Geopolitical risks and climate change stocks

Abstract

This paper aims to examine the impact of geopolitical risk (GPR), threats (GPT) and acts (GPA) on returns and volatilities of regional climate change stocks under different market conditions, employing quantile regressions. Our main results suggest that climate change stock returns positively (negatively) respond to GPR in bullish (bearish) market states, however the effect is not uniform across the regions. The volatilities mainly show a positive response to geopolitical tensions; geopolitical acts appear to have a more pronounced impact on volatilities than geopolitical threats. We further find that GPR leads to higher volatility during the Russia-Ukraine war, creating heightened uncertainty. Overall, the results reveal that geopolitical risks have an asymmetric and heterogenous impact on climate change stocks. The results provide significant insights and implications for financial market participants and policy makers.

Keywords: Geopolitical risks, climate change, equity markets, quantile regressions

1.Introduction

Geopolitical risks (GPR) have raised intensive concerns due to their unprecedented scale and complexity in recent years (e.g., Russia-Ukraine conflict, contentious U.S.-China trade relationship and ongoing pandemic-related economic distortions). GPR refers to the adverse events related to conflicts, terrorism, and tensions among states and political entities that disrupt the peaceful conduct of international relations (Caldara and Iacoviello, 2022). Geopolitical events and conflicts have triggered uncertainties and fluctuations in financial markets (Iyke et al., 2022; Gong and Xu, 2022). Salisu et al. (2022) document that GPR is a significant predictor of equity returns and stock markets are more vulnerable to adverse effects of threats of GPR, such as threats of war and terrorism, than to the actual occurrence of these events. Additionally, prolonged geopolitical shocks could delay firms' investment and consumers' consumptions (Wang et al.; 2019). In an environment of uncertainty and heightened geopolitical risks, businesses are more cautious about new investments or expanding their existing operations since making prediction of future demand, costs or return on investment is quite challenging, leading firms to postpone or scale down their investment plans.

GPR can also significantly affect green investments. Considering that oil price fluctuations are influenced by geopolitical risks (Bouoiyour et al., 2019; Ivanovski and Hailemariam, 2022) and oil and renewable energy prices are highly covariant (Dutta and Dutta, 2022), it is plausible that GPR could significantly impact sustainable financial assets. As discussed above, GPR may lead to a decline in future investments, which may potentially delay the transition from fossil fuel-based energy sources to low-carbon alternatives. However, the opposite effect is also possible. For instance, consider the ongoing Russia-Ukraine conflict. Some argue that the conflict may hinder the EU's energy transition plan due to the dependence on Russian natural gas and oil, while others believe that it could accelerate the transition as a strategic response to this reliance (Pata et al., 2023). In addition, GPR can influence investors' investment decisions through shifts in investor sentiment (Song et al., 2019). In a period characterized by heightened geopolitical risks, investors' expectations regarding future oil supply and demand could change, shaping their views on the alternative energy industry and hence, fluctuations in geopolitical risk may affect the returns on such investments.

Companies have been facing significant exposure to climate-related events, and thus they have committed to reducing their carbon emission, promoting sustainable practices, and addressing climate change challenges after the Paris agreement. The increased awareness of global warming and climate change in recent years has catalyzed the development of sustainable stock indices and the rise of Socially Responsible Investments (SRI). One of these investments is climate change equity indexes (CCIs) which are designed to exceed the minimum requirements of the EU Climate Transition Benchmark and account for both the opportunities and risks involved in transitioning to a low carbon economy. This enables investors and wealth managers to incorporate climate risk considerations into their global equity investment process. However, these new indices have not been considered in previous research that analyze the performance of sustainable investments. One exception is a new study by Polat et al. (2023) that investigates the impact of market sentiment, measured by the media coverage index on the returns and volatility connectedness of climate change indices during the pandemic. They find that the returns of the markets are more connected than the volatility of markets, especially in the first pandemic wave.

In this paper, we examine the response of CCIs to geopolitical risks, threats, and acts. The heightened tension arising from the recent Russia-Ukraine conflict has offered a unique opportunity to study the reactions of green stocks to such geopolitical challenges. As suggested by Demiralay and Kilincarslan (2019), GPR could impact stock prices through two main channels. Firstly, heightened geopolitical risks might lead to lower stock prices and dividends as adverse geopolitical events often create uncertainty in financial markets. In times of increased geopolitical tensions, there might be disruptions to global supply chains, accompanied by a surge in raw material costs and the imposition of barriers hindering international trade, which in turn can lead to lower dividend payouts and subsequently a decrease in stock prices. Secondly, investors usually demand a higher risk premium for their equity investments in an environment characterized by high geopolitical risks as heightened geopolitical tensions create additional uncertainty and higher volatility in financial markets. To compensate for increased risks, investors demand higher returns, leading to elevated discount rates in stock valuations. When future cash flows of a company are discounted at a higher rate, the present value of these cash flows decreases, causing a decrease in stock prices. Apart from these two channels, GPR can also contribute to fear sentiment and erode investors' confidence when uncertainties arise due to geopolitical events or conflicts (Chen et al., 2020). Investors tend to reevaluate their risk exposure and investment strategies, prompting a shift towards safer or more stable investments to reduce their exposure to riskier assets. This shift in investment preferences could result in volatilities and price fluctuations of financial markets.

Geopolitical events have the potential to directly impact companies in the energy sector, resulting in disruptions in the production and distribution of oil and gas. Wang et al. (2019) suggest that the escalation of GPR caused by the war between Russia and Ukraine leads to higher commodities prices as both are major suppliers of energy resources, driving the returns and volatilities spillovers in commodity markets. Companies tend to consider renewable and clean energy as a substitute for fossil fuels to reduce their exposure to higher energy prices when GPR increase (Zhao et al., 2023). Thus, this could cause fluctuations in the equity prices of climate change stocks.

The existing literature tend to focus on the impact of GPR on market dynamics of green investments, such as green bonds and equities, renewable and clean energy (Sarker et al., 2023; Sohag et al, 2022; Zhang et al., 2023). Sohag et al (2022) find that returns of green bonds and equities respond positively to GPR from bearish to bullish market states and only negatively to the highest quintile of GPR. Moreover, Zhang et al. (2023) suggest that GPR has a prolonged impact on the volatility of green bonds than on their returns. They also investigate the impact of GPR on renewable and clean energy and find that GPR has a more substantial influence on the return of clean energy than on volatility. Sarker et al. (2023) report that GPR has greater short-run effects on realized volatility than on returns, whereas movements in GPR have significant long-run effects. In another study, Dutta and Dutta (2022) report that investors tend to consider clean energy as a substitute for fossil-fuel energy sources when GPR increases, which may lead to an increase in the stock prices of renewable energy firms and a drop in volatility.

Recent studies have also focused on the impact of GPR on renewable energy demand and deployment. Pata et al. (2023) investigate the impact of economic policy uncertainty (EPU) and geopolitical risk (GPR), controlling for economic growth (GDP) and urbanization (URB) on renewable energy investments in G7 countries. Their results reveal that renewable energy investments increase as economies grow, but decrease as EPU, GPR, and URB increase. Analyzing the effects of geopolitical risks on renewable energy demand in OECD countries, Zhao et al. (2023) show that heightened GPR causes a lower demand for renewable energy and threatens climate change mitigation policies. In another study, Sweidan (2021) explores the impact of GPR on renewable energy deployments in the USA and reports that GPR positively influences renewable energy deployment in the United States, acting as a driver rather than a barrier to its diffusion. This suggests that heightened geopolitical uncertainty is expected to promote cleaner production and a more sustainable environment. As can be seen, the literature is divided and presents mixed results regarding the impacts of geopolitical risks on clean energy stock prices, returns, and alternative energy investments.

The relationship between GPR and climate change stocks remains relatively unexplored. Since concerns about the environmental impact of industries intensify, investors are increasingly seeking opportunities to align their portfolios with sustainable and environmentally conscious businesses, driving positive change and fostering a more environmentally and socially responsible global economy. Thus, it has become increasingly crucial to understand how environmentally friendly companies respond to GPR, providing valuable insights for responsible investors pursuing investments in climate change indices. Moreover, we are particularly interested in its impact on climate change stocks during periods of geopolitical turbulence considering Russia's invasion of Ukraine is the most unprecedent geopolitical shock since the Second World War. Therefore, in this paper, we attempt to answer the following research questions. Are climate change stocks resilient to adverse geopolitical shocks? Do the responses of climate change stocks to GPR vary across different market conditions? Does the Russian-Ukrainian conflict change the sensitivity of returns and volatilities of climate change stocks to GPR?

In order to address our research questions, we collect the daily data of six regional MSCI CCIs (ACWI, Asia Pacific, Emerging Markets, Europe, North America and World). Meanwhile, a news-based GPR index, developed by Caldara and Iacovielllo (2022), is adopted to measure the geopolitical exposure by counting the occurrence of words related to adverse geopolitical events in 11 leading international newspapers. First, we employ Quantile Regression approach (QR) to examine the impact of GPR on CCI returns under different market circumstances. Our findings indicate that GPR has negative effects on CCI returns at the lower quantiles (bearish market states) and positively affects CCI returns at the upper quantiles (bullish market states). Furthermore, our results suggest that MSCI ACWI, Asia Pacific and World are more responsive to GPR. In contrast, Emerging and European markets seem to be resilient to GPR across all quantiles. We then use GARCH model to investigate whether conditional volatilities of CCI are driven by GPR. We find that an increase in GPR is associated with higher volatility in CCI for all six Indices. Specifically, this relationship is more pronounced at the lower quantiles, but is insignificant at the higher quantiles except for European markets. Second, we further decomposed our GPRs measure into the Geopolitical Threats Index (GPT) and Geopolitical Acts Index (GPA) and investigate the responses of CCI returns and volatilities to different geopolitical components of GPR indices across all quantiles. The findings reveal that GPA affects CCI returns in most cases except for ACWI and Emerging Markets while ACWI and world indices are more responsive to GPT, indicating the heterogeneity of CCIs in terms of the sensitivity to geopolitical risks. As for volatilities, our findings suggest that the impact of geopolitical acts on CCI volatilities is more pronounced compared to that of geopolitical threats. Furthermore, we find that both GPA and GPT are more influential for CCI volatilities than CCI returns. Finally, it is widely acknowledged that GPR is significantly exacerbated by Russia's invasion of Ukraine since 2022 (Umar at al., 2022a), therefore we also explore whether Russia-Ukraine war has changed the sensitivity of stock returns and volatilities of green companies to GPR across the timeline of this conflict. Our results suggest that GPR does not significantly affect CCI returns but leads to higher volatility during Russia-Ukraine war.

The main contribution of this paper is twofold. First, our paper complements the literature by providing additional evidence of the impact of GPR on green markets. This paper aims to shed light on the impacts of GPR and its-subcomponents on climate change stocks under various market conditions, which are considered as increasingly popular low carbon assets among investors (Polat et al., 2023). We do not only assess stock price responses of environmentally friendly companies to GPR, but also their volatilities to the exposure of GPR. To the best of our knowledge, this is the first paper to analyze return and volatility dynamics of CCI and their sensitivity to GPR. Consistent with Sohag et al. (2022), our results indicate that CCIs respond negatively to GPR at the bearish states and positively to GPR at the bullish states. As for volatilities, we observe a positive relationship between CCI volatilities and all measures of GPR from bearish to bullish market states. Second, our research provides new insights on the impact of Russia-Ukraine conflict on financial markets. The existing literature explore the impact of the war on the returns of commodities (Wang et al., 2022), energy sectors (Umar et al., 2022b) and stock markets (Boubaker et al. 2022; Izzeldin et al., 2023), but there is no evidence on the responses of climate change stocks to this conflict. Our paper fills the gap by assessing the sensitivity of CCI returns and volatility to all measures of GPR in the context of extreme geopolitical conditions, providing valuable perspectives for responsible investors for their decision-making during times of geopolitical turmoil. The findings reveal that CCI volatilities are significantly driven by GPR during the war, but this is not case for CCI returns. Moreover, we explore the impact of GPR and other sub-indexes on CCI across three phases of the war and find out that the impact of GPR on CCI volatilities is more pronounced during the early stages of the war, which is consistent with Polat et al. (2023) who suggest that markets reacted more strongly during the beginning of turmoil.

The rest of the paper is structured as follows. Section 2 outlines the methodology, describes the data and presents the summary statistics. Section 3 provides the results and discussion, and Section 4 concludes.

2. Methodology and Data

2.1. Methodology

As stated earlier, we aim to analyze the impacts of geopolitical risks (GPR), threats (GPT) and acts (GPA) on climate change index returns and volatilities. Therefore, the baseline regression model is estimated as:

$$y_{i,t} = \alpha + \beta GPR_t + \lambda X_t + \varepsilon_{i,t} \tag{1}$$

where $y_{i,t}$ represents climate change index returns or volatilities of index i at time t, GPR_t stands for geopolitical risks (GPR, GPA or GPT) and X_t is a vector of control variables.[1] α denotes the constant term and β and λ are the parameters to be estimated. More specifically, β measures the effects of geopolitical risks whereas λ quantifies the impacts of the control variables.

Equation (1) above allows us to measure symmetric linear dependence between the variables and discards any potential asymmetric impact. However, numerous previous studies have shown that the degree of dependence significantly varies with respect to changing market conditions (e.g. Mensi et al., 2014; Xiao et al., 2019; Khalfaoui et al., 2022). Therefore, we employ quantile regressions (QR) introduced by Koenker and Bassett (1978) to capture asymmetric associations. More specifically, QR models can enable us to distinguish the degree of impact of geopolitical risks on CCI returns and volatilities under various market conditions,

[1] We employ GARCH (1,1) to estimate conditional volatilities. We do not produce the results from the GARCH (1,1) model in this paper, however the relevant results are available upon request.

such as bull market and bear market circumstances. In addition, the QR models produce more precise and accurate estimates of the response of the observed variable to explanatory variables (Koenker, 2005), as they are robust to heteroskedasticity and outliers (Koenker and Hallock, 2001).

The quantile regression of y_i given x_i can be formulated as follows:

$$Q_{y_i}(\tau|x) = \alpha(\tau) + x_i'\beta(\tau) \tag{2}$$

where $Q_{y_i}(\tau|x)$ stands for the τ-th conditional quantile of yi and 0< τ<1. $\alpha(\tau)$ denotes the unobserved effect whereas $\beta(\tau)$ represents the estimate of the quantile regression which can be written as:

$$\hat{\beta}(\tau) = \ arg\ min_{\beta\in R^p} \sum_{i=1}^{n} \rho_\tau \left(y_i \ - \ \alpha(\tau) \ - \ x_i'\beta(\tau)\right) \tag{3}$$

where $\rho_\tau = u\big(\tau \ - \ I(u < 0)\big)$ represents the check function and I(·) is an indicator function given by $u = y_i \ - \ \alpha(\tau) \ - \ x_i'\beta(\tau)$.

In this paper, we report the estimation results for seven quantiles τ =(0.05, 0.10, 0.25, 0.50, 0.75, 0.90, 0.95), however, the QR process quantiles are also plotted for each quantile to view the full effect across the whole spectrum of quantiles. Typically, the lower quantiles (0.05, 0.10, 0.25) correspond to periods where the expected return or volatility is low, whereas higher quantiles (0.75, 0.90, 0.95) refer to the periods where the expected return or volatility is high. In addition, we use the pairs bootstrapping procedure of Buchinsky (1995) to compute standard errors as the standard errors produced by this procedure are asymptotically valid under misspecification and heteroscedasticity. We further assess the validity of the QR estimations using various tests, such as Quasi Likelihood ratio (QLR) and the slope equality tests by Koenker and Bassett (1982) and the goodness-of-fit by Pseudo Rsquared.

2.2. Data and Summary Statistics

Our dataset consists of six regional MSCI Climate Change indices (CCI) (ACWI, Asia Pacific, Emerging Markets, Europe, North America and World)[2], geopolitical risk indices (GPR, GPT, GPA) and control variables as described in the previous section. We retrieved the data from DataStream for the period spanning from 26 November 2013 to 19 October 2022

[2] MSCI ACWI CCI includes both developed and emerging markets (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the UK, the US, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Kuwait, Malaysia, Mexico, Peru, Philippines, Poland, Qatar, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey and United Arab Emirates. MSCI Asia Pacific CCI includes Australia, Hong Kong, Japan, New Zealand and Singapore, China, India, Indonesia, Korea, Malaysia, the Philippines, Taiwan and Thailand. MSCI Emerging Markets CCI includes Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Kuwait, Malaysia, Mexico, Peru, Philippines, Poland, Qatar, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey and United Arab Emirates. MSCI Europe CCI includes Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the UK. MSCI North America includes the US and Canada. MSCI World CCI includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Israel, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the UK and the US.

and used daily data.[3] Following the relevant literature (e.g. Mensi et al., 2014; Demiralay and Kilincarslan, 2019), control variables include MSCI World index (COMP), implied volatility index (VIX), US news-based economic policy uncertainty index (EPU), the WTI crude oil price expressed in U.S. dollars per barrel and the gold price expressed in U.S. dollars per ounce. These variables can be treated as global factors that significantly affect the performance of equities. As known, gold and oil are the most actively traded commodities in the world (Barunik et al., 2016) and investors use these two assets as hedging instruments (Dai et al., 2022), hence their price movements influence investors' decision-making process. VIX measures the expected volatility of the US stocks derived from the S&P 500 index call and put options. It is also called the "fear index"; higher values of VIX reflect greater level of fear and uncertainty in the market, therefore it is considered as an important piece of information for market participants (Whaley, 2009). Lastly, US news-based EPU index of Baker et al. (2016) measures policy-related economic uncertainty based on newspaper archives. Baker et al. (2016) found that higher EPU leads to greater stock price volatility and reduces employment and investment. Therefore, this indicator has become a metric used in studies that focus on financial markets and numerous papers documented that EPU is an important risk factor for stocks (Brogaard and Detzel, 2015).

Table 1 reports the summary statistics. Firstly, it is worth noting that all the variables used in this study are stationary as the ADF and PP tests show that we reject the null hypothesis of a unit-root. The price variables including CCI, composite index, gold and oil are stationary at first difference, therefore, we used log-difference data for these variables. For the rest of the variables (volatilities, GPR indices, VIX and EPU), we used the original sequence in natural logarithm form, similar to Qin et al. (2020). Secondly, North America (N.A.) provides the highest average return while it possesses higher risk as measured by standard deviations. Higher moment statistics, namely skewness and kurtosis, show that both returns and volatilities have fatter tails than normal distribution. Figure 1 that presents the quantile–quantile (Q–Q) plots also visually confirms the non-normality of the return distributions. The presence of fat tails and non-normality suggests that OLS may not capture the true relationship between the variables, quantile regressions can provide more efficient estimates instead (Naifar, 2016).

[Insert Table 1 here]

[Insert Figure 1 here]

As stated earlier, our focus in this paper is MSCI CCIs as these indices are unique in that they allow market participants to integrate climate risks in their portfolios. These indices are designed to exceed the EU Climate Transition Benchmark minimum requirements; hence they enable investors and portfolio managers to increase (decrease) their exposure to companies involved in transition-related opportunities (risks). Furthermore, they are constructed based on a heuristic-approach to meet certain criteria, such as a minimum 30% reduction in greenhouse gas intensity compared to the reference index, targeting an annual decarbonization rate of 7%, and increasing weights of companies that benefit from climate transition. In this way, they

[3] Our data starts from November 2013 because the back-tested data on MSCI CCI starts from that date.

integrate climate change considerations into a company's weighting, which helps investors increase their exposure to companies that are well-positioned for the transition to a low carbon economy and decrease exposure to those companies that may face higher risks due to their vulnerability to the impacts of climate change.

The price series of MSCI CCIs for each region are plotted in Figure 2. The sample period witnesses several extreme events, such as the COVID-19 pandemic and the Russian invasion of Ukraine. The visual evidence demonstrates that the prices gradually increased after the Paris agreement signed on 12 December 2015 and came into effect on 4 November 2016. This is linked to increased attention to green and low-carbon assets post Paris Agreement, as documented by previous studies (Monasterolo and De Angelis, 2020; Fahmy, 2022). The prices plummet during March 2020 following the announcement of World Health Organization (WHO) declaring the COVID-19 a global pandemic. However, they appear to have quickly recovered from the shock as their prices surge significantly after April 2020. We can argue that the pandemic provided governments a unique opportunity to target their support toward a green recovery, promoting an environmentally friendly revival, which in turn boosts prospects for green assets (Demiralay et al., 2022). In addition, as suggested by Agoraki et al. (2023), economic support and stringency during the pandemic can be positively associated with sustainable investments. CCI prices experience a fall during the Russia's war of aggression in Ukraine, particularly after the invasion began on 24 February 2022. Therefore, the invasion of Ukraine might have created uncertainties not only in the availability of fossil fuel sources but also complicated the transition to a low carbon economy.

[Insert Figure 2 here]

We use the geopolitical risk indices of Caldara and Iacoviello (2022) downloaded from Iacoviello’s website.[4] They construct three indicators of geopolitical risks at daily frequency, namely the composite geopolitical risk index (GPR), geopolitical threats (GPT), and geopolitical acts (GPA). These indices are measured by the frequency of words related to adverse geopolitical events in eleven newspapers.[5] They construct the GPR indices based on automated text-searches that identify articles containing references to six groups of words: “Group 1 includes words associated with explicit mentions of geopolitical risk, as well as mentions of military-related tensions involving large regions of the world and a U.S. involvement. Group 2 includes words directly related to nuclear tensions. Groups 3 and 4 include mentions related to war threats and terrorist threats, respectively. Finally, Groups 5 and 6 aim at capturing press coverage of actual adverse geopolitical events (as opposed to just risks)”. The Geopolitical Threats (GPT) index only includes words belonging to Search Groups 1 to 4 above whereas the Geopolitical Acts (GPA) index only includes words belonging to Search Groups 5 and 6. The daily GPR index is plotted in Figure 3. As can be seen, the index clearly captures significant geopolitical events, such as the Russian annexation of Crimea, Paris

[4] GPR indices are accessible at https://www.matteoiacoviello.com/gpr.htm
[5] The newspapers include the Boston Globe, Chicago Tribune, The Daily Telegraph, Financial Times, The Globe and Mail, The Guardian, Los Angeles Times, The New York Times, The Times, The Wall Street Journal, and The Washington Post.

attacks and the North Korean crisis, during the sample period. The index reached its highest points in late February and early March in 2022 as Russia invaded Ukraine.

[Insert Figure 3 here]

3. Empirical results

3.1. Geopolitical risks and CCI returns

Table 2 presents the ordinary least squares (OLS) and quantile regression (QR) estimates of the impact of geopolitical risks (GPR) on climate change stock returns (CCI). First, the results of OLS reported in column 1 show that geopolitical risks (GPR) are negatively but insignificantly associated with climate change stock returns across all the regions. The findings suggest geopolitical risks have no influence on CCI when OLS regressions are considered. However, as explained in the methodology section, OLS estimates the mean of the dependent variable given certain values of independent variables, whereas QR estimates focus on not only the median but also other quantiles (such as lower and upper quantiles), thus it provides a more comprehensive view of the possible effect of the independent variables on the dependent variable (Koenker and Bassett, 1978).

[Insert Table 2 here]

The results of quantile regression (QR) reported in Table 2 show that geopolitical risks (GPR) have significant and negative impact on climate change stock returns in the ACWI (Developed and Emerging markets) region in the lower quantiles of 0.1 and 0.25. As for the Asia Pacific region shown in Panel B, geopolitical risks have negative and significant impact on climate change returns at the lower quantiles of 0.05 and 0.25, whereas they exhibit a significantly positive impact at the upper quantile of 0.95. Regarding EM (Emerging Market) and Europe markets reported in Panel C and D, although the impact of GPR is negative in the lower quantiles and positive in the upper quantiles, the results are statistically insignificant. The results for North America presented in Panel E show a positive and significant impact of geopolitical risks on climate change returns in the upper quantiles of 0.75 and 0.9. When it comes to the CCI World, GPR have negative and significant impact on climate change returns at the lower quantiles of 0.05, 0.1 and 0.25, whereas the effect is significantly positive at the upper quantile of 0.95. In short, while North America experiences a positive influence from GPR at higher quantiles, Asia Pacific and World markets exhibit negative and significant coefficients at lower quantiles but positive and significant coefficients at upper quantiles, indicating that the impact of GPR varies across the distribution of stock returns during different market conditions (Balcilar et al., 2018; Kang et al., 2016; Kizys and Pierdzioch, 2009). Considering the statistical significance, both emerging markets and Europe demonstrate resilience to GPR across all quantiles.

Figure 4 presents the estimates for all the quantiles across the distribution. The X-axis denotes the quantiles, while the Y-axis represents the response magnitude. The black lines represent the 90% confidence intervals, while the blue line indicates the magnitude of the reaction. When both the lower and upper bounds of the confidence intervals fall within the same domain (either below or above the zero line), the estimated quantile coefficient is statistically significant. For instance, the response of the ACWI stock returns to GPR is negative and statistically significant within the 0.1 to 0.30 quantiles, but it is not significant at higher quantiles. The figure illustrates the presence of an asymmetric response, indicating that the impact of GPR on CCIs varies with respect to changing market conditions. More specifically, when the market is in a bearish state (lower quantiles), heightened geopolitical risks may lead to lower CCI returns. Conversely, in a bullish market state (higher quantiles), the effect tends to be positive, albeit insignificant in most cases.

Taken together, the results provide evidence of asymmetric reaction of CCIs to GPR. In addition, the impact appears to be heterogeneous in that GPR does not affect regional CCI returns in a uniform way. This is consistent with the findings of Qin et al. (2020) and Wang et al. (2019), which show that the effect of geopolitical risks varies across the distribution of energy stock returns and green bonds. Higher geopolitical risk may create uncertainty in the business environment, leading firms to retain more earnings as a precautionary measure, rather than distributing them as dividends (Chen and Chen, 2011). This could signal financial distress or reduced growth opportunities, negatively impacting investor confidence and returns of climate change stocks. However, in the upper quantiles, the positive relationship suggests that in periods of high returns, increases in geopolitical risk can boost the returns of climate change stocks. This implies that climate change stocks might be viewed as a safer investment option due to their long-term growth potential and the increasing demand for sustainable solutions (Cunha et al., 2020). Additionally, as geopolitical risks rise, there could be a growing awareness of the necessity for sustainable investments. Investors might anticipate that geopolitical instability, as in the Russian invasion of Ukraine, will eventually force a global transition to a low-carbon economy, thus they could reallocate their investments in favour of climate change stocks (Batten et al., 2017; Busch et al., 2016). This would increase demand for these stocks and, in turn, increase the returns.

[Insert Figure 4 here]

Regarding the control variables, we have found that the impact of global stock market (COMP) is positive and significant for all the markets across all the quantiles, which is something expected, showing that CCIs and COMP tend to move in the same direction. North America and World CCIs seem to have higher systematic risk than the composite index. VIX has significant and negative effects on the returns of climate change stocks in the low and medium quantiles across different markets. VIX is used to measure the level of fear and uncertainty in the market (Whaley, 2009). High VIX values, indicating increased future market volatility, might make investors more risk averse. This could lead to decreased investments in climate change-related stocks, especially if these stocks are perceived as more risky or uncertain, leading to lower returns (Da et al., 2015). EPU is insignificant for most of the markets, except for the World market where the EPU is negative and significant in the lower quantiles but positive and significant in the upper quantiles, which suggest the presence of asymmetric across different quantiles. The oil and gold prices are mostly negatively affecting the returns of Climate change stocks in the ACWI, North America and World markets. This finding implies that investors should employ hedging strategies to safeguard against unfavorable fluctuations in oil and gold prices (Demiralay and Kilincarslan, 2019).

3.2. The impact of geopolitical threats and acts on CCI returns

In this section, we aim to examine whether the effects of geopolitical risks are attributed to the potential threats of adverse events, or their actual occurrences. We utilize two sub-indexes developed by Caldara and Iacoviello (2022), which allow us to differentiate between geopolitical threats (GPT) and their realizations (GPA). For example, the GPT index measures geopolitical threats, such as escalating tensions following terrorist incidents or preceding wars, whereas the GPA index measures the manifestation of unfavorable geopolitical events.

Panel A of Table 3 and Figure 5 show the impact of geopolitical threats on climate change returns across six markets.[6] The results of the OLS show that both GPT and GPA have no impact on climate change returns of all the markets. On the other hand, the results of QR show that GPT have significant impact on CCI returns for the ACWI, Asia Pacific, and World markets, while Emerging market, Europe and North America are not affected. More specifically, the results show that geopolitical threats have negative and significant impact on climate change returns for the ACWI region in the lower quantiles of 0.05, 0.1 and 0.25, whereas positive and significant impact is reported for the Asia Pacific region in the upper quantiles of 0.95. As for the World market, we find a negative and significant impact in the lower quantiles of 0.05, 0.1 and 0.25 at conventional significance levels, but a positive and significant impact in the upper quantiles of 0.95 at 10% significant level. The findings indicate that the effects of geopolitical threats become more pronounced when climate change stocks are in a bearish market (low returns). The results partially support the findings of Qin et al. (2020) that geopolitical threats have a significant negative effect on crude oil returns at the lower quantiles.

Panel B of Table 3 and Figure 6 show the impact of geopolitical acts on climate change returns. We find that GPA influence climate change returns for the Asia Pacific, Europe and North America and World markets but no significant impact for the other markets. Specifically, geopolitical acts have negative and significant impact on climate change returns for the Asia Pacific market in the lower quantiles of 0.05 and 0.1, while positive and significant impact for the North America market in the upper quantiles of 0.75, 0.9 and 0.95. As for the Europe market, we also find a negative and significant impact in the lower quantiles of 0.05 and 0.1, but a positive and significant impact in the upper quantiles of 0.9 and 0.95. The findings lend empirical support to the previous literature (Kang et al., 2016; Kizys and Pierdzioch, 2009; Sohag et al., 2022) and indicate that the influence of geopolitical acts varies across the distribution of stock returns under different market conditions which are consistent with our main findings of Table 2. In sum, although geopolitical risks (GPR) do not impact Europe, geopolitical acts demonstrate a significant negative impact at lower quantiles. This implies that geopolitical acts may further decrease stock returns in Europe when expected returns are low, particularly during bearish market conditions. On the other hand, geopolitical threats are more pronounced in the ACWI and the World market. Geopolitical acts exhibit a stronger effect on the Asia-Pacific, Europe, and North America regions (specifically at higher quantiles for North America). However, the impacts of both acts and threats on emerging markets are relatively negligible across nearly all quantiles.

[Insert Table 3 here]

[6] We used control variables in each regression; however, we did not reproduce the results here as they are qualitatively same.

[Insert Figure 5 here]

[Insert Figure 6 here]

3.3. The impact of geopolitical risks on CCI volatilities

We investigate the impact of geopolitical risks on CCI volatilities across different markets. First, as shown in Table 4 and Figure 7, the results of OLS show that geopolitical risks have no influence on CCI volatilities, except for Europe, whereas the results from QR show that GPR has significant and positive effects on all CCI index volatilities. The results clearly demonstrate a notable and positive effect, i.e. 0.05, 0.1, 0.25, 0.5 and 0.75 for the ACWI market, 0.25 for the Asia Pacific market, 0.1, 0.25, 0.5 and 0.75 for the Emerging market, all quantiles except for 0.1 for Europe market, 0.05, 0.1, 0.25, 0.5 and 0.75 for the North America market, and 0.05, 0.1, 0.25, 0.5 and 0.75 for the World. The most pronounced impact was observed in Europe, with a coefficient of 0.397 at the quantile of 0.95. Therefore, even though CCI Europe seems to be resilient to GPR in terms of returns, their volatility is significantly driven by GPR. In all other cases, except for Europe, the coefficients were found to be statistically insignificant in the upper quantiles of 0.90 and 0.95.

All in all, our results reveal that geopolitical risks have a significant positive impact on climate change stock volatilities; however, the effect is asymmetric and substantially dependent on the quantile. This is consistent with Qin et al. (2020) that analyze the effects of geopolitical risks on oil volatility. A plausible explanation is that geopolitical risks can introduce significant uncertainties in the market during relatively stable periods, which can lead to erratic trading behaviors, resulting in increased volatility (Baur and McDermott, 2010; Chang et al., 2013). For instance, fears about a potential war or a sudden change in international trade policies can make investors nervous, leading to erratic buying and selling and thus increasing volatility (Baur and McDermott, 2010; Smales, 2014). Our results further demonstrate that geopolitical risks have a larger effect on volatilities than on returns, which is in line with Balcilar et al. (2018) who found that GPR influence market volatility more consistently than returns, suggesting that geopolitical tensions might cause volatility spillovers in financial markets due to their exposure.

As for the control variables, COMP, VIX and EPU exert significant effects on CCI volatilities at varying quantiles. The VIX, particularly, has a large and consistent impact on volatilities which is somewhat expected. As discussed before, the VIX, often referred to as "fear gauge index", reflects the market expectation of volatility in the near future based on S&P 500 index options. The results imply that higher expected market volatility leads to higher volatility in climate change stock indices. When investors expect higher volatility over the near term, their trading actions driven by fear or risk aversion may cause increased market volatility. Therefore, VIX as a measure is a good predictor of volatility in climate change equities.

[Insert Table 4 here]

[Insert Figure 7 here]

3.4. The impact of geopolitical threats and acts on CCI volatilities

Table 5, Figure 8 and 9 report the results regarding the impact of GPT and GPA on CCI volatilities. The results of OLS regressions show that geopolitical threats significantly and negatively affect CCI volatilities for the ACWI, North America and World markets, whereas the impact of geopolitical acts on CCI volatilities is positive and significant for the Asia, Emerging and Europe. These findings demonstrate that geopolitical threats and actions have different impacts on the CCI volatilities.

The results of QR suggest that GPT affect CCI volatilities of the ACWI, North America and World markets, while the impact of geopolitical threats is negligible for the Asia, Emerging and Europe Markets. More specifically, geopolitical threats have positive and significant impact on the CCI volatilities for the ACWI market except for the 0.90 quantile. Similarly, we find that North America and World markets show the same pattern with positive and significant impact across most quantiles. On the other hand, Asia, Emerging and Europe markets seem to be resilient to geopolitical threats for the most of quantiles. In short, geopolitical threats do not influence volatility of climate change stocks in these regions.

Regarding the effect of GPA on the CCI volatilities, we find that all the markets are positively influenced by the geopolitical acts. The impact is more pronounced in Europe, North America and World indices. Another interesting observation is that while Europe seems to be resilient to GPT, their volatility is significantly driven by GPA. Indeed, it is the market affected most from the materialization of geopolitical events at higher quantiles. Therefore, we can argue that GPT and GPA have an heterogenous impact on volatilities depending on the region; while some regional CCI volatilities show no reaction to GPT, others exhibit a higher sensitivity to GPT. For instance, the volatility of CCI North America appears to have higher sensitivity to GPT than to GPA. Nevertheless, comparing GPT and GPA, we can see that GPA have more pronounced effects on CCI volatilities than GPT. In general, GPR, GPT and GPA exert more significant impacts on volatilities rather than returns, which means geopolitical events lead to higher volatility in CCI.

[Insert Table 5 here]

[Insert Figure 8 here]

[Insert Figure 9 here]

3.5. Results for the period of the Russian invasion of Ukraine

In this section, we conduct further analysis to explore the effects of geopolitical risks, threats, and acts on CCI returns and volatilities during the Russian invasion of Ukraine. We divide this period into three Phases to track the evolution of the war: Phase 1 covers the initial invasion (24 February-7 April 2022), Phase 2 covers Southeastern front (8 April- 28 August 2022) and Phase 3 covers Ukrainian counteroffensives (29 August-19 October 2022). For the analysis, we generate dummy variables that take the value of 1 in the phases of the conflict and then create interaction terms by multiplying the dummy variables with GPR, GPT and GPA.

As shown in Table 6, we observe that geopolitical risks do not have a significant impact on the returns of CCIs during the conflict in the majority of the cases. However, ACWI, Asia Pacific and WORLD indices are vulnerable to GPR, GPT and GPA at the lowest and highest quantiles, suggesting that these markets exhibit sensitivity to geopolitical risks, threats and acts in extreme bearish and bullish market conditions during the invasion. When it comes to medium quantiles, the results show no significant impact, suggesting that heightened geopolitical risks in the periods of Russo-Ukraine war do not influence CCIs under median-return conditions. In addition, it is noteworthy that most of the coefficients at the highest (lowest) quantiles are positive (negative) except for Asia Pacific, indicating that CCIs may react to GPR, GPT and GPA positively (negatively) in the bullish (bearish) market circumstances amidst the conflict. This is somewhat in parallel with several recent studies (e.g. Nerlinger and Utz, 2022; Umar et al., 2022a; Mohammed et al., 2023) that provide evidence of high abnormal returns on clean energy stocks during the war in Ukraine. However, these studies do not distinguish between changing market environments, such as bull and bear market conditions. Our analysis implies that CCIs might suffer from losses during the crisis, especially when the returns are lower than the average. Nevertheless, our findings show evidence of lack of significance for most quantiles and regions, which can be attributed to the long-term nature of climate change investments. Climate change stocks are often driven by factors such as long-term policies, global trends, and technological advancements rather than short-term geopolitical events (Ahmed et al., 2023; Będowska-Sójka et al., 2022; Venturini, 2022).

Our findings indicate that geopolitical risks significantly contribute to higher volatility for all the markets. Our undocumented results also reveal that the effects of geopolitical risks on volatility are more pronounced during Phase 1 of the conflict, which encompasses the initial invasion period from 24th February to 7th April 2022.[7] This suggests that the heightened uncertainty and geopolitical tensions during this phase had a stronger influence on CCI volatility. There are also a few instances where the effect is negative or statistically insignificant. It is also worth noting that the effect is more pronounced at the lowest and medium quantiles, showing that geopolitical risks, threats and acts significantly drive CCI volatilities, particularly when they are low to moderate. However, taken as a whole, the results show significant and positive effect of GPR, GPT and GPA on CCI volatilities. This can be explained by ripple effect (Zhou and Lu, 2023) as the Russia-Ukraine conflict has caused increased risk transmission and spillover effects across global financial markets (Umar et al., 2022c). Our results further support the findings of Fang and Shao (2022) reporting that the conflict has intensified the volatility of energy markets.

Overall, the results suggest pronounced impact of geopolitical risks, threats and acts on CCI volatilities in the period of Russo-Ukraine war. It appears that geopolitical tensions in this period have increased market uncertainty, which in turn leads to greater volatility in CCIs. This calls for factoring in geopolitical risks more prominently when evaluating climate change equity investments as these risks can significantly impact their volatilities. Therefore, financial market participants should reassess their investment strategies and consider diversification and risk management strategies that account for geopolitical tensions. In addition, policy makers and authorities should formulate appropriate strategies to ensure that environmental targets are not undermined by the conflict.

[Insert Table 6 here]

4. Conclusion

In this paper, we investigate the effects of geopolitical risk (GPR), threats (GPT), and acts (GPA) on the returns and volatilities of climate change stocks/CCI under different market conditions, particularly in the context of Russian-Ukrainian war. Quantile regression model is

[7] We do not present the empirical estimates in this section for the sake of brevity, however the results are available upon request.

employed to study return and volatility responses of CCI. Our results show that their reactions to GPR, GPT and GPA are heterogonous across changing market conditions and different geographic regions. Furthermore, we show that geopolitical threats are more pronounced in the ACWI and the World markets, while geopolitical acts exhibit a stronger effect on the Asia-Pacific, Europe, and North America markets. The impacts of both acts and threats on emerging markets are relatively negligible across nearly all quantiles. As for the volatility in CCIs, the results indicate significant positive impacts of geopolitical risks. Furthermore, geopolitical acts have a more pronounced effect on CCI volatilities than geopolitical threats. Finally, our results provide evidence of how CCIs response to GPR, GPT and GPA during the period Russo-Ukraine conflict. We document that the volatilities of CCI are significantly driven by geopolitical tensions in this period, however the effect on CCI returns is more limited.

Our results have important practical implications. First, our paper provides new insights on investing in green portfolios by taking companies' exposure to climate change related issues into consideration. Second, our results could be beneficial for investors to inform their investment decision making as they indicate heterogenous effects of geopolitical events on CCI, so investors could rebalance their portfolios based on the responses of CCI to such events to maximize their returns. Third, our results could give some suggestions to investors on reducing risk exposure when facing with extreme geopolitical events. They could use our findings to identify opportunities and mitigate risks associated with CCI investments and make informed and rational investment decisions during the geopolitical turmoil.

As in any research, our study has potential limitations. Firstly, our focus is regional climate change stocks, which limits the broader applicability of our results. Future research could incorporate firm-level data to better capture the impacts of geopolitical risks. Secondly, although geopolitical risk indices developed by Caldara and Iacoviello (2022) have been widely used by researchers, alternative measures of geopolitical uncertainty could be constructed based on the search volume from Google Trends. Future research could check the robustness of geopolitical risk indices by using this alternative measure. Finally, although quantile regressions are useful to analyze the impact across the entire spectrum of distributions, they do not allow us to examine the short and long run effects of geopolitical events. Therefore, non-linear models could be useful to distinguish between these impacts and would provide further insights.

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Table 1. Descriptive statistics

	Panel A. CCI Returns						Panel B. CCI Volatilities					
	ACWI	A. P.	E.M.	E.U.	N.A.	WORLD	ACWI	ASIA P.	E.M.	E.U.	N.A	WORLD
Mean	0.018	-0.001	-0.004	-0.005	0.033	0.020	0.887	0.815	1.015	1.291	1.339	0.966
Median	0.052	0.035	0.041	0.050	0.051	0.059	0.437	0.600	0.756	0.802	0.599	0.454
Maximum	7.898	5.247	5.983	8.172	8.990	8.187	40.286	9.603	14.728	32.159	72.839	45.211
Minimum	-9.874	-5.702	-6.777	-13.815	-12.905	-10.287	0.120	0.217	0.297	0.284	0.151	0.128
Std. Dev.	0.927	0.897	1.009	1.125	1.138	0.966	2.158	0.748	1.066	2.004	3.498	2.410
Skewness	-1.176	-0.304	-0.487	-1.144	-0.928	-1.147	10.776	4.849	7.028	7.700	11.806	10.825
Kurtosis	20.116	6.567	7.546	18.308	19.475	20.275	145.455	38.251	68.961	81.087	179.807	147.365
ADF	-10.696[a]	-31.144[a]	-17.935[a]	-15.361[a]	-10.272[a]	-10.752[a]	-6.596[a]	-7.166[a]	-7.228[a]	-7.493[a]	-7.613[a]	-6.634[a]
PP	-46.951[a]	-44.708[a]	-41.959[a]	-46.689[a]	-54.881[a]	-48.551[a]	-7.932[a]	-6.730[a]	-6.681[a]	-9.048[a]	-8.242[a]	-7.960[a]

Panel C. Control Variables								
	GPR	GPT	GPA	COMP.	VIX	EPU	OIL	GOLD
Mean	4.623	4.730	4.297	0.018	2.828	4.529	0.019	0.012
Median	4.625	4.738	4.377	0.055	2.763	4.489	0.132	0.028
Maximum	6.291	6.699	6.312	8.406	4.415	6.694	31.963	4.693
Minimum	2.250	2.066	2.060	-10.441	2.213	1.200	-28.221	-5.898
Std. Dev.	0.435	0.521	0.693	0.949	0.348	0.641	2.944	0.868
Skewness	-0.062	-0.125	-0.581	-1.217	0.810	0.308	0.094	-0.228
Kurtosis	4.077	3.839	3.521	22.007	3.709	3.548	26.092	6.246
ADF	-7.176[a]	-5.254[a]	-5.637[a]	-14.714[a]	-5.015[a]	-4.268[a]	-8.318[a]	-47.955[a]
PP	-47.171[a]	-46.416[a]	-51.466[a]	-48.162[a]	-6.023[a]	-41.371[a]	-47.504[a]	-47.954[a]

Notes: This table presents summary statistics of the daily data series covering the full sample period from 26 November 2013 to 19 October 2022. ADF and PP represents the empirical statistics of the Augmented Dickey and Fuller (1979) and the Phillips and Perron (1988) unit root tests, respectively. Both tests have the null hypothesis of a unit root. (a), (b) and (c) denote statistical significance at 1%, 5% and 10% levels, respectively. A.P, E.M, E.U and N.A represent Asia Pacific, Emerging Market, European Union and North America, respectively.

Table 2. The impact of geopolitical risks on CCI returns

	OLS		0.05		0.1		0.25		0.5		0.75		0.9		0.95	
Panel A: ACWI																
C	0.065[c]	(0.034)	0.414[a]	(0.063)	0.341[a]	(0.043)	0.242[a]	(0.036)	0.051	(0.044)	-0.123[b]	(0.059)	-0.286[a]	(0.087)	-0.426[a]	(0.069)
GPR	-0.004	(0.006)	-0.020	(0.013)	-0.024[a]	(0.009)	-0.014[b]	(0.006)	-0.003	(0.005)	0.005	(0.008)	0.011	(0.009)	0.011	(0.008)
COMP.	0.975[a]	(0.003)	0.984[a]	(0.005)	0.978[a]	(0.006)	0.978[a]	(0.005)	0.979[a]	(0.003)	0.981[a]	(0.004)	0.980[a]	(0.006)	0.990[a]	(0.004)
VIX	-0.026[a]	(0.008)	-0.162[a]	(0.015)	-0.139[a]	(0.014)	-0.087[a]	(0.009)	-0.019[c]	(0.012)	0.034[a]	(0.012)	0.088[a]	(0.016)	0.139[a]	(0.014)
EPU	0.006	(0.005)	-0.016	(0.012)	-0.004	(0.008)	-0.008	(0.007)	0.004	(0.004)	0.014[b]	(0.006)	0.019[a]	(0.006)	0.023[a]	(0.006)
OIL	-0.009[a]	(0.001)	-0.012[a]	(0.002)	-0.012[a]	(0.002)	-0.011[a]	(0.001)	-0.010[a]	(0.001)	-0.010[a]	(0.001)	-0.009[a]	(0.002)	-0.012[a]	(0.002)
GOLD	-0.003	(0.003)	-0.004	(0.008)	0.000	(0.004)	-0.003	(0.003)	-0.001	(0.003)	-0.001	(0.003)	-0.004	(0.004)	-0.007	(0.007)
Panel B: Asia Pacific																
C	0.498[b]	(0.230)	2.619[a]	(0.526)	2.121[a]	(0.393)	1.722[a]	(0.401)	0.516[c]	(0.283)	-0.499[b]	(0.232)	-1.557[a]	(0.389)	-2.190[a]	(0.511)
GPR	-0.021	(0.037)	-0.157[c]	(0.093)	-0.038	(0.054)	-0.111[b]	(0.054)	-0.018	(0.040)	-0.031	(0.041)	0.010	(0.064)	0.162[c]	(0.095)
COMP.	0.444[a]	(0.018)	0.445[a]	(0.097)	0.454[a]	(0.070)	0.421[a]	(0.052)	0.456[a]	(0.039)	0.498[a]	(0.034)	0.523[a]	(0.046)	0.532[a]	(0.054)
VIX	-0.228[a]	(0.056)	-1.443[a]	(0.120)	-1.210[a]	(0.115)	-0.721[a]	(0.079)	-0.149[b]	(0.062)	0.310[a]	(0.0490	0.711[a]	(0.098)	1.039[a]	(0.068)
EPU	0.052[c]	(0.030	0.109	(0.070)	0.085	(0.067)	0.071[c]	(0.042)	0.021	(0.035)	0.015	(0.0250	-0.013	(0.035)	-0.052	(0.046)
OIL	-0.007	(0.006)	0.008	(0.016)	-0.020[c]	(0.011)	-0.005	(0.007)	-0.006	(0.007)	-0.009	(0.007)	0.005	(0.011)	0.003	(0.017)
GOLD	0.083[a]	(0.019)	0.071	(0.056)	0.076[b]	(0.033)	0.086[a]	(0.031)	0.093[a]	(0.023)	0.067[a]	(0.021)	0.090[b]	(0.043)	0.059	(0.043)
Panel C: Emerging M.																
C	0.386	(0.241)	2.836[a]	(0.823)	2.286[a]	(0.656)	0.907[b]	(0.367)	0.258	(0.274)	-0.412	(0.267)	-1.444[b]	(0.557)	-2.671[a]	(0.580)
GPR	-0.019	(0.039)	-0.078	(0.080)	-0.039	(0.078)	-0.021	(0.044)	0.036	(0.042)	0.055	(0.054)	0.026	(0.069)	0.091	(0.099)
COMP.	0.593[a]	(0.019)	0.642[a]	(0.055)	0.602[a]	(0.047)	0.615[a]	(0.045)	0.639[a]	(0.033)	0.605[a]	(0.041)	0.674[a]	(0.040)	0.670[a]	(0.048)
VIX	-0.165[a]	(0.059)	-1.277[a]	(0.134)	-1.119[a]	(0.161)	-0.558[a]	(0.091)	-0.097	(0.062)	0.185[a]	(0.052)	0.631[a]	(0.057)	0.965[a]	(0.095)

EPU	0.034	(0.032)	-0.057	(0.080)	0.013	(0.078)	0.063	(0.043)	0.007	(0.030)	0.049	(0.033)	0.028	(0.037)	0.079	(0.070)
OIL	0.014[b]	(0.006)	0.022	(0.021)	0.015	(0.020)	0.008	(0.012)	0.019[a]	(0.007)	0.012	(0.009)	0.012	(0.014)	0.028	(0.018)
GOLD	0.032	(0.020)	0.032	(0.034)	0.029	(0.040)	0.037	(0.033)	0.039[b]	(0.020)	0.025	(0.023)	0.034	(0.031)	-0.032	(0.035)
Panel D: Europe																
C	0.138	(0.217)	3.462[a]	(0.560)	2.743[a]	(0.340)	1.108[a]	(0.193)	-0.134	(0.237)	-1.312[a]	(0.228)	-2.266[a]	(0.242)	-2.587[a]	(0.481)
GPR	-0.023	(0.035)	-0.103	(0.084)	-0.104	(0.066)	-0.052	(0.044)	-0.042	(0.039)	0.038	(0.042)	0.038	(0.053)	0.016	(0.084)
COMP.	0.897[a]	(0.017)	1.034[a]	(0.075)	0.991[a]	(0.060)	0.976[a]	(0.041)	0.949[a]	(0.034)	0.923[a]	(0.023)	0.964[a]	(0.0470	0.992[a]	(0.068)
VIX	-0.025	(0.053)	-1.273[a]	(0.134)	-0.970[a]	(0.122)	-0.456[a]	(0.087)	0.028	(0.067)	0.486[a]	(0.055)	0.885[a]	(0.076)	1.207[a]	(0.116)
EPU	0.004	(0.029)	-0.050	(0.055)	-0.021	(0.038)	0.015	(0.031)	0.009	(0.027)	0.001	(0.026)	0.041	(0.038)	0.115[b]	(0.045)
OIL	-0.003	(0.005)	-0.007	(0.019)	0.001	(0.012)	0.003	(0.007)	-0.012[b]	(0.006)	0.000	(0.005)	-0.008	(0.012)	0.003	(0.011)
GOLD	0.013	(0.018)	0.014	(0.052)	0.039	(0.045)	0.033	(0.028)	0.030	(0.020)	-0.025	(0.0190	-0.040	(0.031)	-0.023	(0.033)
Panel E: North America																
C	-0.060	(0.101)	1.023[a]	(0.136)	0.759[a]	(0.149)	0.482[a]	(0.149)	-0.055	(0.099)	-0.520[a]	(0.157)	-1.064[a]	(0.211)	-1.125[a]	(0.331)
GPR	0.003	(0.017)	-0.003	(0.027)	-0.024	(0.035)	-0.006	(0.019)	0.008	(0.014)	0.037[c]	(0.019)	0.047[c]	(0.026)	0.030	(0.028)
COMP.	1.158[a]	(0.008)	1.151[a]	(0.026)	1.138[a]	(0.022)	1.151[a]	(0.014)	1.158[a]	(0.007)	1.157[a]	(0.015)	1.127[a]	(0.030)	1.112[a]	(0.036)
VIX	0.029	(0.025)	-0.533[a]	(0.054)	-0.393[a]	(0.052)	-0.187[a]	(0.036)	0.036	(0.038)	0.232[a]	(0.036)	0.454[a]	(0.062)	0.562[a]	(0.057)
EPU	-0.005	(0.013)	0.001	(0.022)	0.016	(0.021)	-0.003	(0.018)	-0.009	(0.017)	-0.010	(0.014)	-0.022	(0.030)	-0.026	(0.025)
OIL	-0.014[a]	(0.003)	-0.016[a]	(0.005)	-0.015[b]	(0.007)	-0.019[a]	(0.006)	-0.017[a]	(0.004)	-0.016[a]	(0.004)	-0.011[c]	(0.006)	-0.010	(0.008)
GOLD	-0.044[a]	(0.008)	-0.046[c]	(0.024)	-0.036[c]	(0.019)	-0.041[a]	(0.011)	-0.041[a]	(0.008)	-0.056[a]	(0.011)	-0.063[a]	(0.014)	-0.045[b]	(0.019)
Panel F: WORLD																
C	0.028	(0.027)	0.480[a]	(0.041)	0.372[a]	(0.040)	0.174[a]	(0.024)	0.013	(0.028)	-0.137[a]	(0.024)	-0.394[a]	(0.048)	-0.453[a]	(0.062)
GPR	-0.003	(0.004)	-0.024[b]	(0.008)	-0.019[b]	(0.007)	-0.012[b]	(0.005)	-0.005	(0.004)	0.003	(0.003)	0.009	(0.005)	0.014[c]	(0.008)
COMP.	1.023[a]	(0.002)	1.030[a]	(0.007)	1.026[a]	(0.006)	1.020[a]	(0.004)	1.022[a]	(0.004)	1.021[a]	(0.003)	1.023[a]	(0.006)	1.029[a]	(0.007)

VIX	-0.008	(0.007)	-0.168[a]	(0.012)	-0.118[a]	(0.012)	-0.048[a]	(0.006)	-0.004	(0.007)	0.047[a]	(0.005)	0.107[a]	(0.011)	0.132[a]	(0.014)
EPU	0.003	(0.004)	-0.009	(0.008)	-0.010[c]	(0.006)	-0.007[b]	(0.003)	0.002	(0.003)	0.003	(0.002)	0.013[a]	(0.004)	0.021[a]	(0.005)
OIL	-0.012[a]	(0.001)	-0.017[a]	(0.002)	-0.017[a]	(0.002)	-0.015[a]	(0.001)	-0.014[a]	(0.001)	-0.012[a]	(0.001)	-0.014[a]	(0.002)	-0.016[a]	(0.004)
GOLD	-0.007[a]	(0.002)	-0.006	(0.006)	-0.005	(0.004)	-0.008[a]	(0.002)	-0.007[a]	(0.002)	-0.007[a]	(0.002)	-0.009[a]	(0.004)	-0.008	(0.005)

Notes. This table reports the OLS and QR estimates for the impact of geopolitical risks on CCI returns as shown by equation (1) and (2). The bootstrapped standard errors are given in the parentheses. (a), (b) and (c) denote statistical significance at 1%, 5% and 10% levels, respectively.

Table 3. The impact of geopolitical threats and acts on CCI returns

	OLS		0.05		0.1		0.25		0.5		0.75		0.9		0.95	
Panel A: Threats																
ACWI	-0.002	(0.005)	-0.021[c]	(0.011)	-0.021[a]	(0.006)	-0.010[c]	(0.005)	0.001	(0.005)	0.007	(0.005)	0.011	(0.007)	0.012	(0.007)
Asia Pacific	-0.021	(0.031)	-0.070	(0.076)	-0.001	(0.048)	-0.050	(0.042)	-0.012	(0.033)	0.001	(0.037)	0.023	(0.047)	0.133[b]	(0.064)
Emerging M.	0.004	(0.033)	-0.061	(0.065)	-0.009	(0.067)	-0.005	(0.043)	0.030	(0.038)	0.051	(0.044)	0.025	(0.069)	0.108	(0.078)
Europe	-0.006	(0.029)	-0.024	(0.063)	-0.072	(0.049)	-0.046	(0.035)	-0.023	(0.029)	0.003	(0.033)	-0.016	(0.049)	-0.009	(0.066)
North America	0.003	(0.014)	0.023	(0.026)	-0.005	(0.028)	-0.002	(0.014)	0.001	(0.011)	0.008	(0.016)	0.010	(0.024)	0.003	(0.024)
WORLD	-0.003	(0.004)	-0.024[a]	(0.007)	-0.020[a]	(0.005)	-0.008[b]	(0.004)	-0.002	(0.003)	0.001	(0.002)	0.006	(0.004)	0.013[c]	(0.008)
Panel B: Acts																
ACWI	-0.005	(0.004)	-0.004	(0.008)	-0.006	(0.006)	-0.003	(0.004)	-0.002	(0.003)	0.002	(0.005)	0.004	(0.005)	0.006	(0.004)
Asia Pacific	0.008	(0.023)	-0.104[b]	(0.050)	-0.073[c]	(0.038)	-0.067	(0.029)	-0.016	(0.023)	-0.018	(0.022)	0.025	(0.039)	0.063	(0.061)
Emerging M.	-0.015	(0.025)	-0.035	(0.043)	-0.052	(0.051)	-0.035	(0.029)	0.024	(0.025)	0.023	(0.034)	0.032	(0.044)	0.062	(0.057)
Europe	-0.003	(0.022)	-0.106[b]	(0.047)	-0.084[b]	(0.039)	-0.031	(0.022)	-0.036	(0.024)	0.023	(0.024)	0.041[c]	(0.024)	0.063[c]	(0.037)
North America	-0.009	(0.011)	-0.026	(0.025)	-0.022	(0.016)	-0.002	(0.010)	0.015	(0.010)	0.030[a]	(0.010)	0.048[a]	(0.018)	0.047[a]	(0.014)
WORLD	-0.004	(0.003)	-0.002	(0.005)	-0.001	(0.003)	-0.005[b]	(0.002)	-0.003	(0.002)	0.003	(0.002)	0.004	(0.003)	0.010[b]	(0.004)

Notes. This table reports the OLS and QR estimates for the impact of geopolitical acts and threats on CCI returns as shown by equation (1) and (2). The bootstrapped standard errors are given in the parentheses. (a), (b) and (c) denote statistical significance at 1%, 5% and 10% levels, respectively.

Table 4. The impact of geopolitical risks on CCI volatilities

	OLS		0.05		0.1		0.25		0.5		0.75		0.9		0.95	
Panel A: ACWI																
C	-8.771[a]	(0.527)	-0.748[a]	(0.137)	-1.324[a]	(0.153)	-2.188[a]	(0.117)	-3.267[a]	(0.096)	-4.779[a]	(0.227)	-6.780[a]	(0.599)	-8.501[a]	(1.668)
GPR	-0.070	(0.086)	0.034[b]	(0.014)	0.066[a]	(0.015)	0.094[a]	(0.014)	0.085[a]	(0.014)	0.132[a]	(0.027)	0.092	(0.058)	-0.093	(0.101)
COMP.	0.212[a]	(0.042)	0.042[a]	(0.010)	0.077[a]	(0.012)	0.077[a]	(0.009)	0.092[a]	(0.014)	0.113[a]	(0.033)	0.124	(0.111)	0.200	(0.301)
VIX	3.322[a]	(0.129)	0.336[a]	(0.038)	0.525[a]	(0.047)	0.850[a]	(0.033)	1.252[a]	(0.028)	1.711[a]	(0.073)	2.358[a]	(0.165)	3.128[a]	(0.564)
EPU	0.129[c]	(0.070)	-0.025[a]	(0.007)	-0.035[a]	(0.009)	-0.047[a]	(0.010)	-0.007	(0.010)	0.053[a]	(0.018)	0.238[a]	(0.047)	0.454[a]	(0.125)
OIL	-0.057[a]	(0.013)	0.003	(0.002)	0.001	(0.003)	0.000	(0.003)	0.000	(0.004)	-0.003	(0.008)	-0.013	(0.019)	-0.036	(0.038)
GOLD	-0.051	(0.043)	-0.004	(0.004)	0.001	(0.005)	-0.005	(0.007)	0.000	(0.007)	-0.013	(0.015)	-0.025	(0.032)	0.036	(0.075)
Panel B: Asia Pacific																
C	-3.354[a]	(0.165)	-0.522[a]	(0.078)	-0.656[a]	(0.082)	-1.183[a]	(0.124)	-1.745[a]	(0.113)	-2.561[a]	(0.172)	-4.485[a]	(0.424)	-6.206[a]	(0.783)
GPR	0.039	(0.027)	-0.003	(0.011)	-0.005	(0.012)	0.032[b]	(0.014)	0.026	(0.019)	0.032	(0.025)	0.058	(0.047)	0.085	(0.066)
COMP.	0.141[a]	(0.013)	0.041[a]	(0.009)	0.051[a]	(0.008)	0.053[a]	(0.010)	0.077[a]	(0.015)	0.117[a]	(0.029)	0.219[a]	(0.052)	0.176[b]	(0.088)
VIX	1.446[a]	(0.041)	0.331[a]	(0.021)	0.411[a]	(0.020)	0.592[a]	(0.034)	0.883[a]	(0.029)	1.248[a]	(0.050)	1.978[a]	(0.091)	2.491[a]	(0.204)
EPU	-0.023	(0.022)	-0.008	(0.007)	-0.016[c]	(0.008)	-0.027[b]	(0.011)	-0.036[a]	(0.011)	-0.039[b]	(0.019)	0.000	(0.048)	0.112[c]	(0.059)
OIL	-0.008[c]	(0.004)	0.004[c]	(0.003)	0.006[b]	(0.003)	0.005	(0.003)	0.006	(0.005)	0.002	(0.004)	-0.003	(0.013)	-0.007	(0.020)
GOLD	0.003	(0.014)	0.000	(0.005)	-0.004	(0.005)	-0.007	(0.008)	-0.006	(0.010)	-0.010	(0.014)	0.017	(0.025)	0.003	(0.031)
Panel C: Emerging																
C	-4.579[a]	(0.250)	-0.526[a]	(0.122)	-0.778[a]	(0.113)	-1.125[a]	(0.127)	-1.816[a]	(0.153)	-3.122[a]	(0.271)	-4.702[a]	(0.590)	-8.004[a]	(1.320)
GPR	0.062	(0.041)	0.008	(0.016)	0.031[b]	(0.016)	0.033[b]	(0.015)	0.042[c]	(0.023)	0.097[a]	(0.036)	0.050	(0.063)	0.160	(0.128)
COMP.	0.178[a]	(0.020)	0.034[a]	(0.010)	0.030[a]	(0.010)	0.045[a]	(0.012)	0.075[a]	(0.015)	0.120[a]	(0.038)	0.240[b]	(0.098)	0.250[c]	(0.145)
VIX	1.794[a]	(0.062)	0.393[a]	(0.039)	0.454[a]	(0.030)	0.627[a]	(0.035)	0.934[a]	(0.037)	1.376[a]	(0.063)	2.023[a]	(0.139)	2.774[a]	(0.296)
EPU	0.051	(0.033)	-0.030[b]	(0.013)	-0.023[b]	(0.012)	-0.031[b]	(0.013)	-0.037[b]	(0.016)	-0.016	(0.023)	0.078[c]	(0.042)	0.341[a]	(0.090)
OIL	-0.016[a]	(0.006)	0.005	(0.005)	-0.001	(0.004)	0.002	(0.004)	0.001	(0.005)	-0.002	(0.007)	-0.024	(0.017)	-0.033	(0.035)
GOLD	0.012	(0.020)	-0.007	(0.007)	-0.003	(0.006)	-0.005	(0.006)	0.003	(0.013)	-0.009	(0.018)	-0.016	(0.033)	-0.060	(0.062)
Panel D: EUROPE																
C	-8.835[a]	(0.488)	-1.049[a]	(0.121)	-1.288[a]	(0.133)	-2.152[a]	(0.141)	-3.501[a]	(0.187)	-5.565[a]	(0.360)	-8.768[a]	(0.734)	-12.856[a]	(1.374)
GPR	0.147[c]	(0.080)	0.027[c]	(0.015)	0.021	(0.016)	0.071[a]	(0.019)	0.134[a]	(0.025)	0.174[a]	(0.049)	0.297[a]	(0.087)	0.397[b]	(0.173)
COMP.	0.262[a]	(0.039)	0.067[a]	(0.014)	0.082[a]	(0.016)	0.118[a]	(0.014)	0.131[a]	(0.021)	0.196[a]	(0.048)	0.201[c]	(0.114)	0.315	(0.292)

VIX	3.052[a]	(0.120)	0.498[a]	(0.046)	0.640[a]	(0.052)	0.991[a]	(0.043)	1.401[a]	(0.052)	2.142[a]	(0.078)	3.032[a]	(0.171)	4.151[a]	(0.536)
EPU	0.179[a]	(0.065)	-0.002	(0.013)	-0.017	(0.014)	-0.058[a]	(0.014)	-0.024	(0.017)	0.024	(0.030)	0.194[a]	(0.052)	0.481[a]	(0.137)
OIL	-0.034[a]	(0.012)	0.003	(0.003)	0.000	(0.004)	0.002	(0.005)	0.000	(0.007)	0.006	(0.014)	-0.005	(0.015)	-0.031	(0.045)
GOLD	-0.032	(0.040)	0.004	(0.008)	0.001	(0.007)	0.008	(0.008)	-0.001	(0.013)	-0.008	(0.022)	0.007	(0.044)	-0.110	(0.085)
Panel E: North America																
C	-13.731[a]	(0.860)	-1.375[a]	(0.168)	-1.889[a]	(0.208)	-3.573[a]	(0.211)	-5.346[a]	(0.212)	-7.521[a]	(0.354)	-10.164[a]	(0.770)	-13.855[a]	(1.897)
GPR	-0.148	(0.140)	0.086[a]	(0.018)	0.107[a]	(0.018)	0.167[a]	(0.024)	0.179[a]	(0.031)	0.175[a]	(0.031)	-0.035	(0.100)	-0.162	(0.142)
COMP.	0.272[a]	(0.069)	0.075[a]	(0.013)	0.078[a]	(0.016)	0.117[a]	(0.018)	0.158[a]	(0.027)	0.191[a]	(0.057)	0.154	(0.176)	0.257	(0.420)
VIX	5.339[a]	(0.211)	0.519[a]	(0.056)	0.699[a]	(0.072)	1.274[a]	(0.064)	1.923[a]	(0.068)	2.707[a]	(0.110)	3.800[a]	(0.214)	5.229[a]	(0.508)
EPU	0.144	(0.114)	-0.033[c]	(0.015)	-0.038[a]	(0.014)	-0.040[a]	(0.013)	0.003	(0.020)	0.100[a]	(0.033)	0.389[a]	(0.080)	0.656[a]	(0.165)
OIL	-0.100[a]	(0.022)	0.001	(0.003)	0.002	(0.003)	0.002	(0.005)	-0.004	(0.007)	-0.008	(0.011)	-0.021	(0.028)	-0.060	(0.058)
GOLD	-0.082	(0.070)	0.001	(0.006)	-0.008	(0.009)	-0.014	(0.011)	-0.021	(0.013)	-0.012	(0.024)	-0.035	(0.077)	0.064	(0.129)
Panel F: WORLD																
C	-9.913[a]	(0.587)	-0.803[a]	(0.130)	-1.398[a]	(0.137)	-2.457[a]	(0.121)	-3.612[a]	(0.187)	-5.471[a]	(0.226)	-7.554[a]	(0.573)	-9.549[a]	(1.690)
GPR	-0.068	(0.096)	0.034[b]	(0.013)	0.070[a]	(0.013)	0.101[a]	(0.013)	0.099[a]	(0.019)	0.145[a]	(0.024)	0.093	(0.062)	-0.093	(0.117)
COMP.	0.225[a]	(0.047)	0.053[a]	(0.012)	0.079[a]	(0.012)	0.087[a]	(0.009)	0.100[a]	(0.016)	0.129[a]	(0.027)	0.095	(0.097)	0.209	(0.328)
VIX	3.712[a]	(0.144)	0.347[a]	(0.037)	0.544[a]	(0.052)	0.933[a]	(0.041)	1.357[a]	(0.048)	1.928[a]	(0.075)	2.588[a]	(0.162)	3.473[a]	(0.594)
EPU	0.153[b]	(0.078)	-0.018[b]	(0.008)	-0.032[a]	(0.011)	-0.041[a]	(0.008)	-0.001	(0.010)	0.077[a]	(0.022)	0.293[a]	(0.049)	0.514[a]	(0.114)
OIL	-0.064[a]	(0.015)	0.003	(0.002)	0.002	(0.003)	0.001	(0.003)	0.000	(0.005)	-0.007	(0.009)	-0.011	(0.021)	-0.046	(0.035)
GOLD	-0.057	(0.048)	0.000	(0.005)	-0.001	(0.007)	-0.005	(0.008)	-0.003	(0.010)	-0.017	(0.019)	-0.038	(0.039)	0.051	(0.079)

Notes. This table reports the OLS and QR estimates for the impact of geopolitical risks on CCI volatilities as shown by equation (1) and (2). The bootstrapped standard errors are given in the parentheses. (a), (b) and (c) denote statistical significance at 1%, 5% and 10% levels, respectively.

Table 5. The impact of geopolitical threats and acts on CCI volatilities

	OLS		0.05		0.1		0.25		0.5		0.75		0.9		0.95	
Threats																
ACWI	-0.144[b]	(0.072)	0.021[b]	(0.008)	0.029[a]	(0.011)	0.052[a]	(0.011)	0.052[a]	(0.010)	0.095[a]	(0.019)	0.060	(0.049)	-0.139[c]	(0.066)
Asia Pacific	-0.024	(0.023)	-0.006	(0.007)	-0.008	(0.008)	0.011	(0.010)	-0.003	(0.012)	-0.027	(0.021)	-0.051	(0.052)	0.002	(0.063)
Emerging M.	-0.004	(0.034)	0.003	(0.011)	0.006	(0.012)	0.017[c]	(0.009)	0.005	(0.015)	0.028	(0.027)	-0.009	(0.052)	0.023	(0.101)
Europe	-0.026	(0.066)	-0.003	(0.015)	-0.005	(0.012)	0.013	(0.017)	0.036	(0.023)	0.045	(0.032)	0.153[c]	(0.071)	0.236	(0.156)
North America	-0.245[b]	(0.117)	0.049[a]	(0.013)	0.068[a]	(0.015)	0.091[a]	(0.015)	0.106[a]	(0.021)	0.115[a]	(0.033)	-0.006	(0.085)	-0.119	(0.133)
WORLD	-0.149[c]	(0.080)	0.020[b]	(0.008)	0.037[a]	(0.012)	0.056[a]	(0.015)	0.063[a]	(0.014)	0.117[a]	(0.016)	0.065	(0.050)	-0.128[c]	(0.076)
Acts																
ACWI	0.068	(0.055)	0.027[a]	(0.006)	0.043[a]	(0.009)	0.050[a]	(0.007)	0.062[a]	(0.012)	0.080[a]	(0.016)	0.088[b]	(0.036)	0.047	(0.070)
Asia Pacific	0.071[a]	(0.017)	0.012[b]	(0.006)	0.014[c]	(0.008)	0.028[a]	(0.009)	0.044[a]	(0.010)	0.059[a]	(0.012)	0.095[a]	(0.019)	0.063[c]	(0.037)
Emerging M.	0.071[a]	(0.026)	0.019[b]	(0.010)	0.024[b]	(0.010)	0.026[b]	(0.013)	0.046[a]	(0.013)	0.073[a]	(0.018)	0.056	(0.040)	0.069	(0.054)
Europe	0.209[a]	(0.051)	0.039[a]	(0.011)	0.046[a]	(0.010)	0.084[a]	(0.010)	0.117[a]	(0.014)	0.172[a]	(0.033)	0.208[a]	(0.043)	0.252[a]	(0.096)
North America	0.084	(0.090)	0.039[a]	(0.011)	0.050[a]	(0.012)	0.090[a]	(0.012)	0.100[a]	(0.016)	0.102[a]	(0.026)	0.055	(0.059)	0.032	(0.099)
WORLD	0.081	(0.061)	0.023[a]	(0.008)	0.048[a]	(0.010)	0.050[a]	(0.009)	0.070[a]	(0.012)	0.095[a]	(0.014)	0.093[b]	(0.045)	0.047	(0.085)

Notes. This table reports the OLS and QR estimates for the impact of geopolitical acts and threats on CCI volatilities as shown by equation (1) and (2). The bootstrapped standard errors are given in the parentheses. (a), (b) and (c) denote statistical significance at 1%, 5% and 10% levels, respectively.

Table 6. Summary empirical results for the effects of geopolitical risks, threats and acts on CCI returns and volatilities during the Russian invasion of Ukraine

		ACWI			Asia Pacific			Emerging M.			Europe			North America			WORLD		
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Panel A. Returns																			
GPR	Phase 1	NS	NS	+	NS	NS	+	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	+
	Phase 2	NS	NS	+	+	NS	NS	-	NS	NS	NS	NS	NS	NS	NS	NS	-	NS	+
	Phase 3	NS	NS	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	NS	NS
GPT	Phase 1	-	NS	+	NS	NS	+	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	+
	Phase 2	-	NS	NS	+	NS	NS	-	NS	NS	NS	NS	NS	NS	NS	NS	-	NS	+
	Phase 3	NS	NS	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GPA	Phase 1	-	NS	+	NS	NS	+	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	+
	Phase 2	-	NS	+	+	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	NS	+
	Phase 3	NS	NS	+	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	NS	NS
Panel B. Volatilities																			
GPR	Phase 1	+	+	NS	+	+	-	NS	+	+	+	+	+	+	+	-	+	+	NS
	Phase 2	+	+	NS	+	+	-	+	+	-	+	+	-	+	+	NS	+	+	NS
	Phase 3	+	+	NS	+	+	-	+	NS	-	+	+	NS	+	+	NS	+	+	NS
GPT	Phase 1	+	+	NS	+	+	+	NS	+	+	+	+	+	+	+	-	+	+	NS
	Phase 2	+	+	NS	+	+	-	+	+	-	+	+	-	+	+	NS	+	+	NS
	Phase 3	+	+	NS	+	+	-	+	NS	-	+	+	NS	+	+	NS	+	+	NS
GPA	Phase 1	+	+	NS	+	+	+	NS	+	+	+	+	+	+	+	-	+	+	NS
	Phase 2	+	+	NS	+	+	-	+	+	-	+	+	-	+	+	NS	+	+	NS
	Phase 3	+	+	NS	+	+	-	+	NS	-	+	+	NS	+	+	NS	+	+	NS

Notes. This table provides a summary of empirical results for the impacts of geopolitical risks, acts and threats during the Russian invasion of Ukraine. L, M and H stand for low (0.05), medium (0.5) and high (0.95) quantiles. Phase 1, 2 and 3 covers the periods of the initial invasion (24 February-7 April 2022), Southeastern front (8 April- 28 August 2022) and Ukrainian counteroffensives (29 August-19 October 2022), respectively. +, - and NS show positive, negative and non-significant impact, respectively.

Figure 1. QQ Plots

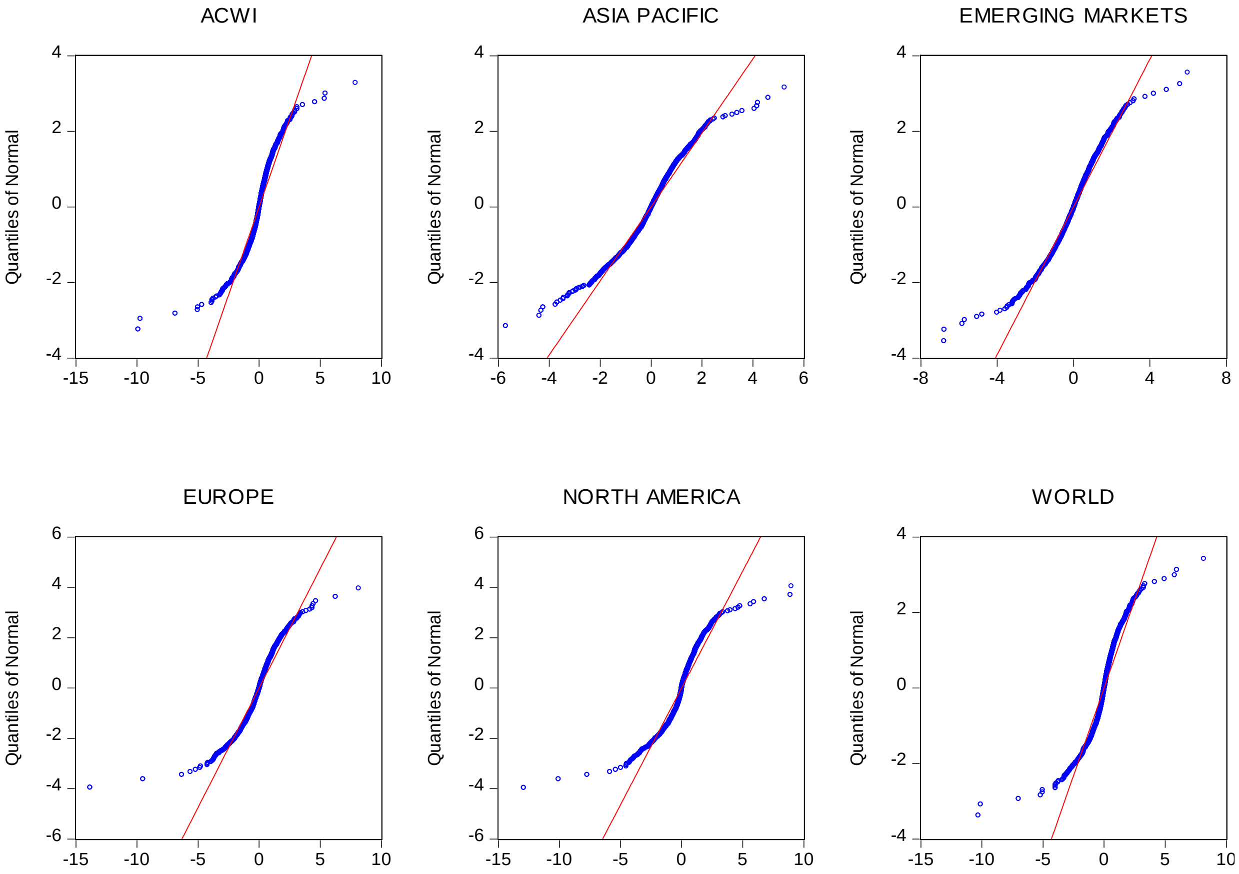

Figure 2. Price series of CCI

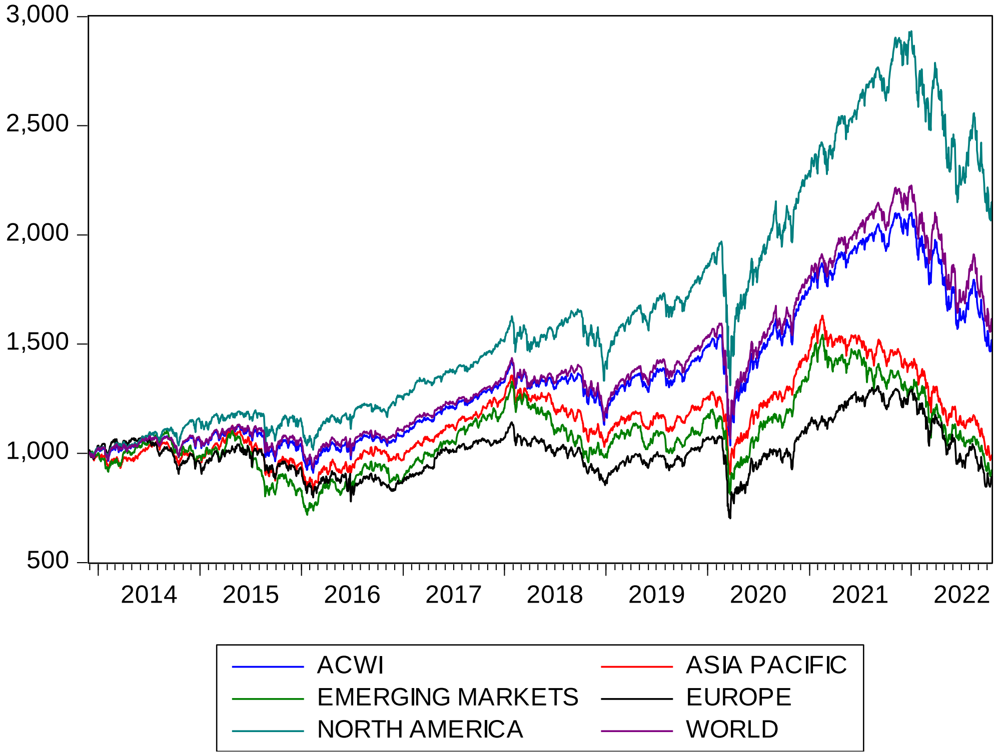

Figure 3. Time evolution of GPR

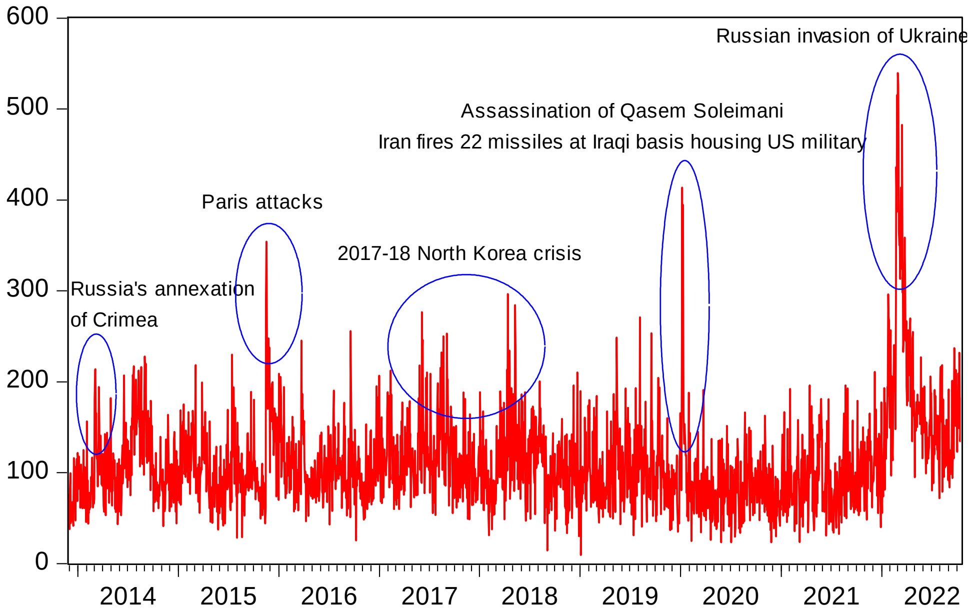

Figure 4. Quantile estimates for the effects of GPR on CCI returns

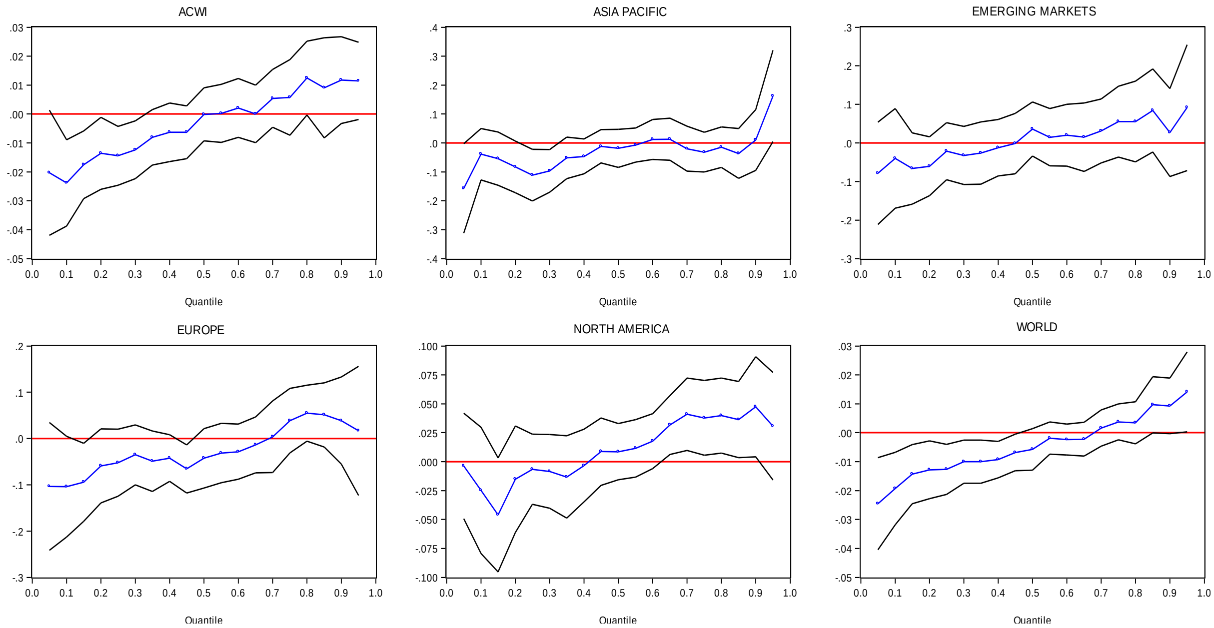

Figure 5. Quantile estimates for the effects of geopolitical threats on CCI returns

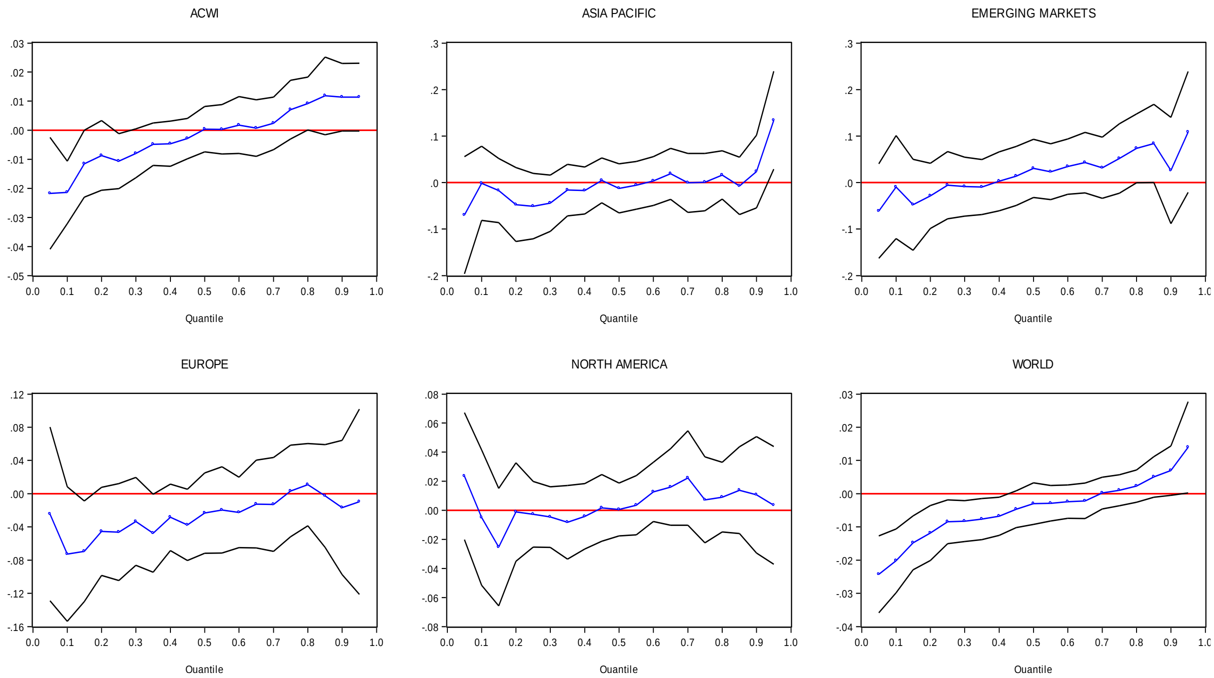

Figure 6. Quantile estimates for the effects of geopolitical acts on CCI returns

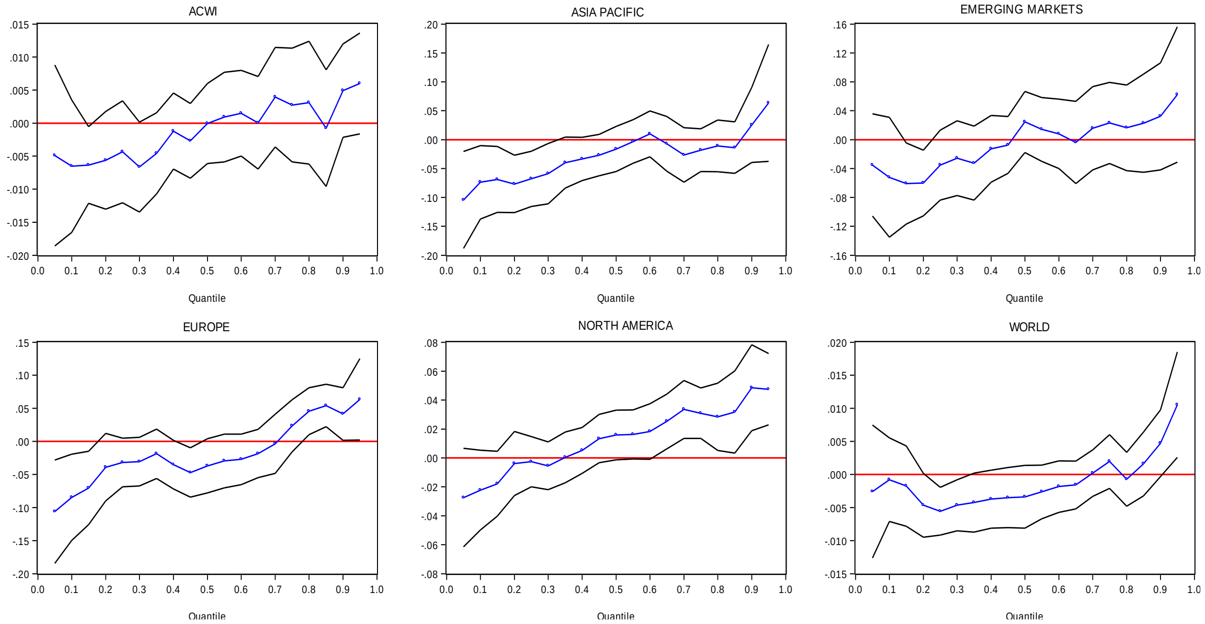

Figure 7. Quantile estimates for the effects of GPR on CCI volatilities

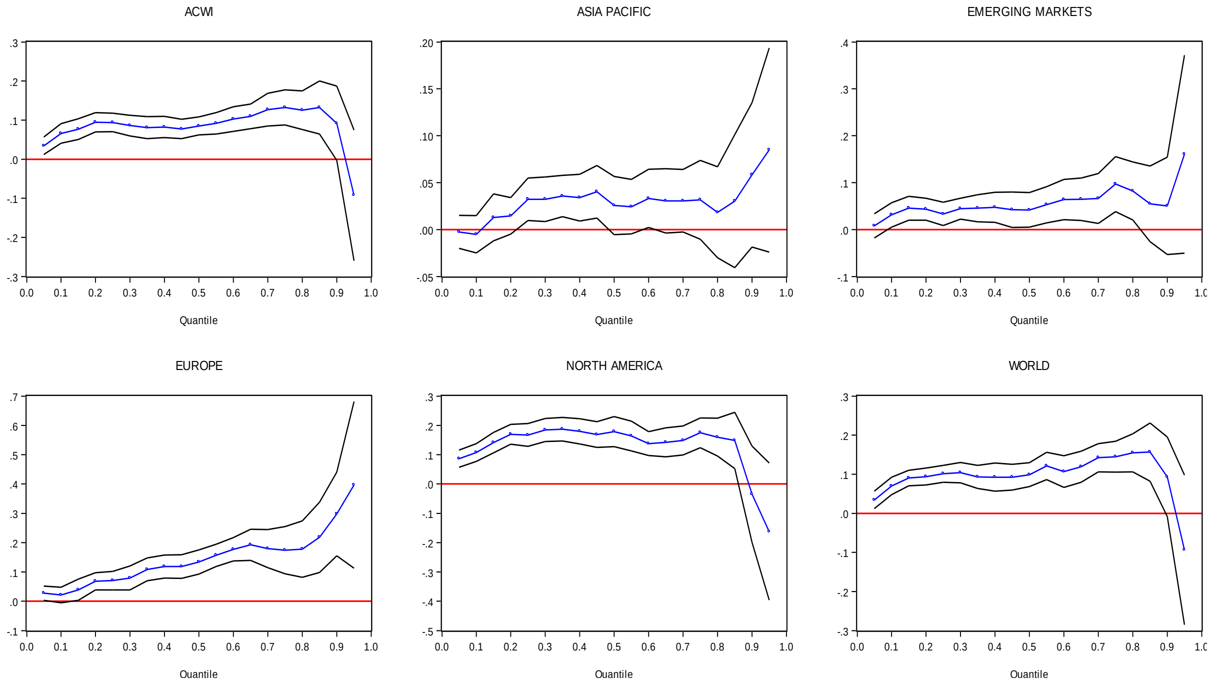

Figure 8. Quantile estimates for the effects of geopolitical threats on CCI volatilities

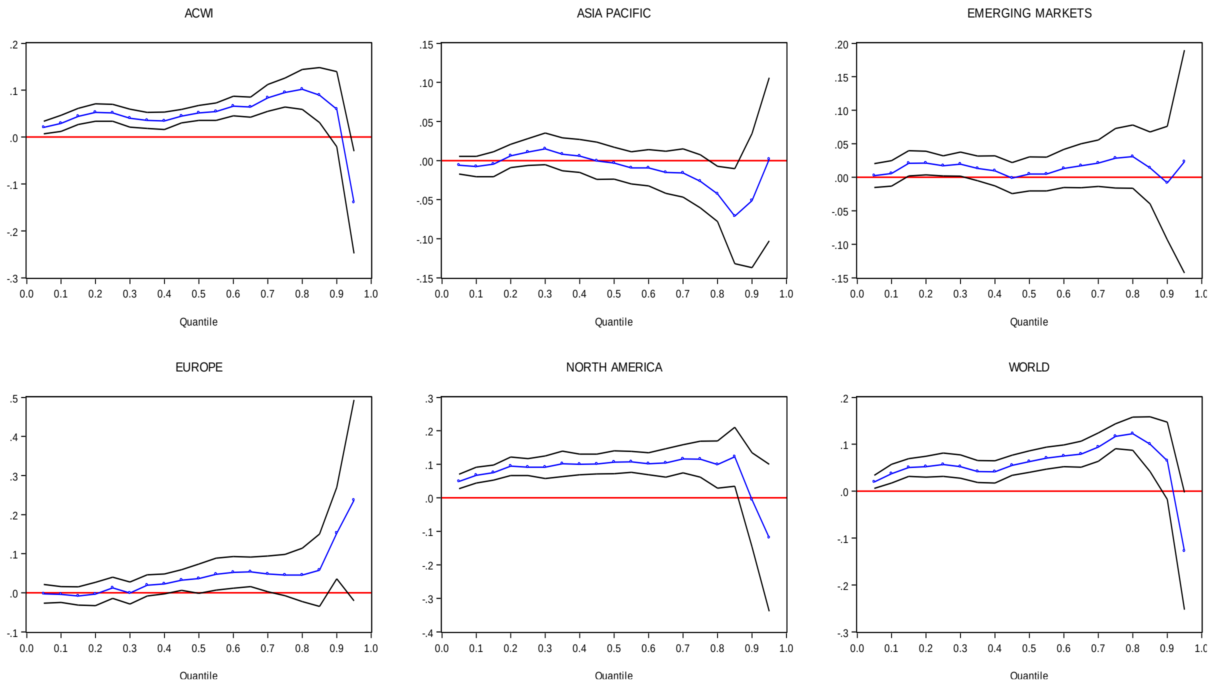

Figure 9. Quantile estimates for the effects of geopolitical acts on CCI volatilities