
YTM does not Granger Cause OIL	0.01313	0.9088
OIL does not Granger Cause YTM	0.222	0.6376
GPR does not Granger Cause GOLD	1.32658	0.2495
GOLD does not Granger Cause GPR	2.88605	0.0895
MSCI does not Granger Cause GOLD	0.18227	0.6695
GOLD does not Granger Cause MSCI	2.70631	0.1001
USDX does not Granger Cause GOLD	9.12002	0.0025
GOLD does not Granger Cause USDX	1.5635	0.2113
YTM does not Granger Cause GOLD	42.4755	8.00E-11
GOLD does not Granger Cause YTM	1.3563	0.2443
MSCI does not Granger Cause GPR	1.36077	0.2435
GPR does not Granger Cause MSCI	0.00967	0.9217
USDX does not Granger Cause GPR	0.0036	0.9521
GPR does not Granger Cause USDX	0.17639	0.6745
YTM does not Granger Cause GPR	0.0055	0.9409
GPR does not Granger Cause YTM	1.13968	0.2858
USDX does not Granger Cause MSCI	12.2821	0.0005
MSCI does not Granger Cause USDX	33.2469	9.00E-09
YTM does not Granger Cause MSCI	13.2614	0.0003
MSCI does not Granger Cause YTM	21.0799	5.00E-06
YTM does not Granger Cause USDX	6.41662	0.0114
USDX does not Granger Cause YTM	0.44854	0.5031

As shown in Fig. 1, a network is created with the asset returns and GPR as nodes and Granger causality between the variables as edges. GPR doesn't play the role of core intermediary for risk contagion between the asset classes as expected. The future change of GPR can even be partially explained by GOLD. It implies that GPR exhibits a lagged response to asset prices following heightened geopolitical risk. This may be because the geopolitical risk index is constructed by analyzing news articles, media reports, and other publications for mentions of geopolitical risk, but geopolitical events may not be reported immediately or widely covered in media. By contrast, financial markets often react swiftly to geopolitical events, sometimes even before the events are fully understood or reported. Traders and investors may act on rumors or expectations of future events, causing immediate changes in asset prices.

The crude oil market is relatively independent in the network. OIL can't be explained by other variables, and it doesn't contribute to the prediction of variables other than USDX. Furthermore, the US dollar, US Treasury bond, and gold are three traditional safe-haven assets, whose demand usually increases in response to the rise of geopolitical risk, thereby driving up the prices. In the network, YTM is connected to both USDX and GOLD, indicating risk contagion happens among the 10-year US Treasury bond, US dollar index futures, and gold futures undermining the safe-haven effect. The 10-year US Treasury bond acts as the primary transmitter of risk among the safe-haven assets. Further, stock plays the most significant role in transmitting contagion because MSCI is mutually causal with YTM and USDX, and it is unique in having a feedback relationship with multiple variables.

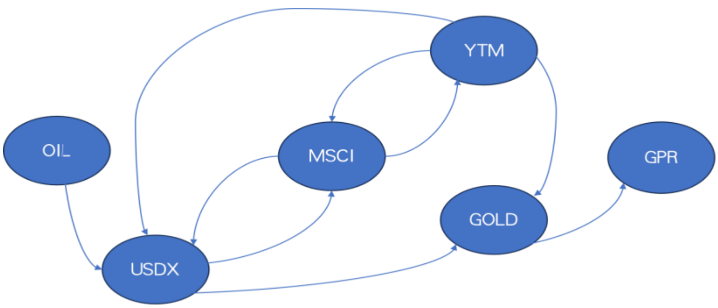

Fig. 1. Contagion across The Variables.

5 Conclusion

This paper examines the impact of geopolitical risk on the pattern of risk contagion across asset classes including stock, bond, foreign exchange, gold, and crude oil from a global perspective by using the Granger causality test and the network model. The result shows that GPR does not Granger cause the returns of selected asset classes, however, GOLD is the Granger cause of GPR. In other words, geopolitical risk has little impact on the pattern of risk contagion across the asset classes, and geopolitical risk index is affected by the changes in the return of gold futures. This may result from the reliance of geopolitical risk index on media reports regarding geopolitical events and the time lag between the occurrence and report of geopolitical events. Furthermore, the crude oil market is relatively independent since OIL isn't connected to any asset returns except USDX in the network. Moreover, contagion occurs among the safe-haven assets such as the US dollar, US Treasury bond, and gold, and the US Treasury bond acts as the primary transmitter of risk. Further, stock plays a more crucial role in transmitting contagion than other asset classes.

Geopolitical risk index may not be a suitable indicator that provides early warning of rising global geopolitical risk and timely guidance in constructing a resilient and well-diversified portfolio to withstand heightened geopolitical risk. Efforts should be made to seek other indicators that can reflect the increase in geopolitical risk before financial markets do. What's more, crude oil futures can be added to a portfolio to reduce systemic risk. Regulatory bodies should prioritize monitoring risks in the stock market. In the event of a financial crisis, priority should also be given to stimulating the stock market, as it has a relatively strong transmission effect on other financial markets.

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