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Predictability of risk appetite in Turkey: Local versus global factors

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ABSTRACT

We examine the impacts of four local and five global factors on the risk appetite in Turkey using weekly data for the period 2008–2022. There are significant causal effects of both global and local factors under various market conditions. Local factors, particularly CDS spreads, exert stronger causal effects than global factors, and qualified investors are more predictable than domestic or foreign investors. Uncertainty during the pandemic crisis weakens the explanatory powers of most factors. All investor groups are generally exposed to negative shocks and this effect strengthens at lower and middle quantiles. Policy implications are discussed.

1. Introduction

'Risk appetite' reflects the willingness of investors to bear risk, and its level differs substantially between risk-averse and risk-taking investors [1] (Gai and Vause, 2006; González-Hermosillo, 2008). Unlike investors' degree of risk aversion, which rarely changes over time as it reflects underlying preferences, investors' degree of risk appetite tends to change frequently, responding to fluctuating macroeconomic and financial environments (Gai and Vause, 2004; González-Hermosillo, 2008). Interestingly, changes in risk appetite constitute an important factor determining asset prices (Bekaert et al., 2022; Qadan, 2019), given their influence on risk-off and risk-on environments and thus on the decisions of investors to switch between risky and less risky (e.g. safe-haven) assets. In this regard, investors bearing a particular investment risk are rewarded with a risk premium, which can be defined as expected excess return (in excess of a reference risk-free rate) (Hui et al., 2013). Accordingly, within the framework of asset pricing theory, the demands of risk-seeking investors who have a high-risk appetite for risky assets in periods of optimism lead to high asset prices and low-risk premiums (Bauer et al., 2022; Chen and Poon, 2007; Kumar and Persaud, 2002). Conversely, when there is an increase in the level of risk aversion, the lower demand for risky assets from risk-seeking investors and the higher demand for safe-haven assets from risk-averse investors lead to an increase in risk premiums, a simultaneous decrease in risky asset prices, and an increase in safe-haven asset prices (Coudert and Gex, 2008; Dupuy, 2009). Therefore, during contraction periods, such as the LTCM collapse in October 1998 or the recent financial crisis, investors become risk-averse and switch to safe-haven assets, whereas in expansion periods, such as bull markets, investors bear more risk by moving their investments into risky assets (Bekaert and Hoerova, 2016; Hassan et al., 2017; Lee and Kim,

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[1] Risk aversion is the agent's attitude to risky prospects when simultaneously confronted with definite payments and gambles of equal expected payoffs. We thank an anonymous referee for pointing to this.

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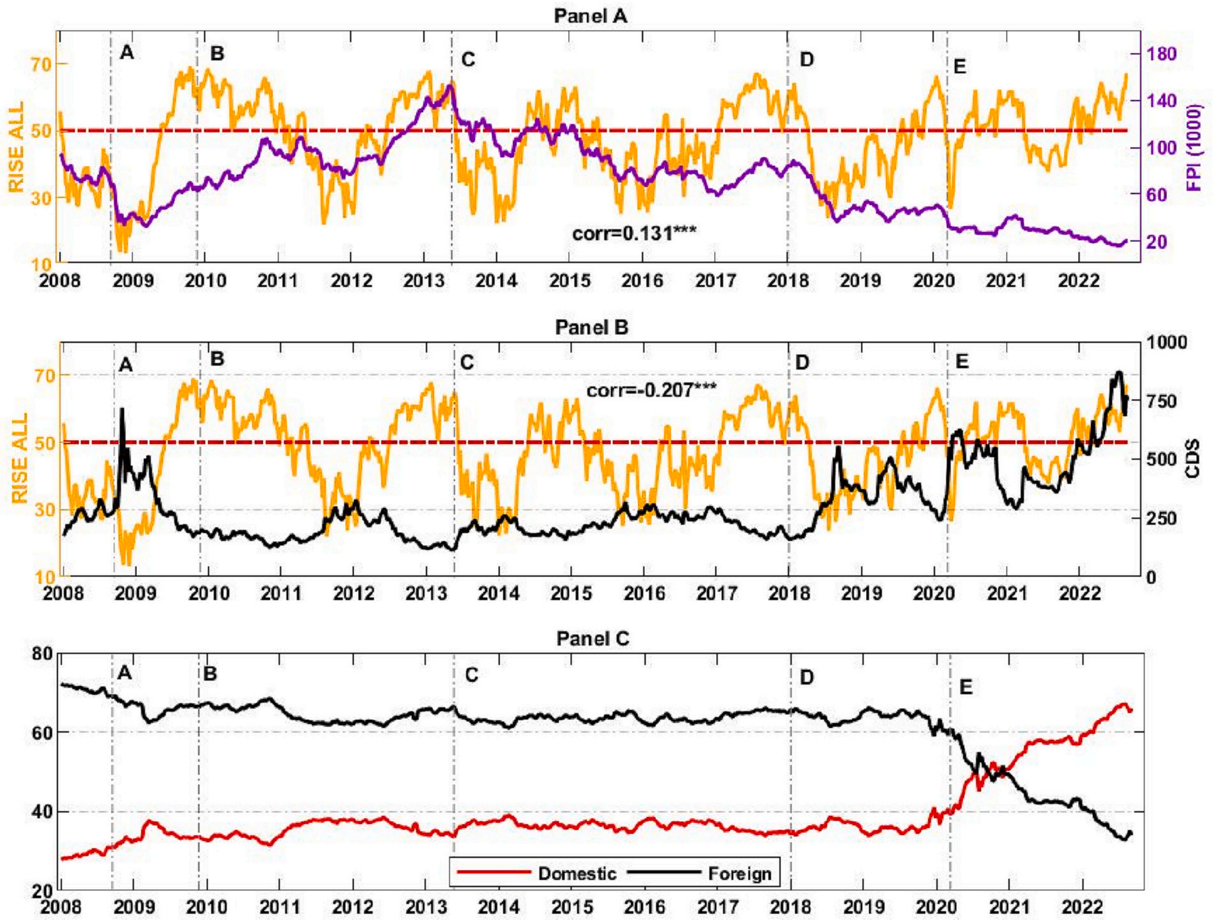


Fig. 1. Time series plot of risk appetite index, portfolio flows to Turkey, CDS, and shares of domestic and foreign investors.
Note: A: the collapse of Lehman Brothers; B: Eurozone sovereign debt crisis; C; FED tapering; D: currency crisis in Turkey, and E: first COVID-19 related death reported in Turkey and the declaration of COVID-19 as a pandemic.

2019).

Many investment banks and central banks have developed their own risk appetite indices to measure the risk perception of investors. These risk appetite indices are: (i) JP Morgan's liquidity, credit, and volatility index; (ii) UBS's investor sentiment index; (iii) Merrill Lynch's financial stress index; (iv) Westpac's risk appetite index; (v) the Tarashev et al. (2003) risk appetite index developed at the Bank for International Settlements; (vi) the Gai and Vause (2004) risk appetite index developed at the Bank of England; (vii) the Kumar and Persaud (2002) global risk appetite index used by both the IMF and JPMorgan; (viii) Wilmot et al. (2004) global risk appetite index developed at the Credit Suisse First Boston; (ix) the State Street investor confidence index; and (x) the Goldman Sachs risk aversion index. Finally, the Chicago Board options exchange volatility index (VIX), which is derived from S&P 500 options that investors buy and sell to change the amount of risk they are exposed to, is often considered a quick and easy proxy for risk appetite and is the most commonly used in the literature (e.g., Fender et al., 2012; Jung Park et al., 2019; Miyajima et al., 2015).

Risk appetite (RISE) in Turkey is calculated for various investor groups (all investors, domestic investors, foreign investors, domestic real entities, domestic legal entities, domestic funds, and qualified investors) with the cooperation of the Central Registry Agency (MKK) and Ozyegin University (Saraç et al., 2016). RISE is calculated based on the weekly portfolio changes of each investor with a stock portfolio value of at least 5000 Turkish Lira (TL) in any previous period. The threshold value for the risk appetite index is accepted as 50. The fact that the announced index value is above 50 indicates that investors have a higher risk position than the average risk of their previous 52-week positions in the stock market. If the index value is below 50, it means that there is a decrease in position risks on average compared to the previous 52-week period. Since the risk perception of each investor type is different in the markets, separate indices are calculated for the six investor groups (domestic investors,[2] foreign investors,[3] domestic real entities,[4] domestic legal entities,[5] domestic funds, and qualified investors[6]) as well as the general RISE index covering all investors.

After the 1980s, the Turkish financial market grew rapidly as a result of liberal economic policies and various domestic reforms including the transition from a fixed exchange rate to a flexible exchange rate regime, and improved perceptions of foreign capital towards Turkey (Guliyev, 2022; Tarakçı et al., 2022). Therefore, it is crucial to understand the risk appetite of international investors in determining portfolio flows (Aktas and Eksi, 2020).

The time series plot of several financial indicators is shown in Fig. 1 to provide an overview of the risk appetite of the stock market in Turkey. The risk appetite of all investors and portfolio flows to Turkey (Panel A) move significantly in the same direction (0.131), while it is significantly negatively correlated (−0.207) with the level of risk premium (Panel B) over the sample period, which covers several major financial events. Since early 2020, however, the correlation coefficient switches sign from positive (negative) to negative (positive) for the portfolio flows (CDS spreads) amid the coronavirus and ongoing currency crisis. For example, a strengthening co-movement (a correlation coefficient about 0.27) between risk appetite and risk premium since the pandemic crisis is obvious and this may be interpreted as evidence of investors seeking safety in Turkish equities with the spread of the coronavirus and rising inflation pressure. This results in an extraordinary increase in the share, particularly in the number, of domestic investors' equity holdings (Panel C).

At the end of 2008, with the effect of the global financial crisis (GFC), large outflows were seen, especially in the bond and equity markets of emerging economies. However, thanks to the ample liquidity injected by central banks after the crisis, and the expansionary policies followed by advanced economies, investors' risk appetite for high-yielding assets in developing countries such as Turkey increased (Erduman and Kaya, 2014; Ferriani, 2021; Özen and Tetik, 2019). Along with the GFC, increasing global risk aversion with the deepening of the Eurozone crisis in 2011–12 and the US Federal Reserve's (FED) May 2013 'taper tantrum' announcement caused sharp capital outflows in emerging economies such as Turkey (Ananchotikul and Zhang, 2014; Aktas and Eksi, 2020; Çepni et al., 2021).

It is crucial to examine the relationship between the CDS premium and risk appetite, which matters for foreign investors' investment decisions and policy makers' economic policies regarding liquidity conditions (Fettahoğlu, 2019). Notably, due to economic and political instability, an increase in country risk adversely affects investment decision processes, causing foreign investors to sell securities in the country's currency and send funds back to their home countries (Hui and Fong, 2015). Countries with low country CDS premiums can attract more foreign investors through securities (Kartal et al., 2022). In August 2018, Turkey faced a currency crisis and Turkey's 5-year CDS premium increased to 576 basis points. Finally, the uncertainty caused by COVID-19 in the first half of 2020 and the increase in CDS premiums by 39 basis points in developed countries and 770 basis points in developing countries (Cevik and Öztürkkal, 2021) caused investors to include less risky investments in their portfolios and significantly reduce their risky investments in developing countries (Çakmaklı et al., 2020). For example, the graph of the domestic/foreign investor ratio (Panel C of Fig. 1) on the basis of equity shows that foreign investors in Turkey made sharp capital outflows, especially with the 5-year CDS premium of Turkey rising up to 650 in April 2020. Thanks to falling deposit interest with the interest rate cuts of the Turkish Central Bank, overvalued gold and Dollars on a global basis led domestic investors to flow into Borsa Istanbul, which gave an opportunity to buy during the stock market dip of March 2020. In light of this discussion, the motivation of this study is to predict investor risk appetite around local and global events.

In the academic literature, several studies examine the impact of risk appetite on asset prices: including Cipollini et al. (2018), Cuadro-Sáez et al. (2009), Dai and Chang (2021), and Demirer et al. (2018) for stock markets; Daude et al. (2016), and Fatum et al. (2017) for currency markets; and Buncic and Moretto (2015), Demirer et al. (2019), and Shahzad et al. (2019) for commodity markets. The common point of these studies is that the global risk indicator, VIX (stock market volatility index), is included as an explanatory variable in the model. However, uncertainty and macroeconomic factors can affect the risk appetite of investors and their effect tends to vary over time (González-Hermosillo, 2008; Hui et al., 2013). In this paper, we enrich the existing literature by examining the effect of four domestic and five global macroeconomic factors on risk appetite in Turkey.

There are a limited number of studies in the literature examining the relationship between risk appetite and asset prices. Cohen and

[2] Domestic investors, including domestic real entities and domestic legal entities, refer to citizens of the Republic of Turkey even if they reside abroad.

[3] Foreign investors refers to foreign nationals even if they reside in Turkey.

[4] Domestic real entities refers to local individual investors.

[5] Domestic legal entities refers to institutional investors.

[6] According to Communiqué on the Sales of Capital Market Instruments (II-5.2) art. 4/1-m qualified investor refers to a *"professional customer that is defined in regulations on investment institution and customers who become a professional customer on demand"*. Professional customer is defined in Communiqué on Principles of Establishment and Activities of Investment Firms (III-39.1) as "*a customer who has experience, knowledge and expertise required for giving his own investment decisions and evaluating and assessing associated risks*." According to art 31/1-a: a person (regardless of whether it is legal or natural person) also can be a professional customer on demand in the case that the person meets at least two conditions mentioned in art. 32. These conditions are: 1- *"Having executed at least 10 transactions and a minimum trading volume of 500,000 Turkish Lira in the markets where trading is requested for each quarterly period during the past one year"*, 2- "*Holding total financial assets, including but not limited to cash deposits and capital market instruments, excess of 1,000,000 Turkish Lira"*, 3- "*Having worked at any one of top managerial positions in the field of finance for at least 2 years or as specialized personnel in capital markets for at least 5 years or holding Capital Market Activities Advanced Level License or Derivative Instruments License"*. In the case that a customer meets at least two of these three criteria, it can be a professional customer. If a customer only can meet the second criteria, it cannot be a professional customer but can be a qualified investor.

Qadan (2010) examine the relationship between gold prices and the fear of market participants, as reflected by VIX, from November 18, 2004 to July 22, 2009, and find that an increase in gold prices leads to a higher level of fear. Qadan and Yagil (2012) examine the causal relationship between the volatility index (VIX), which is an indicator of fear sensitivity, and future gold prices for the period 3 January 1995 to 17 May 2010, and conclude that the VIX drives gold futures returns. González-Hermosillo (2008) examines the relationship between risk appetite and bond prices using the bond prices of 17 countries and the global risk appetite index (VIX), and shows a significant relationship between risk appetite and bond prices. Adrian et al. (2010) examine the relationship between the currencies of 23 countries against the Dollar and the global risk appetite index (VIX) for the period 1993 M01–2014 M12, and conclude that there is a significant relationship between the exchange rate and the global risk appetite index.

The existing studies on the risk appetite index for Turkey are limited in number, scope, and applied methods. Saraç et al. (2016) examine the predictability of the risk appetite series of domestic and foreign investors over the period 2008–2013. They find evidence that the risk appetite series of domestic investors is linear and does not have a threshold effect, while the risk appetite series of foreign investors is not linear but has a threshold effect and is predictable only during periods of decreasing risk appetite. Fettahoğlu (2019) tests the relationship between Turkish CDS premiums and the risk appetite index, and shows that the risk appetite of foreign and domestic investors can explain CDS premiums and there is a significant negative correlation between CDS premiums and the risk appetite index. Uzkaralar and Kandir (2020) study the relationship between CDS premiums and risk appetite, and find a bi-directional causality. İskenderoğlu and Akdağ (2019) investigate whether there is a causal relationship between the risk appetite data of all investor types and oil prices, exchange rates, gold prices, and interest rates, using weekly data for the period 2008–2015. They find a long-term causality relationship between oil prices and risk appetite, evidence that exchange rates have short, medium, and long-term causal flow on risk appetite, and that changes in gold prices and interest rates have a short-term causal effect on investors' risk appetite. Akdağ and Iskenderoğlu (2019) examine whether the risk appetite index of all investors is parametrically divided into regimes for the period 2008–2016, and their results suggest that the risk appetite index of all investors shows high and low volatility regimes. They indicate that economic crisis, political instability, and increasing terror attacks globally and in Turkey occur during high volatility periods of risk appetite. Akdağ et al. (2020) examine the volatility spillover effects between the US CBOE VIX and the investor risk appetite index for the period January 2010 to December 2018, and show a unilateral causal impact from the VIX to the investor risk appetite index.

This study complements the existing literature in the following ways. It constitutes one of the first attempts to investigate the risk appetite of investors in an emerging market considering the effects of local and global factors simultaneously over conditional distributions. To do so, this study uses two nonparametric quantile-based approaches, the causality-in-quantile method proposed by Balcilar et al. (2016)[7] and quantile-on-quantile regressions introduced by Sim and Zhou (2015), which are widely used and robust to possible errors due to nonlinearity, the existence of structural breaks, and nonparametric structures. By doing this, this study can measure the effects of several factors on risk appetite changes over various market conditions and offer suitable implications for investors and policymakers to adjust their investment and risk strategies and policies accordingly. Furthermore, this study is comprehensive in terms of the number of independent variables (four local and five global factors) and the sample period, including both crisis (financial crisis, pandemic, and war) and non-crisis periods, and this constitutes an important contribution by providing specific insight into causal flows and effects from various factor groups on the risk appetite of investors in Turkey over various quantiles.

The analysis in this paper offers noteworthy findings. The investor risk appetite indices receive causation impacts from both local and global factors over the entire period and various market conditions. Although their explanatory powers vary over the entire conditional distribution, both factor groups Granger-cause change rather than volatility of the risk appetite indices, pointing to their importance in predicting the decisions of investors. The most important drivers of risk appetite indices are changes in CDS spreads, followed by bonds, the financial stress index, and VIX. Three subindices are relatively more resilient to shocks originating from global factors, and the degree of predictability of risk appetite of domestic and qualified investors is weaker than that of foreign investors. Both factors are successful in predicting risk appetite indices before the pandemic crisis; however, their explanatory powers deteriorate with rising uncertainty during COVID-19. Among the investor groups, domestic investors are identified as the most insensitive to shocks deriving from both factor groups over all quantiles. Other than the VIX index, all variables negatively affect changes in risk appetite indices, suggesting that all investors change their total investment whenever they are exposed to negative shocks from both local and global factors. The magnitude of shocks differs over various quantiles but intensifies at lower quantiles and weakens as the level of the factor increases. Overall, the level of quantiles and type of factors considerably determine the direction and strength of the effects on the risk appetite indices, suggesting the necessity of taking appropriate investment and policy decisions compatible with various market conditions.

This study proceeds as follows. The applied quantile-based approaches are explained in Section 2. The dataset is described in Section 3. The empirical analysis and findings are presented and discussed in Section 4. Concluding remarks and implications for investors and policymakers are provided in Section 5.

[7] We prefer to use the nonparametric causality-in-quantiles approach of Balcilar et al. (2016), as this method has received great interest in the financial literature in recent years, including Balcilar et al. (2017), Jena et al. (2019), and Shao et al. (2021), among others.

2. Methodology

2.1. Causality-in-quantiles

Considering the causal effects on the risk appetite index in a bivariate framework, we implement the causality-in-quantiles approach introduced by Balcilar et al. (2016). This approach is an extension of the frameworks of Nishiyama et al. (2011) and Jeong et al. (2012). For simplicity of notation, we define the changes in the (log level of) risk appetite index as y_t and the changes in (log level of or price level of) independent variables as x_t.

As a first step, let $Y_{t-1} \equiv y_{t-1}, \ldots, y_{t-m}$, $X_{t-1} \equiv x_{t-1}, \ldots, x_{t-m}$ and $Z_t = (X_t, Y_t)$, and $F_{y_t|Y_{t-1}}(y_t, Y_{t-1})$ and $F_{y_t|Z_{t-1}}(y_t, Z_{t-1})$ represent the conditional distribution functions of y_t given Y_{t-1} and Z_{t-1}, respectively. After denoting $Q_\theta(Y_{t-1}) \equiv Q_\theta(y_t|Y_{t-1})$ and $Q_\theta(Z_{t-1}) \equiv Q_\theta(y_t|Z_{t-1})$, we obtain $F_{y_t|Z_{t-1}}\{Q_\theta(Z_{t-1})|Z_{t-1}\} = \theta$ with probability one. Consequently, the (non)causality in the θ-th quantile hypothesis that "*x_t does not cause y_t*", can be expressed as:

$$H_0 : P\left\{F_{y_t|Z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} = \theta\right\} = 1 \tag{1}$$

$$H_1 : P\left\{F_{y_t|Z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} = \theta\right\}\langle 1 \tag{2}$$

Following the procedure in Jeong et al. (2012), the feasible kernel based sample analogue can be written as:

$$\widehat{J}_T = \frac{1}{T(T-1)h^{2m}} \sum_{t=m+1}^{T} \sum_{s=m+1, s\neq t}^{T} K\left(\frac{Z_{t-1} - Z_{s-1}}{h}\right)\widehat{\epsilon}_t\widehat{\epsilon}_s. \tag{3}$$

where the distance measure is $J = \epsilon_t E(\epsilon_t|Z_{t-1})f_z(Z_{t-1})$, $K(\bullet)$ represents the kernel function with bandwidth h, while m, T, and $\widehat{\varepsilon}_t$ denote, respectively, the lag–order, sample size, and estimate of the unknown regression residual as follows:

$$\widehat{\epsilon}_t = 1\{y_t \leq \mathcal{Q}_\theta(Y_{t-1})\} - \theta \tag{4}$$

To estimate the θ-th conditional quantile of y_t given Y_{t-1}, we use the nonparametric kernel method $\widehat{\mathcal{Q}}_\theta(Y_{t-1}) = \widehat{F}^{-1}_{y_t|Y_{t-1}}(\theta|Y_{t-1})$ if the Nadarya-Watson kernel estimator is specified as:

$$\widehat{F}_{y_t|Y_{t-1}}(y_t|Y_{t-1}) = \frac{\sum_{s=m+1, s\neq t}^{T} (L(Y_{t-1} - Y_{s-1})/h)1(y_s \leq y_t)}{\sum_{s=m+1, s\neq t}^{T} L((Y_{t-1} - Y_{s-1})/h)} \tag{5}$$

We test the following hypotheses for higher-order quantile causality (the second-moment causality):

$$H_0 : P\left\{F_{y_t^k|Z_{t-1}}\{\mathcal{Q}_\theta(Y_{t-1})|Z_{t-1}\} = \theta\right\} = 1 \; for \; k = 1, 2, \ldots, K \tag{6}$$

$$H_1 : P\left\{F_{y_t^k|Z_{t-1}}\{\mathcal{Q}_\theta(Y_{t-1})|Z_{t-1}\} = \theta\right\}\langle 1 \; for \; k = 1, 2, \ldots, K \tag{7}$$

Accordingly, we test whether "*return (price) of series, x_t, Granger causes risk appetite index changes, y_t*" in quantile θ up to the *k-th* moment by employing Eq. (6) to construct the test statistic of Eq. (7) for each k. Similarly, we can study the causal impact on the θ-th quantile of risk appetite index variance by replacing y_t in Eqs. (3) and (4) with y_t^2. Including the sequential-testing method of Nishiyama et al. (2011) with some modifications, we can test for the existence of causality-in-mean (the first moment, $k = 1$). It should be noted that if the test fails to reject the null hypothesis in the first moment, it does not mean that there is also no causality-in-variance. This leads to extending the nonparametric causality to detect the variance. Lastly, this test requires specifying (*i*) the lag order m, (*ii*) the bandwidth h, and (*iii*) the kernel type for $K(\bullet)$ and $L(\bullet)$.

2.2. Quantile-on-quantile regressions

We adopt the quantile-on-quantile regression approach introduced by Sim and Zhou (2015), firstly by postulating the equation:

$$RISE_t = \beta^q(F_t) + \alpha^q RISE_{t-1} + \varepsilon_t^q \tag{8}$$

where $RISE_t$ and F_t represent endogenous (logarithmic first difference of RISE index levels) and exogenous (logarithmic first difference of local or global factors) variables at the weekly frequency, and ε_t^q is an error term with a zero q-quantile. To investigate the effect of the changes in local/global factors, F_t, at quantile τ on the changes of risk appetite index, $RISE_t$, at quantile q, we examine Eq. (8) in the neighbourhood of β^q. Since $\beta^q(\bullet)$ is assumed to be unknown a priori, this link function is linearized by taking a first-order Taylor expansion around F^τ, and thus the following equation arises:

$$\beta^q(F_t) \approx \beta^q(F^\tau) + \beta^{q'}(F^\tau)(F_t - F^\tau) \tag{9}$$

Or we can revise Eq. (9) to:

$$\beta^q(F_t) \approx \beta_0(q,\tau) + \beta_1(q,\tau)(F_t - F^\tau) \tag{10}$$

Substituting Eq. (10) into Eq. (8), we obtain:

$$RISE_t = \underbrace{\beta_0(q,\tau) + \beta_1(q,\tau)(F_t - F^\tau) + \alpha(q)RISE_{t-1}}_{(*)} + \varepsilon_t^q \tag{11}$$

where we have used the notation $\alpha(q) \equiv \alpha^q$. Note that Part(*) in the equation indicates the q conditional quantile of the changes in risk appetite index and it enable us to capture the impact of explanatory factors at quantile q on the risk appetite index at quantile τ, assuming that β_0 and β_1 are doubly indexed in q and τ. Hence, to capture the overall dependence between $RISE_t$ and F_t, we exchange, respectively, F_t and F^τ with their counterpart and empirical quantile $\widehat{F}_t$ and $\widehat{F}^\tau$. To obtain the estimates, $\widehat{\beta}_0(q,\tau)$ and $\widehat{\beta}_1(q,\tau)$, we solve the equation:

$$\min_{b_0,b_1} \sum_{i=1}^{N} \rho_q\left[RISE_t - b_0 - b_1(\widehat{F}_t - \widehat{F}^\tau) - \alpha(q)RISE_{t-1}\right] \times K\left(\frac{F_n(\widehat{F}_t) - \tau}{h}\right) \tag{12}$$

where $\rho_q[\bullet]$ is the absolute value function and gives the conditional quantile of the risk appetite index changes, $RISE_t$, as the solution. In order to disentangle the locally exerted impact originating from τ-quantile of local or global factor changes, a Gaussian kernel $K(\bullet)$ is used to weight the observations in the neighbourhood of $\widehat{F}^\tau$, based on selected optimal bandwidth parameter h. Note that these weights are inversely related to the distance of $\widehat{F}_t$ from $\widehat{F}^\tau$. The distance of the empirical distribution function therefore can be written as:

$$F_n(\widehat{F}_t) = \frac{1}{n}\sum_{k=1}^{n} I(\widehat{F}_t > \widehat{F}_k) \tag{13}$$

3. Data

This paper uses weekly data on four Turkish RISE indices, four local financial variables,[8] and five global factors from March 2008 to September 2022, consisting of 766 observations for each series. The indices of RISE, including all investors, local investors, foreign investors, and qualified investors' risk appetite indices, are obtained from the official website of the Central Registry Agency of Turkey (CRA, MKK).[9] The four local variables are 2-year government bond yields, 5-year sovereign CDS spreads, USDTRY foreign exchange rate, and gold prices in Turkish Lira. Bond yields and CDS spreads of Turkey are extracted from the Bloomberg terminal, while USDTRY and gold prices are obtained from the Central Bank of the Republic of Turkey (CBRT) EVDS Statistics database and the World Gold Council website, respectively. The five global factors are the global geopolitical risk index (GPR) proposed by Caldara and Iacoviello (2022), CBOE crude oil volatility index (OVX), financial stress index from emerging markets (FSI), CBOE volatility index (VIX), and the safe-haven index (Baur and Dimpfl, 2021). The OVX and VIX are retrieved from https://finance.yahoo.com, while the GPR (Caldara and Iacoviello, 2022), FSI (Office of Financial Research, 2022), and safe-haven index (Baur and Dimpfl, 2021) are extracted from https://www.matteoiacoviello.com/gpr.htm, https://www.financialresearch.gov, and https://datascience.uni-hohenheim.de/en/applications, respectively. We first take the 12-week moving average of each RISE index and calculate the continuously compounded growth rates of the four RISE indices by taking the first difference in the logarithms of two consecutive closing levels. For the explanatory variables, we compute the continuously compounded growth rates. We report the summary statistics of the data in Table 2.

As shown in Table 2, the average growth rates are close to zero for all variables; the changes in risk appetite indices and the explanatory variables—except for BOND, FSI, and VIX—are positive on average. The largest weekly changes among the RISE indices are observed in RISE_FRG at more than 73.5%, followed by RISE_QFI, RISE_ALL, and RISE_DOM. The largest negative growth rates for all RISE indices, ranging from −0.0914 to −0.0664, as well as the largest positive growth rates, coincide with the 2008–2009 financial crisis. Among the local variables, the changes in CDS spreads exhibit the maximum and minimum values of 37.3% and − 44.8%, respectively, during the pandemic and recent financial crisis. The gold and currency markets, respectively, encounter the lowest and highest weekly changes (−11.4% and − 16.2%) during the currency crises of August 2018 and December 2021, coinciding with the unconventional monetary policy era of the CBRT guided by political considerations. The largest decrease in the government bond market is observed in April 2020, that is, during the early stages of the pandemic. RISE_FRG sees the highest standard deviation (2.54%), while RISE_DOM has the least volatility (1.99%) among the RISE indices. The CDS market (6.61%) is more volatile than the other three markets. The standard deviations of the GPR and VIX indices are highest among the global factors. The changes in the RISE indices are significantly negatively skewed. Except BOND, all explanatory variables are significantly right-skewed and leptokurtic. The Jarque-Bera normality test rejects the assumption of normality at the conventional levels for all series.

The results of Kapetanios (2005) unit root test for 'Model C' are reported in Table 2. The results suggest that, except for the GPR index, all variables are nonstationary at levels in the presence of five structural breaks at the conventional levels. However, all

[8] We consider only the most important subindices and thus excluding the three subindices of investors resident in Turkey (domestic individuals, domestic institutional, and domestic funds) from the analysis does not have a significant impact on the generalizability of the findings.

[9] https://www.vap.org.tr/Endeksler/Sayfalar/RISE-Risk-Istahi-Endeksi.aspx

variables become stationary in the presence of two structural breaks at the conventional levels using their first logarithm differences. Accordingly, we use the log level of GPR and the growth rates of others to investigate the linear and nonlinear relationships.

To confirm our unit root results in the upper table, we conduct the quantile autoregressive unit root test of Koenker and Xiao (2004) and Galvao (2009) on the first difference of variables and present the results in Table 4, which gives the t-statistics of the null hypothesis, $H_0 : a(\tau) = 1$, (in the second row) along with the persistence estimates (in the first row), for each quantile ranging from 0.05 to 0.95. The results reject the null hypothesis of unit root for all indices, indicating that all variables are stationary at various quantiles of the conditional distributions at the 95% confidence level, which strongly confirm the results in Table 3.

4. Results and discussion

4.1. Preliminary analysis

Before presenting the results of the quantile-based approaches, we conduct the BDS test, proposed by Broock et al. (1996), for nonlinearity of VAR(1) equation residuals, and report the results in Table 5. They suggest a rejection of the null of linearity at various embedded dimensions for all VAR(1) models, except SAFEH residuals on the RISE_FRG index, at conventional levels, indicating that each series in the VAR(1) models is independently and identically distributed. Altogether, the results of the Jarque-Berra and BDS tests point to the relevance of studying the causality at various quantiles.

We apply the Bai and Perron (2003) and Andrews (1993) structural break tests, and Table 6 shows the results. The null hypothesis of "*no structural break against an unknown number of breaks*" can be strongly rejected only for the pair FRG ~ CDS and three of the four risk appetite indices when changes in USDTRY is chosen as the independent variable, since the unweighted maximized statistic (UDMax) far exceeds the critical value, implying the existence of at least one break between variables (see Panel A). Similarly, the null hypothesis could be rejected for the OVX and SAFEH equations for changes in the RISE_ALL, RISE_DOM, and RISE_FRG indices, and for the VIX equation when factors other than the foreign investors risk appetite index are selected as the dependent variable. However, the UDMax statistic indicates that not a single break exists for changes in the BOND, GOLD, FSI, and GPR equations.

Panel B in Table 6 gives the results of the three test statistics of parameter instability suggested by Andrews (1993). The parameter instability test shows homogeneous evidence to reject the null hypothesis, "*no breakpoints within 15% trimmed data*". For example, the results reveal strong evidence of parameter instability for three of the nine VAR(1) models—with a constant and at a lag = 1 level—when the changes in CDS, USDTRY, and VIX are selected as dependent variables. The results also suggest weak evidence of parameter non-constancy in the GPR and OVX equations for all RISE indices, except changes in the RISE_QFI index. Conversely, the BOND, GOLD, FSI, and SAFEH equations have stable parameters when changes in all RISE indices are selected as the dependent variable, given that none of the test statistics of the three tests exceed their critical values, indicating the nonexistence of breakpoints in VAR(1) models. Taken together, the results of the tests of breakpoints, parameter instability, and nonlinearity justify the suitability of studying the impacts of the nine factors on the RISE indices at various quantiles via the application of the causality-in-quantiles approach of Balcilar et al. (2016) and the quantile-on-quantile regression of Sim and Zhou (2015).

4.2. Causality-in-quantiles results

We present the results of the causality-in-quantile tests (Balcilar et al., 2016) in Figs. 4 and 5, where the *x*-axis shows an equally spaced grid of 19 quantiles, [0.05;0.95] and the *y*-axis shows the causality results of two moments of each model considering the 10% critical value (1.645). The rejection of the null hypothesis, "*return of x variable does not Granger cause changes in RISE index*" for the first and second moments, is represented by a green circle and black triangle, respectively. We classify the lower quantiles of each of the four RISE indices [$0.05\leq \theta\leq 0.30$] as bearish, the middle quantiles [$0.35\leq \theta\leq 0.65$] as normal, and the upper quantiles [$0.70\leq \theta\leq 0.95$] as bullish.

Fig. 4 shows all local factor changes exhibit significant causal impacts on the changes of RISE indices at varying degrees over various quantiles. The most influential predictors are the changes in BOND and CDS spreads, while the changes in the gold and currency markets are the least influential predictors. Moreover, the changes and volatility of the RISE_ALL index emerges as the most Granger-caused variable by all local explanatory variables, indicating that the future movements of risk appetite of all investors could be predicted using the current fluctuation in local markets. The most immune to the US Dollar-dependent (currency and gold) markets is the changes and volatility of risk appetite index of domestic investors, followed by foreign and qualified investors, as their test statistics hardly exceed the critical value of 1.645 at the 90% confidence level. We find that the causal impacts for the first moment hold approximately across all quantiles, whereas the causality-in-variance intensifies from middle to upper quantiles. For example, the null hypothesis of no causality in the first moment could be strongly rejected for the changes in CDS spreads over all quantiles—except for the last quantiles—for all risk appetite index changes, whereas the volatility of the four local variables Granger-cause the volatility of the four RISE indices under various market conditions for quantiles in the range 0.05 to 0.85 for RISE_ALL; at the first two normal quantiles for RISE_DOM; from quantile 0.30 to 0.50 for RISE_QFI, and under middle and high volatility states for the foreign investors index. These results indicate that the subindices of risk appetite of investors are relatively resilient to volatility shocks under the low volatility state of the CDS market, that is, falling risk premium does not exert any significant causal flows on stock market investors' holdings. Our results reinforce the findings of Uzkaralar and Kandir (2020), which indicate a two-way causal linkage between the changes of CDS and the RISE_ALL index using the standard Granger causality test for the period 2010–2019. This also agrees with the results of Srivastava et al. (2016), who reveal strong causality in mean, variance, and value-at-risk from global risk levels to CDS spreads of 59 countries and point to the contribution of local and global factors to the price discovery of the CDS market. Furthermore, the bond and currency markets Granger-cause the returns rather than the volatility of the indices and subindices, that is, they have causal impacts on indices under low and/or middle quantiles for the first moment, whereas evidence of significant causality holds only over two middle quantiles for the second moment. These results imply that the statistical significance of the causal flows for returns from the bond market to the subindices of risk appetite for the stock market is more pronounced over low and middle quantiles, but the predictive power of government bond rates for volatility in risk appetite indices is reasonably weak, since it holds when the market is normal only for foreign investor risk appetite volatility. The results also show no evidence of causality-in-mean and variance from the gold market on domestic and qualified investors, but a weak causal flow on foreign investors only at quantiles 0.65 and 075 (0.80 and 0.85) for the first (second) moment. Our findings agree with those of İskenderoğlu and Akdağ (2019), who document frequency-based causal impacts from the returns of gold, foreign exchange, and interest rates to the RISE_ALL index in the short, medium, and long-term. Similarly, Qadan and Yagil (2012) find that changes in investor sentiment Granger-cause volatility, but not returns of gold prices, which is partially in line with our findings.

The causal linkages from the global factors are highlighted in Fig. 5, from which several noteworthy findings emerge. Among all the global factors, the FSI arises as the most powerful predictor, whereas the OVX index is the least significant predictor for the four RISE indices. Both changes and volatility of the all investors risk appetite index are concurrently exposed to causal flows from all global explanatory variables over various quantiles at varying magnitudes, indicating that its return and volatility is reasonably predictable from the previous information regardless of the state of market conditions, confirming the results shown in Fig. 4. The results confirm the findings of Qadan and Idilbi-Bayaa (2020), who reveal a two-way causality between risk appetite (equity variance risk premium) and oil returns over the sample period 2004–2017. The predictability power of the VIX index on the RISE_ALL index returns and volatility is in line with Akdağ et al. (2020), who find a unidirectional causality from VIX to the RISE_ALL index. Furthermore, the FSI index Granger-causes the returns (but not the volatility) of the risk appetite of domestic and qualified investors over the middle quantiles, pointing to no probability for the predictability of those indices under extreme market conditions. Similarly, the VIX index causes returns but not volatility of the domestic and foreign investors' risk appetite indices over the quantile range from 0.25 to 0.40 and 0.60, respectively. Both volatility and returns of GPR and VIX indices improve the prediction of return and volatility in the risk appetite of qualified investors under low extreme and normal market conditions, albeit at varying degrees. We find no causality impacts from OVX and SAFEH indices to the three subindices either for the first or second moment, indicating the strength of the resilience of domestic, foreign, and qualified investor risk preferences in stock markets to causality flows from those indices under various volatility states. Likewise, the risk appetite of domestic and foreign investors is immune to geopolitical risk shocks whenever the stock market is bearish, normal, or bullish. However, the GPR index only, albeit weakly, Granger-causes changes at quantile θ=0.45 and the volatility of the RISE_ALL index at quantiles ranging from 0.55 to 0.65.

To measure whether the predictability of the risk appetite of investors in the Turkish stock market is resilient or vulnerable to causal flows from local and global factors, we use the same causality procedure on two subperiods: before (December 22, 2017 to March 6, 2020) and during (from March 13, 2020 to May 27, 2022) the COVID-19 pandemic, yielding a total of 116 weekly observations for each period. After determining the integration orders of the variables, we conduct the causality test for stationary *VAR*(1) models and present the results for the pre-COVID-19 period on the left side and the during COVID-19 period on the right side of Figs. 6 and 7 for the equally spaced grid of 10 quantiles, [0.05;0.95]. Note that we define [0.05≤ θ≤0.25] as bearish, [0.35≤ θ≤0.65] as normal, and [0.75≤ θ≤0.95] as bullish market conditions. We plot the causality-in-quantile impacts from the local factors during both subperiods in Fig. 6. A visual inspection suggests the predictability of the all investors risk appetite index weakens for the bond and CDS markets and disappears for both US Dollar-dependent markets—the currency and gold markets—before the pandemic. During the pandemic, however, the results show that the role of being a significant causal factor on the all investors risk appetite index strengthens for the CDS spreads, dissipates for the bond market, but rises for the currency and gold markets for the first and second moment, indicating that the global spread of COVID-19 may play a predominant role in enhancing/reducing the predictability of investors' reactions to the financial shocks driven by CDS, currency, and gold markets. On the one hand, the returns and volatility of domestic investor risk appetite for the Turkish stock market are significantly caused by all local factors over various quantiles before the pandemic; the predictability of this index entirely, however, disappears during the COVID-19 period, indicating that the level of risk appetite of domestic investors loses its vulnerability and becomes resilient to fluctuations in the local markets with the onset of the pandemic. On the other hand, the findings show the changes and volatility of the risk appetite of the foreign investors are exposed to weak and strong improvements in the currency and CDS markets, respectively, during the pandemic compared to pre-COVID19, indicating that the uncertainty regarding the pandemic in bearish or normal market conditions strengthens or weakens the predictability of foreign investors' investment preferences in the stock market. Although the bond, CDS, and currency markets (weakly) Granger-cause the risk appetite of qualified investors before the pandemic, they entirely lose their causal effects with the outbreak of the pandemic, making the qualified investors' stock market decisions resilient and unpredictable.

We plot the causal impacts from the five global factors on the conditional distribution of returns and volatility of risk appetite indices in Fig. 7. The financial stress from emerging markets index emerges as the only significant global factor rendering the risk appetite of all investors predictable, at quantile θ=0.45 for the first moment, before the pandemic. However, the test reveals a significant lagged causality-in-mean from the geopolitical risk at quantile 0.15 and 0.35; both causality-in-mean and variance from the oil volatility and the safe-haven indices θ=0.05 and 0.25; and from the CBOE volatility index at four lower quantiles range from 0.05 to 0.35. These results imply that the predictability of risk appetite of all investors is possible using past information of GPR, OVX, SAFEH, and VIX during the pandemic. Like the local factors, all global factors exert causal impacts on the risk appetite of domestic investors when the stock market is bearish and normal, before the pandemic, whereas this index becomes unpredictable and resilient to uncertainty shocks driven by global financial markets and geopolitical risks. The strengthening (weakening) causality flows from the FSI, SAFEH, and VIX (GPR) indices on the risk appetite of foreign investors are more prominent during the pandemic. The sensitiveness of

Table 1
Descriptive Statistics.

	Mean	Max	Min	SD	Skewness	Kurtosis	JB
Panel A: RISE indices							
RISE_ALL	0.00059	0.00180	0.06340	−0.08220	0.02260	−0.22**	0.55***
RISE_DOM	0.00067	0.00140	0.06060	−0.06650	0.01990	−0.1400	0.38**
RISE_FRG	0.00041	0.00170	0.07350	−0.09140	0.02540	−0.19**	0.57***
RISE_QFI	0.00051	0.00180	0.07310	−0.06640	0.02130	−0.25***	0.35*
Panel B: Local factors							
BOND	−0.00032	−0.00070	0.17580	−0.29240	0.03630	−0.49***	9.25***
CDS	0.00129	−0.00120	0.37300	−0.44830	0.06610	0.43***	6.19***
GOLD	0.00432	0.00280	0.10770	−0.11400	0.02440	0.28***	3.48***
USDTRY	0.00356	0.00170	0.17910	−0.16220	0.01990	1.22***	19.32***
Panel C: Global factors							
FSI	−0.00062	−0.00470	0.53280	−0.59800	0.06920	1.49***	22.48***
GPR	0.00079	−0.01490	1.45180	−0.86010	0.26030	0.34***	1.51***
OVX	0.00018	−0.00640	0.73670	−0.42570	0.09480	1.6***	11.25***
SAFEH	0.00015	0.00010	0.03670	−0.03930	0.00760	0.0700	2.67***
VIX	−0.00013	−0.01230	0.77000	−0.37360	0.12170	1.06***	4.61***

Note: The sample period is March 2008 to September 2022, yielding 766 weekly observations for the growth rates. ***, **, and * denote rejection of the null hypothesis at the 1%, 5%, 10% significance levels, respectively.

Table 2
Kapetanios (2005) Unit Root Test Results.

Model C (Break on constant and trend)			Model A (Break on constant)		
Log Level	Test Stat.	Breakpoints	First-Diff.	Test Stat.	Breakpoints
Panel A: RISE indices					
L(RISE_ALL)	5.745	[42, 83, 124, 187, 314]	D(RISE_ALL)	−6.256***	[40, 82]
L(RISE_DOM)	6.888	[40, 77, 124, 164, 201]	D(RISE_DOM)	−6.614***	[40, 82]
L(RISE_FRG)	5.824	[42, 79, 124, 185, 313]	D(RISE_FRG)	−5.553*	[413, 539]
L(RISE_QFI)	5.532	[41, 78, 129, 202, 313]	D(RISE_QFI)	−5.936**	[539, 619]
Panel B: Local factors					
L(BOND)	3.898	[46, 548, 585, 641, 713]	D(BOND)	−19.428***	[514, 551]
L(CDS)	4.828	[51, 88, 132, 169, 221]	D(CDS)	−24.140***	[50, 95]
L(GOLD)	3.824	[49, 90, 145, 182, 708]	D(GOLD)	−22.372***	[48, 181]
L(USDTRY)	4.8	[52, 357, 451, 521, 705]	D(USDTRY)	−22.582***	[546, 703]
Panel C: Global factors					
FSI	7.141	[37, 596, 633, 675, 713]	FSI	−17.339***	[37, 77]
L(GPR)	16.418***	[153, 311, 617, 660, 718]	D(GPR)	−17.987***	[616, 715]
L(OVX)	5.417	[39, 110, 149, 193, 337]	D(OVX)	−25.439***	[631, 715]
L(SAFEH)	4.902	[42, 581, 623, 672, 710]	D(SAFEH)	−22.609***	[181, 715]
L(VIX)	6.215	[38, 512, 551, 622, 694]	D(VIX)	−21.266***	[37, 626]

Note: *** and * indicate rejection of the null hypothesis at the 1% and 10% significance level, respectively. L and D stand for the logarithm and first difference of each series while ʎ1 (ʎ2) shows the first (second) breakpoint.

the qualified investors to global factors remains the same for FSI, GPR, and VIX, whereas its volatility predictability is visible only for VOX and at quantile θ=0.45.

Table 1 provides the results of the three tests for the quantile regressions. The third row gives the significance of the Koenker and Machado (1999) goodness-of-fit measure, the Quasi-LR test statistics, for each case. The results point to the explanatory power of all four estimated models using the returns of the local variables at the 1% significance level. Likewise, the explanatory powers of OVX and VIX-based models are found to be statistically significant for all RISE indices. Additionally, the test statistics of the FSI-based models exceed the relevant critical values for the RISE_ALL, RISE_DOM, and RISE_QFI indices. However, the results do not ensure the significance of the other two variables on any risk appetite level changes. The findings regarding the slope equality test suggested by Koenker and Bassett (1982) indicate the rejection of the null hypothesis of slope equality at the conventional significance levels when changes in the CDS, gold, USDTRY, FSI, and SAFEH are selected as the independent variable for all cases; OVX in three of the four models; and bond, GPR, and VIX in two of the four models. The results show that the slope coefficients differ across quantiles and therefore the conditional quantiles are not identical. The response of other variables to the risk appetite of investors, however, is not state-dependent as the slope coefficients are found to be constant across quantiles. The symmetric quantiles test results proposed by

Table 3
Quantile Autoregression Unit Root Test Results.

tau	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95
$\widehat{\alpha}$	0.97	0.91	0.92	0.91	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.86	0.86	0.85	0.83	0.82	0.79	0.78
ALL	−0.43	−2.19	−2.6*	−3.7*	−5.2*	−5.3*	−6*	−6.5*	−6.4*	−6.2*	−6.4*	−6.6*	−6.5*	−5.8*	−5.7*	−5.3*	−5*	−5.3*	−3.4*
$\widehat{\alpha}$	0.89	0.88	0.89	0.88	0.87	0.86	0.85	0.84	0.84	0.84	0.83	0.84	0.85	0.83	0.81	0.80	0.77	0.76	0.78
DOM	−1.61	−2.6*	−3*	−4.1*	−5.2*	−6.1*	−6.5*	−7.8*	−7.9*	−8.2*	−8.4*	−7.5*	−6.6*	−6.9*	−7.4*	−6.4*	−6.7*	−5.2*	−3.3*
$\widehat{\alpha}$	0.94	0.93	0.91	0.91	0.92	0.91	0.91	0.92	0.91	0.91	0.90	0.90	0.89	0.88	0.88	0.86	0.82	0.81	0.78
FRG	−0.89	−1.82	−2.9*	−3.9*	−4*	−5.1*	−5.2*	−4.8*	−5.9*	−5.6*	−5.7*	−5.3*	−5.1*	−5.3*	−4.8*	−5.1*	−5.3*	−4.8*	−3.2*
$\widehat{\alpha}$	0.94	0.94	0.90	0.87	0.87	0.85	0.85	0.85	0.85	0.84	0.85	0.83	0.83	0.82	0.82	0.79	0.78	0.77	0.76
QFI	−0.73	−1.67	−2.8*	−4.5*	−5.5*	−6.6*	−7.5*	−7.1*	−7.2*	−7.5*	−7.1*	−8.2*	−7.5*	−7.7*	−6.9*	−7.4*	−6.4*	−5.2*	−3.1*
$\widehat{\alpha}$	0.17	0.24	0.32	0.34	0.34	0.33	0.32	0.30	0.33	0.32	0.32	0.33	0.37	0.37	0.40	0.44	0.45	0.45	0.38
BOND	−7.3*	−9.1*	−12*	−14.6*	−17.2*	−21.2*	−24.1*	−24.5*	−23.9*	−23.4*	−23.6*	−21.9*	−18.8*	−17.3*	−14.3*	−12.6*	−10.2*	−7*	−4.3*
$\widehat{\alpha}$	−0.01	0.03	0.04	0.05	0.10	0.08	0.10	0.11	0.09	0.11	0.14	0.15	0.16	0.19	0.20	0.21	0.26	0.22	0.20
CDS	−12*	−13.6*	−18.2*	−21.1*	−21.1*	−22.2*	−22.9*	−23.6*	−24.3*	−24.1*	−22.7*	−21.4*	−20.7*	−19.2*	−18*	−17.1*	−14.1*	−11.9*	−4.1*
$\widehat{\alpha}$	0.11	0.11	0.17	0.18	0.17	0.18	0.19	0.22	0.22	0.20	0.23	0.22	0.25	0.26	0.25	0.31	0.36	0.35	0.39
GOLD	−6.2*	−9.7*	−16*	−19.3*	−22.5*	−24.4*	−25.1*	−23.5*	−23.7*	−23.2*	−21.6*	−21.4*	−20*	−17.8*	−16*	−14*	−9.9*	−7.6*	−3.3*
$\widehat{\alpha}$	0.00	0.07	0.16	0.20	0.24	0.25	0.23	0.26	0.26	0.26	0.28	0.31	0.34	0.32	0.33	0.38	0.44	0.47	0.39
USDTRY	−11.7*	−14.5*	−20.8*	−21.5*	−23.6*	−23.6*	−26*	−25*	−25*	−24.2*	−23.6*	−22*	−18.1*	−18.5*	−17.7*	−14.5*	−10.1*	−7.3*	−4.4*
$\widehat{\alpha}$	0.25	0.28	0.28	0.27	0.26	0.26	0.29	0.29	0.28	0.27	0.29	0.33	0.34	0.34	0.33	0.39	0.43	0.52	0.59
FSI	−6.6*	−11*	−17.3*	−21.7*	−26.1*	−29.2*	−30.9*	−31.9*	−31.6*	−29.3*	−26.6*	−24.5*	−21.9*	−20.6*	−18.8*	−16.3*	−12.1*	−6.5*	−2.5*
$\widehat{\alpha}$	0.46	0.48	0.51	0.49	0.50	0.52	0.53	0.55	0.58	0.57	0.58	0.60	0.63	0.62	0.62	0.65	0.66	0.65	0.69
GPR	−7.9*	−11.4*	−13.5*	−15.5*	−14.8*	−13.7*	−12.7*	−12.2*	−12*	−11.1*	−10.8*	−10.2*	−9.9*	−9.8*	−8.6*	−7.6*	−6.4*	−5.5*	−3.1*
$\widehat{\alpha}$	−0.13	−0.10	−0.04	0.00	0.00	−0.01	0.00	0.06	0.07	0.07	0.11	0.14	0.16	0.18	0.19	0.25	0.26	0.25	0.28
OVX	−12.5*	−19*	−24*	−23.6*	−23.4*	−25.9*	−29.8*	−27.1*	−25.8*	−26.7*	−26.6*	−25.6*	−22.9*	−20.8*	−20.1*	−15.6*	−11.1*	−7.7*	−3.9*
$\widehat{\alpha}$	0.14	0.16	0.22	0.22	0.22	0.23	0.20	0.19	0.18	0.20	0.21	0.21	0.19	0.20	0.20	0.19	0.22	0.20	0.24
SAFEH	−7.6*	−11.7*	−13.8*	−15.3*	−16.2*	−17*	−18.2*	−20.4*	−21.3*	−20.5*	−20.3*	−20.1*	−21.2*	−19*	−17.6*	−15.8*	−14*	−10.9*	−5.4*
$\widehat{\alpha}$	0.91	0.92	0.92	0.93	0.94	0.94	0.93	0.93	0.94	0.94	0.95	0.95	0.97	0.98	0.98	0.98	0.97	0.98	0.99
VIX	−2.9*	−4.1*	−5.5*	−5.3*	−5.2*	−5.3*	−5.8*	−5.9*	−5.2*	−4.7*	−3.9*	−3.7*	−2.04	−1.66	−1.27	−0.84	−1.11	−0.55	−0.16

Note: The table shows the persistence estimates ($\widehat{\alpha}$) and t-statistics of the quantile autoregressive unit root test of Koenker and Xiao (2004) and Galvao (2009). * indicates rejection of the null hypothesis, $H_0 : a(\tau) = 1$, at the 95% confidence level.

Table 4
Broock et al. (1996) Test for Nonlinearity for Bivariate VAR(1) Models.

	m = 2	m = 3	m = 4	m = 5	m = 6	m = 2	m = 3	m = 4	m = 5	m = 6
Causality from BOND to RISE indices										
	Residuals of each RISE index					**BOND Residuals**				
A ~ BOND	7.23***	8.95***	10.27***	11.44***	12.76***	6.14***	6.46***	7.35***	8.64***	9.63***
D ~ BOND	6.73***	8.85***	10.37***	11.85***	13.27***	6.1***	6.43***	7.32***	8.61***	9.6***
F ~ BOND	7.12***	8.72***	10.13***	11.11***	12.38***	6.09***	6.41***	7.31***	8.6***	9.57***
Q ~ BOND	5.62***	8.15***	9.93***	11.23***	12.52***	6.08***	6.38***	7.31***	8.62***	9.6***
Causality from CDS to RISE indices										
	Residuals of each RISE index					**CDS Residuals**				
A ~ CDS	6.36***	7.87***	9***	10.02***	11.15***	8.99***	9.54***	9.9***	9.77***	9.89***
D ~ CDS	5.98***	7.78***	9.21***	10.55***	11.88***	9.05***	9.58***	9.96***	9.85***	9.98***
F ~ CDS	5.98***	7.19***	8.25***	8.91***	9.84***	9***	9.55***	9.92***	9.79***	9.9***
Q ~ CDS	5.43***	7.4***	9.01***	10.26***	11.42***	9.03***	9.56***	9.93***	9.83***	9.96***
Causality from GOLD to RISE indices										
	Residuals of each RISE index					**GOLD Residuals**				
A ~ GOLD	6.98***	9.02***	10.7***	11.94***	13.34***	6.4***	7.25***	7.49***	7.94***	8.58***
D ~ GOLD	6.11***	8.74***	10.63***	12.24***	13.86***	6.39***	7.27***	7.52***	8***	8.67***
F ~ GOLD	7***	8.52***	10.13***	11.02***	12.31***	6.38***	7.21***	7.44***	7.88***	8.51***
Q ~ GOLD	5.03***	7.93***	9.89***	11.26***	12.59***	6.38***	7.37***	7.68***	8.19***	8.87***
Causality from USDTRY to RISE indices										
	Residuals of each RISE index					**USDTRY Residuals**				
A ~ USD	7.51***	9.39***	10.65***	11.71***	12.99***	9.29***	9.73***	10.09***	10.84***	11.4***
D ~ USD	6.75***	9.05***	10.65***	12.04***	13.5***	9.34***	9.78***	10.12***	10.89***	11.48***
F ~ USD	7.33***	8.85***	10.1***	10.86***	12.04***	9.3***	9.74***	10.08***	10.81***	11.35***
Q ~ USD	5.58***	8.04***	9.74***	11***	12.23***	9.35***	9.79***	10.13***	10.89***	11.45***
Causality from FSI to RISE indices										
	Residuals of each RISE index					**FSI Residuals**				
A ~ FSI	5.86***	7.46***	8.97***	10.14***	11.51***	7.56***	9.91***	11.22***	12.44***	13.58***
D ~ FSI	5.56***	7.48***	9.25***	10.7***	12.31***	7.59***	9.92***	11.24***	12.44***	13.58***
F ~ FSI	5.65***	6.8***	8.22***	9.12***	10.36***	7.54***	9.88***	11.21***	12.43***	13.56***
Q ~ FSI	4.83***	7.08***	9***	10.37***	11.84***	7.58***	9.94***	11.26***	12.46***	13.59***
Causality from GPR to RISE indices										
	Residuals of each RISE index					**GPR Residuals**				
A ~ GPR	6.65***	8.49***	9.92***	11.07***	12.35***	3.71***	3.53***	3.15***	3.03***	2.71***
D ~ GPR	6.05***	8.25***	9.97***	11.46***	12.96***	3.69***	3.53***	3.18***	3.06***	2.74***
F ~ GPR	6.42***	7.95***	9.33***	10.24***	11.42***	4.7***	7.4***	9.26***	10.62***	11.91***
Q ~ GPR	4.7***	7.4***	9.26***	10.62***	11.91***	3.67***	3.5***	3.16***	3.04***	2.71***
Causality from OVX to RISE indices										
	Residuals of each RISE index					**OVX Residuals**				
A ~ OVX	6.16***	8***	9.67***	11.03***	12.54***	6.84***	7.49***	7.9***	8.33***	8.55***
D ~ OVX	5.77***	8***	9.88***	11.48***	13.15***	6.87***	7.49***	7.89***	8.33***	8.57***
F ~ OVX	5.82***	7.34***	9***	10.1***	11.57***	6.85***	7.52***	7.92***	8.34***	8.57***
Q ~ OVX	4.49***	7.27***	9.31***	10.77***	12.22***	6.9***	7.54***	7.96***	8.39***	8.62***
Causality from SAFEH to RISE indices										
	Residuals of each RISE index					**SAFEH Residuals**				
A ~ SAFE	6.54***	8.43***	9.99***	11.15***	12.42***	2.41**	1.62	2.36**	2.61***	2.84***
D ~ SAFE	5.95***	8.19***	10.01***	11.53***	13.1***	2.45**	1.68*	2.4**	2.66***	2.89***
F ~ SAFE	6.33***	7.74***	9.22***	10.08***	11.2***	2.4**	1.6	2.34**	2.59***	2.83***
Q ~ SAFE	4.77***	7.53***	9.45***	10.83***	12.17***	2.67***	1.94*	2.68***	2.93***	3.2***
Causality from VIX to RISE indices										
	Residuals of each RISE index					**VIX Residuals**				
A ~ VIX	5.95***	7.72***	9.27***	10.52***	11.76***	4.21***	4.93***	5.16***	5.14***	5.16***
D ~ VIX	5.53***	7.69***	9.59***	11.22***	12.77***	4.2***	4.92***	5.17***	5.17***	5.19***
F ~ VIX	5.68***	7.09***	8.62***	9.6***	10.74***	4.23***	4.95***	5.17***	5.14***	5.16***
Q ~ VIX	4.26***	6.88***	8.84***	10.26***	11.58***	4.13***	4.86***	5.08***	5.07***	5.11***

Note: m indicates the embedding dimensions. ** and * signify, respectively, rejection of the null hypothesis at the 1% and 5% level of significance, based on 10,000 bootstrap repetitions. Values in the cells and brackets are BDS z-statistic and the lag length using AIC for each VAR(1) model. A: RISE_ALL, D: RISE_DOM, F: RISE_FRG, Q: RISE_QFI and USD: USDTRY.

Table 5
Parameter Stability and Breakpoint Tests Results.

Panel A: Bai-Perron tests of 1 to M globally determined breaks						*Panel B: Quandt-Andrews unknown breakpoint test*				
DEPV	**ALL**	**DOM**	**FRG**	**QFI**		**DEPV**	**ALL**	**DOM**	**FRG**	**QFI**
INDV	**BOND [1,1,1,1]**					**INDV**	**BOND**			
UDMax	6.618	9.729	12.813	7.697		**Sup LR**	2.310	4.030	2.160	2.780
# of BP	0	0	0	0		**Exp LR**	0.440	0.870	0.260	0.650
						Mean LR	0.820	1.500	0.470	1.210
INDV	**CDS [1,1,1,1]**									
UDMax	10.322	9.273	14.984**	12.914		**Sup LR**	7.24***	12.1***	8.34***	3.540
# of BP	0	0	2	0		**Exp LR**	2.4***	3.76***	2.16***	0.520
						Mean LR	4.42***	5.8***	3.11***	0.900
INDV	**GOLD [1,1,1,1]**									
UDMax	8.025	7.592	6.254	5.51		**Sup LR**	2.570	2.330	2.730	1.330
# of BP	0	0	0	0		**Exp LR**	0.460	0.590	0.490	0.270
						Mean LR	0.750	1.110	0.770	0.520
INDV	**USDTRY [1,1,1,1]**									
UDMax	65.592***	13.554	70.09***	41.603***		**Sup LR**	3.860	6.7***	3.360	1.740
# of BP	3	0	3	4		**Exp LR**	1.21*	1.72**	0.980	0.320
						Mean LR	2.28**	3.17***	1.75*	0.600
INDV	**FSI [1,1,1,1]**									
UDMax	6.166	6.756	5.603	9.607		**Sup LR**	2.180	1.860	2.320	1.550
# of BP	0	0	0	0		**Exp LR**	0.510	0.530	0.480	0.450
						Mean LR	0.990	1.040	0.940	0.900
INDV	**GPR [1,1,1,1]**									
UDMax	5.566	7.358	5.917	5.626		**Sup LR**	4.25*	3.940	4.25*	1.950
# of BP	0	0	0	0		**Exp LR**	1.070	0.940	1.130	0.450
						Mean LR	1.640	1.530	1.72*	0.850
INDV	**OVX [1,1,1,1]**									
UDMax	22.189***	12.705*	13.748*	11.831		**Sup LR**	4.07*	4.65**	3.380	1.240
# of BP	1	0	0	0		**Exp LR**	0.740	0.900	0.620	0.240
						Mean LR	1.040	1.330	0.960	0.470
INDV	**SAFEH [1,1,1,1]**									
UDMax	19.525***	18.227**	21.737***	8.977		**Sup LR**	2.030	1.780	2.440	2.060
# of BP	2	2	2	0		**Exp LR**	0.290	0.260	0.280	0.360
						Mean LR	0.530	0.490	0.500	0.650
INDV	**VIX [1,1,1,1]**									
UDMax	20.322***	13.416*	11.057	15.892**		**Sup LR**	8.09***	6.23***	7.88***	2.110
# of BP	3	0	0	3		**Exp LR**	1.86**	1.49**	1.73**	0.390
						Mean LR	2.47**	2.45**	2.12**	0.680

Note: ***, **, and * indicate the rejection of the null hypothesis at the 99%, 95% and 90% level of confidence, respectively, based on the bootstrapped *p*-values and computed with 10,000 replications. Values in the cells and brackets are BDS z-statistic (Panel A) or LR F-statistic (Panel B) and the lag length chosen by AIC for each VAR(1) model. Sup LR, Exp LR, and Mean LR denotes the supremum, exponential and average likelihood ratio, respectively.

Newey and Powell (1987) are given in the fifth row and show the rejection of the null hypothesis of symmetry across quantiles for four RISE index changes when changes in CDS is chosen as the independent variable, and for three RISE models in the case of the foreign exchange rate changes being chosen as the independent variable. The results demonstrate significant evidence of asymmetry in FSI, GPR, SAFEH, and VIX for changes in RISE_QFI across quantiles, but not in BOND, GOLD, or OVX with no rejection of the null hypothesis for all four cases.

4.3. Quantile-on-quantile regression results

4.3.1. Quantile-on-quantile (QQ) effects of local factors on risk appetite indices

Here, we apply the quantile-on-quantile (QQ) regression to reveal the two-dimensional dependence of the variables by focusing on the effect of the independent variables on the four RISE indices for the equally spaced grid of 19 quantiles, [0.05–0.95]. As in the

Table 6
Test Results for Quantile Regressions.

	RISE_ALL	RISE_DOM	RISE_FRG	RISE_QFI
BOND				
Quasi-LR Statistics	160.8***	148.44***	157.66***	149.01***
Slope Equality Test	40.93***	25.030	26.06*	21.810
Symmetric Quantiles Test	16.530	9.460	9.840	13.110
CDS				
Quasi-LR Statistics	320.55***	261.14***	357.57***	258.37***
Slope Equality Test	31.89**	37.66***	31.2**	32.88**
Symmetric Quantiles Test	43.38***	44.24***	52.45***	36.1***
GOLD				
Quasi-LR Statistics	18.17***	11.27***	30.22***	14.84***
Slope Equality Test	49.94***	37.13***	49.18***	30.79**
Symmetric Quantiles Test	21.060	14.420	15.150	23.060
USDTRY				
Quasi-LR Statistics	79.29***	52.94***	107.37***	69.76***
Slope Equality Test	82.9***	76.13***	110.12***	77.89***
Symmetric Quantiles Test	29.18**	26.53*	38.03***	25.680
FSI				
Quasi-LR Statistics	3.99**	9.65***	0.060	12.77***
Slope Equality Test	95.92***	98.14***	64.36***	68.18***
Symmetric Quantiles Test	20.710	35.37***	19.880	32.01**
GPR				
Quasi-LR Statistics	0.280	0.030	0.770	1.160
Slope Equality Test	30.97**	18.260	28.95**	25.120
Symmetric Quantiles Test	19.720	22.210	14.540	26.66*
OVX				
Quasi-LR Statistics	48.85***	56.76***	41.39***	38.81***
Slope Equality Test	26.34*	31**	37.21***	17.650
Symmetric Quantiles Test	21.580	22.660	20.840	8.460
SAFEH				
Quasi-LR Statistics	0.180	0.200	1.940	2.250
Slope Equality Test	36.57***	32.22**	32.33**	64.05***
Symmetric Quantiles Test	15.420	14.440	20.760	34.67**
VIX				
Quasi-LR Statistics	78.09***	81.3***	74.89***	50.79***
Slope Equality Test	19.340	32.01**	33.18**	21.230
Symmetric Quantiles Test	17.170	17.250	16.450	27.39*

Note: ***, **, and * indicate the rejection of the null hypothesis for each test at the 99%, 95%, and 90% level of confidence, respectively.

causality-in-quantile test, we choose the same quantile bands for the three market conditions; that is, [$0.05\leq\theta\leq0.30$], [$0.35\leq\theta\leq0.65$], and [$0.70\leq\theta\leq0.95$] as bearish, normal, and bullish. By doing this, the local impact of the τ-th quantile of the local/global factor changes on the q-th quantile of the changes in the risk appetite of investors can be investigated. In each of Fig. 2 to Fig. 16, the estimated β parameters obtained through the application of the QQ regression between the changes in interest rates and RISE indices with a constant are plotted on the z-axis (the slope) against the quantiles of the independent variable (τ) and the dependent variable (q) on the x- and y-axis, respectively.

In Figs. 2–11, we provide the impacts of the four local factors on the risk appetite changes, and the analysis starts with the changes in interest rates of government bonds (Fig. 2). A visual inspection suggests that the changes in bond yields exhibit a similar pattern on the RISE indices, that is, we observe a strong and positive impact at the lower (q) and a negative effect at the normal and upper quantiles (q) of all four RISE indices. Explicitly, the declining risk appetite for the stock market leads investors to seek safety in Turkish bonds at lower quantiles of RISE indices, and the effect is stronger for the foreign investors than the remaining types of investors. At the normal and upper (except for the last) quantiles, we observe that falling interest rates, i.e. rising bond prices, result in a higher proportion of holdings for the Turkish stock market. However, a positive impact emerges at the last quantiles (q) of all four RISE indices as the level of bond yield increases until the median quantile τ=0.50, and the impact switches sign to negative and hits its highest at the top quantiles of both variables.

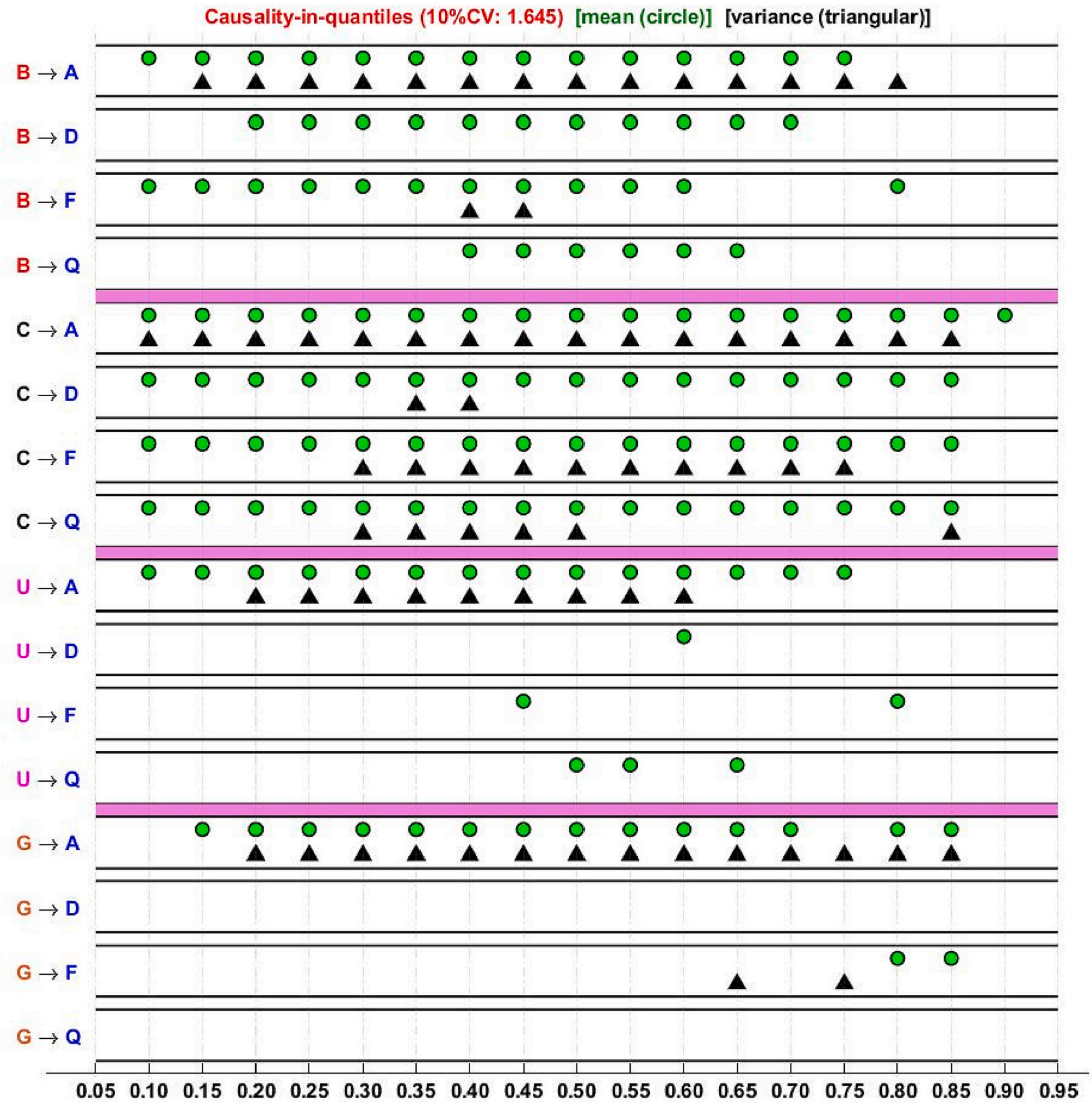


Fig. 2. Causality-in-quantiles from local financial variables to investor risk appetite indices.
Note: B, C, U, and G are the returns of the 2-year government bond rates, 5-year CDS spreads, USDTRY exchange rates, and gold prices in Turkish Lira, respectively. A, D, F, and Q represent the risk appetite index changes for all, domestic, foreign, and qualified investors, respectively. The existence of a green circle (black triangle) indicates the rejection of the null hypothesis at the 10% significance level, implying causality at quantile τ for the first (second) moment. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

In Fig. 9, we present the QQ results for CDS spread changes. The impacts of CDS on the risk appetite indices are heterogonous and vary under various quantiles. Firstly, the effects on the RISE indices are positively strong and stable over all quantiles of CDS spreads, indicating that the risk appetite for the equities is low and insensitive to the conditional distribution of CDS changes for all RISE indices. Considering the subindices, we find that the effect over all quantiles (τ) is strongest for the foreign investors, followed by the qualified and domestic investors. A relatively low level of risk premium results in an increase in risk appetite for the equities at quantiles (q) ranging from 0.30 to 0.45, in which the impact on the level of risk appetite for the foreign investors is strongest among the three subindices. Over the normal quantiles (q) [0.50–0.75], we observe a negative, and steadily decreasing, impact on RISE indices as the level of CDS spread increases. At upper quantiles (τ) and lower level of risk premium, the stock market acts as a safe-haven for all investors, but the rising risk premium exerts a negative impact on the risk appetite of investors when both variables are at top quantiles.

Fig. 10 shows the impact of gold returns on the four RISE indices at various quantiles and the results are quite similar, as well as intriguing. Firstly, the impact on risk appetite level changes is negative at the vast majority of quantiles, ranging from 56.8% to 81.4%.

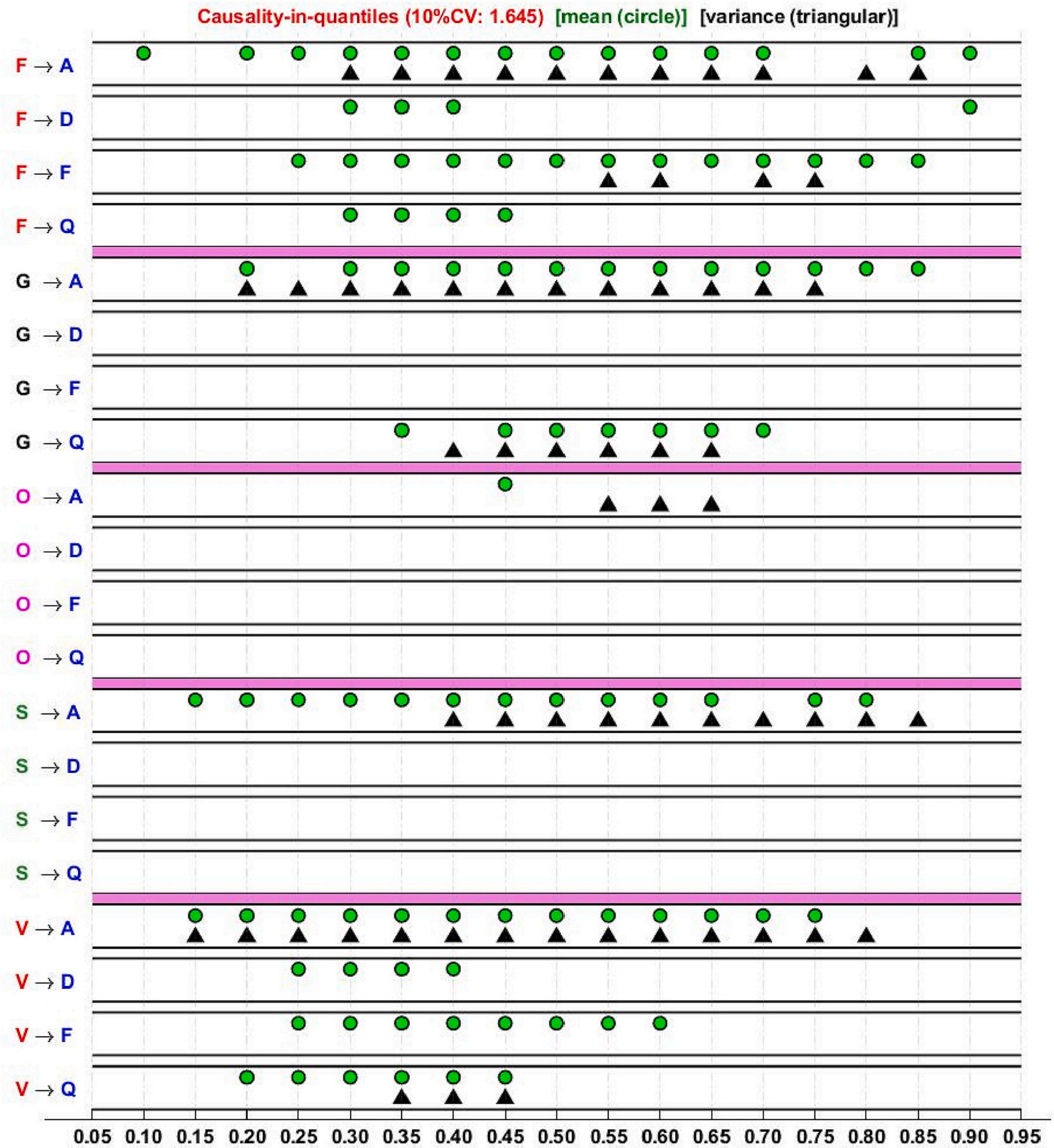


Fig. 3. Causality-in-quantiles from global factors on the investor risk appetite indices.
Note: A, D, F, and Q represent the risk appetite index changes for all, local, foreign, and qualified investors, respectively. F, G, O, S, and V are the financial stress from emerging markets index, geopolitical risk (GPR) index, CBOE crude oil volatility index, safe-haven index, and Chicago Board options exchange volatility index (VIX). The existence of a green circle (black triangle) indicates the rejection of the null hypothesis at the 10% significance level, implying causality at quantile τ for the first (second) moment. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

At the lower quantiles of both variables, there is a positive impact from gold returns, indicating that both markets respond concurrently to rising uncertainty/shocks in financial markets in the same way, with the RISE_FRG being the strongest. This evidence partially reinforces the conclusion drawn by Cohen and Qadan (2010), who find a positive relationship between gold returns and the level of investor fear index for the entire period. From the middle to upper quantiles (q), the negative impacts on risk appetite rise sharply, highlighting the role of stock equities as a strong hedge against gold when the stock market is in its normal and bullish phases, of which foreign investors are the biggest beneficiary, whereas qualified investors are the smallest. We observe a weak hedging role for gold, as the effect is negative at normal quantiles of both variables. As gold returns have a positive impact on the RISE indices at the upper

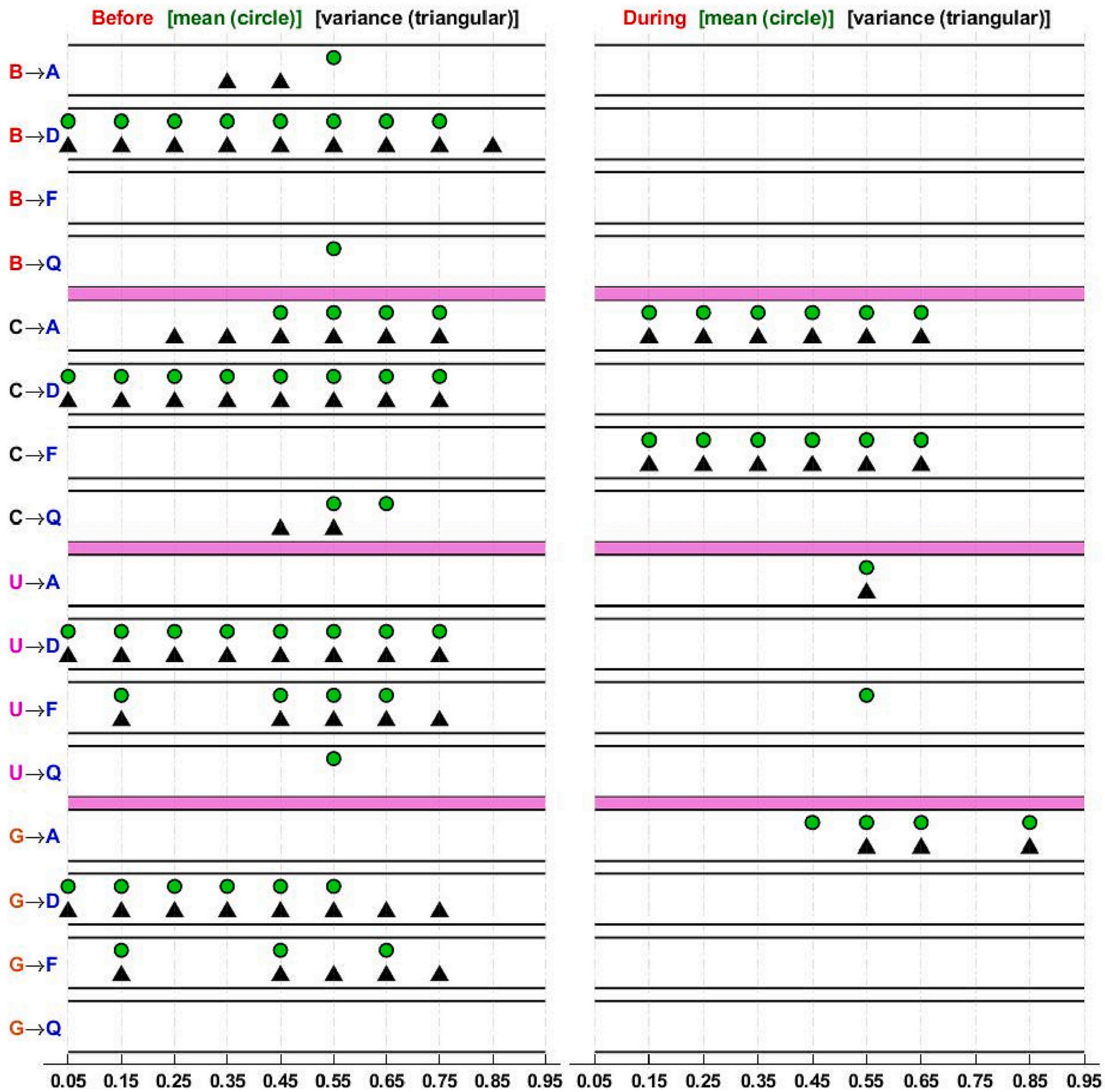


Fig. 4. Causality-in-quantiles from local factors around the COVID19 pandemic subperiods.

quantiles (q) and (τ), the results emphasize the strong substitution effect for stock investors, particularly qualified ones, when both markets are in their bullish phase.

We plot the effect of the last local factor, USDTRY, on the RISE indices in Fig. 11. It is obvious that the effect of currency returns on the risk appetite indices is mostly negative—ranging from 80.6% to 75.3%— and resembles the impacts of gold, albeit stronger. A positive impact emerges at extreme lower quantiles of both variables and at top quantiles (q), which gradually weakens and switches sign to negative at top quantiles (q) and (τ). This result suggests that the appreciation of the TL against the US Dollar reduces the risk appetite for the stock market at lower and upper quantiles (q), where the risk appetites of domestic and qualified investors are affected at virtually the same magnitude but more strongly than foreign investors. Likewise, the changes in currency market react negatively to the level of risk appetite changes during normal and extreme lower market conditions for the stock market, and this effect weakens as the level of USDTRY increases. That is, the appreciation of TL against the US Dollar has a negative impact on all risk appetite indices and investors reduce their asset positions in TL, and this effect peaks at normal (q) and lower quantiles (τ), where the foreign (domestic) investors experience the highest (lowest) changes their investment positions, implying a higher (lower) sensitiveness to the currency market.

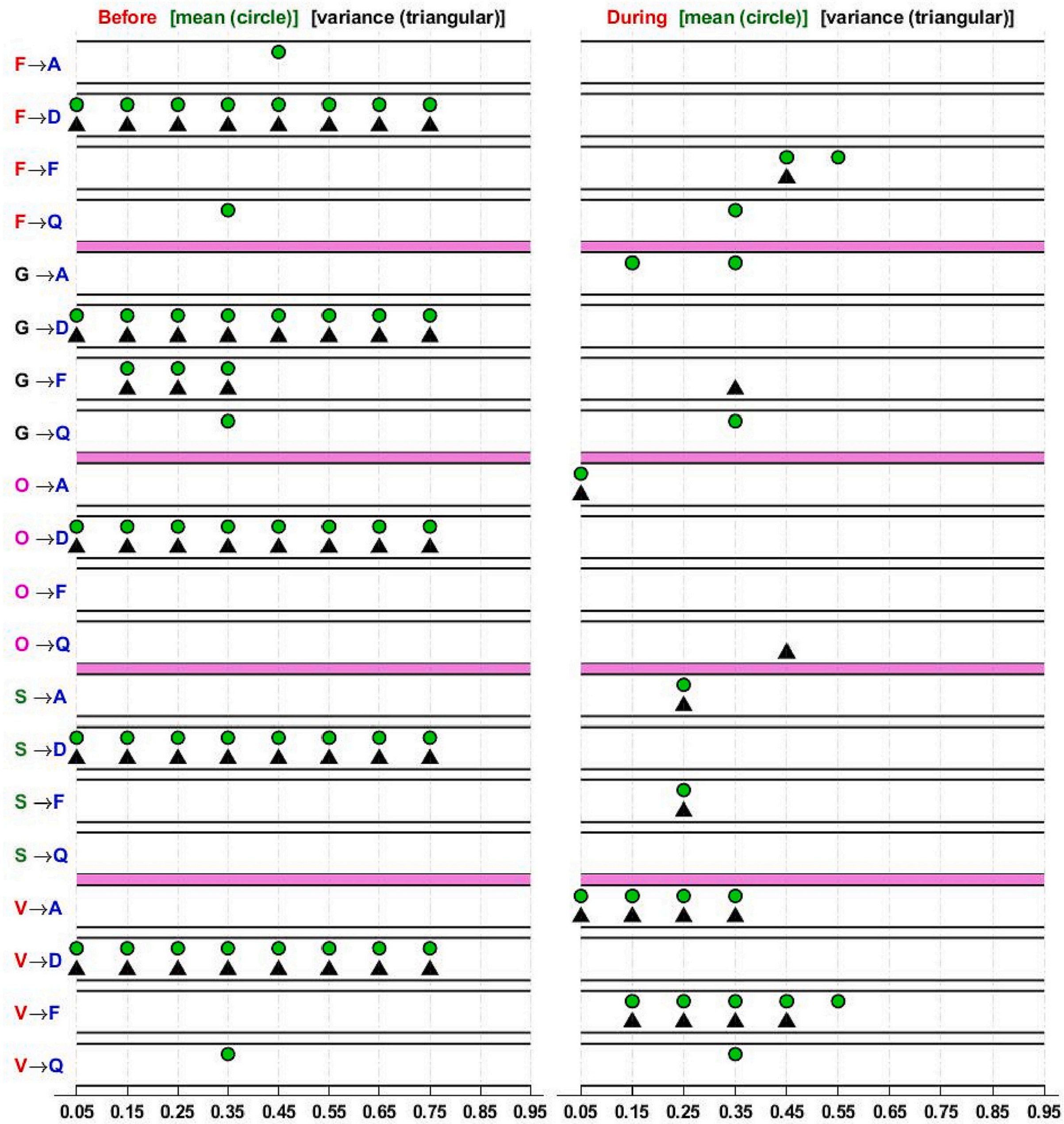


Fig. 5. Causality-in-quantiles from global factors around the COVID19 pandemic subperiods.
Note: The left and right panels show the results before and during the COVID19 period. A, D, F, and Q signify the risk appetite index changes for all, local, foreign, and qualified investors, respectively. C, G, and S represent, respectively, the changes in 5-year CDS spreads, gold prices, and the safe-haven index, while G, E, and V are the geopolitical risk (GPR) index, the financial stress from emerging markets, and Chicago Board options exchange volatility index (VIX) at levels. The existence of a green circle (black triangle) indicates the rejection of the null hypothesis at the 10% significance level, implying causality at quantile τ for the first (second) moment. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4.3.2. QQ effects of global factors on risk appetite indices

Figs. 12–16 show the impacts of the five global factors on risk appetite changes. For the local factors, the number of negative coefficients is proportionally higher than positive coefficients for all other than VIX, ranging from 50.4% to 73.9%. The changes of risk appetite for all investors are most negatively vulnerable to fluctuations in the financial stress from emerging markets index volatility, followed by the domestic, foreign, and qualified investors. However, this ranking is reversed for the positive impacts, and qualified investors' investment decisions are most sensitive to positive shocks from financial stress movements. The effect of financial stress is

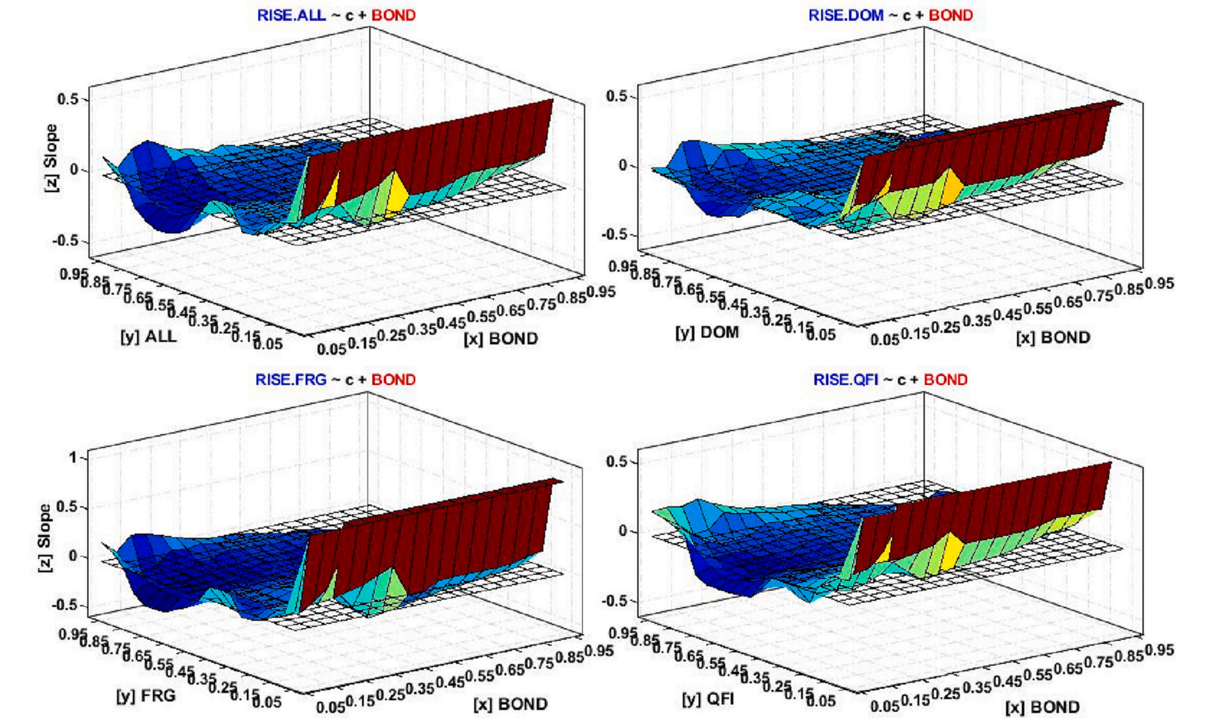


Fig. 6. QQ plot between the RISE index changes and bond yields changes.

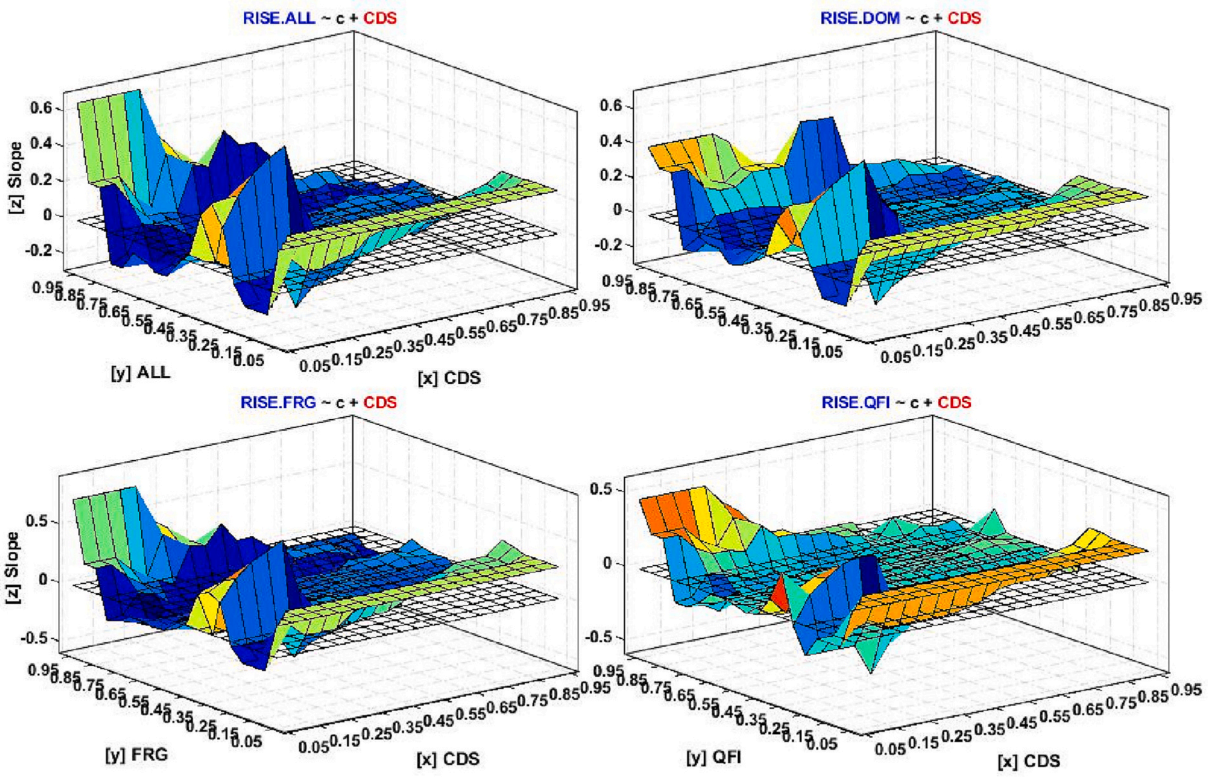


Fig. 7. QQ plot between the RISE index changes and CDS changes.

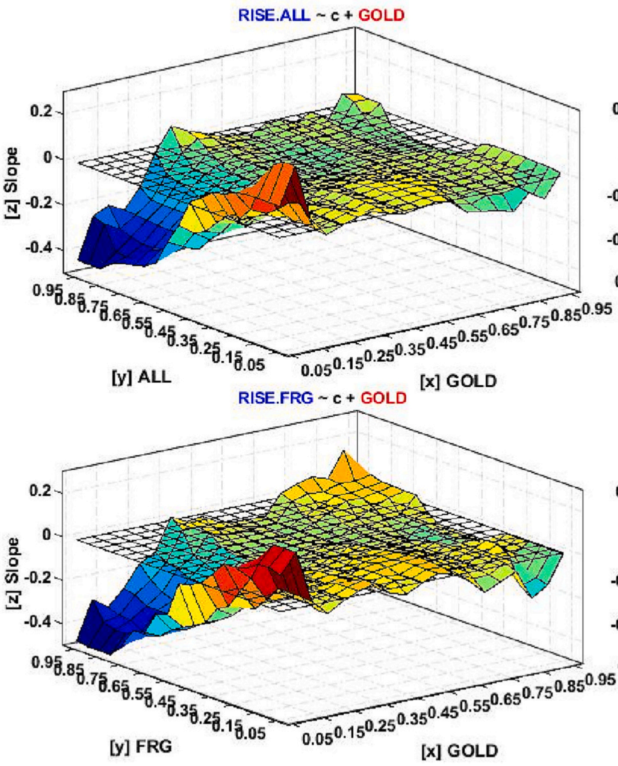


Fig. 8. QQ plot between the RISE index changes and gold price changes.

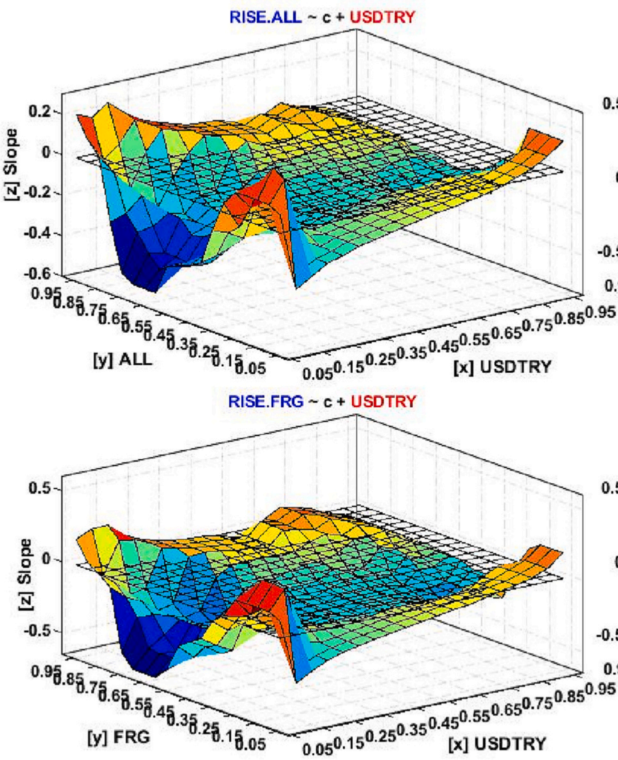


Fig. 9. QQ plot between the RISE index changes and USDTRY changes.

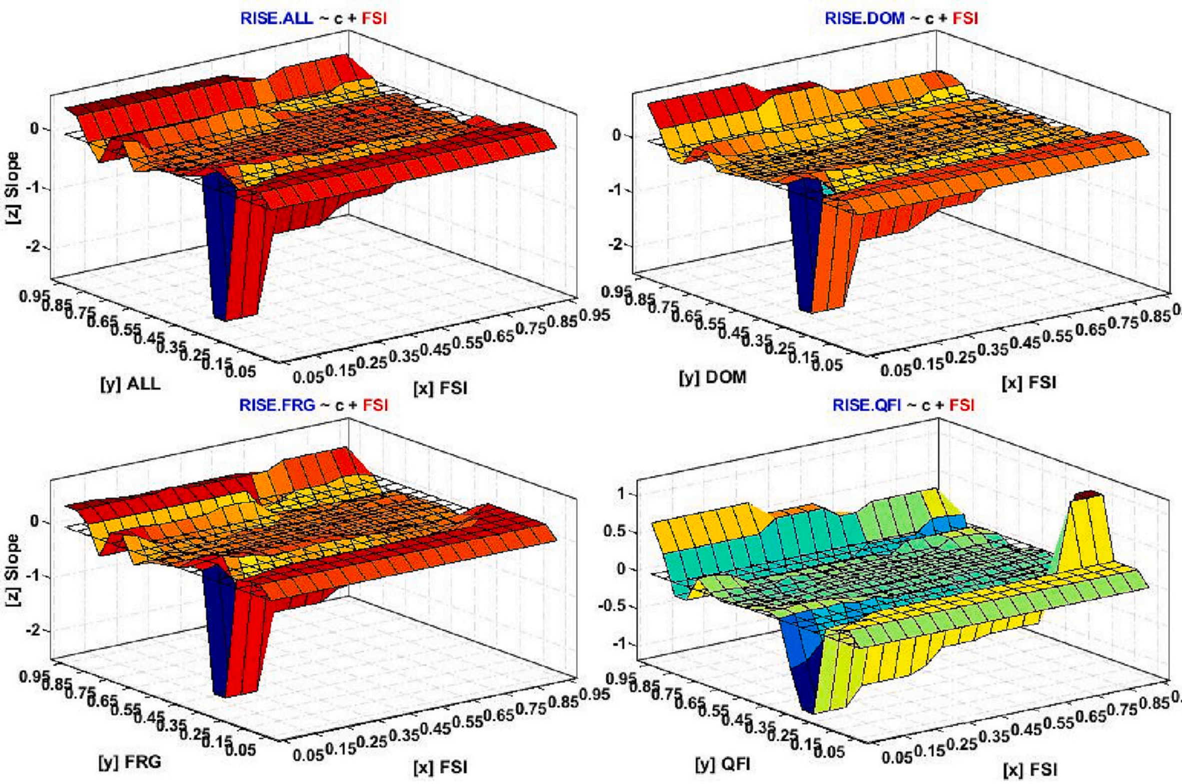


Fig. 10. QQ plot between the RISE index changes and FSI from emerging markets.

zero at the bottom quantile q=0.05, whereas we observe a stable but a positive impact at the lower quantile of RISE indices. This result implies that investors in the Turkish stock market respond positively to fluctuation in peer emerging markets when they are bearish to purchase/hold securities. However, the impact switches sign to negative and peaks from the last lower quantiles (q) until the upper quantiles of FSI index, τ=0.80, except for domestic investors being negatively impacted at all quantiles. In other words, the risk appetite for equities rises and hits its peak when the level of financial stress from emerging markets volatility is at low or normal levels. This negative effect remains the same for domestic investors as the level of financial risk increases, while others react positively to the rising financial risk and reduce their equity holdings. During the normal level of risk appetite, 0.35<q<0.45, there is a positive impact at the low level of financial risk; but the effect turns to negative as the level of financial risk rises, except for foreign investors being affected positively at the median quantiles (τ). For the remaining normal quantiles of RISE indices, we see that the impact is negative for all quantiles of the FSI index and highest for foreign investors. The test reveals heterogonous effects at the upper quantiles; a positive impact emerges at the first quantiles, then switches sign to negative, but we observe a strong, but steadily decreasing, positive impact when the risk appetite is at its highest level. This result implies that investor appetite for the stock market peaks during low, normal or high levels of financial risks originating from peer countries' markets and the reaction of the domestic investors is most, while that of foreign investors is least.

Fig. 13 shows the results of the impact of the geopolitical risk index on the risk appetite indices. The influence of geopolitical risk level is heterogeneous and mostly negative and strongest for the risk appetite of all investors, followed by domestic, foreign, and qualified investors. We observe a negative, albeit gradually decreasing, impact from the geopolitical risk level at the bottom quantile q=0.05 and the risk appetite for qualified investors emerges as the most sensitive, followed by domestic, all, and foreign investors. This result suggests that rising geopolitical risk results in a lower risk appetite when the Turkish stock market is in its bearish phase. The impact is low and close to zero as the level of risk appetite increases during normal quantiles. We observe that the impact is mostly positive but of various magnitudes, and the qualified investors risk appetite index emerges as the most affected. Although there is a stable and low impact at the upper quantiles (q), the strongest negative impact arises when both variables are in their bullish phases, indicating that rising geopolitical risk level causes a huge decrease in the risk appetite for equities and leads investors to seek safety outside the Turkish stock market. The risk appetites for qualified and domestic investors emerge as the two indices most exposed to heightened geopolitical risk.

The QQ impact of OVX on the RISE indices is presented in Fig. 14. Like all other factors, the number of negative coefficients is proportionally higher than positive coefficients and ranges from 50.4% to 54.3%. The crude oil volatility index changes exert a symmetric impact on the foreign and qualified investors' investment decisions, where the proportions of negative and positive co-efficients are virtually the same for those investor types. Notably, the OVX index generates the strongest positive and negative impact

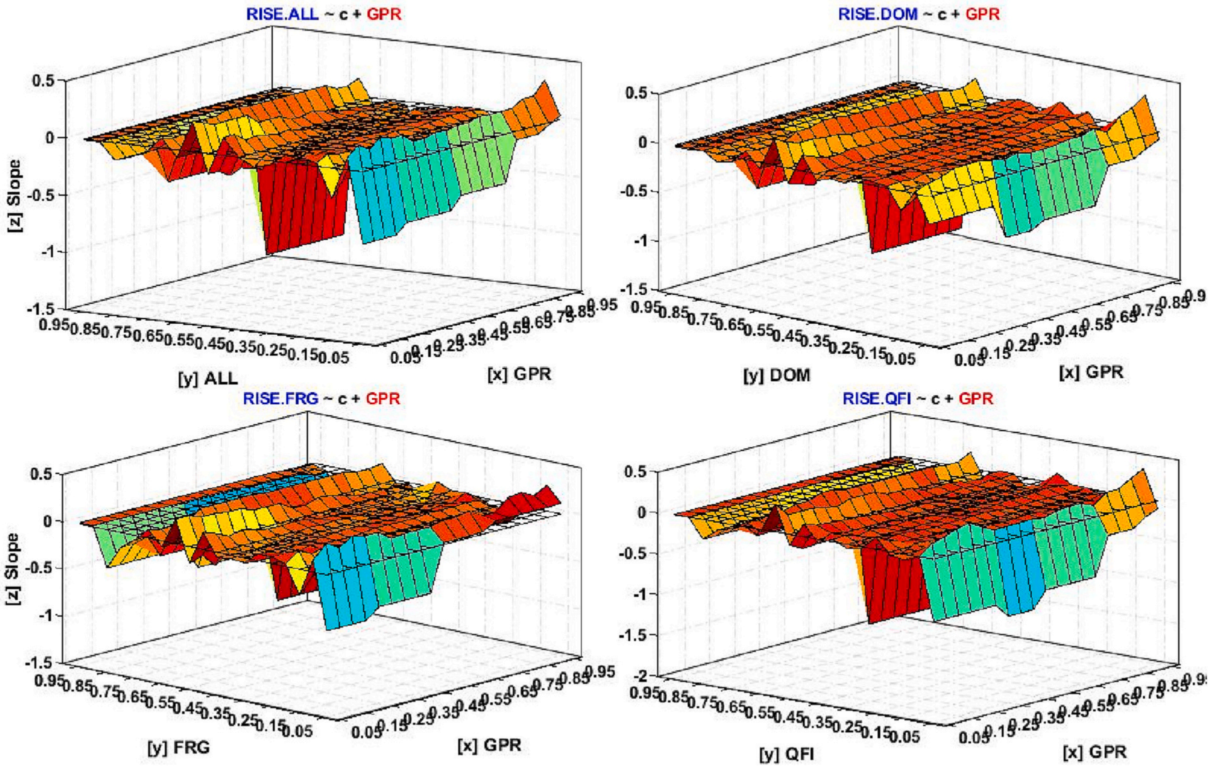


Fig. 11. QQ plot between the RISE index changes and GPR index.

on the risk appetite level changes at lower and upper quantiles and this effect is highest for the foreign and qualified investors, respectively. At the bottom quantile, q=0.05, the OVX index negatively impacts the risk appetite of investors and this effect strengthens as the level of the OVX index rises, indicating that rising volatility in the crude oil market reduces the proportion of equity holdings in the Turkish stock market. Over the quantile range 0.70 to 0.80 of the conditional distribution of changes in risk appetite levels, we observe a gradually decreasing and strongly positive impact of crude oil market volatility, pointing to the fact that as the volatility of the crude oil market rises, the risk appetite for the stock market in Turkey falls. The effect at the lower and middle quantiles is close to zero and reaches a plateau over all quantiles of crude oil market volatility. At the upper quantiles (q), the negative impact hits its peak and remains unchanged, indicating the insensitiveness of the risk appetite of investors to the level of volatility in the oil market. The changes in oil volatility present the strongest (weakest) negative impact on the qualified (domestic) investors' risk appetite changes. Such finding can be interpreted as evidence that the risk appetite for equities is strongly and negatively influenced by positive changes in the crude oil market when investors are bullish to purchase securities, and the qualified investors' response is strongest.

Fig. 15 shows the QQ effect of the safe-haven index changes on the four risk appetite indices. The findings are quite intriguing, as they indicate that the extent of the negative impact is considerably larger than that of the positive impact for the risk appetite for all, domestic, and foreign investors, whereas the positive impact is greater for the qualified investors. The shocks from the global safe-haven index are transmitted to the risk appetite indices at varying magnitudes, but same direction, and a gradually weakening positive and negative impact, respectively, emerges at lower and upper quantiles (τ). When the index of global safe-haven assets is at its lowest level, the risk appetites of all (domestic and foreign) investors are positively affected over all (below the median) quantile(s), implying that investors adopt a similar attitude to local and global financial assets during the three (lower extreme) market conditions. However, as we move from the bottom to middle quantiles (τ), a gradually decreasing negative affect arises, suggesting a rush from investors towards the global safe-haven assets in times of market turmoil in Turkey due to rising uncertainty and falling demand for the stock market among investors. At the upper quantiles, the impact of the SAFEH index changes is prominently positive for the four risk appetite indices, at varying magnitudes, implying a co-movement between the local and global assets when the global markets are in a bullish phase, and this impact is stable and strong for qualified investors, and weakens for other indices as the level of risk appetite increases.

Fig. 16 shows the results for the impact of VIX on the RISE indices. We should emphasize that, unlike others, the effect is positive at the vast majority of quantiles, ranging from 56.5% (qualified) to 57.3% (domestic), and this impact varies over quantiles and intensifies mostly at the upper quantiles of risk appetite indices. The strongest positive and negative impact is seen for the risk appetite of foreign domestic investors at the upper quantiles (q). Although the impact is weakly positive and/or negative at the lower and normal quantiles, a persistent impact emerges at the upper quantiles. There is a strong positive impact at the lower quantiles of the VIX index and at the upper quantiles of all, domestic, and, particularly, foreign investors, which weakens as we move towards the end of the

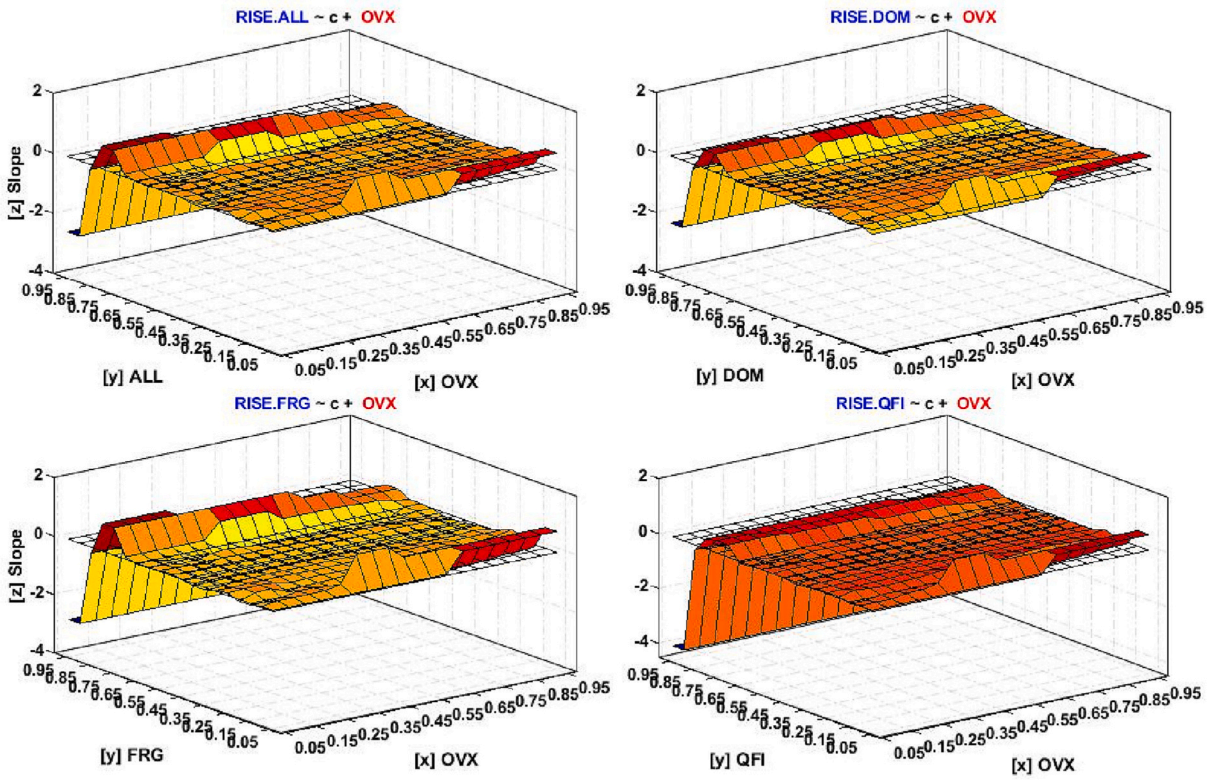


Fig. 12. QQ plot between the RISE index changes and OVX index.

conditional distribution of the VIX index. This evidence suggests that lower market volatility in option prices results in a higher proportion of holdings for the Turkish market. Among the three subindices, the risk appetite for the foreign investors again responds strongly positively, albeit at a lesser magnitude, to the rising level of market volatility. This result shows that rising volatility in futures markets leads investors to seek safety in Turkish equities. A similar but more stable positive reaction is visible at the top quantiles regardless of movements in the fear of global investors.

We compare and plot the effects of conventional quantile regression (QR) and the average estimates of quantile-on-quantile regression (QQR) in the following figures. Note that the rejection of the null hypothesis at a given quantile (q) for the QR findings is shown by a green circle on the black solid line at each quantile. In Fig. **17**, we provide these findings for the effects of local variables on risk appetite index changes. We find that the QQR curves are exactly similar to those of the QR estimations for the gold and currency markets and the number of the significantly (negative) coefficients is higher for changes in foreign exchange rates than gold prices. Although the average QQR results for the bond and CDS markets are mostly consistent with those of QR estimations, the impact is relatively weaker than gold and currency markets. For example, the effect of the CDS spreads is significantly negative for the risk appetite of all, foreign, and qualified investors whereas the domestic investors are significantly positively affected over all quantiles and the regressions follow a dissimilar path at the upper quantiles. Other than a few exceptions, the local variables adversely affect the risk appetite of investors to purchase/hold equities, and this attitude is resilient to the level of market conditions. Unlike the local factors, the strength, magnitude, and direction of the impact of the global factors vary with changing market conditions (see Fig. **18**). We observe that both GPR and SAFEH exert mostly positive and significant impacts at lower and normal quantiles and this effect switches sign from positive to negative and weakens as the level of risk appetite rises. The impact of FSI is significantly negative or positive during extreme market conditions, whereas it is weak and insignificantly negative/positive in normal markets. Further, the significant but negative impact, on average, from changes in the FSI, OVX, and VIX indices could be evidence that the stock market in Turkey could be considered a strong hedging instrument for the aggregate and subindices of investor types.

5. Conclusions

Using weekly observations and methods involving the nonparametric causality-in-quantiles test and quantile-on-quantile regression, this study investigates the impacts of four local and five global factors on four risk aversion indices in Turkey over the period 2008–2022. The findings reveal significant effects from both factors under various market conditions. Both local and global factor changes mostly Granger-cause the growth rates rather than the volatility of risk appetite indices in the Turkish stock market. Among the local factors, changes in CDS spread is the most influential in terms of causality, followed by changes in bond rates, USDTRY

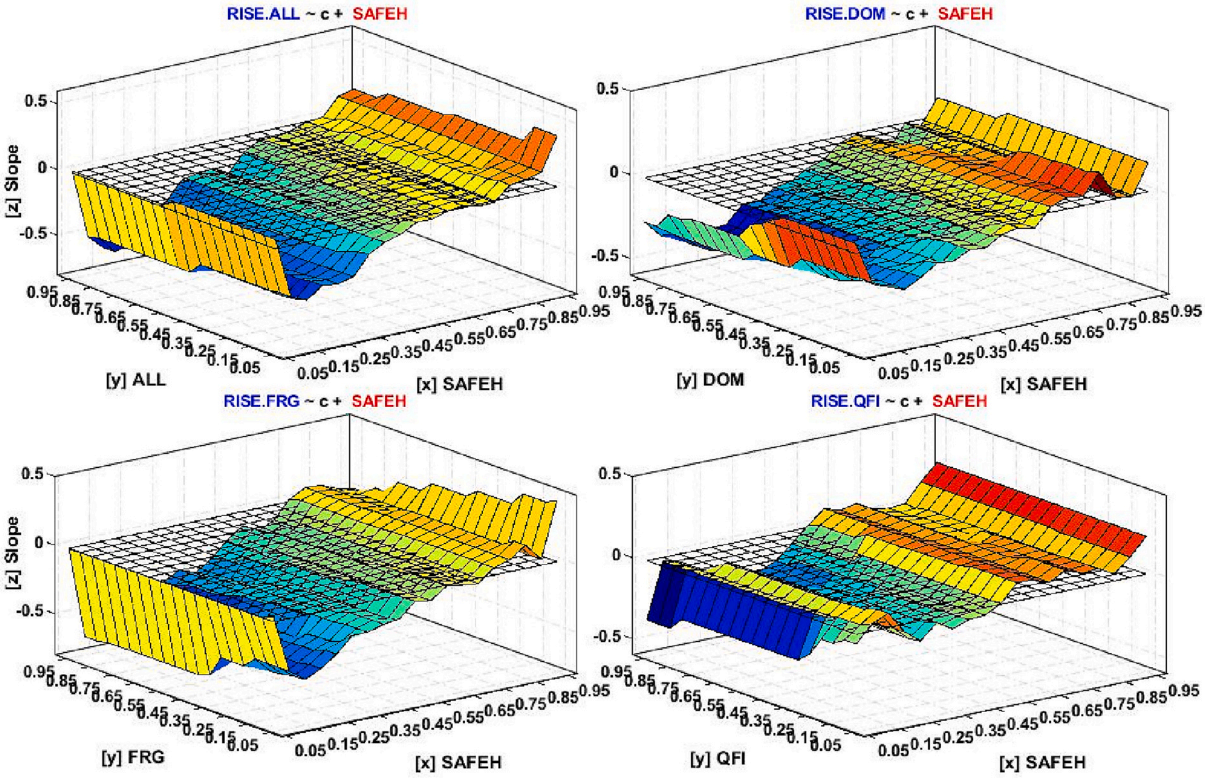


Fig. 13. QQ plot between the RISE index changes and safe-haven index.

exchange rates, and gold prices. The findings reveal that the subindices of risk appetite of investors are relatively robust to the volatility shocks over the extreme market conditions in the bond and CDS markets and thus falling/rising risk premiums do not exert any significant causal flows on stock market investors' holdings. Our results are in line with İskenderoğlu and Akdağ (2019) for unidirectional causality from gold, foreign exchange, and interest rates. The changes and volatility in risk appetite of foreign investors are more predictable than domestic investors' movements using past fluctuations in local variables. The risk appetite of domestic investors emerges as the most immune to shocks originating in the currency and gold markets, while qualified investors are the least immune. In the case of global factors, the changes and volatility in financial stress from emerging markets and global investor fear index emerge as the most powerful predictors, whereas the oil market volatility and safe-haven indices are the least influential variables among the five global factors for predicting the risk appetite of investors trading in Turkey, which reinforces the findings of Akdağ et al. (2020) and Qadan and Idilbi-Bayaa (2020) of a unidirectional causation impact from VIX and OVX to RISE_ALL. Both the returns and volatility of the risk appetite of all investors are most exposed to movements of the global factor variables at varying magnitudes over the entire conditional distribution. The results suggest that both volatility and returns of the GPR and VIX indices improve the prediction of returns and volatility in the risk appetite of qualified investors when the markets are bearish and normal. Furthermore, the no causation effects for either the first or second moment from the OVX and SAFEH indices to the three subindices highlight the strong resilience of domestic, foreign, and qualified investors' risk preferences in stock markets to the causality flows from those indices over various market conditions. We find that the risk appetite of domestic and foreign investors is immune to geopolitical shocks whether the stock market is in its bearish, normal, or bullish phase. We also investigate the causality impacts from both factor groups around the pandemic, and the findings reveal that the predictive power of most factors (bond rates) weakens (disappears) during COVID-19. Moreover, the global factors have higher explanatory power than local factors in predicting the risk appetite of investors at lower extreme and normal quantiles during the pandemic crisis period. The risk appetites of all and foreign investors are most predictable, while neither local nor global factors improve the prediction of changes in the risk appetite of domestic investors.

The QQR analysis yields several noteworthy findings. The influence of both local and global factors, with the exception of VIX, is mostly negative. While foreign investors are the most affected by the dynamics of local markets, the results suggest that local investors emerge as the group most affected by rising uncertainty in global markets. The magnitude and direction of the effect on risk appetite indices vary considerably according to market conditions and the group of factors. The magnitude of the effect hits its peak at the lower quantiles of explanatory factors, as the level of risk appetite increases. The impact remains stable at extreme quantiles of the risk appetite index, regardless of the level of uncertainty in both factors. The strongest negative and positive impacts are driven by the global factor changes, with the OVX being the strongest factor. Moreover, the risk appetite index changes of the qualified and foreign investors are the most exposed to positive and negative shocks. Changes in gold and currency markets are the two local factors most

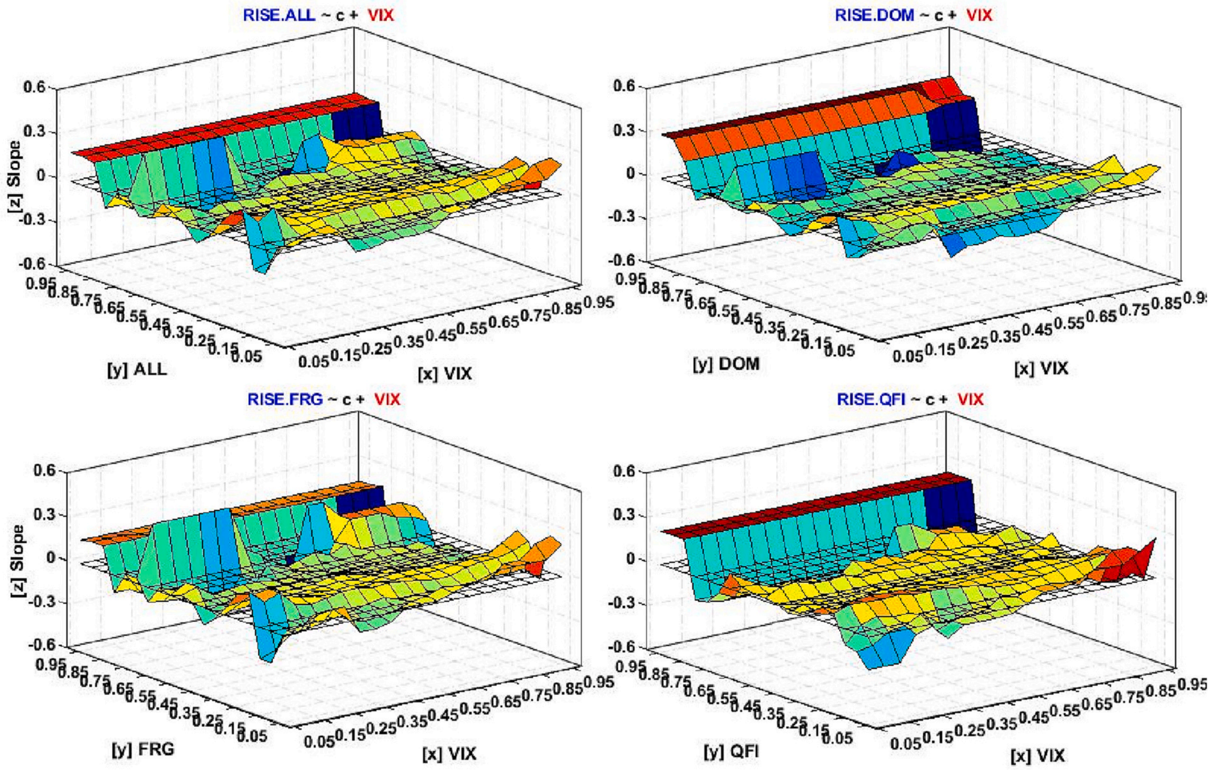


Fig. 14. QQ plot between the RISE index changes and VIX.

affecting the risk appetite changes of all four investor groups, positively and negatively, respectively. Notably, the risk appetite indices are the least vulnerable of the nine factors to negative shocks in VIX.

Overall, the results offer potential implications for investors assessing and measuring factors affecting their risk appetite levels and policymakers constructing monetary policies to strengthen economic and financial stability through decreasing uncertainty in financial markets. From the investors' perspective, the results show that rather than global factors, local factors are the major drivers of risk appetite indices. Since the changes in bond, CDS, FSI, GPR, and VIX indices emerge as the most influential factors in terms of causality, this suggests investors consider their past movements in predicting volatility in risk appetite indices of the four investor groups. Particularly, the risk appetites of foreign and qualified investors emerge as the most predictable groups, rather than the domestic investors, which are mostly resilient to shocks originating from global factors, and their unpredictability holds at upper quantiles. Furthermore, both factor groups, with the exception of VIX, negatively affect the risk appetite indices. These results underline the importance of monitoring fluctuations in local factors rather than global factors when measuring and monitoring the preferences of investors over various market conditions, and thus suggest formulating appropriate risk and investment strategies to avoid or reduce downside risk. To attain and sustain the economic and financial stability of an emerging country with a high sensitivity to internal and external shocks, it is necessary for policymakers to develop a strong policy framework and thus eliminate or reduce the effects of the local and global factors that drive and adversely affect the risk appetite level of stock investors. Since we focus on the effects of factors on risk appetite indices over the entire sample period, future studies may consider a time-varying framework or different econometric approaches, such as quantile or cross-quantilogram correlation.

CRediT authorship contribution statement

Eray Gemici: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Remzi Gök:** Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Elie Bouri:** Project administration, Conceptualization, Visualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

None. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

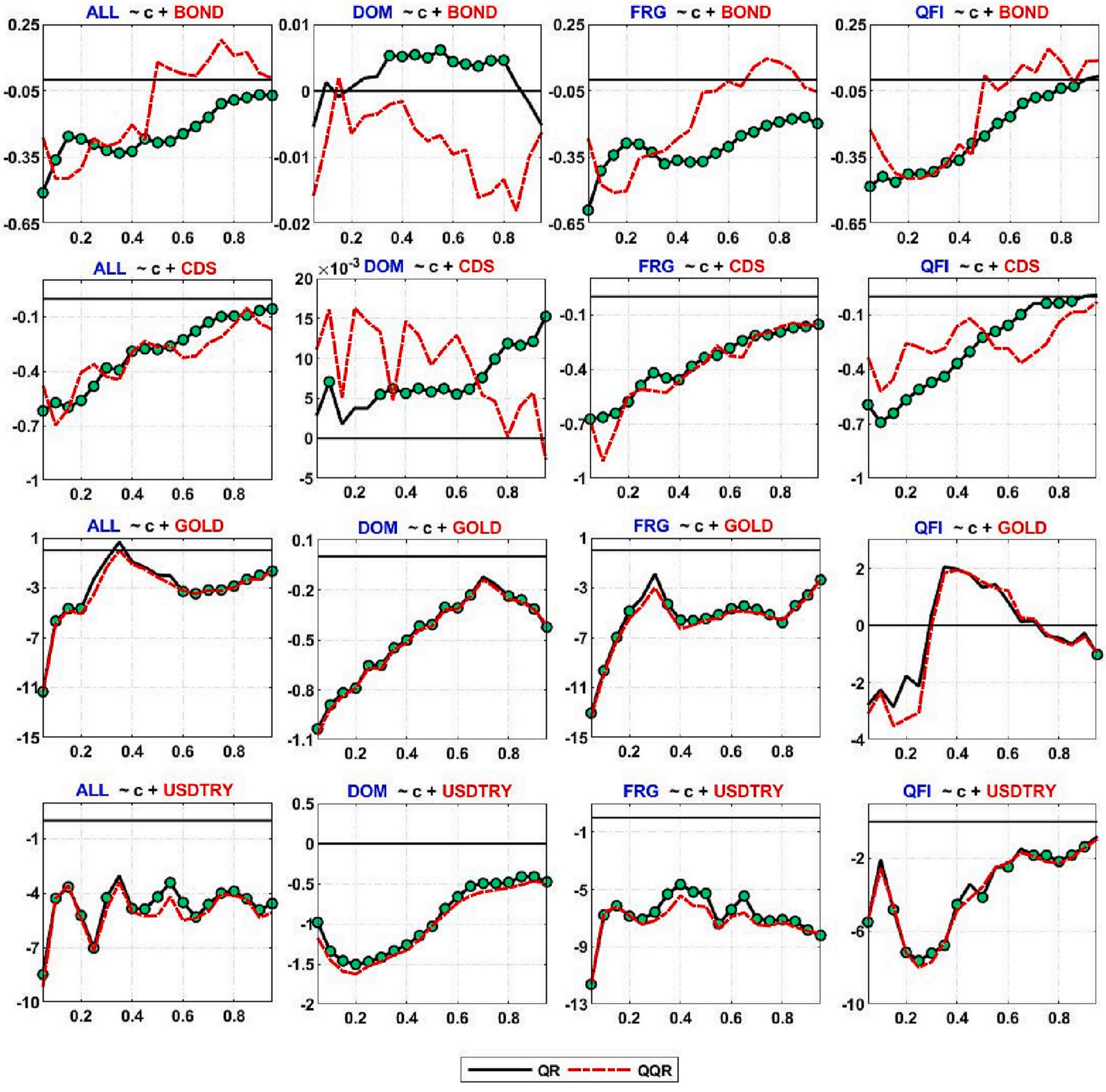
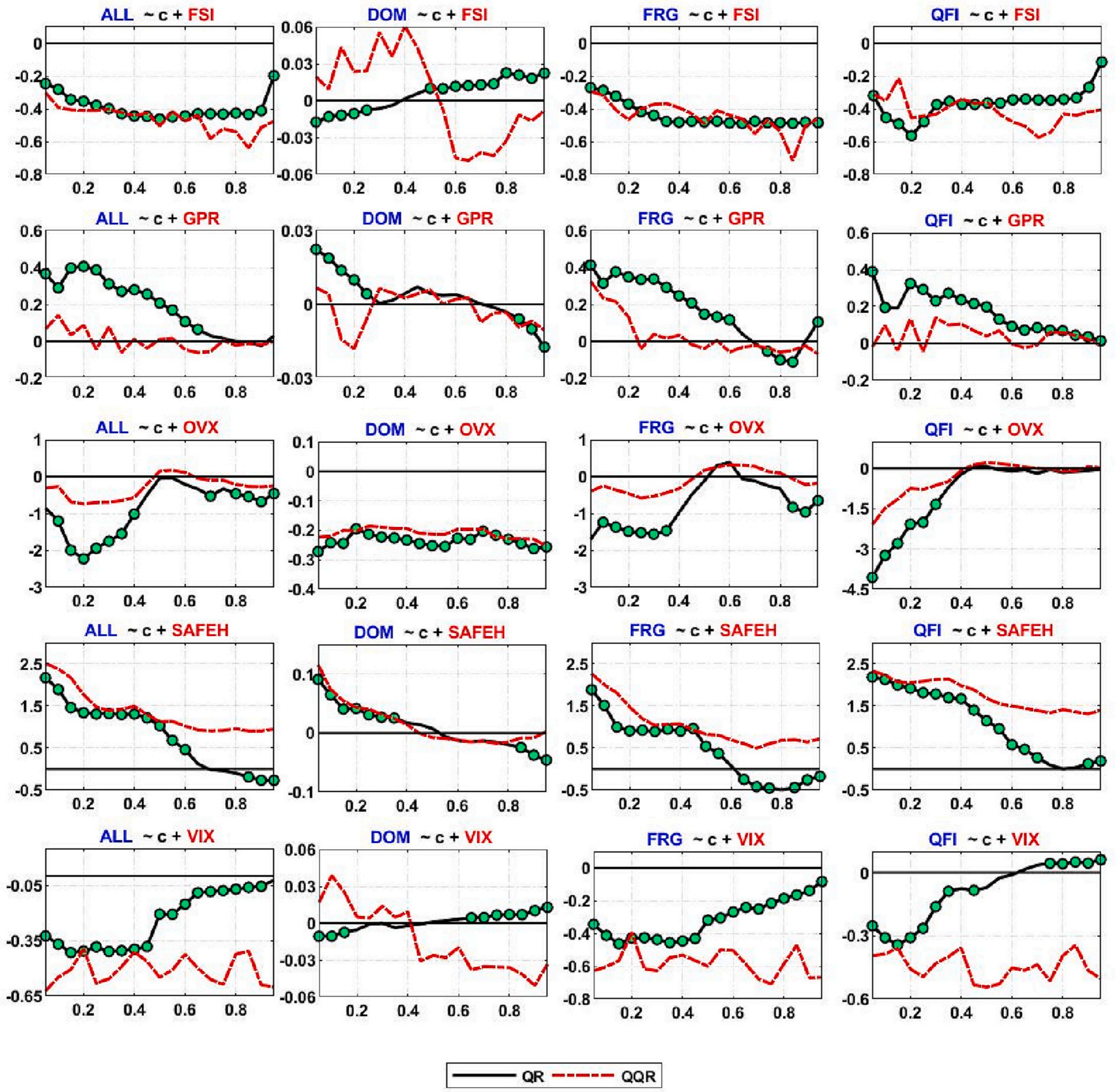


Fig. 15. QR and QQR results for the local variables.
Note: A green circle indicates the rejection of the null hypothesis at a 90% level of confidence. The black solid and red dashed lines show the slope coefficients of quantile regression and averaged quantile-on-quantile regression. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)



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Data availability

Data will be made available on request.

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