



Investor trends during periods of geopolitical risk in Türkiye: Which assets serve as safe havens?

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ABSTRACT

This study investigates the safe-haven properties of different asset classes during periods of geopolitical risk in Türkiye and examines their comovement with the Geopolitical Risk Index. The research covers the period from January 2010 to January 2023 and employs wavelet coherence analysis and quantile-on-quantile regression methods. The findings reveal that geopolitical risk has varying long- and short-term effects on financial markets and housing prices. Additionally, our results show that the housing market can anticipate geopolitical risk fluctuations in the long run, and investors tend to shift to real estate during high-risk periods. Although gold acts as a safe haven in both the long and short run when geopolitical risk rises, oil prices respond in various ways in terms of direction and timing. Furthermore, fixed-income instruments are not perceived as safe-haven assets during periods of heightened geopolitical risk; instead, they tend to increase in parallel with perceptions of rising risk. The findings offer valuable insights into how investors formulate strategies during periods of uncertainty and have significant implications for policy makers and market participants.

1. Introduction

Geopolitical risks lead to significant and complex interactions between financial markets and macroeconomic indicators. By increasing the perception of risk in financial markets, geopolitical uncertainty undermines investor confidence and negatively affects stock prices (Indić, Mirović, Kalaš, & Pjanić, 2024). In developing countries such as Türkiye, rising geopolitical risk leads to fluctuations in the BIST 100 Index, increasing investor risk aversion and driving down the exchange rate of the lira (TL), the country's currency, against the dollar (Tuncay, 2018). Similarly, higher demand for safe-haven assets, such as gold and government bonds, leads to price fluctuation in gold and change in the five-year bond yield (Akhtaruzzaman, Boubaker, Lucey, & Sensoy, 2021). Furthermore, exchange rate fluctuation impacts trade balances, leading to reductions in the Business Confidence Index (BCI) (Neumann & Tabrizy, 2021).

The primary goal of this study is to identify assets perceived as safe havens by investors during periods of geopolitical risk in Türkiye and to examine interaction among these assets. One research question explored in this study is whether co-movement is found among specific financial and macroeconomic indicators during high-risk periods and the

responses of these variables to geopolitical risk. In this regard, the study investigates which assets investors turn to in times of uncertainty and what influences these assets' price dynamics. Geopolitical risk levels are measured using the Geopolitical Risk (GPR) Index developed by Caldara and Iacoviello (2018), and the relationship between the GPR Index and the BIST 100 Index, exchange rate, the free market gold price, the Brent crude oil price, the BCI, the three-month deposit interest rate, the Housing Price Index, and Türkiye's five-year bond yield is analyzed. Wavelet coherence analysis and quantile-on-quantile regression (QQR) methods are employed to assess the dynamic effects of GPR on financial markets and macroeconomic indicators. Using monthly data from January 2010 to November 2023, this study examines the effects of GPR on different financial asset classes from both short- and long-term perspectives.

In this study, Türkiye was selected for an investigation of whether different asset classes act as safe havens during periods of GPR for several economic, financial, and political reasons. First, because of its strategic location, Türkiye is directly affected by both regional and global developments, making it an important case for analyzing how geopolitical risks impact economic and financial markets. In recent years, Türkiye had various events involving geopolitical uncertainty

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because of both domestic dynamics and external developments. Regional conflicts—such as the Syrian civil war, maritime boundary disputes and natural gas exploration-related tensions in the Eastern Mediterranean, diplomatic disputes with the United States and the European Union, and the Russia-Ukraine war—have directly affected the Turkish economy, increasing financial market volatility. Additionally, as an emerging market economy, Türkiye provides a valuable research setting for explaining the response of global investors to geopolitical risks. Macroeconomic variables, such as high inflation, exchange rate fluctuations, and interest rate changes, shape investor perceptions of risk and play a crucial role in identifying safe-haven assets. Finally, the diversity of Türkiye's financial markets and the broad range of investment instruments make it an ideal environment for analyzing investor behavior in response to GPR.

Our empirical results from using the QQR approach reveal a significant relationship between GPR and various financial assets in Türkiye. The findings highlight that during periods of high geopolitical risk, assets such as gold and real estate act as safe havens, and gold has a strongly positive relationship at high levels of GPR. In contrast, the Turkish stock market (Borsa Istanbul, or BIST) and exchange rates have varying responses to GPR; the stock market has more fluctuation during high-risk periods, and the exchange rate rises when GPR is high. Furthermore, fixed-income instruments, including government bonds, are not perceived as safe havens; instead, their yields tend to increase in line with rising perceptions of risk. When GPR is high, the BCI and the HPI fluctuate significantly, whereas interest rates on deposits (DIR) and Turkish bond yields rise. These results demonstrate the complex dynamics in the relationship between GPR and various asset classes in Türkiye, providing valuable insights for investors and policy makers.

This study contributes to the literature in four key ways. First, because of its strategic position, Türkiye is highly sensitive to GPR, which has direct effects on financial markets and the real economy. Although the impact of GPR on financial markets has been extensively studied, its effects on the housing market, the BCI, and interest rates in high-risk economies such as Türkiye are underexplored. This study assesses the holistic impact of GPR on both the financial and real sectors, providing valuable insights for investors and policy makers. Second, this study contributes to the literature by employing advanced methods that analyze the temporal dependence structure of GPR and the degree of dependence at different frequencies for both stationary and nonstationary data. Using wavelet coherence analysis and QQR, this study examines changes in dependence among variables over time across different frequency ranges. Unlike traditional analysis methods that focus on linear relationships in time series, this study offers a more detailed understanding of the asymmetric and evolving dependence of GPR on various market variables. Third, analyzing the relationships among all variables affected by GPR is crucial for optimal portfolio diversification. Although it is well known that investors seek safe-haven assets during periods of uncertainty, more empirical evidence is needed to determine which assets benefit from GPR. This study provides insights for investors regarding optimization of portfolio diversification decisions and risk-hedging strategies. Lastly, understanding Türkiye's sensitivity to GPR can contribute to exchange rate management, reassessment of regional relations, and the development of risk mitigation policies for sustainable growth. In highly volatile geopolitical environments such as Türkiye, in which financial markets experience fragility, this study offers policy makers insights for making informed decisions on exchange rate and interest rate policies. The findings act as a strategic guide for reassessing regional policies and minimizing economic uncertainty.

The remainder of this paper is structured as follows. Section 2 provides the theoretical background and reviews the related literature. Section 3 presents the data employed in the analysis. Section 4 explains the methodological framework used in the study. Section 5 reports the empirical findings. Finally, Section 6 concludes the paper and offers policy suggestions based on the results.

2. Theoretical background and related literature

GPR has a significant impact on financial markets, macroeconomic indicators, and investor confidence. The topics extensively studied in the literature include the effects of GPR on economic growth (Saint Akadiri, Eluwole, Akadiri, & Avci, 2020; Xue, Shahbaz, Ahmed, Ahmad, & Sinha, 2022), inflation (Haque & Magnusson, 2021), unemployment rates (Eksi & Tas, 2022), trade flows (Gupta et al., 2019), financial markets (Gong & Xu, 2022; Wang & Su, 2023), energy and metal prices (Umar et al., 2022a), crude oil prices (Cunado, Gupta, Lau, & Sheng, 2020; Mei, Ma, Liao, & Wang, 2020; Wang, Su, & Umar, 2021), gold prices (Baur & Smales, 2020; Triki & Ben Maatoug, 2021), exchange rates (Bossman, Gubareva, & Teplova, 2023; Hui, 2022; Iyke, Phan, & Narayan, 2022; Kisswani & Elian, 2021), green bonds (Dogan, Majeed, & Luni, 2021; Li, Cong, Xie, Wang, & Wang, 2022), and Bitcoin (Al Mamun, Uddin, Suleman, & Kang, 2020; Umar et al., 2022b). The impact of GPR on DIRs, housing price indexes, and business confidence indicators is attracting increasing attention.

The effects of GPR on financial markets, in particular, have been examined in the context of gold, exchange rates, and oil prices. The question of whether gold serves as a safe haven against GPR is widely explored in the literature (Gkillas, Gupta, & Pierdzioch, 2020; Yilanci & Kilci, 2021). Baur and Smales (2018), Gkillas et al. (2020), and Baur and Lucey (2010) demonstrate that gold offers portfolio diversification advantages during crises. Triki and Ben Maatoug (2021) find that the relationship between gold and the stock market strengthens during geopolitical events but is weak under normal market conditions. Additionally, Li, Huang, and Chen (2021) analyze the spillover effects of GPR on gold prices, showing a strong relationship in developing countries. Cheng, Zhang, and Cao (2022) identify long-term transmission of GPR to the gold-oil relationship. Yilmazkuday (2024a) examines the impact of global GPR on stock prices in 29 economies, finding that a positive GPR shock drives down stock prices in most countries, except Iceland, where it increases them. These effects are seen in the United States, China, and the euro area, in the first period (2010–2019), whereas the impact is concentrated in Russia, Poland, the United Kingdom, and the euro area, largely due to the Russia-Ukraine war, in the second period (2020–2023).

The relationship between GPR and exchange rates is more evident during periods of crisis. Eldor and Melnick (2007) and Narayan, Khademaloom, and Phan (2018) find that terrorist attacks contribute to exchange rate volatility. Hui (2020, 2022) reveal that, in ASEAN (Association of Southeast Asian Nation) member countries, GPR leads to local currency depreciation, putting pressure on monetary policies. Kisswani and Elian (2021) examine the symmetric and asymmetric effects of GPR on exchange rates, and Iyke et al. (2022) argue that GPR improves predictive accuracy about exchange rates. Furthermore, Bossman et al. (2023) demonstrate that major geopolitical crises, such as the Russia-Ukraine war, have asymmetric effects on exchange rates.

Yilmazkuday (2025a) analyzes the impact of GPR on exchange rates, revealing that increasing GPR amplifies exchange rate volatility and causes depreciation, particularly in developing countries. Hossain, Masum, and Saadi (2024) examine the impact of the Russia-Ukraine war on currency markets, finding that such geopolitical shocks cause severe exchange rate fluctuations and heighten market uncertainty. Notably, energy-importing countries experience significant currency depreciation. Liu and Zhang (2024) study the effect of GPR on exchange rate returns, showing that rising geopolitical uncertainty increases volatility in currency markets and leads investors to seek safe-haven currencies. Similarly, Będowska-Sójka, Demir, and Zaremba (2022) analyze the GPR-hedging potential of different asset classes in the context of the Russia-Ukraine war, demonstrating that currency markets have significant reactions to such risks. Additionally, Lee (2023) investigates the relationship between household participation in financial markets and GPR, highlighting that rising geopolitical uncertainty leads investors to shift to more liquid and secure assets, such as foreign currency. These

studies indicate that GPR directly influences exchange rate movements and causes significant shifts in investor behavior.

The interaction between oil prices and GPR is a crucial issue with respect to energy security and global balance between supply and demand. [Vadlamannati and De Soysa \(2020\)](#) and [Wang et al. \(2021\)](#) emphasize that GPR is a critical predictor of volatility in oil markets. [Abdel-Latif and El-Gamal \(2020\)](#) note that declining oil prices trigger higher GPR levels, whereas [Cunado et al. \(2020\)](#) find that lower oil demand has a negative effect on oil returns. [Mei et al. \(2020\)](#) and [Liu, Ma, Tang, and Zhang \(2019\)](#) show that GPR directly impacts oil price volatility. [Ivanovski and Hailemariam \(2022\)](#) state that the bidirectional relationship between oil prices and GPR varies over time. [Yilmazkuday \(2024b\)](#) investigates the interaction between global GPR and energy uncertainty and its effect on energy prices. The results show that whereas GPR increases energy uncertainty, it does not have a significant impact on energy prices. Additionally, energy uncertainty reduces energy prices and negatively affects economic activity.

The impact of GPR on financial markets has also been analyzed in terms of stock markets and bond yields. [Balçılar et al. \(2018\)](#) note that, among the BRICS (Brazil, Russia, India, China, and South Africa) countries, the Russian stock market is the most sensitive to GPR. [Choi \(2022\)](#) finds that stock markets in Northeast Asia are negatively affected by GPR. [Gong and Xu \(2022\)](#) reveal that GPR negatively impacts industrial metal markets, whereas [Wang and Su \(2023\)](#) analyze the effect of the Russia-Ukraine war on China's financial markets. [Bouri, Gupta, and Roubaud \(2019\)](#) emphasize that GPR changes increase the volatility of Islamic stocks.

The impact of GPR on interest rates varies based on investor risk perceptions and safe-haven preferences. [Hui \(2022\)](#) finds that GPR depresses interest rates in ASEAN member countries, whereas [Bettin, Mensi, and Recchioni \(2023\)](#) demonstrate that GPR strengthens the relationship between DIRs and market risk premiums in the eurozone banking sector. [Himounet \(2022\)](#) shows that interest rates fluctuate during periods of uncertainty, prompting investors to seek safe-haven assets.

Real estate markets are also directly affected by GPR. [Chien and Setyowati \(2021\)](#) note that global uncertainty causes fluctuations in housing prices, whereas [Yuni, Enwo-Irem, and Urom \(2024\)](#) find that during periods of high risk, the real estate market stagnates as investors shift to more liquid assets. [Barkham and Holberton \(2017\)](#) highlight that geopolitical developments impact real estate demand. [Coën and Desfleurs \(2024\)](#) analyze the US Real Estate Investment Trust market and find that GPR has a larger effect on REIT returns than does economic policy uncertainty.

Finally, the impact of GPR on business and investor confidence has also been explored in the literature. [Pehlivanoglu, Akdağ, and Alola \(2021\)](#) and [De Wet \(2023\)](#) find that GPR depresses producer and consumer confidence. [Jawadi et al. \(2024\)](#) conclude that geopolitical uncertainty negatively affects business confidence in Europe. [Tsagkanos, Koumanakos, and Pavlakis \(2024\)](#) emphasize the connection between business confidence and market volatility, whereas [Polat et al. \(2024\)](#) demonstrate that geopolitical tension weakens business confidence. [Sempiga \(2023\)](#) examines the impact of the Russia-Ukraine war on political confidence and business expectations.

[Yilmazkuday \(2025b\)](#) examines the impact of global geopolitical risks, threats, and acts on the daily returns of 10 major cryptocurrencies, finding that none of them had a significant response to geopolitical acts. These findings suggest that these cryptocurrencies do not provide reliable protection against GPR.

Previous research has comprehensively examined the effects of GPR on financial markets, macroeconomic indicators, and investor confidence. These studies identify the influence of GPR on economic growth, inflation, exchange rates, stock markets, prices of commodities such as gold and oil, and real estate markets, as well as its relationship to investor confidence and financial stability. However, few studies have focused on the perception of safe-haven assets by investors in developing

economies, especially in countries such as Türkiye, during periods of GPR. [Yilmazkuday \(2024a, 2024b, 2025a, 2025b\)](#) examines the effects of global GPR on different financial assets, focusing on global indicators, such as exchange rates, stock prices, energy prices, and cryptocurrency returns. These studies primarily explore the effects on macroeconomic indicators and asset prices in developed economies. In contrast, this study examines the impact of GPR in the context of Türkiye and analyzes the assets that investors consider safe havens against these risks. This paper, focusing on local economic indicators, such as the BIST 100 Index, exchange rates, gold prices, housing prices, and five-year bond yields, shows the reactions of different asset classes in Türkiye to geopolitical risks, in both the short and long term, distinguishing it from prior studies.

3. Data

This paper examines the assets that investors in Türkiye consider safe havens during periods of geopolitical risk. The study covers the period January 2010 to November 2023, with data analyzed at a monthly frequency. Geopolitical risk is measured using the GPR Index developed by [Caldara, Cavallo, and Iacoviello \(2019\)](#). The GPR Index encompasses factors such as conflicts for sovereignty and territorial control, wars, terrorist acts, and tensions that affect international relations. The index is constructed by scanning daily news articles related to GPR in 11 major national and international newspapers and normalizing the results to an average value of 100.

[Fig. 1](#) illustrates the fluctuations in Türkiye's GPR Index from January 2010 to November 2023, highlighting significant geopolitical events that influenced the country's risk perception. The graph demonstrates that multiple sharp increases occurred in Türkiye's GPR during this period, with values generally above 0.40, suggesting a persistent level of geopolitical uncertainty. Key periods of heightened risk can be associated with major political, military, and diplomatic events, both domestically and internationally.

The first notable spike occurred during the Gaza Flotilla Raid (May–June 2010),¹ reflecting heightened tension in Türkiye's foreign relations. Subsequently, GPR increased during the acts of terrorism and the onset of the Syrian war (March 2011–June 2012)² and the siege of Kobani by ISIS (September 2014),³ indicating that regional conflicts and terrorist activity significantly affect Türkiye's perception of GPR.

GPR reached its highest level, peaking above 1.2, between 2015 and 2016, when several critical events occurred: Türkiye's downing of a Russian warplane (November 2015),⁴ a failed coup attempt (July 2016),⁵ and Operation Euphrates Shield (July–August 2016),⁶ the last of which was Türkiye's first direct military intervention in Syria.

Subsequently, geopolitical tension continued to affect the index.

¹ The Gaza Flotilla Raid refers to the Israeli military's boarding of the Turkish-owned ship Mavi Marmara, which was part of a civilian aid convoy attempting to break the blockade of Gaza. The raid resulted in multiple deaths and severely strained Türkiye–Israel relations.

² This refers to a wave of terrorist attacks in Türkiye during 2011–2012, mainly involving the PKK and early ISIS activity, coinciding with the outbreak of the Syrian civil war, which led to refugee inflows and heightened border security concerns.

³ The siege of Kobani was an ISIS offensive to seize a Syrian Kurdish town near Türkiye's border, triggering international attention and increased Turkish border security.

⁴ Türkiye downed a Russian military jet, triggering a major diplomatic crisis between the two countries.

⁵ A coup attempt by a faction within the Turkish military led to a state of emergency and mass detentions.

⁶ Türkiye launched a ground operation in Syria targeting ISIS and halting YPG advances near its border.

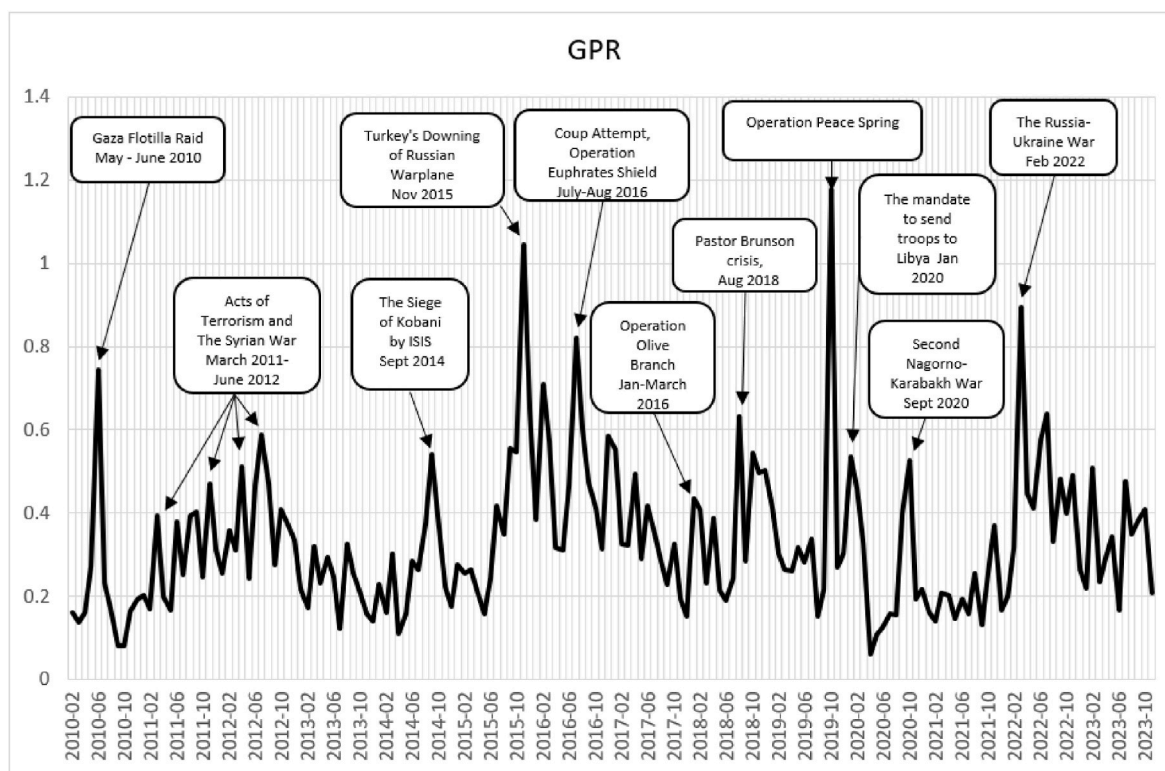


Fig. 1. Türkiye's Geopolitical Risk Index and significant events.

Note: This figure illustrates the monthly Geopolitical Risk Index (GPR) for Türkiye from February 2010 to October 2023. The GPR data come from the index by Caldara et al. (2019), which is constructed using automated textual analysis of geopolitics-related keywords in major international newspapers. Significant geopolitical events on the timeline were selected based on their historical relevance and their coinciding with notable spikes in the GPR series. They include military operations, international crises, and diplomatic tensions involving Türkiye, as identified in verified news sources and academic references. The goal is to illustrate how geopolitical tensions are reflected in the GPR movements over time.

Operation Olive Branch (January–March 2018)⁷ and the Pastor Brunson crisis (August 2018),⁸ which strained Türkiye's relations with the US, led to further fluctuations. In 2019, the index spiked again during Operation Peace Spring (October 2019),⁹ Türkiye's military campaign in northern Syria. The following year, GPR increased when Türkiye sent troops to Libya (January 2020)¹⁰ and the second Nagorno-Karabakh war (September 2020)¹¹ broke out, reflecting Türkiye's growing involvement in regional conflicts.

The most recent spike occurred in February 2022, coinciding with the onset of the Russia-Ukraine war, which significantly impacted global geopolitical dynamics, including Türkiye's strategic environment. After this peak, the index periodically fluctuated but did not return to its previous lows, suggesting a sustained level of geopolitical tension.

Overall, the graph indicates that Türkiye's perception of GPR is highly sensitive to both domestic events, such as political crises and military interventions, and international developments, particularly regional conflicts and tensions involving neighboring countries. The persistent volatility in GPR during the period analyzed highlights the importance of geopolitical factors in shaping Türkiye's economic and

⁷ Türkiye carried out a military operation against the YPG in Afrin to secure its southern border.

⁸ The arrest of a U.S. pastor led to diplomatic tensions with the United States and financial market instability.

⁹ Türkiye launched a cross-border operation in northern Syria to establish a safe zone and push back the YPG.

¹⁰ Türkiye deployed troops to Libya to support the internationally recognized government.

¹¹ Türkiye supported Azerbaijan in its conflict with Armenia, reinforcing its regional alliances.

investment environment.

In addition to the GPR Index, this study includes the following variables as alternative investment instruments. The BIST 100, the benchmark index of Borsa Istanbul, is the most important indicator of investment preferences in the equity market. This data reflects investors' positions in the stock market and their risk appetite. The BIST 100 Index is particularly crucial as an indicator for measuring market sentiment and investor confidence.

The price of the Turkish Republic gold coin, a popular form of physical gold investment in Türkiye, is used to proxy for investment in precious metals. Historically, gold has been considered a safe haven in periods of uncertainty and crisis, making it a traditional store of value preferred by investors, especially when GPR is high. In this study, we prefer to use Republic gold coin prices instead of international gold ounce prices because it better reflects investor behavior and local market dynamics in Türkiye. The Republic gold coin is not only the most common form of physical gold investment in Türkiye but also more accurately represents local risk perceptions and investment preferences.

The USD/TRY exchange rate is used to proxy for the foreign exchange market. Particularly in emerging markets, exchange rates are among the alternative investment instruments frequently preferred by investors during periods of economic and political uncertainty. Exchange rate movements provide essential insights for analyzing international capital flows and investor behavior.

The price of Brent crude oil, a key indicator of the commodity market, is also included. In addition to being a critical indicator of global economic activity, oil prices also represent investment in the energy sector.

Fixed-income investment instruments are proxied by two different indicators. The three-month DIR reflects short-term savings preferences,

and the Türkiye five-year Government Bond Yield demonstrates long-term investment preferences and trends in the government debt market.

The performance of real estate investment is measured using the HPI. For cultural and economic reasons, real estate investment is among the most preferred traditional investment instruments in Türkiye. It plays a significant role in investors' portfolios, particularly because it offers protection against inflationary pressures and potential long-term capital appreciation, as well as generating regular rental income. The HPI is a reliable indicator for measuring price dynamics and investment performance in the real estate market.

The BCI is used to represent investment in the real estate sector. This index reflects businesses' assessment of their current conditions and their expectation about the future, indicating investors' tendency to invest in their own enterprises. The BCI is particularly important for analyzing whether real sector investment exhibits safe-haven characteristics during periods of GPR.

We use all the variables in logarithm except the BCI. In analyses of financial time series, logarithmic transformation normalizes potential variability in the series and better reflects the percentage changes of the variables. Because of its structural characteristics — such as its forward-looking nature, sensitivity to economic and political uncertainty, and reflection of real sector expectations — the BCI is included in the analysis.

The descriptive statistics in [Appendix Table A1](#) reveal the fundamental characteristics and behaviors of the variables. During the study period, the free market Republic gold coin has the highest average return (2.2 %), and Brent crude oil prices have the highest volatility (standard deviation) (10.7 %). All variables, except for the BCI, have a positive average. The exchange rate (5.2 %) and gold prices (4.8 %) have lower volatility, whereas bond yields (11.6 %) and oil prices have high volatility. The HPI has the lowest volatility, with a standard deviation of 2.5. The high standard deviation of the GPR Index (52.1) indicates significant fluctuations in risk perception during the period analyzed.

4. Methodology

The methodological framework used in this study examines the dynamics of safe-haven assets during periods of GPR in financial markets from a multidimensional perspective. The methodological approach consists of econometric techniques that enable a comprehensive analysis of nonlinear dependence, long-term cointegration relationships, interaction between variables under different conditions, and time-frequency dependence.

This study employs several advanced methodologies to analyze the dynamic effects of GPR on various classes of financial assets and macroeconomic indicators. The primary goal of these methods is to capture both short- and long-term relationships and comovement among different variables during periods of GPR in Türkiye. First, we use the Brock, Dechert, and Scheinkman (BDS) test to examine the presence of nonlinear dependence among the variables, such as interaction between GPR and financial assets. The BDS test is particularly useful for capturing nonlinear relationships in time-series data, which is crucial for dealing with financial markets in which these relationships often are nonlinear.

Next, we use the quantile unit-root test to investigate the stationarity of the variables at different quantiles of their distributions. Unlike traditional unit-root tests, which assume a single, constant effect across the entire distribution, this approach enables a more nuanced understanding of variable behavior at various points in their distribution. Given the varying responses of financial and macroeconomic variables to GPR shocks, this methodology provides deeper insights into how these shocks might affect different quantiles of the variables, particularly during high-risk periods.

We choose the quantile cointegration test to examine long-run relationships among variables across different quantiles. This test is advantageous because it enables the identification of cointegrating relationships that might manifest at only specific points in the data

distribution, such as during periods of extreme market movements or geopolitical shocks. This approach enables us to explore whether the long-term equilibrium holds between variables such as the BIST 100 Index, exchange rate, and gold price at varying GPR levels.

Furthermore, we employ QQR to analyze changes in the relationship between GPR and selected financial assets across different quantiles. This method is particularly important because it enables the modeling of asymmetrical relationships that may vary across different levels of the variables, providing a more detailed view of how GPR impacts asset prices in both high- and low-risk periods.

Finally, we use wavelet coherence analysis to examine the frequency-domain relationship between GPR and financial variables. This methodology is highly effective for capturing both short- and long-term dynamics by decomposing the time-series data into different frequency components. By performing wavelet analysis, we can identify changes in interactions between GPR and financial assets over time, revealing underlying patterns that might not be observable using traditional time-domain analysis. This multiscale approach provides comprehensive understanding of how GPR influences financial markets across different time horizons.

These methods are carefully selected to capture the complexity and dynamics of the relationships between GPR and financial assets in Türkiye, creating a robust framework for understanding the broader implications of GPR on financial markets and macroeconomic indicators.

4.1. BDS test

In the first stage of the methodological framework, we employ the BDS test, developed by [Broock et al. \(1996\)](#). This test detects nonlinear structures and chaotic dynamics in financial time series. The BDS test statistic is calculated as follows:

$$W_m(\varepsilon) = \frac{\widehat{C}_m(\varepsilon) - \widehat{C}_1^m(\varepsilon)}{\sigma_m(\varepsilon)} \quad (1)$$

where $\widehat{C}_m(\varepsilon)$ is the m -dimensional correlation integral, $\widehat{C}_1^m(\varepsilon)$ is the **correlation integral under the assumption of independent and identically distributed processes**, and $\sigma_m(\varepsilon)$ is the **standard deviation of the test statistic**. If the BDS statistic is significantly different from zero, it suggests the presence of **nonlinear structures**, indicating that conventional linear models may be inadequate for capturing the complex interactions between financial markets and GPR.

4.2. Quantile unit-root test

To examine variation in the stationarity properties of variables under different market conditions, we employ the quantile unit-root test proposed by [Koenker and Xiao \(2004\)](#). Unlike traditional unit-root tests, this approach investigates whether a time series is stationary at different points of its conditional distribution. The test is based on the quantile autoregressive model:

$$Q_\tau(X_t|X_{t-1}) = \alpha_\tau + \rho_\tau X_{t-1} + \varepsilon_{t,\tau} \quad (2)$$

where $Q_\tau(X_t|X_{t-1})$ is the **conditional quantile function of X_t , given X_{t-1}** , α_τ represents the **quantile-specific intercept**, ρ_τ is the **unit-root parameter**, and $\varepsilon_{t,\tau}$ is the **error term**. If the null hypothesis $\rho_\tau = 1$ is rejected, the series is considered **stationary at the specified quantile level**, implying that stationarity properties may vary across different market conditions.

4.3. Quantile cointegration test

To investigate the long-term equilibrium relationships between GPR and financial assets, we use the quantile cointegration test, developed by

Koenker and Xiao (2006). This methodology extends traditional cointegration tests by enabling heterogeneous and asymmetric cointegration relationships at different quantiles. The model is constructed as follows:

$$Q_{\tau}(Y_t|X_t) = \alpha_{\tau} + \beta_{\tau}X_t + u_{t,\tau} \quad (3)$$

where the dependent variable is Y_t (financial asset price), the independent variable is X_t (geopolitical risk index), β_{τ} is the quantile-specific cointegration coefficient, and $u_{t,\tau}$ is an error term. If β_{τ} is statistically significant across different quantile levels, then GPR and financial asset prices have a stable long-term relationship that varies depending on market conditions.

4.4. Quantile-on-quantile regression (QQR)

To examine the short-term effects of GPR on financial assets under varying levels of risk, we use the QQR method, developed by Sim and Zhou (2015). This technique extends standard quantile regression by capturing nonlinear interactions among different quantile levels of independent and dependent variables. The QQR model is defined as follows:

$$Q_{\tau}(Y_t|X_t = x_{\theta}) = \alpha_{\tau,\theta} + \beta_{\tau,\theta}x_{\theta} + \varepsilon_{\tau,\theta} \quad (4)$$

where τ and θ are the quantile levels of the dependent and independent variables, respectively, $\alpha_{\tau,\theta}$ is the quantile-specific intercept, $\beta_{\tau,\theta}$ is the impact of GPR at different quantiles, and $\varepsilon_{\tau,\theta}$ is an error term. The QQR methodology enables identification of variations in the effect of GPR across different financial asset distributions, revealing heterogeneous risk transmission mechanisms.

4.5. Wavelet coherence analysis

To analyze evolution in the relationship between GPR and financial assets over time and across different frequency bands, we use wavelet coherence analysis, proposed by Grinsted et al. (2004). This approach provides insights into both the temporal and spectral dependence among variables by measuring the strength of the coherence between two time series at different time scales.

The wavelet coherence function is formally defined as follows:

$$R^2(s, t) = \frac{|S(W_{XY}(s, t))|^2}{S(|W_{XX}(s, t)|^2) \cdot S(|W_{YY}(s, t)|^2)}$$

where $W_{XY}(s, t)$ is the wavelet cross-spectrum of the two time series, capturing localized covariance between them in both time and frequency domains. $W_{XX}(s, t)$ and $W_{YY}(s, t)$ are wavelet power spectra of each individual time series, providing information on their respective energy distribution across different time scales. We use the smoothing operator $S(\cdot)$ to ensure the stability and reliability of coherence estimates by reducing short-term fluctuations and enhancing the interpretability of time-frequency relationships. Finally, $R^2(s, t)$ measures the coherence between the two series, indicating the strength and significance of their dependence at a specific time t and frequency scale s . A higher value of $R^2(s, t)$ suggests stronger comovement between the variables, whereas a lower value indicates weaker or no association.

Wavelet coherence analysis enables identification of periods when the relationship between GPR and financial assets strengthens or weakens, as well as the time horizons at which this dependence is most significant. The resulting coherence maps give a detailed illustration of dynamic dependence, highlighting whether the relationship is stable or fluctuates over time. Additionally, the phase differences extracted from wavelet coherence help determine whether GPR leads or lags financial asset price movements at different frequencies.

5. Empirical results

5.1. BDS test results

To detect the presence of nonlinear dependence and chaotic structures in financial time series, we perform the BDS test, developed in 1987. The test identifies nonlinear patterns in the series by examining whether they are independently and identically distributed (i.i.d.). The null hypothesis of the BDS test is that the series is i.i.d. If this hypothesis is rejected, then the series has a nonlinear structure or deterministic chaotic process (Broock et al., 1996).

The BDS test results in Appendix Table A2 show that GPR, BIST, OIL, BCI, DIR, HPI, and TRBOND are statistically significant across all dimensions ($m = 2$, $m = 3$, $m = 4$). These results indicate that these variables are not i.i.d., implying the presence of nonlinear dependence. However, the results for ER and GOLD are not statistically significant, suggesting that these variables are i.i.d., and do not have nonlinear dependence.

The fact that most financial variables in this study have nonlinear structures shows that traditional linear models may be insufficient for analyzing the relationships among these variables. Therefore, we use quantile cointegration, QQR, and wavelet coherence analyses below to capture the potential relationships.

5.2. Quantile unit-root test results

We perform the quantile unit-root test, developed by Koenker and Xiao (2004) and Galvao (2009), to examine the stationarity properties of financial variables for different distributions. Although traditional unit-root tests assess the stationarity of series at their mean, the quantile unit-root test analyzes whether variables have different stationarity patterns at low, medium, and high means. This approach enables a detailed examination of the asymmetric and nonlinear characteristics of financial assets.

In Appendix Table A3, the coefficients $\alpha(\tau)$ reveal the persistence of the series at different quantiles, whereas the t -statistics test the stationarity hypothesis at the respective quantiles. The critical value for the t -statistics at the 5 percent significance level is 1.959.

The results in Appendix Table A3 indicate that GPR, BIST, OIL, and DIR exhibit stationarity across all quantiles, whereas ER, GOLD, and HPI display asymmetric behavior at different points of the distribution. The exchange rate and gold prices deviate from stationarity at higher quantiles ($\tau = 0.90$), with t -statistics of -6.04 and -7.01 , respectively. The BCI shows signs a unit root at lower quantiles, suggesting potential instability under negative economic conditions. The weakening stationarity of HPI at higher quantiles ($\tau = 0.80$ and $\tau = 0.90$) illustrate that extreme price increases may have persistent effects. Although TRBOND generally has a stationary structure, it can have long-term price movements when interest rates are high ($\tau = 0.90$, $t = -9.34$).

These findings highlight the nonlinear and asymmetric characteristics of financial markets and show that responses to market shocks vary across risk levels. The tendency of certain assets to demonstrate persistence, particularly in periods of high risk or speculation, indicates that traditional analytical methods might not sufficiently capture these dynamics. Consequently, we need to use quantile-based approaches and nonlinear methods to clarify the dynamics of GPR and financial markets. Therefore, we employ quantile cointegration, QQR, and wavelet coherence analysis below to perform a more comprehensive examination of the interactions between GPR financial markets.

5.3. Quantile cointegration test results

In this section, we perform a quantile cointegration test to analyze the long-term relationship between GPR and selected financial variables (BIST, exchange rates, gold, oil, etc.) across different quantiles. Whereas traditional cointegration tests assess the long-term relationship between

series only at the mean, the quantile cointegration method enables us to examine change in the direction and intensity of this relationship under different market conditions (i.e., varying risk levels) (Koenker & Xiao, 2006).

The results of the quantile cointegration test in Appendix Table A4 reveal significant differences in the long-term relationships between GPR and financial variables at different points of the distribution. A comparison of the test statistics (sup_Vn) and critical values (cv1) shows that $\text{sup_Vn} < \text{cv1}$ across all quantiles. This indicates the presence of a strong long-term equilibrium relationship among the variables.

With respect to the GPR-BIST relationship in Appendix Table A4, the beta coefficients vary across the distribution, from -0.38 to -1.27 . The negative relationship strengthens at higher quantiles (-1.27 , $\tau = 0.80$), demonstrating that the impact of GPR on the stock market becomes more pronounced as GPR rises. This finding suggests that stocks generally are not regarded as safe-haven assets during periods of GPR. Previous studies also show that GPR has a negative and statistically significant effect on stock returns (Agoraki et al., 2022; Lee & Lee, 2023, p. 58; Salisu et al., 2022; Xu et al., 2023).

The exchange rate response has an asymmetric pattern in the GPR-ER interaction. Although the relationship is negative and strong at low and medium quantiles (-2.02 , $\tau = 0.40$), it turns positive at higher quantiles (0.84 , $\tau = 0.80$). This finding demonstrates that the impact of GPR on exchange rates varies depending on market conditions. The literature consistently shows that the US dollar is considered a safe-haven asset in periods of heightened GPR, hence, investors shift from riskier currencies to the dollar (Hui, 2022; Lilley et al., 2022).

From the perspective of commodity markets, the GPR-GOLD relationship is negative at lower quantiles (-0.52 , $\tau = 0.10$), but it turns positive at higher quantiles (2.20 , $\tau = 0.80$). This indicates that gold has safe-haven properties during periods of heightened GPR. The literature also shows that gold responds differently to GPR than to other assets and acts as a safe haven, particularly under conditions with extreme GPR (Baur & Smales, 2018, 2020; Triki & Maatoug, 2021).

However, the GPR-OIL relationship has a relatively stable pattern across all quantiles. In terms of macroeconomic indicators, the GPR-BCI relationship appears to be quite weak, with betas of nearly zero. By contrast, the GPR-HPI relationship varies significantly across quantiles. Housing prices are negatively related at lower quantiles (-3.98 , $\tau = 0.20$) but the relationship turns positive and significant at higher quantiles (1.24 , $\tau = 0.90$). This suggests that the housing market is negatively affected during periods of low GPR, but when GPR is high, investors might perceive real estate as an alternative safe haven. A study conducted in Türkiye consistently supports this finding, indicating that moderate and high levels of GPR have no significant impact on housing prices, whereas extreme GPR can have short-term negative effects (Bekar, 2022).

The examination of the GPR-DIR relationship illustrates that the beta coefficients are predominantly negative, and the relationship is stronger at lower quantiles (-1.25 , $\tau = 0.20$). The intensity of this relationship declines at higher quantiles (-0.21 , $\tau = 0.90$), indicating a weaker structure. This suggests that the impact of GPR on DIRs is more pronounced when interest rates are low.

The GPR-TRBOND relationship has a different pattern. Whereas the relationship is positive at lower quantiles (0.38 , $\tau = 0.10$) and relatively stable at medium quantiles, it turns positive at higher quantiles (0.72 , $\tau = 0.90$).

These findings indicate that the impact of GPR on financial markets is nonlinear and asymmetric. In particular, the sensitivity of asset prices to GPR varies significantly based on market conditions.

5.4. Quantile-on-quantile regression results

Figs. 2 and 3 illustrate the results of the QQR analysis regarding the relationships between GPR and selected financial assets (BIST, ER, GOLD, OIL, BCI, DIR, HPI, TRBOND). This method evaluates

interactions between GPR and other variables at different quantiles, revealing nonlinear and asymmetric effects (Sim & Zhou, 2015).

Fig. 2 shows that the GPR-BIST relationship is negative when GPR is low ($0.1-0.3$), but large fluctuations occur on BIST when GPR is high ($0.8-0.9$). This result suggests that during when GPR is high, the stock market may have varying responses to uncertainty.

The analysis of the GPR-ER relationship reveals a weakly negative relationship at low quantiles when GPR is low. In the medium quantiles, as GPR increases, the exchange rate experiences significant fluctuation. At the upper quantiles (high GPR), the exchange rate rises, indicating a positive relationship. This result supports the findings by Hui (2022) and Lilley et al. (2022), suggesting that, when GPR is high, investors demonstrate risk-averse behavior by abandoning the domestic currency and seeking refuge in foreign currency as a safe haven.

The GPR-GOLD relationship is relatively stable and neutral at low and medium quantiles ($0.10-0.70$). However, at the upper quantiles (high GPR), the relationship is strong and positive, consistent with findings in the literature (Baur & Smales, 2018, 2020; Triki & Maatoug, 2021). This indicates that gold's safe-haven properties become more pronounced in periods of heightened GPR.

The GPR-OIL relationship is negative and neutral at low and medium GPR levels ($0.10-0.70$), whereas oil prices increase significantly at high levels of GPR. This result suggests that large-scale geopolitical crises have a substantial impact on Brent crude oil prices, as supply-side concerns drive price increases. However, it would not be accurate to consider oil a safe haven for Türkiye. Türkiye has high energy import dependence, therefore, rising oil prices increase inflationary pressures (Köse & Ünal, 2021), widen the current account deficit (Karadaş, Salihoğlu, & Koşaroglu, 2019), and deepen economic vulnerability. In this context, during periods of high GPR, investors typically turn to foreign currency and gold, whereas rising oil prices present economic risk, so oil cannot act as a safe haven for Türkiye.

In Fig. 3, the BCI remains relatively stable at low GPR levels ($0.10-0.30$), whereas negative effects become more pronounced at moderate GPR levels ($0.40-0.60$). When GPR is high ($0.70-0.90$), the BCI experiences significant fluctuation. This finding aligns with the literature (Tan et al., 2022), indicating that GPR creates uncertainty, thereby influencing business decision-making.

DIR remains relatively stable at low and moderate GPR levels ($0.10-0.60$). However, at high GPR levels ($0.70-0.90$ quantiles), it increases significantly. This suggests that, in response to rising GPR, banks' perception of heightened risk leads to higher costs for deposits, prompting them to offer higher interest rates in order to maintain liquidity (Olalere & Mukuddem-Petersen, 2023).

Similarly, the HPI has a neutral or slightly positive trend at low and moderate GPR levels ($0.1-0.7$ quantiles), but trends upward at high GPR levels ($0.8-0.9$ quantiles). This finding is consistent with Bekar (2022), indicating that during periods of high GPR, investors perceive real estate as a safe haven.

Türkiye's five-year government bond yields (TRBOND) remain stable at low GPR levels ($0.1-0.3$ quantiles), while volatility increases at moderate GPR levels ($0.4-0.6$ quantiles), and bond yields rise at high GPR levels ($0.7-0.9$ quantiles). This result aligns with that of De Wet (2023), suggesting that, as GPR in Türkiye increases, investors' risk perception about the bond market rises, leading them to demand higher returns. This implies that Turkish bonds are not considered a safe haven; instead, they are assets that investors tend to avoid when risk is rising.

In conclusion, the rise in GPR increases uncertainty in the Turkish economy, leading to higher interest rates, a loss of confidence in the business sector, and a shift by investors to alternative assets, such as real estate. Although the effects are relatively limited at low and moderate risk levels ($0.1-0.6$ quantiles), economic indicators change significantly in periods of high GPR ($0.7-0.9$ quantiles).

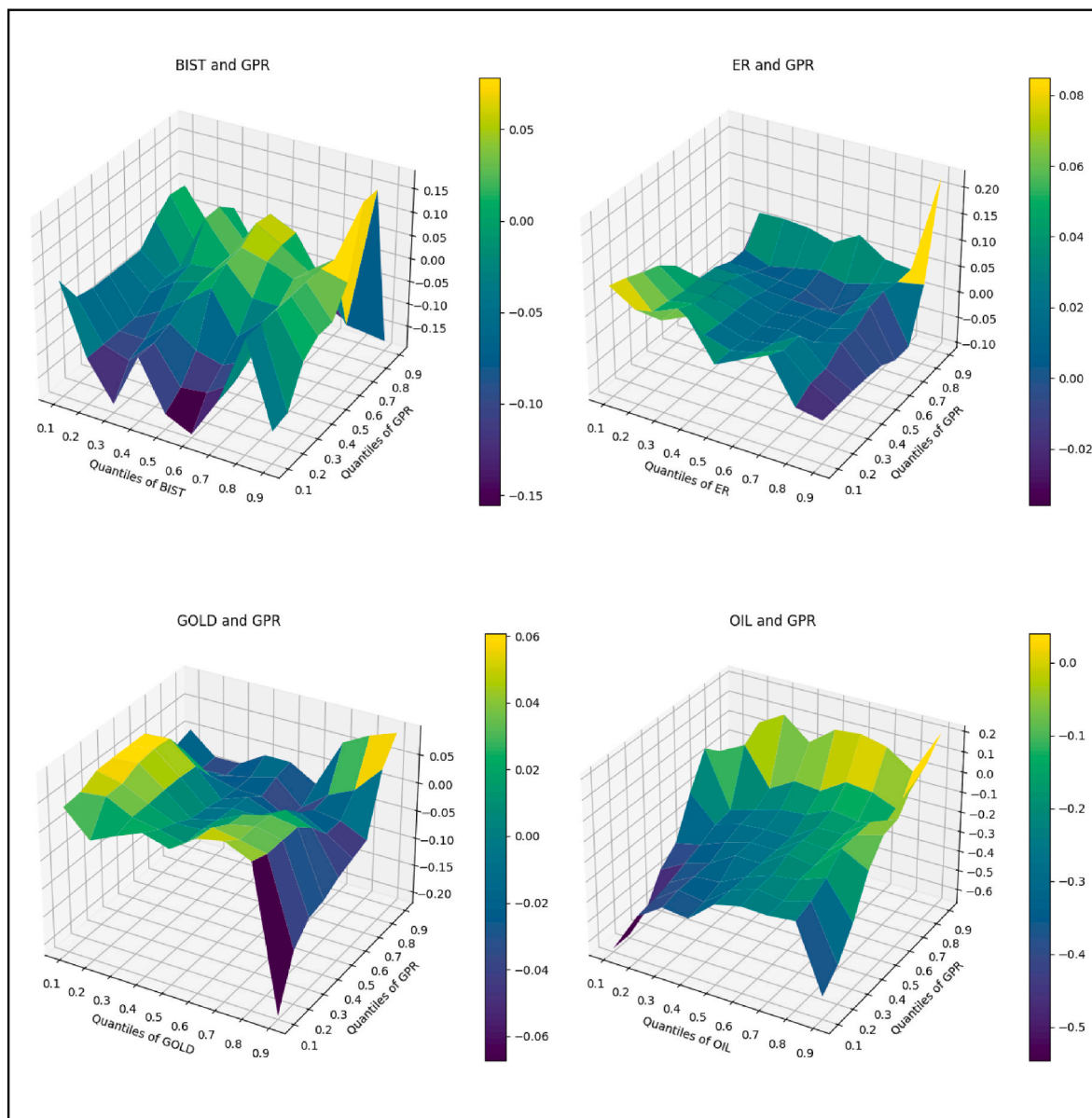


Fig. 2. Interaction between Geopolitical Risk Index and additional financial indicators: Quantile-on-quantile regression results (1).

Note: This figure displays the quantile-on-quantile regression (QQR) surfaces between the Geopolitical Risk Index (GPR) and four financial variables in Türkiye: BIST 100 Index (BIST), Exchange Rate (ER), Gold Price (GOLD), and Brent Oil Price (OIL). Based on monthly data from January 2010 to November 2023, the QQR method captures nonlinear and asymmetric relationships across quantiles. Color gradients represent the magnitude and direction of the estimated coefficients. All estimations follow the methodology by Sim and Zhou (2015).

5.5. Wavelet coherence results

In this section, the relationship between GPR and asset returns is presented using wavelet coherence analysis graphs. Higher frequencies correspond to shorter periods, whereas lower frequencies correspond to longer periods. In this study, on the y-axis, frequencies from 0 to 8 represent the short term, and frequencies from 8 to 32 represent the long term.

In the wavelet coherence analysis (see Figs. 4 and 5), the color palette on the right-hand side of the graph ranges from 0 to 1, in which red indicates comovement between time series and blue indicates no relationship between the series. The black contours represent regions that are statistically significant at the 5 percent level. The direction of the relationship in the wavelet coherence analysis is shown using arrows. Typically, the result of a wavelet coherence analysis is shown as a figure composed of five main components: eight black directional arrows (←,

→, ↑, ↓, ↘, ↗, ↙, ↖), warm and cool colors, white contours, two axes, and a cone of influence.

Rightward arrows (→) indicate that GPR and the related variable move simultaneously. Arrows pointing rightward and upward (↗) indicate that the related variable responds to GPR with a lag, but arrows pointing rightward and downward (↘) indicate that the related variable leads GPR.

In this context, for the financial assets analyzed to exhibit safe-haven properties, they must demonstrate a strong positive relationship with GPR when it is high.

Fig. 4 presents the results of the wavelet coherence analysis between GPR and BIST, ER, GOLD, and OIL. Our examination of the GPR-BIST relationship shows that the two time series move together in the short and medium term. For example, in long-term frequencies of 16–32 months, GPR has a negative (↖) leading effect on BIST during the initial phase of the Russia-Ukraine war. These findings indicate that BIST does

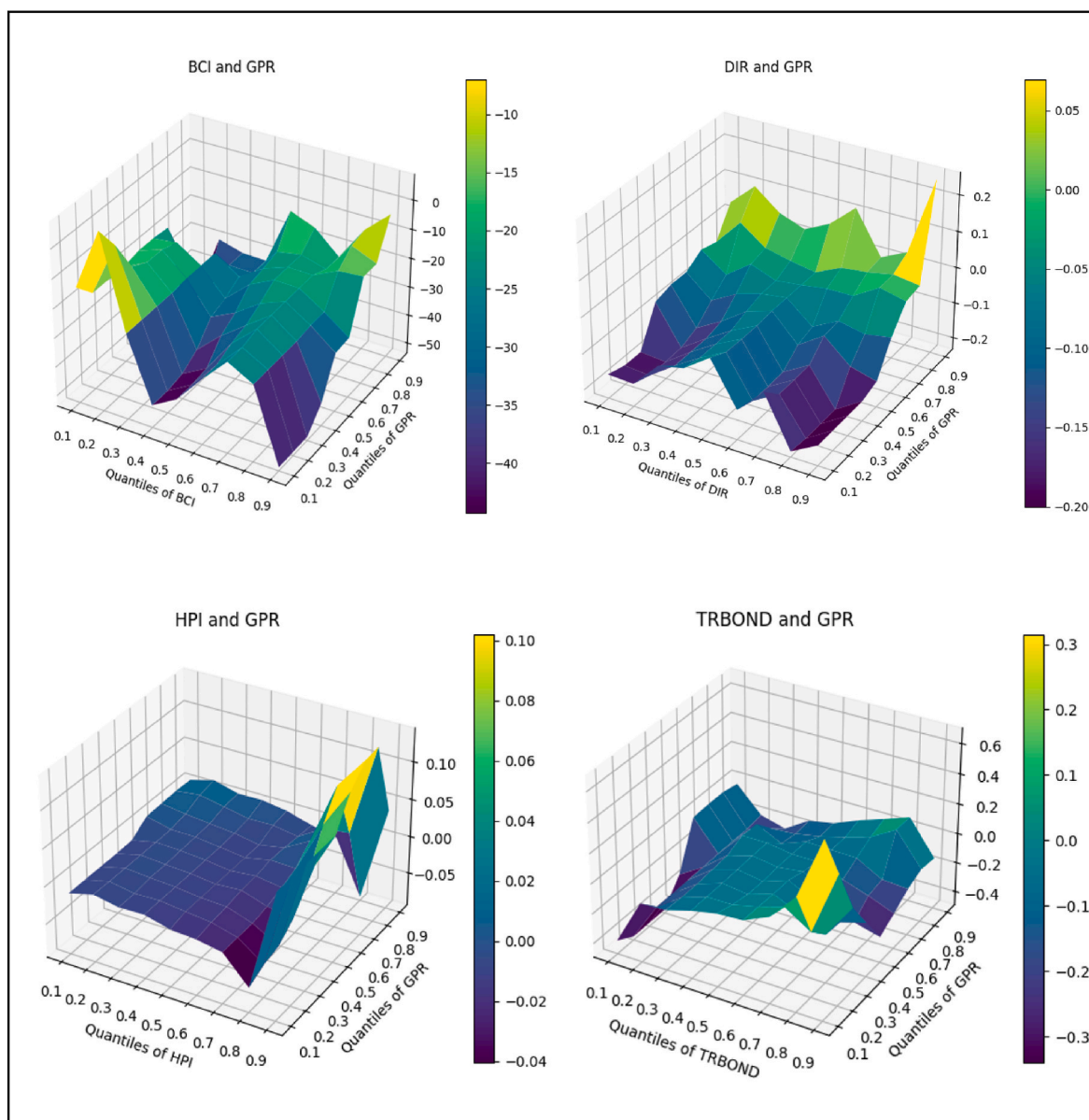


Fig. 3. Interaction between Geopolitical Risk Index and additional financial indicators: Quantile-on-quantile regression results (2).

Note: This figure displays the quantile-on-quantile regression (QQR) surfaces between the Geopolitical Risk Index (GPR) and four additional financial indicators in Türkiye: Business Confidence Index (BCI), three-month Deposit Interest Rate (DIR), Housing Price Index (HPI), and five-year Government Bond Yield (TRBOND). Based on monthly data from January 2010 to November 2023, the QQR method captures nonlinear and asymmetric relationships across quantiles. Color gradients indicate the magnitude and direction of the estimated coefficients. All estimations follow the methodology by Sim and Zhou (2015).

not have safe-haven properties during periods of heightened GPR.

In the GPR-ER graph, the two time series move together during some periods in both the short and long term. In particular, in the short term (0–8 months, e.g., late in 2013 and 2015), GPR leads (↑) the exchange rate, suggesting that fluctuations in GPR can have a leading effect on the exchange rate with the dollar in the short term. However, long-term comovement between GPR and the dollar exchange rate is observed in the long-term frequencies (32 months). Specifically, during the Gaza Flotilla Raid (May–June 2010), the relationship is positive (↘), with the dollar leading. This finding suggests that during some crisis periods, the dollar might price in geopolitical developments in advance or respond more quickly to rising risk. This data leads us to conclude that the dollar might not always serve as a “safe haven” in short-term periods of heightened GPR.

In the GPR-GOLD graph, the red clusters that GPR and gold returns move together in both the short term (0–4 months) and the long term

(over 32 months). In the short term (frequency of 0–4-months), the correlation between GPR and gold prices is positive (↘) in 2011 (when terrorist attacks and the Syrian civil war began) and in 2013 (during the Gezi Park protests¹² and period December 17–25¹³). The finding that gold prices lead this relationship suggests that GPR increases are rapidly priced into the gold market, prompting investors to turn to gold even in the short term.

However, at long-term frequencies (i.e., exceeding 32 months;

¹² The Gezi Park protests began as a small environmental demonstration in Istanbul and quickly escalated into nationwide anti-government protests, reflecting widespread political unrest.

¹³ The December 17–25 period refers to a series of judicial investigations involving high-ranking government officials. The government framed these investigations as an attempted judicial coup.

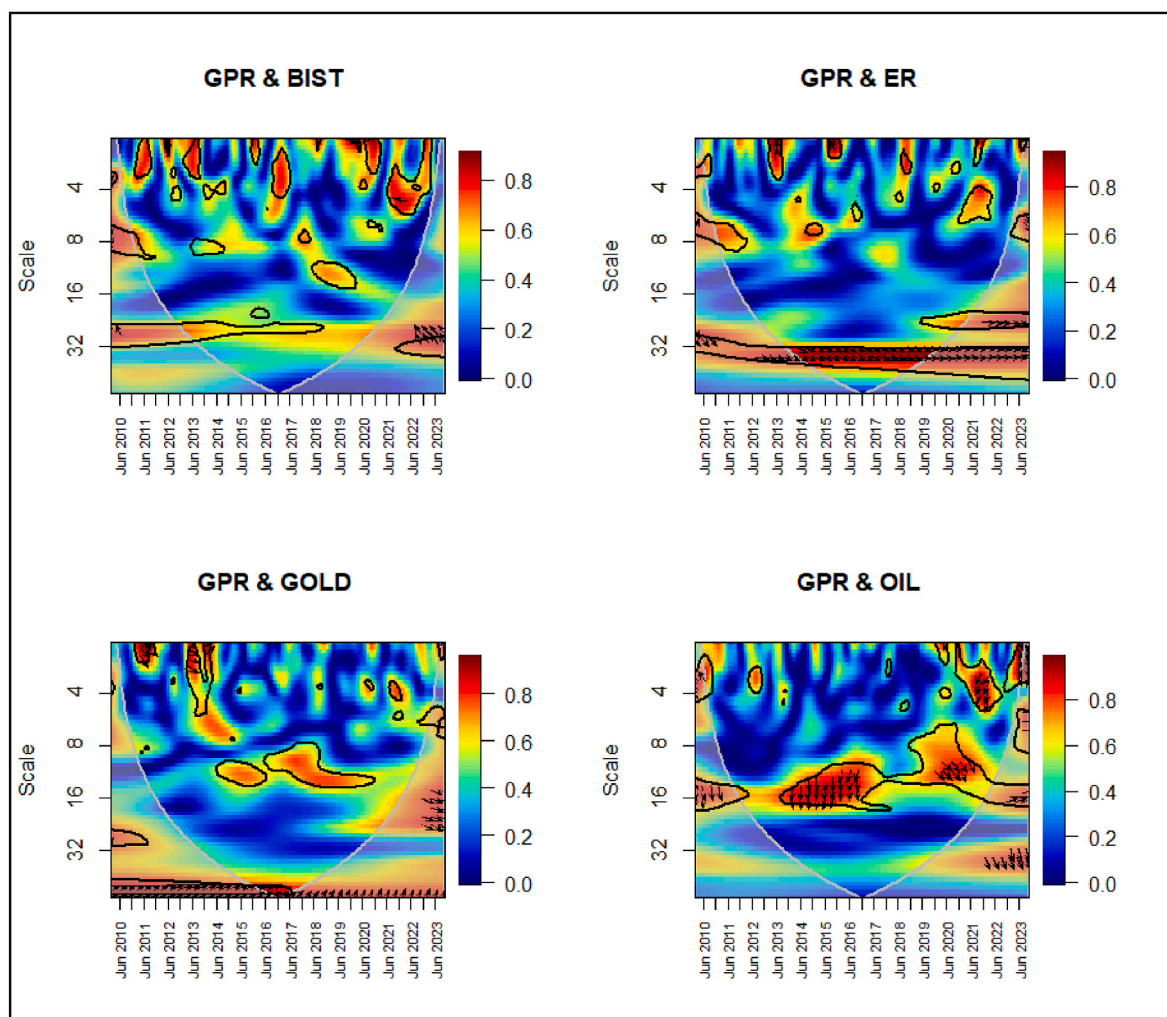


Fig. 4. Wavelet coherence results (1): GPR and selected financial variables.

Note: This figure illustrates the wavelet coherence between the Geopolitical Risk Index (GPR) and four key financial variables in Türkiye: BIST 100 Index (BIST), Exchange Rate (ER), Free Market Republic Gold Price (GOLD), and Brent Oil Price (OIL). The x-axis represents time, and the y-axis indicates frequency. Warmer colors (e.g., red) indicate stronger comovement, and cooler colors (e.g., blue) reflect weak or no relationship. Black contours represent regions that are significant at the 5% level. Arrows indicate phase relationships: → indicates in-phase and simultaneous movement; ← indicates antiphase (negative correlation); ↗ and ↘ show that GPR leads, with positive and negative effects, respectively; ↖ and ↙ suggest that the other variable leads GPR.

between 2010 and 2023), GPR and gold prices have a distinct and positive (↗) relationship. In these long-term “clusters,” GPR leads gold prices (↗), indicating that persistent or upward-trending fluctuations in GPR are gradually reflected in gold prices over time.

These results suggest that gold maintains its safe-haven properties for investors during periods of heightened GPR—in both the short and long term—and align with findings in previous studies (Baur & Smales, 2018, 2020; Triki & Maatoug, 2021). When perceptions of risk are heightened, gold prices typically move in the same direction as GPR, either simultaneously or with gold leading the movement.

In the GPR-OIL graph, “red clusters” indicate comovement between the two series in both the short- and long-term frequencies. However, the direction of the correlation and phase difference changes periodically. In the short term (frequency of 0–4-months), a negative (↘) out-of-phase relationship led by GPR began in 2010. This suggests that increases in GPR during that period had a delayed and inverse effect on oil prices.

But, in the long term, our analysis shows that oil has a leading (↖) effect on GPR. Between 2013 and 2017, geopolitical events such as the Syrian civil war and the illegal oil exports by ISIS terrorists directly impacted oil markets, resulting in more pronounced synchronization between the GPR Index and oil prices. In 2020–2021, another short-

term, negative, out-of-phase interaction occurs, in which oil prices again take the lead. This indicates that rapid price changes in the oil market, driven by fluctuations in risk perception, tend to lead movements in the GPR index, especially during certain periods. The presence of out-of-phase arrows (↖) in the wavelet coherence plot suggests that oil prices anticipate geopolitical risk rather than respond to it. These results suggest that oil does not act as a safe haven during periods of heightened GPR. Unlike traditional safe-haven assets, oil prices respond to risk perceptions in different directions and with varying phase differences in both the short and long term.

Fig. 5 illustrates the wavelet coherence analysis between GPR and BCI, DIR, HPI, and TRBOND. The GPR-BCI graph shows that the relationship between GPR and business confidence varies in different directions. In the short term, the relationship is positive (→) between 2010 and 2012 (during the Gaza Flotilla Raid and the Syrian war), but negative (←) in the long term. This suggests that entrepreneurs could capitalize on uncertainty in the short term, but business confidence weakens in the long term. In 2022 (at the outset of the Russia-Ukraine war), the short-term correlation is positive (→), whereas between 2020 and 2022, GPR has a leading (↑) effect on business confidence. In the long term (2015–2023), a negative (↘) relationship led by business confidence emerged, indicating that prolonged uncertainty has a

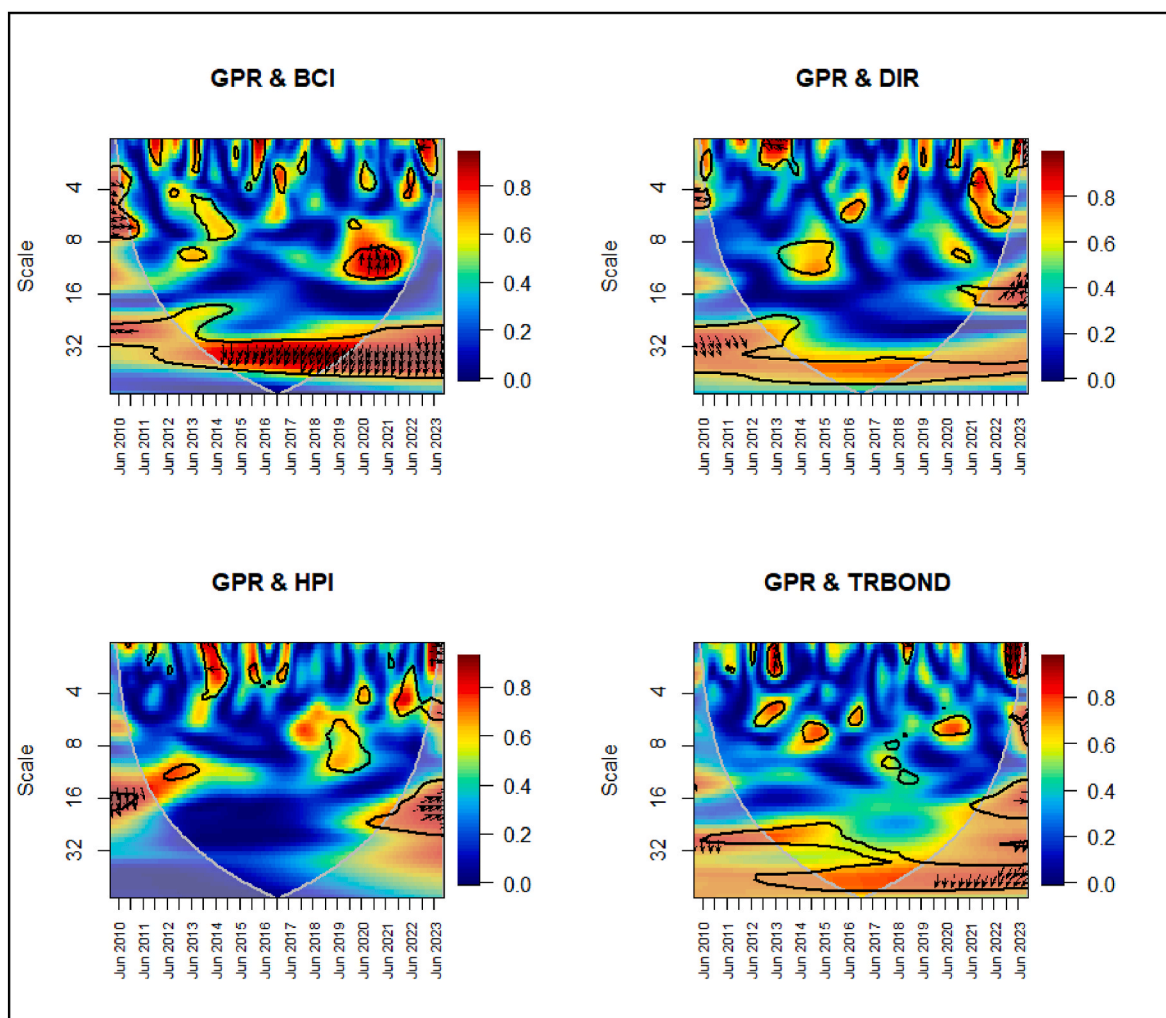


Fig. 5. Wavelet coherence results (2): GPR and selected financial variables.

Note: This figure illustrates the wavelet coherence between the Geopolitical Risk Index (GPR) and four additional financial variables in Türkiye: Business Confidence Index (BCI), three-month Deposit Interest Rate (DIR), Housing Price Index (HPI), and five-year Government Bond Yield (TRBOND). The x-axis represents time, and the y-axis indicates frequency. Warmer colors (e.g., red) indicate stronger comovement, and cooler colors (e.g., blue) reflect weak or no relationship. Black contours mark regions that are statistically significant at the 5% level. Arrows indicate phase relationships: → indicates in-phase and simultaneous movement; ← indicates antiphase (negative correlation); ↘ and ↙ show that GPR leads, with positive and negative effects respectively; ↖ and ↗ suggest that the other variable leads GPR.

negatively impact on investment decisions. These findings suggest that whereas GPR may create opportunities for some investors in the short term, but it weakens business confidence and the investment environment in the long term. Therefore, it is difficult to assume that business confidence functions as a “safe haven” during periods of rising GPR. Although entrepreneurs could seize short-term opportunities, prolonged risk leads to a decline in business confidence and negatively affects the investment environment.

In the GPR-DIR relationship, correlation between GPR and deposit interest rates is low in the short term (0–8 months). However, in the medium term (8–16 months), particularly after 2018, the correlation becomes more pronounced, in which the direction of the arrows periodically changes. This indicates that the impact of GPR on interest rates fluctuates, rather than remaining stable. In the longer term (more than 16 months, until 2020), the coordination between GPR and DIR becomes clearer, in a positive relationship led by interest rates (↖). This finding suggests that increases or decreases in DIR can predict movement in GPR and that interest rates show sensitivity to risk perception over the long term.

The GPR-TRBOND relationship shows a negative out-of-phase effect led by GPR (↗) in the short term (0–4 months). This suggests that sudden geopolitical tensions might place delayed and inverse pressure

on government bond yields. However, in long-term frequencies (more than 16 months, particularly after 2018), distinct alignment and positive correlation emerge between bond yields and GPR. The relationship, led by bond yields (↖), indicates that, as risk perception increases, bond yields tend to rise as well. Although investor demand for bonds might increase during periods of GPR, this demand also raises the risk premium, pushing yields higher in the long term. In summary, GPR influences fixed-income investment differently in the short and long term. In the short term, sudden increases in risk can have inverse or unclear effects on DIR and bond yields. However, in the long term, interest rates and bond yields tend to reflect fluctuations in GPR, sometimes even leading those fluctuations. These findings align with those by De Wet (2023), suggesting that fixed-income instruments are not considered “safe havens” during periods of rising GPR. Rather, they tend to have an upward trend in response to increasing risk perception over the long term.

The GPR and HPI relationship has distinct areas of correlation in the short (0–4 months) and medium (8–16 months) term, particularly in 2011–2013. During this period, increases in GPR has an inverse or out-of-phase effect on housing prices in the short term. The direction of the arrows indicates that GPR sometimes leads with a negative out-of-phase effect (↗), but at other times, HPI has a delayed response (←). This

suggests that the housing market can fluctuate in response to GPR in the short term. In the longer term (16 months and beyond), particularly in 2015–2023, a distinct and positive region of correlation emerges between GPR and HPI. In this period, the direction of the arrows generally indicates that HPI leads the relationship (\searrow) or moves simultaneously with GPR (\rightarrow). This suggests that the housing market can price in changes in GPR in advance over the long term or that rising risk perception prompts investors to shift to real estate as a “physical asset.” Although these results align with those by Bekar (2023) in the short term, they differ in the medium and long term.

6. Concluding remarks and policy suggestions

This study examines the safe-haven assets preferred by investors in Türkiye during periods of geopolitical risk. Using monthly data for the period January 2010 to November 2023, the analysis is based on the GPR Index developed by Caldara and Iacoviello (2018). To reveal the nonlinear and asymmetric structure of financial market dynamics, we use advanced econometric methods, such as the quantile unit-root test, quantile cointegration test, QQR, and wavelet coherence analysis.

The findings indicate that increases in GPR have varying effects on different assets in Türkiye’s financial markets. Gold has proven to be a valuable hedging tool for investors, especially during periods of high GPR, demonstrating its safe-haven properties. The USD/TRY exchange rate has responded positively during periods of heightened risk, making it another preferred safe-haven asset among local investors. However, this relationship is not consistent in the short term, as the exchange rate’s response to risk changes over time. The real estate market has also shown an upward trend when GPR is high, positioning itself as an alternate investment asset in the long term.

During periods of increases in GPR, the BIST 100 Index has been unstable, indicating that it does not have safe-haven properties. Similarly, oil prices (Brent) are considered an economic risk factor because of Türkiye’s dependence on energy imports. Among fixed-income investment instruments, the three-month DIR and Türkiye’s five-year Government Bond Yield (TRBOND) reflect the demand for higher returns as GPR increases, creating a market outlook for them shaped by rising risk premiums, rather than their acting as safe-haven assets.

The study contributes to the literature by revealing the nonlinear and asymmetric effects of GPR on financial markets using quantile-based methods. The safe-haven properties of gold when GPR is high found here are consistent with findings in previous studies, such as Triki and Maatoug (2021) and Baur and Smales (2018, 2020). The exchange rate has safe-haven properties in the long term but fluctuates in the short term, a finding that mirrors that of Hui (2022) and Lilley et al. (2022). Although our finding of the real estate market’s upward trend when is high supports the findings by Bekar (2022), we obtain different results in the medium and long term, hence, this study contributes to an ongoing debate in the literature.

Our findings reveal the complex effects of GPR on Türkiye’s financial markets and macroeconomic indicators. Because of investor demand for safe-haven assets, promoting assets such as gold and real estate might be crucial for maintaining economic stability in periods of geopolitical uncertainty. Additionally, risk management strategies should be developed that take into account the responses of fixed-income investments

and stock markets to GPR. Creating environments in which investors can diversify their portfolios and build a more resilient financial structure could help increase Türkiye’s resilience to external shocks.

The study offers significant insights for both investors and policy makers. Turkish investors can mitigate risk during periods of heightened geopolitical tension by holding gold and foreign currency in their portfolios. Real estate investment can provide long-term protection against GPR, although short-term fluctuations should be kept in mind. Policy makers should implement effective monetary and fiscal policies to maintain economic stability by controlling exchange rate volatility and rising bond yields during periods of GPR.

One limitation of this study is that the analysis uses monthly data, which might not fully capture the effects of short-term shocks. Future research could achieve more detailed analyses by employing weekly or daily data. Additionally, incorporating alternative indicators, such as cryptocurrencies and Credit Default Swap (CDS) premiums could yield a broader perspective about investor behavior in the face of GPR. These findings offer valuable guidance for investors in Türkiye who wish to diversify their portfolios and optimize risk management strategies during periods of geopolitical uncertainty.

CRedit authorship contribution statement

Durmuş Yıldırım: Conceptualization, Methodology, Funding acquisition, Visualization, Writing – review & editing, Formal analysis, Supervision. **Mirac Eren:** Conceptualization, Data curation, Writing – original draft, Writing – review & editing, Validation, Project administration, Supervision. All authors read and approved the final manuscript. **Mesut Dogan:** Visualization, theoretical background, Data curation, Writing – original draft, Conceptualization, Validation, Project administration, Supervision, Writing – review & editing. All authors read and approved the final manuscript.

Availability of data and material

Data and material would be available on request.

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Competing interests

The authors declare having no known competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

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APPENDIX

Appendix Table A1

Variables and descriptive statistics

Variable label	Variable	Source	Mean	Max	Min	Std.Dev.
GPR	Geopolitical Risk Index	Refinitiv Eikon	0.004	1.691	-1.696	0.521
BIST	BIST 100 Index	Refinitiv Eikon	0.016	0.219	-0.186	0.076
ER	Exchange Rate	Refinitiv Eikon	0.018	0.322	-0.112	0.052
GOLD	Free market republic gold price	Martiks Datastream	0.022	0.259	-0.079	0.048
OIL	Brent Oil Price	Refinitiv Eikon	0.001	0.416	-0.784	0.107
BCI	Business Confidence Indicator	Refinitiv Eikon	-3.701	24.8	-57.5	11.84
DIR	3-Month Deposit Interest Rate	EVDS Data Central	0.009	0.58	-0.294	0.095
HPI	Housing Price Index	EVDS Data Central	0.019	0.128	-0.011	0.025
TRBOND	Türkiye 5-Year Bond Interest Rate	Refinitiv Eikon	0.006	0.422	-0.385	0.116

Appendix Table A2

BDS independence test

Variable	m = 2		m = 3		m = 4	
	z-stat.	prob.	z-stat.	prob.	z-stat.	prob.
GPR	2.009	0.045	2.522	0.012	2.368	0.018
BIST	6.204	0.000	7.115	0.000	6.385	0.000
ER	1.262	0.207	1.243	0.214	1.201	0.230
GOLD	-0.406	0.685	-0.461	0.645	-0.273	0.785
OIL	5.427	0.000	5.215	0.000	5.340	0.000
BCI	23.340	0.000	23.110	0.000	22.900	0.000
DIR	5.436	0.000	5.416	0.000	5.088	0.000
HPI	14.173	0.000	13.974	0.000	13.741	0.000
TRBOND	2.382	0.017	2.315	0.021	2.062	0.039

Notes: The entries indicate the z-statistics from the BDS test based on the residuals of the variables considered. m denotes the embedding dimension of the BDS test. All the hypotheses are rejected at the 1% significance level.

Appendix Table A3

Quantile unit-root test

	GPR	BIST	ER	GOLD	OIL	BCI	DIR	HPI	TRBOND
Tau	$\alpha(\tau)$	$\alpha(\tau)$	$\alpha(\tau)$	$\alpha(\tau)$	$\alpha(\tau)$	$\alpha(\tau)$	$\alpha(\tau)$	$\alpha(\tau)$	$\alpha(\tau)$
0.10	-1.49 (-27.37)	-0.95 (-25.96)	-1.02 (-10.05)	-0.91 (-15.64)	-0.58 (-7.79)	0.12 (-6.10)	-0.89 (-24.82)	-0.31 (-16.85)	-1.37 (-18.21)
0.20	-1.39 (-26.93)	-0.91 (-17.93)	-1.05 (-21.14)	-0.83 (-23.70)	-0.74 (-11.99)	-0.15 (-10.34)	-0.89 (-22.57)	-0.31 (-27.22)	-1.09 (-16.80)
0.30	-1.30 (-28.31)	-0.75 (-14.62)	-1.01 (-27.59)	-0.86 (-31.70)	-0.84 (-20.22)	-0.23 (-14.60)	-0.87 (-20.07)	-0.30 (-29.58)	-0.97 (-21.27)
0.40	-1.25 (-22.26)	-0.86 (-16.94)	-0.95 (-30.40)	-0.88 (-32.03)	-0.75 (-16.75)	-0.30 (-16.71)	-0.77 (-20.56)	-0.31 (-22.40)	-0.98 (-23.44)
0.50	-1.29 (-25.58)	-0.93 (-19.30)	-0.91 (-23.93)	-0.90 (-21.59)	-0.79 (-20.17)	-0.33 (-15.56)	-0.77 (-20.89)	-0.21 (-16.26)	-0.96 (-26.22)
0.60	-1.37 (-26.69)	-0.94 (-20.63)	-0.96 (-21.85)	-0.91 (-21.66)	-0.88 (-17.52)	-0.38 (-19.17)	-0.79 (-27.25)	-0.16 (-17.87)	-0.94 (-24.87)
0.70	-1.32 (-25.38)	-1.04 (-17.91)	-0.87 (-15.81)	-0.76 (-21.52)	-0.89 (-33.71)	-0.44 (-24.36)	-0.77 (-14.91)	-0.02 (-8.49)	-0.94 (-26.24)
0.80	-1.35 (-19.32)	-1.03 (-15.77)	-0.77 (-16.84)	-0.67 (-13.52)	-0.99 (-25.58)	-0.44 (-22.83)	-0.80 (-13.86)	0.10 (-11.05)	-0.99 (-19.72)
0.90	-1.21 (-19.04)	-1.13 (-28.60)	-0.65 (-6.04)	-0.30 (-7.01)	-0.97 (-17.91)	-0.56 (-17.27)	-0.75 (-3.53)	0.13 (-5.66)	-1.16 (-9.34)

Note: The table shows the persistence estimates $\alpha(\tau)$, t-statistics of the quantile unit-root test by [Koenker and Xiao \(2004\)](#) and [Galvao \(2009\)](#). t-statistics are in parentheses; the critical value is 1.959 at the 5% level of significance.

Appendix Table A4

Quantile cointegration test

Tau	GPR-BIST			GPR-ER			GPR-GOLD			GPR-OIL		
	Beta	sup_Vn	cv1	beta	sup_Vn	cv1	beta	sup_Vn	cv1	beta	sup_Vn	cv1
0.1	-0.38	8.26	19.79	-0.60	8.11	20.02	-0.52	8.71	19.72	-0.41	8.49	19.71
0.2	-0.97	5.55	13.23	-1.40	5.18	13.43	0.17	4.50	13.35	-0.10	5.32	13.29
0.3	-0.68	3.18	8.73	-1.81	3.38	8.82	1.25	2.98	8.81	0.12	3.15	8.72

(continued on next page)

Appendix Table A4 (continued)

Tau	GPR-BIST			GPR-ER			GPR-GOLD			GPR-OIL		
	Beta	sup_Vn	cv1	beta	sup_Vn	cv1	beta	sup_Vn	cv1	beta	sup_Vn	cv1
0.4	-0.54	2.11	5.12	-2.02	2.41	5.20	1.20	2.00	5.20	-0.29	2.15	5.15
0.5	-0.45	0.89	2.15	-1.34	1.04	2.23	2.35	0.61	2.16	-0.59	0.63	2.23
0.6	-0.16	1.79	5.09	-1.32	1.22	5.08	2.02	1.38	5.21	-0.73	2.03	5.24
0.7	-0.94	4.05	8.85	1.30	3.74	8.90	3.49	4.09	8.81	-0.87	3.70	8.82
0.8	-1.27	5.86	13.24	0.84	5.71	13.20	2.20	5.83	13.19	-0.48	5.64	13.36
0.9	-1.08	7.94	19.70	0.46	8.18	19.94	1.69	8.27	19.86	0.43	8.24	19.52
tau	GPR-BCI			GPR-DIR			GPR-HPI			GPR-TRBOND		
	Beta	sup_Vn	cv1	beta	sup_Vn	cv1	beta	sup_Vn	cv1	beta	sup_Vn	cv1
0.1	0.001	8.75	19.74	-0.58	7.71	19.92	-3.18	7.96	19.96	0.38	8.33	19.83
0.2	0.002	4.51	13.23	-1.25	4.78	13.32	-3.98	5.05	13.12	1.21	5.37	13.11
0.3	0.001	3.04	8.85	-0.80	3.42	8.79	1.15	3.02	8.88	0.47	3.33	8.81
0.4	-0.001	2.04	5.09	-0.93	2.51	5.08	2.22	1.97	5.10	0.25	2.32	5.18
0.5	-0.002	0.98	2.17	-0.39	0.96	2.18	2.75	0.98	2.26	0.24	0.84	2.17
0.6	-0.003	1.61	5.23	-0.82	1.50	5.13	3.23	1.38	5.17	-0.08	1.53	5.17
0.7	-0.001	4.26	8.82	-0.54	4.07	8.86	1.29	3.51	8.73	-0.10	4.19	8.79
0.8	-0.003	5.63	13.25	-0.87	5.87	13.40	0.08	5.77	13.25	0.22	5.77	13.20
0.9	0.001	8.30	19.84	-0.21	8.33	19.79	1.24	8.19	19.96	0.72	8.31	19.96

Note: This table presents the results from the quantile cointegration test on the relationship between Geopolitical Risk (GPR) and financial variables across quantiles (τ). The beta coefficient represents the cointegration parameter, sup_Vn is the test statistic, and cv1 is the 1% critical value from Monte Carlo simulations. Cointegration occurs if $\text{sup_Vn} < \text{cv1}$, indicating a long-term relationship at that quantile. The results highlight the asymmetric impact of geopolitical risk on financial markets.

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