Relationship of global geopolitical risk and exchange rates: Evidence from Covid-19 and Russia–Ukraine crisis, January 2020–August 2022

Ngo Thai Hung
University of Finance-Marketing,
Ho Chi Minh City,
Vietnam
E-mail: hung.nt@ufm.edu.vn

The recent health crisis and Russia–Ukraine conflict have had an impact on countries around the world. Foreign exchange rate markets have been considerably influenced. The author examine the dynamic interaction over crises between geopolitical risk (GPR) and major exchange rate markets. The asymmetric impact of geopolitical risk and major exchange rates was discovered utilizing a novel time-varying Granger causality approach. The sample includes noteworthy occurrences such as Covid-19 and the ongoing conflict between Russia and Ukraine. The empirical findings uncover bidirectional causality, with geopolitical risks significantly influencing exchange rate markets during Covid-19 and the beginning of the Russia–Ukraine war. However, this phenomenon became weaker as the Russia–Ukraine war continued, which could show that GPR and exchange rate markets were not linked during the Russia–Ukraine war. This research has important implications that may be advantageous to forex investors, helping them make a variety of investment decisions in such turbulent times. Certain policy choices may be advantageous to banks, global organizations, institutional investors, and policy-makers.

Keywords:
time-varying Granger causality,
Russia–Ukraine crisis,
Covid-19,
exchange rates

Introduction

As a result of decentralization and a relatively low barrier to participation, exchange rate markets are widely appealing to investors. They are susceptible to changes in the political and financial climate due to their enormous trade volumes and continuous activities on trading days. News on the macroeconomy and government action is generally regarded to have a considerable impact on currency market volatility (Hung 2023, Ruiz-Marín et al. 2023). To be more precise, foreign exchange markets react differently based on the timiang and techniques of macro news releases, and the origins and kinds of announcement matters. The new coronavirus disease (Covid-19) spread around the world at the end of December 2019 and the beginning of 2020. As

a result, the currency markets were very volatile. Large changes occurred because the government stopped most activities to slow the spread of the virus, panicked investors sold off much of their stocks, and the pandemic's effects and length were unclear (Kapas 2022). Furthermore, the recent Russia–Ukraine crisis worsened on February 21, 2022, when Russia declared the Donetsk and Luhansk regions of Ukraine to be independent states and sent Russian troops to keep the peace in those two parts of Ukraine. World leaders said that this action constituted the beginning of a war. Because the Russian economy is so tied to the economies of European countries, especially through the trading of food, fuel, raw materials, and oil, the rise in geopolitical tension and the sanctions that followed were likely to hurt the economies of both the West and Russia. This makes us want to determine how investors in the exchange rate markets reacted to these events.

Geopolitical risk (GPR) has become increasingly important as a component of risk analyses since 24 February 2022 (Salisu et al. 2022). GPR is broadly described as one or more countries' exposure to political actions in other countries; it has become more prevalent in recent years and is a major factor in financial market price fluctuations (Saâdaoui et al. 2022). For instance, Kisswani–Elian (2021) reveal that GPR has asymmetric influences on exchange rate volatility. Dos Santos et al. (2021) explore the influence of GPR on the exchange rate returns of Mexico, Russia and Brazil. The authors describe the presence of a risk premium for all currencies, and GPR has a negative impact on trade returns in Brazil. Iyke et al. (2022) propose that geopolitical risk is predictive of currency markets. The authors uncover that GPR forecast in-sample tests predict 10 of 17 (59%) of exchange rate returns, whereas out-of-sample tests predict 88% of exchange rate returns. Salisu et al. (2022) predict geopolitical risks for currency volatility in BRICS countries using the GARCH-MIDAS-X model and provide evidence that recent GPR data have a greater impact on BRICS exchange rates than historical data. Similarly, Kisswani–Elian (2021) reveal that global geopolitical risk has asymmetric influences on exchange rate fluctuation. During the health crisis, Hung et al. (2022) report that key currency markets have a positive equicorrelation, and there is a bidirectional causality among exchange rate returns, which identifies a contagion risk across currency markets.

Previous literature examining the nexus between political uncertainty and financial market performance indicates that the rear of political instability has a detrimental impact on both the return on the stock market and the risk profiles of financial assets. Renewable energy is an effective instrument for mitigating geopolitical threats, and rising geopolitical risks tend to drive up demand for renewable energy, as shown by Cai–Wu (2021). Ivanovski–Hailemariam (2022) unveil the dynamic impact of oil prices on geopolitical risk in 16 countries for the period 1997–2020. Moreover, there is a negative relationship between GPR and oil prices during the research period. In a similar vein, according to Gong–Xu (2022), the effect of geopolitical risk on the dynamic interconnectedness of the energy, industrial metal, agriculture, precious

metal, and livestock commodity markets is significant. As per Yang et al. (2022), the aggregate commodity market has been significantly influenced by GPR over time, with the former having a primarily short-term effect prior to 2006 and a medium- to long-term effect afterward and the latter having a primarily long-term effect.

Bouri et al. (2022) demonstrate that cojumps are significant only in the case of Bitcoin, with previous corroborating research suggesting that Bitcoin is a hedge against geopolitical risk. Umar et al. (2022) document that global financial assets have a mixed association with GPR during the Russian–Ukrainian conflict. Similarly, the Swiss currency, green bonds, silver, gold, and real estate are the assets that are the most resilient to changes in geopolitical risk, according to Będowska-Sójka et al. (2022). Mitsas et al. (2022) report that negative effects on the prices of crude oil, gold, platinum, and silver are triggered by GPR. Lee–Chen (2020) confirm that developing nations have the greatest total death, total damage, total affected averages, and GPR. Chiang (2021) uncovers that stock-gold return relationships are positively connected with geopolitical risk.

This article examines the effect of GPR on major exchange rate markets during the recent crises of Covid-19 and the Russia–Ukraine war. The GPR proposed by Caldara–Iacoviello (2022) is the indicator we use to represent geopolitical risk. We utilize the time-varying Granger approach introduced by Shi et al. (2018, 2020) to explore time variation in the Granger causal interaction between GPR and selected exchange rate markets. Our results suggest that changes in global geopolitical risk significantly contribute to fluctuations in exchange rates during Covid-19 and the beginning of the Russia–Ukraine war periods, while GPR has virtually no influence during the Russia–Ukraine war. Therefore, risk managers and global investors must modify their strategies to account for variations in reaction time. Moreover, exchange rate markets appear to be the best hedge during geopolitical unpredictability.

Our studies are connected to a new body of research that addresses GPR and exchange rate markets (Salisu et al. 2022, Kisswani–Elian 2021, Iyke et al. 2022). In fact, the price process of financial assets exhibits discontinuity and volatility, and such scenarios can co-occur among exchange rate returns, leading to so-called causal linkages (Salisu et al. 2022). Causality behavior significantly affects asset allocation, risk management, derivative pricing, and trading processes (Ivanovski–Hailemariam 2022, Hung et al. 2022, Hung 2022).

Our work advances three subfields of scholarly investigation. First, we contribute to the quickly expanding body of knowledge on geopolitical risk in exchange rate markets. Caldara–Iacoviello (2022) develop the GPR index in their work, which brings new data to the field of geopolitical risk measurement. This effect has been investigated in the context of different financial assets, consisting of exchange rates (Kisswani–Elian 2021, Iyke et al. 2022, Salisu et al. 2022, Kisswani–Elian 2021), stock returns (Chiang 2021), bonds (Będowska-Sójka et al. 2022) and energy commodities

(Cai–Wu 2021, Ivanovski–Hailemariam 2022, Gong–Xu 2022, Yang et al. 2022, Mitsas et al. 2022, Hung 2020).

Second, we add to the recent debate regarding the influence of GPR on exchange rate prices during the Covid-19 and Russia–Ukraine crises. To the best of our knowledge, we are the first to use time-varying Granger causality to analyze the impact of GPR on major exchange rate returns during recent financial crises. The literature surrounding this event is currently limited to a handful of working papers (Będowska-Sójka et al. 2022). Past studies have examined the association between GPR and exchange rate markets (Kisswani–Elian 2021, Iyke et al. 2022, Salisu et al. 2022, Kisswani–Elian 2021). In fact, these articles tend to examine recent data from the 21st century separately, concentrating on specific events such as the 2008 global financial crisis, the 2014-2015 crude oil price war, and the Covid-19 pandemic.

Third, the interplay between changes in economic policy and financial market prices is delicate and sensitive to various periods, making the detection of the lead-lag nexus in real time imperative. In this paper, the time-varying Granger method was utilized to comprehensively understand the time-varying characteristics in the context of time-varying variations in GPR and major exchange rate markets. This is an innovative effort in GPR and financial markets research. We extend the static Granger causality framework to a time-varying nature that is very sensitive to the size of the window using the unique time-varying causality technique developed by Shi et al. (2018, 2020) based on the recursive evolving algorithm and rolling window algorithms. Given that the joint distributions of the GPR and exchange rates are not time-invariant, the parameters of Granger causality may also comove through time; consequently, Granger causality linkages may exist only during some time periods while disappearing during others. The advantage of the time-varying Granger approach is that it employs strong econometric techniques and is able to precisely determine the onset and end dates of causality, which is commonly used in financial markets (Wang et al. 2022, Hammoudeh et al. 2020, Shahzad et al. 2021). Consequently, the findings of this study may offer market participants and policy-makers a potential tool for dynamic analysis, particularly for risk management, strategic planning, and asset administration.

The rest of the study is structured as follows: methodology and dataset, results and conclusion.

The time-varying Granger causality

In this paper, we employ a recent time-varying Granger causality test introduced by Shi et al. (2018, 2020) to explore the causal associations between GPR and exchange rate markets. The approach is based on the lag-augmented VAR specification and takes into account three algorithms utilized in making test statistics: the forward

expanding, rolling, and recursive evolving windows. The model is based on a long process of recursive calculations of Wald test statistics from a VAR technique:

$$y_{1t} = \phi_0^{(1)} + \sum_{k=1}^{m} \phi_{1k}^{(1)} y_{1t-k} + \sum_{k=1}^{m} \phi_{2k}^{(1)} y_{2t-k} + \varepsilon_{1t} \quad (1)$$

and

$$y_{2t} = \phi_0^{(2)} + \sum_{k=1}^{m} \phi_{1k}^{(2)} y_{1t-k} + \sum_{k=1}^{m} \phi_{2k}^{(2)} y_{2t-k} + \varepsilon_{2t} \quad (2)$$

where y_{1t} and y_{2t} are GPR and exchange rates, respectively, and y_{1t} is said to Granger cause y_{2t} if the past values of y_{1t} have predictive power for the current value of y_{2t}, conditional on the past values of y_{2t}.

The null hypothesis of no Granger causality from y_{1t} to y_{2t} is verified by testing the joint significance of $\phi_{1k}^{(2)} \left(k = \overline{1,m}\right)$ by means of a Wald test.

Shi et al. (2018, 2020) introduced a time-varying Granger causality test according to the supremum Wald statistic sequences utilizing forward recursive (Thoma 1994), rolling window (Swanson 1998), and recursive evolving algorithms (Phillips et al. 2015a, 2015b). Shi et al. (2018, 2020) document that the rolling window and recursive evolving window procedures provide the best estimations. As a result, we pay attention to these approaches in this paper.

For the recursive evolving method, the Wald statistic over $[f_1, f_2]$ with a sample size fraction of $f_w = f_2 - f_1 \geq f_0$ is denoted by $W_{f_2}(f_1)$, and the sup Wald statistic is written by

$$SW_f(f_0) = \frac{\sup}{(f_1, f_2) \in \hat{0}, f_2 = f} \left\{ w_{f_2}(f_1) \right\} \quad (3)$$

where $\hat{0} = \left\{ (f_1, f_2) : 0 < f_0 + f_1 \leq f_2 \leq 1, and\, 0 \leq f_1 \leq 1 - f_0 \right\}$ for several minimal sample sizes $f_0 \in (0,1)$ in the regressions.

The rolling window procedure is a special case of the recursive evolving procedure (Shi et al. 2018).

The crucial values for the origination and termination points of the causal links are exceeded by or below the test statistics for the initial estimated chronological observations, which are designated as $\hat{f}_e$ and $\hat{f}_f$.

Rolling

$$\hat{f}_e = \frac{\inf}{f \in [f_0, 1]} \left\{ f : W_f(f - f_0) > cv \right\} \quad (4)$$

and

$$\hat{f}_f = \frac{\inf}{f \in \left[\hat{f}_e, 1\right]} \left\{ f : W_f \left(f - f_0 \right) < cv \right\} \tag{5}$$

Evolving

$$\hat{f}_e = \frac{\inf}{f \in \left[f_0, 1\right]} \left\{ f : SW_f \left(f_0 \right) > cv \right\} \tag{6}$$

and

$$\hat{f}_f = \frac{\inf}{f \in \left[\hat{f}_e, 1\right]} \left\{ f : SW_f \left(f_0 \right) > cv \right\} \tag{7}$$

where cv is the corresponding critical value of the SW_f statistic.

Because the rolling window and recursive evolving window procedures are better, this study examines how global geopolitical risk and major exchange rates might be related to each other.

Data

The data used in this article consist of six daily major exchange rates against the United States dollar (USD): the Euro (EUR), the British pound (GBP), the Canadian dollar (CAD), the Japanese yen (JPY), the Swiss Franc (CHF), and the Australian dollar (AUD). We use historical data from on overall global geopolitical risk (GPR), which is produced by calculating the frequency of phrases associated with tensions in geopolitics based on automated text searches of three newspapers (Salisu et al. 2022). Depending on data availability, our sample period ranges from January 2020 to August 2022, which covers the Covid-19 and Russia–Ukraine crises. The exchange rate data are collected from the Thomson Reuters Eikon database, while GPR is gained from https://www.policyuncertainty.com/. Following Iyke et al. (2022) and Salisu et al. (2022), this paper utilizes daily logarithmic changes in the series for the causality analysis.

The summary statistics for the examined variables are represented in Table 1. During the research period, there are no currencies with average negative prices, which implies that six major currency markets depreciated during the Covid-19 and Russia–Ukraine war crises. The standard deviations of GPR are larger than those of the exchange rate prices, which means that GPR is the most volatile series. In addition, all variables experience positive kurtosis and a departure from normal distribution as per the Jarque-Bera test. The findings of the augmented Dickey–Fuller (ADF) test of the investigated series taken at their log levels are also presented in Table 1. The findings reveal that all the variables are stationary because we reject the null hypothesis of a unit root. As a result, these findings are suitable for additional statistical analysis. Furthermore, Figure 1 depicts the correlational relationship between variables, and it is clear that the variables in this study have a strong association.

Table 1

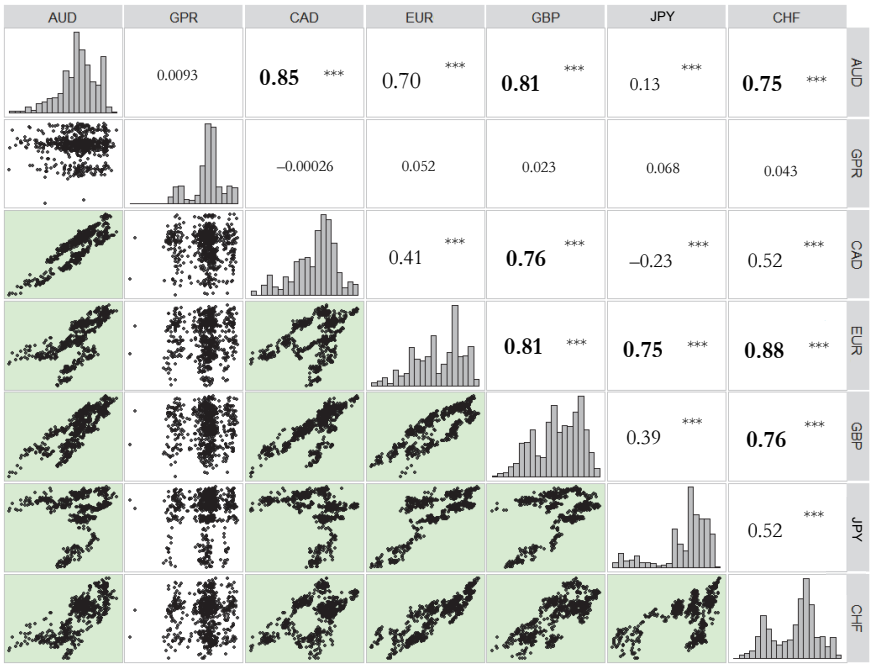
Descriptive statistics

Denomination	GPR	EUR	GBP	AUD
Mean	6.548707	1.143932	1.319237	0.719580
Maximum	7.063904	1.234111	1.422678	0.797703
Minimum	5.308268	1.002567	1.149439	0.574290
Std. Dev	0.266751	0.054255	0.060155	0.040607
Skewness	–0.845129	–0.472812	–0.415807	–0.756942
Kurtosis	4.143249	2.350095	2.232648	3.658570
Jarque-Bera	117.6327***	37.19347***	36.17163***	76.99711***
ADF	–5.249017***	–24.84137***	–24.44296***	–24.33324***
	CAD	JPY	CHF	
Mean	0.774993	0.008963	1.074607	
Maximum	0.830703	0.009739	1.138861	
Minimum	0.689741	0.007196	0.996959	
Std. Dev	0.028706	0.000615	0.031586	
Skewness	–0.712391	–1.368178	–0.366546	
Kurtosis	3.191728	4.048230	2.219486	
Jarque-Bera	58.38613***	242.5668***	32.39217***	
ADF	–26.65143***	–25.49685***	–25.21456***	

Notes: *** represents a 1% significance level.

Figure 1

The distribution and the pairwise correlations between GPR and exchange rate markets



Results

The findings of the time-varying causality resulting from global geopolitical risk to major exchange rate markets are discovered by using the framework proposed by Shi et al. (2020). As shown, there are no unit roots in all the examined time series, indicating the validity of utilizing Granger causality tests. Following Shi et al. (2018), we carry out the time-varying Granger causality approach based on a lag-augmented VAR model, which enables us to determine the onset and end dates of the bidirectional effects among time series by estimating the time-varying Granger causality. Here, we conduct the causal nexus between indicators using the rolling window and recursive evolving procedures. Figures 2 and 3 depict the test statistics sequence as well as the 5% critical value sequence. If the critical value falls below the test statistics, it is possible to reject the null hypothesis that there is no Granger causality between the two time series indicators.

Let us begin with Figure 2, where time-varying Granger causality running from GPR to six major exchange rate markets is represented. From the rolling window causality, Figure 2 presents evidence of a significant Granger causality running from GPR to AUD, EUR, GBP, and JPY over many periods, including August 2020, April 2021, and December 2022. Nevertheless, the null hypothesis of no Granger causality cannot be rejected in this pair of GPR-CAD because the test statistic does not exceed the critical value during the research period. In addition, there is only one significant Granger causality running from GPR to CHF at the beginning of 2021.

The Granger causality from GPR to major exchange rate markets exhibits high volatility under recursive evolving causality. The diagram of the recursive evolving approach, as shown in Figure 3, indicates that GPR continuously caused exogenous influences on the exchange rate markets for most of the 2020–2022 period due to the Covid-19 and Russia–Ukraine crises. More importantly, recursive evolving causality detects different episodes where there are causal effects from GPR to exchange rate markets: AUD and JPY (April 2020, August 2020, April 2021, August 2021, December 2021, and April 2022), EUR (April 2020, December 2020, and December 2021), GBP (April 2020, August 2020, and January 2021), and CHF (April 2020 and December 2020). The causality seemingly declined during the Russia–Ukraine war. However, there are no significant causal linkages running from GPR to CAD over the sample period.

The findings of rolling causality are above the critical value line for rejecting the null hypothesis at a larger scale, and recursive evolving causality experiences a significant Granger causality from GPR to exchange rate markets for a slightly longer period. According to Shi et al. (2018), the recursive evolving causality method performs better in the case of limited samples than the rolling causality approach. Therefore, we concentrate on the implications of the recursive evolving causality framework. Figure 3 shows that during the Covid-19 outbreak, global geopolitical risk had considerable predictive power for exchange rate markets. The outcomes underscore the role of geopolitical stability in decreasing currency market variations and are consistent with some past papers.

Figure 2

Time-varying causality running from GPR to exchange rate markets

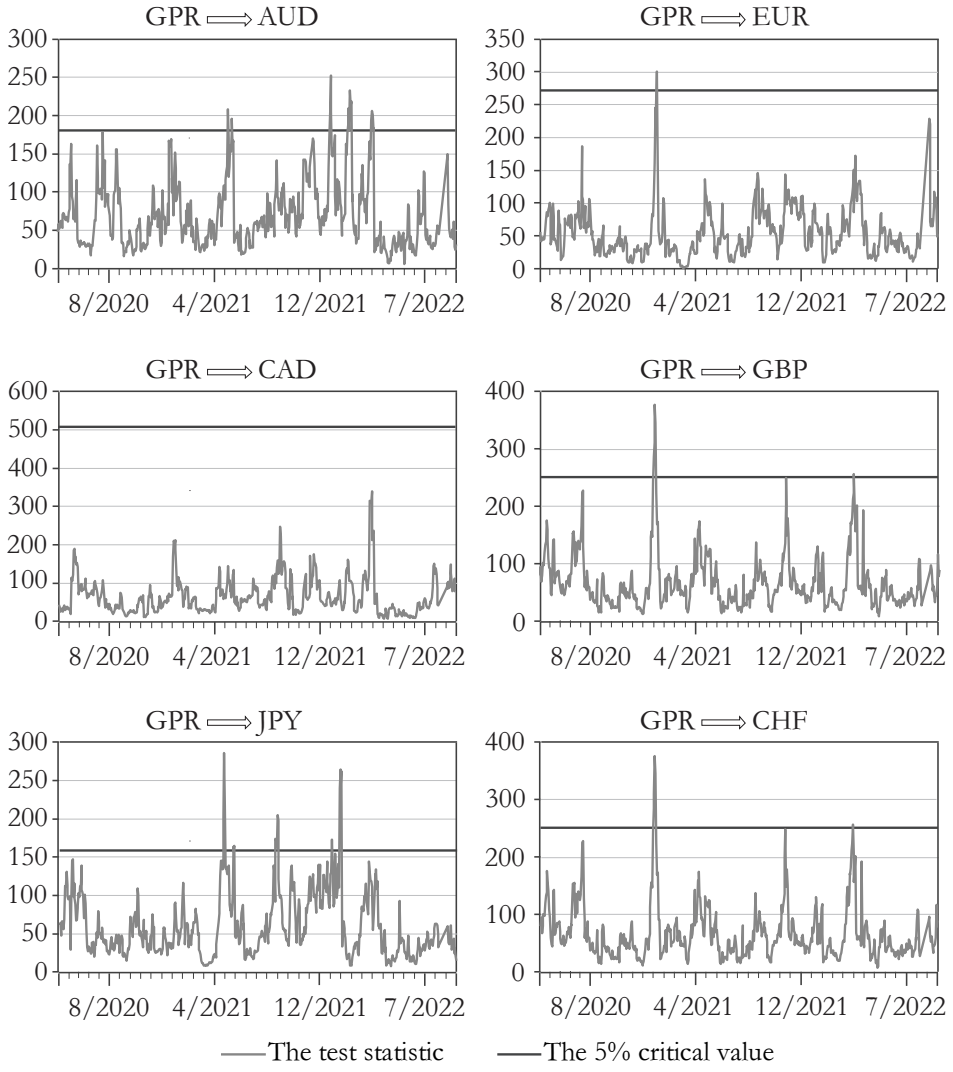


Figure 3

Time-varying causality running from GPR and exchange rate markets

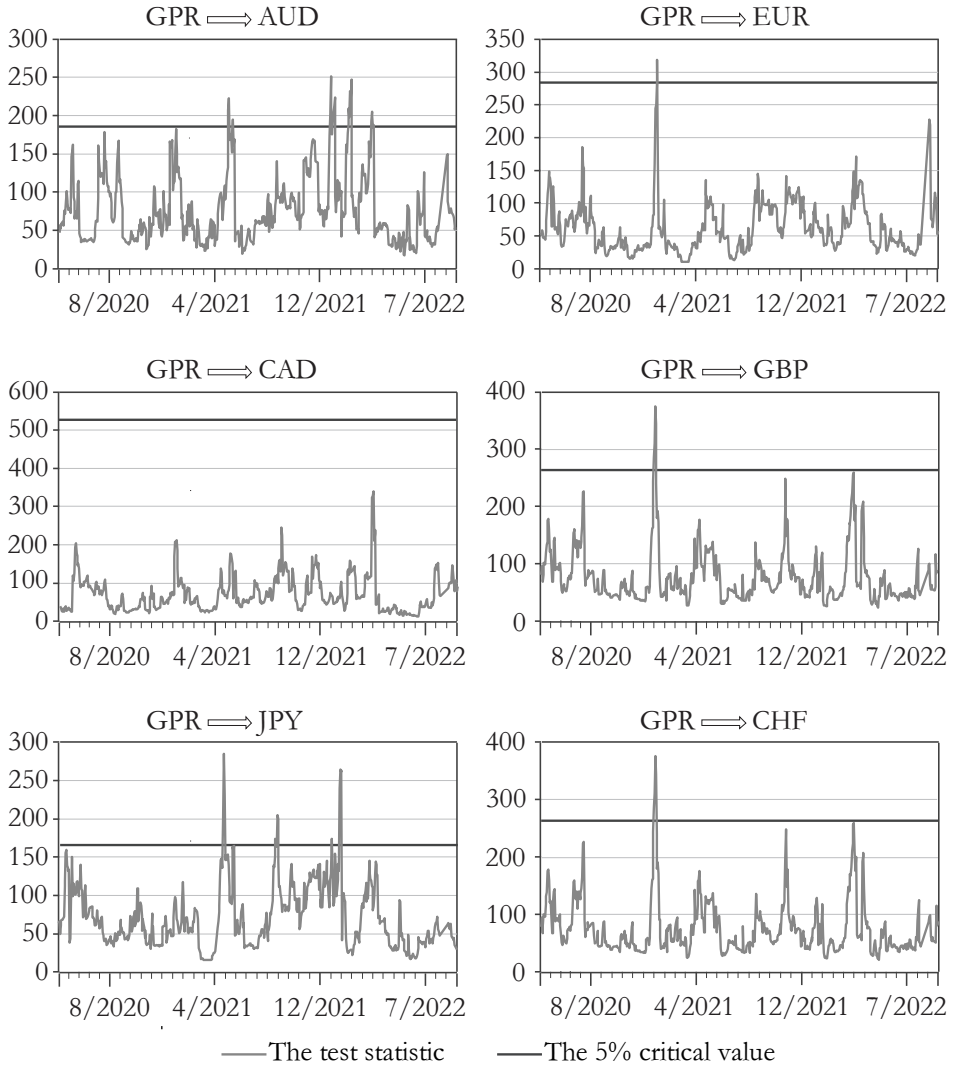


Figure 4

Time-varying causality running from exchange rate markets to GPR

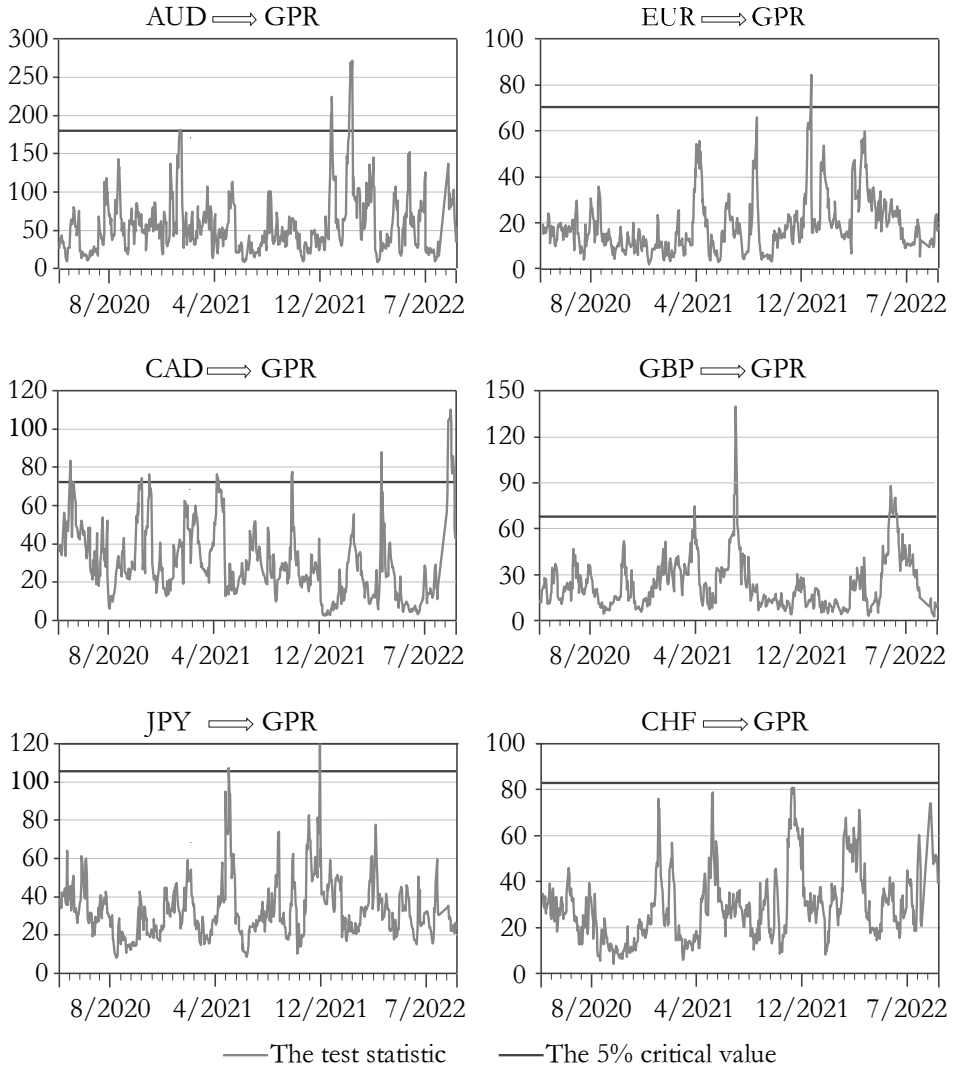
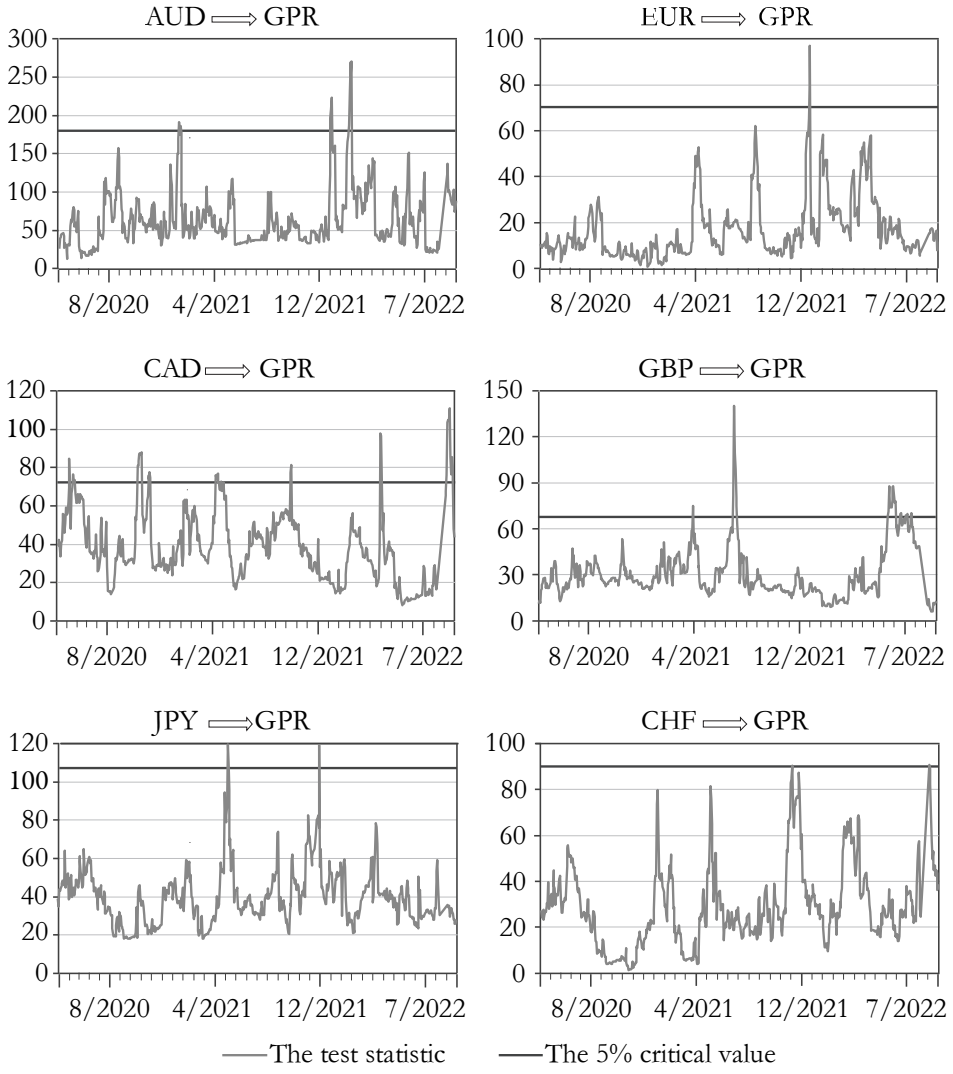


Figure 5

Time-varying causality running from exchange rate markets to GPR



Turning now to the time-varying Granger causality running from selected exchange rate returns to geopolitical risks. Figure 4 illustrates the estimates of the rolling window algorithm between foreign exchange rates and GPR, while Figure 5 shows the recursive evolving algorithm findings. As shown in Figure 4, we can observe that CHF, GBP, CAD, and EUR significantly influence global geopolitical uncertainties, with a huge spike from April 2021 onward to the middle of 2022. Nevertheless, for the rest of the period, these exchange markets are not able to predict

the fluctuations in GPR. Similarly, there is Granger causality running from JPY to GPR at the beginning of the Covid-19 outbreak (6/2020), whereas AUD has a significant impact on GPR over the period shown. The recursive evolving procedure (Figure 5) demonstrates significant values for the periods of Covid-19 and the beginning of the Russia–Ukraine crisis, suggesting higher volatility among causalities between exchange rate returns and GPR under the recursive procedure. Overall, the recursive evolving and rolling algorithms paint a divergent picture from that of an unequivocal failure to reject the null hypothesis of no predictability. In other words, far more time-varying causal associations between EUR, GBP, CAD, JPY, CHF, AUD, and GPR are uncovered. Moreover, the difference between the heteroscedastic and homoscedastic tests is not obvious for the recursive evolving and rolling algorithms. The primary distinction is that significant causality episodes are more frequent from AUD to GPR and less frequent from JPY and CHF to GPR.

These findings suggest that there was a bidirectional causal relationship between major exchange rates and global geopolitical risks during the sample period. The first period of significant causality between these variables coincides with the beginning of 2020, a period characterized by exchange rate market instability due to the Covid-19 pandemic, particularly in the major exchange markets (Kisswani–Elian 2021). Both GPR and exchange markets also have switching roles, which implies that these indicators are impacted by the Covid-19 outbreak. A reasonable explanation is that there is a low demand for exchange rates, but the remarkable increase in risks may be due to the severe pandemic that struck the world in early 2020. The uncertainty around Covid-19, doubts about the vaccine's efficacy, and a significant increase in the number of confirmed cases and deaths have exacerbated investors' anxieties and affected their investment decision-making processes. The other period of significant causality between GPR and exchange rate returns is the beginning of the Russia–Ukraine conflict. This incident exacerbated geopolitical instability around the world for a variety of reasons, including factors related to international relations, economic, energy, and trade dependency, historical and ideological differences, and physical proximity among countries (Będowska-Sójka et al. 2022). The results reveal that since the commencement of the geopolitical conflict between Ukraine and Russia, there has been a dramatic Granger causality between GPR and the exchange rate series under consideration, which emphasizes that risk transmission and contagion are intense during this crisis because of heightened risk aversion and leverage ratios (Bossman–Gubareva 2023), where high returns are associated with high risks. Moreover, global geopolitical risks significantly predict exchange rate market volatility, which suggests their hedging potential against market shocks propagated by geopolitical risk. These findings are consistent with the studies of Salisu et al. (2022), Ivanovski–Hailemariam (2022), and Iyke et al. (2022).

As indicated by Iyke et al. (2022) and Salisu et al. (2022), changes in geopolitical risk tend to dampen economic activity and, as a result, exchange rate markets. This is

because GPR can have a detrimental impact on production and consumption, which is caused by delays in investments and delayed household spending on durable goods. This deterioration in demand may unquestionably pose a risk to potential profits, which would, in turn, cause prices of exchange rates to fall. Cai–Wu (2021) provide evidence that a higher level of GPR can also cause greater volatility in financial markets, as do Ivanovski–Hailemariam (2022), Yang et al. (2022) and Bouri et al. (2022). In addition, we hypothesize that investors who use the information content that is inherent in geopolitical risk to develop buy and sell signals can maximize their profits and minimize their losses. When developing a trading strategy, an investor who capitalizes on the information content of geopolitical risk needs to be aware that the strategy may be less effective during times of conflict such as the one between Russia and Ukraine. Our results have important implications for exchange rate determination models. Specifically, structural changes caused by the Covid-19 outbreak may be linked to shifts in the behavior and preferences of those participating in the market and the implementation of a succession of governmental solutions sparked by crises or health events. Our empirical estimates suggest to policy-makers that GPR is a major cause of exchange rate misalignment and that GRP ought to be taken into account when developing exchange rate strategies. For forex investors, it is obvious that forex trading techniques that take geopolitical risks into account may provide larger returns than basic trading strategies.

Conclusion

Global geopolitical risk and exchange rates have a remarkable relationship. Nevertheless, the nature of this underlying association is widely debated in the literature. This article extends the literature by using a novel method of time-varying Granger causality introduced by Shi et al. (2018, 2020) to examine how GPR is connected to major exchange rates using daily data covering the two recent crises, namely, Covid-19 and the Russia–Ukraine war. This is a critical topic for academic finance literature, investors, and policy-makers, especially during periods of economic distress, such as the Covid-19 and Russia–Ukraine crises. We uncover that fluctuations in global geopolitical risk significantly contribute to fluctuations in exchange rates during Covid-19 and the beginning of the Russia–Ukraine war, while GPR has virtually no influence during the Russia–Ukraine war.

Furthermore, our empirical findings disclose that the causal links between GPR and major exchange rates are significant and support time variation in the interaction, especially during the Covid-19 crisis. However, this observation is less true, which could show that GPR and exchange rate markets are not linked during the Russia–Ukraine war. Put differently, our results suggest that GPR has no predictive power over exchange rates in its domain during the periods of the Russia–Ukraine war. Overall, the findings of this analysis are crucial for understanding the exchange rate

impacts of ongoing conflicts and health crises so that investors, portfolio managers, and policy markets can design effective financial strategies.

Relevant implications should be mentioned. First, based on the outcomes, foreign exchange rate investors could keep an eye on the state of the market and the GPR level to rebalance their portfolios in a timely and efficient manner. Second, it would be prudent for GPR to be carefully regulated during the current crisis to allow opposing dynamics that facilitate diversification and risk management. As a result of these consequences, regulators and policy-makers may employ proactive regulation formulation and timely regulation revisions as a response to internal or external shocks related to geopolitical risk, thereby reducing shock transmission across exchange rate markets.

Additionally, investors and portfolio risk managers can use the information from GPR to increase earnings and create trading and hedging methods that are more effective, particularly in bullish rather than bearish markets. It is important to remember that volatility becomes an important factor in investment decisions when it is viewed as uncertainty. Additionally, to accurately predict the volatility of foreign exchange markets, an investor must price an option. Therefore, when computing exchange rate returns and volatility, they should include the dimension of geopolitical events.

Acknowledgments

This research is funded by the University of Finance-Marketing, Ho Chi Minh City, Vietnam. The authors are grateful to the anonymous referees of the journal for their extremely useful suggestions to improve the quality of the article. Usual disclaimers apply.

REFERENCES

BĘDOWSKA-SÓJKA, B.–DEMIR, E.–ZAREMBA, A. (2022): Hedging geopolitical risks with different asset classes: a focus on the Russian invasion of Ukraine *Finance Research Letters* 50: 103192. https://doi.org/10.1016/j.frl.2022.103192

BOSSMAN, A.–GUBAREVA, M. (2023): Asymmetric impacts of geopolitical risk on stock markets: A comparative analysis of the E7 and G7 equities during the Russian-Ukrainian conflict *Heliyon* 9 (2): e13626. https://doi.org/10.1016/j.heliyon.2023.e13626

BOURI, E.–GUPTA, R.–VO, X. V. (2022): Jumps in geopolitical risk and the cryptocurrency market: The singularity of Bitcoin *Defence and Peace Economics* 33 (2): 150–161. https://doi.org/10.1080/10242694.2020.1848285

CAI, Y.–WU, Y. (2021): Time-varying interactions between geopolitical risks and renewable energy consumption *International Review of Economics & Finance* 74: 116–137. https://doi.org/10.1016/j.iref.2021.02.006

CALDARA, D.–IACOVIELLO, M. (2022): Measuring geopolitical risk *American Economic Review* 112 (4): 1194–1225. https://doi.org/10.1257/aer.20191823

CHIANG, T. C. (2021): Geopolitical risk, economic policy uncertainty and asset returns in Chinese financial markets *China Finance Review International* 11 (4): 474–501. https://doi.org/10.1108/CFRI-08-2020-0115

DOS SANTOS, M. B. C.–KLOTZLE, M. C.–PINTO, A. C. F. (2021): The impact of political risk on the currencies of emerging markets *Research in International Business and Finance* 56: 101375. https://doi.org/10.1016/j.ribaf.2020.101375

GONG, X.–XU, J. (2022): Geopolitical risk and dynamic connectedness between commodity markets *Energy Economics* 110: 106028. https://doi.org/10.1016/j.eneco.2022.106028

HAMMOUDEH, S.–AJMI, A. N.–MOKNI, K. (2020): Relationship between green bonds and financial and environmental variables: A novel time-varying causality *Energy Economics* 92: 104941. https://doi.org/10.1016/j.eneco.2020.104941

HUNG, N. T. (2020): Volatility spillovers and time-frequency correlations between Chinese and African stock markets *Regional Statistics* 10 (02): 63–82. http://dx.doi.org/10.15196/RS100203

HUNG, N. T. (2022): Return equicorrelation and dynamic spillovers between Central and Eastern European, and World stock markets, 2010–2019 *Regional Statistics* 12 (01): 159–192. https://doi.org/10.15196/RS120108

HUNG, N. T. (2023): What effects will Covid-19 have on the G7 stock markets? New evidence from a cross-quantilogram approach *Regional Statistics* 13 (2): 240–264. https://doi.org/10.15196/RS130203

HUNG, N. T.–LINH, N. T. M.–VO, X. V. (2022): Exchange rate volatility connectedness during Covid-19 outbreak: DECO-GARCH and Transfer Entropy approaches *Journal of International Financial Markets, Institutions and Money* 81: 101628. https://doi.org/10.1016/j.intfin.2022.101628

IVANOVSKI, K.–HAILEMARIAM, A. (2022): Time-varying geopolitical risk and oil prices *International Review of Economics & Finance* 77: 206–221. https://doi.org/10.1016/j.iref.2021.10.001

IYKE, B. N.–PHAN, D. H. B.–NARAYAN, P. K. (2022): Exchange rate return predictability in times of geopolitical risk *International Review of Financial Analysis* 81: 102099. https://doi.org/10.1016/j.irfa.2022.102099

KAPAS, J. (2022): Has Covid-19 caused a change in the dynamics of the unemployment rate? The case of North America and continental Europe *Regional Statistics* 12 (01): 3–26. https://doi.org/10.15196/RS120107

KISSWANI, K. M.–ELIAN, M. I. (2021): Analyzing the (a) symmetric impacts of oil price, economic policy uncertainty, and global geopolitical risk on exchange rate *The Journal of Economic Asymmetries* 24: e00204. https://doi.org/10.1016/j.jeca.2021.e00204

LEE, C. C.–CHEN, M. P. (2020): Do natural disasters and geopolitical risks matter for cross-border country exchange-traded fund returns? *The North American Journal of Economics and Finance* 51: 101054. https://doi.org/10.1016/j.najef.2019.101054

MITSAS, S.–GOLITSIS, P.–KHUDOYKULOV, K. (2022): Investigating the impact of geopolitical risks on the commodity futures *Cogent Economics & Finance* 10 (1): 2049477. https://doi.org/10.1080/23322039.2022.2049477

PHILLIPS, P. C.–SHI, S.–YU, J. (2015a): Testing for multiple bubbles: Limit theory of real-time detectors *International Economic Review* 56 (4): 1079–1134. https://doi.org/10.1111/iere.12131

PHILLIPS, P. C.–SHI, S.–YU, J. (2015b): Testing for multiple bubbles: Historical episodes of exuberance and collapse in the S&P 500 *International Economic Review* 56 (4): 1043–1078. https://doi.org/10.1111/iere.12132

RUIZ-MARÍN, M.–MATÉ-SÁNCHEZ-VAL, M.–NOGUERA-VENERO, J. (2023): Did Covid-19 modify the spatial concentration of business failure? *Regional Statistics* 13 (2): 201–213. http://dx.doi.org/10.15196/RS130201

SAÂDAOUI, F.–JABEUR, S. B.–GOODELL, J. W. (2022): Causality of geopolitical risk on food prices: Considering the Russo–Ukrainian conflict *Finance Research Letters* 49: 103103. http://dx.doi.org/10.1016/j.frl.2022.103103

SALISU, A. A.–CUNADO, J.–GUPTA, R. (2022): Geopolitical risks and historical exchange rate volatility of the BRICS *International Review of Economics & Finance* 77: 179–190. https://doi.org/10.1016/j.iref.2021.09.017

SHAHZAD, F.–BOURI, E.–MOKNI, K.–AJMI, A. N. (2021): Energy, agriculture, and precious metals: Evidence from time-varying Granger causal relationships for both return and volatility *Resources Policy* 74: 102298. https://doi.org/10.1016/j.resourpol.2021.102298

SHI, S.–HURN, S.–PHILLIPS, P. C. (2020): Causal change detection in possibly integrated systems: Revisiting the money–income relationship *Journal of Financial Econometrics* 18 (1): 158–180. https://doi.org/10.1093/jjfinec/nbz004

SHI, S.–PHILLIPS, P. C.–HURN, S. (2018): Change detection and the causal impact of the yield curve *Journal of Time Series Analysis* 39 (6): 966–987. https://doi.org/10.1111/jtsa.12427

THOMA, M. A. (1994): Subsample instability and asymmetries in money-income causality *Journal of Econometrics* 64 (1–2): 279–306. https://doi.org/10.1016/0304-4076(94)90066-3

UMAR, Z.–BOSSMAN, A.–CHOI, S. Y.–TEPLOVA, T. (2022): Does geopolitical risk matter for global asset returns? Evidence from quantile-on-quantile regression *Finance Research Letters* 48: 102991. https://doi.org/10.1016/j.frl.2022.102991

WANG, X.–LI, J.–REN, X.–LU, Z. (2022): Exploring the bidirectional causality between green markets and economic policy: evidence from the time-varying Granger test *Environmental Science and Pollution Research* 29 (58): 88131–88146. https://doi.org/10.1007/s11356-022-21685-x

YANG, C.–NIU, Z.–GAO, W. (2022): The time-varying effects of trade policy uncertainty and geopolitical risks shocks on the commodity market prices: Evidence from the TVP-VAR-SV approach *Resources Policy* 76: 102600. https://doi.org/10.1016/j.resourpol.2022.102600