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An Analysis of the Effects of Geopolitical Risks on Stock Returns and Exchange Rates Using a Nonparametric Method*

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ABSTRACT

This study explores whether there is a causal effect of geopolitical risk on stock returns and exchange rate return and volatility using Nonparametric Causality-In-Quantiles Test approach. Analysis was conducted on several quantiles based on the monthly Geopolitical Risk Index, Stock Market Index and USD/National Currency data obtained from 18 developing countries for which Geopolitical Risk information was readily available. According to the results, geopolitical risks affect stock and exchange rate returns in approximately half of the countries included in this study, while such risks have a significant effect on stock market and exchange rate volatility of all the countries in the sample.

Keywords: *Geopolitical Risks, Stock Index, Exchange Rate, Volatility, Emerging Markets.*

Jel Classification*: C22, C32, F31, G10.*

Jeopolitik Risklerin Parametrik Olmayan Bir Yöntem Kullanarak Borsa Getirileri ve Döviz Kurları Üzerindeki Etkilerinin Bir Analizi

ÖZET

Bu çalışma, Jeopolitik Riskin Parametrik Olmayan Nedensellik-Quantiles Test Etme yaklaşımı kullanılarak hisse senedi ve döviz kuru getirileri ve oynaklığı üzerine nedensel bir etkisinin olup olmadığını araştırmaktadır. Jeopolitik Risk bilgisinin ulaşılabilir olduğu 18 gelişmekte olan ülkeden elde edilen aylık Jeopolitik Risk Endeksi, Borsa Endeksi ve USD / ulusal para birimi verilerine dayanarak çeşitli analizler yapılmıştır. Elde edilen sonuçlara göre, jeopolitik risklerin, bu çalışmaya dâhil olan ülkelerin yaklaşık yarısında borsa ve kur getirilerini etkilediği, bu risklerin örneklemdeki tüm ülkelerde borsa ve kur dalgalanması üzerinde önemli bir etkisi olduğu tespit edilmiştir.

Anahtar Kelimeler: *Jeopolitik Risk, Hisse Endeksleri, Faiz Oranları, Volatilite, Gelişmekte Olan Piyasalar.*

JEL Sınıflandırması: *C22, C32, F31, G10.*

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1. INTRODUCTION

Factors affecting the value and volatility of assets traded in financial markets are of utmost importance for policy-makers, investors, exporters, and importers with respect to portfolio management, budgeting, loan agreements (Apergis et al. 2017:27). Aghion et al. (2018) offer the information these natural and/or legal persons need for their businesses. Geopolitical Risk is one of the crucial factors influencing the value and volatility of assets traded in financial markets. The effect of geopolitical risk on the assets traded in financial markets is vital information for the actors of the national markets where geopolitical tensions are on the rise (Bouri et al. 2018:12). With business without boundaries as globalization emerge, such information has been a need for all the natural and/or legal persons in today's world.

Geopolitical Risk (GPR) involves both the risks attached to the occurrence of the aforementioned incidents and the new risks associated with the escalation of existing incidents. GPR index is developed in a way to include factors such as war, acts of terrorism and military-related tensions between states (Caldara and Iacoviello, 2018:5). The index was then normalized to an average value of 100 for the decade 2000-2009. Caldara and Iacoviello stated that their GPR Index performs better than its predecessors and other GPR indicators. In this respect, it can bee seen that this index is a useful tool for measuring the effects of GPR on financial markets. The literature review showed that the GPR Index developed by Caldara and Iacoviello (2018) is used in several experimental studies designed to reveal the effect of GPR on the returns and volatility of the assets traded in financial markets (see, for example, Antonakakis et al. (2017), Apergis et al. (2017), Chang and Chu (2017), Balcilar et al. (2018), Baur and Smales (2018), Bouri et al. (2018), Gkillas et al. (2018), Glick and Taylor (2010), Al-Tamimi et. al. (2011), Berkman et al. (2011), Chen and Siems (2004), Drakos (2004 and 2010), Eldor and Melnick (2004), Hon et al. (2004), Johnston and Nedelescu (2006), Abadie and Gardeazabal (2008).

This study uses the GPR Index of 18 developing countries which readily have Geopolitical Risk Index data, indices representing the stock markets and the value of national currencies against USD in order to explore the effect of geopolitical risks on stock markets and exchange rates. In order to be able to do this, the Nonparametric Causality-In-Quantiles Testing method developed by Balcilar et al. (2016) was used. The reason for choosing this method in this study was the robustness of the extreme values available in the data and it was aimed to capture the general nonlinear dynamic dependencies. The rest of the paper is organized as follows: at the first stage, literature will be reviewed. After the methodology and data part, empirical results will be explained and the study will be completed with the conclusion section.

2. THE AIM OF THE STUDY

The purpose of this study is to measure the effect of geopolitical risks of countries on capital markets and money markets, albeit partially. While the stock indices of the countries were taken as representative of capital markets, the movements of local currencies against the

USD were taken as representing of the money markets. The impact of geopolitical risks on the vulnerabilities of the country's economies has been tried to be measured in a different way.

3. LITERATURE REVIEW

Christofis et al. (2013) examined the effects of one of the exchanges at Borsa Istanbul. It was short-lived and the index recovered quickly. The tourism sector was the most negatively affected by the sectoral indices.

Aksoy (2014), in his work in Turkey between 1996 and 2007 and 11 September 2001 terrorist attacks that occurred in the United States, have analyzed their effects on the Turkish Stock Market. As a result of the study, he found that the stock market continued to decline in the days following the terrorist incident. The volatility models used in the time series analysis showed that the Turkish Stock Market is sensitive to terrorist attacks.

Antonakakis et al. (2017), using a 100-year data set, examined the relationship between the geopolitical risk index and oil returns developed by Caldara and Iacoviello (2018). As a result of the study, they have reached a small effect on geopolitical risk and volatility of oil returns.

Apergis et al. (2017) studied the effect of GPR on stock returns on 24 global firms in their study. In the study in which monthly data between 1985 and 2016 were used, nonparametric causality test was used. As a result of the study, 12 firms concluded that they had an impact on stock returns.

Balcilar et al. (2018), in their study, investigated the effects of GPR on return and volatility dynamics in BRICS exchanges through nonparametric causality quantitative tests. In the study analysis, it was found that GPRs generally affect the stock market volatility measures rather than returns, and are generally affected by the return amounts below the media, and GPRs play the role of bad volatility in these markets. In addition, while Russia is exposed to the greatest risk to GPR in terms of both return and volatility, India appears to be the most flexible BRICS country in the group.

Algan et al. (2017) examined the impact on financial markets of terrorist acts in Turkey, in their study. In the analysis using daily data between January 4, 1988 and May 24, 2016 and 16 sector indices, Balcilar et al. (2016) developed nonparametric quantile causality test.

Bouri et al. (2018) conducted a nonparametric causality test to examine the causal effect of geopolitical risks on the returns and volatility dynamics of the Islamic stock and bond markets. As a result of the study, geopolitical risks have reached the conclusion that Islamic bonds tend to predict the returns and volatilities.

4. METHODOLOGY

This section of the study explains the Nonparametric Causality-In-Quantiles Testing method developed by Balcilar et al. (2016), a generalized version of the method used by Nishiyama et al. (2011) and Jeong et al. (2016).2 In this study, the geopolitical risk index is

denoted as and the stock exchange index and exchange rate returns are denoted as. According to Jeong et al. (2012), in order for the (independent variable) not to be a Granger-cause in the quantile with respect to the lag vector then (dependent variable) must be

$$\theta_0(y_t|y_{t-1},\dots,y_{t-p},x_{t-1},\dots,x_{t-p}) = \theta_0(y_t|y_{t-1},\dots,y_{t-p}) \quad (1)$$

Similarly, in the θ^{th} quantile with respect to the lag vector, $\{y_{t-1},\dots,y_{t-p},x_{t-1},\dots,x_{t-p}\}$, if the variable y_t is

$$\theta_0(y_t|y_{t-1},\dots,y_{t-p},x_{t-1},\dots,x_{t-p}) \neq \theta_0(y_t|y_{t-1},\dots,y_{t-p}) \quad (2)$$

then x_t is a Granger-cause. In Eq (2), $\theta_0(y_t|\cdot)$ is a value between 0 and 1, it depends on the t value and it represents the θth quantile of the variable, y_t. Here, $Y_{t-1} \equiv (y_{t-1},\dots,y_{t-p})$, $X_{t-1} \equiv (x_{t-1},\dots,x_{t-p})$ and $Z_t = (X_t, Y_t)$ are given, and the equations, $F_{y_t|z_{t-1}}(y_t|Z_{t-1})$ and$F_{y_t|Y_{t-1}}(y_t|Y_{t-1})$, represents the conditional distribution of the variable, y_t, with respect to Z_{t-1} and Y_{t-1}, respectfully. It is assumed that $F_{y_t|z_{t-1}}(y_t|Z_{t-1})$ is definitely continuous for any Z_{t-1} at y_t. If the equations, $Q_\theta(Z_{t-1}) \equiv Q_\theta(y_t|Z_{t-1})$ and $Q_\theta(Y_{t-1}) \equiv Q_\theta(y_t|Y_{t-1})$, are defined, then $F_{y_t|z_{t-1}}\{Q_\theta(Z_{t-1})|Z_{t-1}\} = \theta$ can be true. As a result, the definitions given in Equations 1 and 2 are tested in accordance with the following hypotheses.

$$H_0: P\{F_{y_t|z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} = \theta\} = 1 \quad (3)$$

$$H_1: P\{F_{y_t|z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} = \theta\} < 1 \quad (4)$$

Jeong et al. (2012) used the distance measure, $J = \{\varepsilon_t E(\varepsilon_t|Z_{t-1}) f_Z(Z_{t-1})\}$. In this equation, ε_t is the error term obtained after regression, and $f_Z(Z_{t-1})$ is the marginal probability density function of the variable, Z_{t-1}. Standard error occurred due to Eq. (3). In Eq (3), when $\mathbf{1}\{\cdot\}$ is expressed as the indicator function we get $E[\mathbf{1}\{y_t \leq Q_\theta(Y_{t-1})|Z_{t-1}\}] = \theta$ or an equivalent as in $\mathbf{1}\{y_t \leq Q_\theta(Y_{t-1})\} = \theta + \varepsilon_t$. Jeong et al. (2012) suggested the following equation for the distance measure based on the assumption that $J \geq 0$

$$J = E\left[\{F_{y_t|z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} - \theta\}^2 f_Z(Z_{t-1})\right] \quad (5)$$

The hypothesis, H_0, which suggests that there is no causality between the variables if $J = 0$, is tested against the hypothesis, H_1, with the condition of $J > 0$. Jeong et al. (2012) used kernel density estimator to calculate J

$$\hat{J}_T = \frac{1}{T(T-1)h^{2p}} \sum_{t=p+1}^{T} \sum_{s=p+1, s\neq t}^{T} K\left(\frac{Z_{t-1}-Z_{s-1}}{h}\right) \hat{\varepsilon}_t \hat{\varepsilon}_s \quad (6)$$

In this equation, the term, $K(\cdot)$, is the kernel function for the width, h, T is the sample size, p is the lag order, $\hat{\varepsilon}_t$ is the standard error of the estimate and expressed as

$$\hat{\varepsilon}_t = \mathbf{1}\{y_t \leq \hat{Q}_\theta(Y_{t-1})\} - \theta \quad (7)$$

In this study, the equation, $\hat{Q}_{\theta}(Y_{t-1}) = \hat{F}^{-1}_{y_t|Y_{t-1}}(\theta|Y_{t-1})$, a function of Y_{t-1}, is used to obtain the nonparametric kernel estimator for y_t with respect to θth quantile. The section of the equation, $\hat{F}_{y_t|Y_{t-1}}(y_t|Y_{t-1})$, is Nadaraya-Watson estimator and it is obtained using

$$\hat{F}_{y_t|Y_{t-1}}(y_t|Y_{t-1}) = \frac{\sum_{s=p+1,s\neq t}^{T} L\left(\frac{Y_{t-1}-Y_{s-1}}{h}\right)\mathbf{1}(y_s \leq y_t)}{\sum_{s=p+1,s\neq t}^{T} L\left(\frac{Y_{t-1}-Y_{s-1}}{h}\right)} \quad (8)$$

In this equation, the term, $L(\cdot)$, is the kernel estimator, while h is the bandwidth.

The econometric structure used by Jeong et al. (2012) was generalized for the 2nd moment in this study. In this context, a technique similar to the nonparametric Granger quantile causality approach of Nishiyama et al. (2011) was used. Let's consider the following equation

$$y_t = g(Y_{t-1}) + \sigma(X_{t-1})\varepsilon_t \quad (9)$$

for higher order moments to identify causality. In this equation, the term, ε_t, represents the white noise process, while $g(\cdot)$ and $\sigma(\cdot)$ are unknown functions which meet certain conditions for being stationary. This equation will not allow causality from X_{t-1} to y_t. However, if it is a nonlinear general function of $\sigma(\cdot)$, then it allows for causality from X_{t-1} to y_t^2. Thus, there is no need to have the square of X_{t-1} for Granger causality in variance. Here, the null hypothesis and alternative hypothesis were re formulated for the Granger causality in variance as used in Eq. (9):

$$H_0: P\left\{F_{y_t^2|Z_{t-1}}\{Q_{\theta}(Y_{t-1})|Z_{t-1}\} = \theta\right\} = 1 \quad (10)$$

$$H_1: P\left\{F_{y_t^2|Z_{t-1}}\{Q_{\theta}(Y_{t-1})|Z_{t-1}\} = \theta\right\} < 1 \quad (11)$$

The testing statistic achievable for nu ll hypothesis is given in Eq. (10) and the variable, y_t, used in Equations (6) and (8) was replaced with y_t^2 (stock return squared or volatility).

As suggested by Jeong et al. (2012), first moment (means) causality refers to the second moment (variances) causality. Now, let's consider the following equation

$$y_t = g(X_{t-1}, Y_{t-1}) + \varepsilon_t \quad (12)$$

Here, it is clear that the causality in first moment also means causality in second moment.

Thus, it is possible to test higher-order causality as follows:

$$H_0: P\left\{F_{y_t^k|Z_{t-1}}\{Q_{\theta}(Y_{t-1})|Z_{t-1}\} = \theta\right\} = 1 \quad k = 1,2,\ldots,K. \quad (13)$$

$$H_1: P\left\{F_{y_t^k|Z_{t-1}}\{Q_{\theta}(Y_{t-1})|Z_{t-1}\} = \theta\right\} < 1 \quad k = 1,2,\ldots,K. \quad (14)$$

The definition obtained using Eq. (13), that "x_t is the cause of y_t up to K^{th} quantile" may be accounted with the test statistic calculated in Eq. (6) for k. However, it is challenging to assess $k = 1,2, \dots, K$ value as it is calculated using different null hypotheses with Eq. (13). The reason behind this is the fact that these hypotheses are interrelated (Nishiyama et al., 2011:86). First, rejection of the null hypothesis which suggests the existence of causality at the first moment for $(k = 1)$ also shows that there is no causality at the second moment. Therefore, the test is subsequently applied to the $k = 2$ (2nd moment). As a result, it is possible to test means causality or variances causality or subsequently test both the means causality and variances causality.

Among the terms used in quantile causality testing, i.e. Eq. (6) and (8), is the bandwidth, is lag order, and are kernel types. In this study, the lag order defined was selected based ın Schwarz Information Criterion (SIC). SIC is one of the widely used tools for its consistency, therefore it is a good solution for the drawback of a highly-parameterized model.

Least squares method was used for bandwidth calculations. For $K(\cdot)$ and $L(\cdot)$, on the other hand, Gaussian RBF kernel was used.

5. DATA

This study used the index data collected from the stock markets of eighteen nations for which Geographical Risk data was readily available and along with the exchange return rates of their national currencies against USD and Geopolitical Risk Index data was used on a monthly basis. Monthly Geopolitical Risk Index data was collected from www.policyuncertainty.com/gpr.html website, while stock exchange and foreign exchange records were obtained from DataStream. Stock and exchange returns were analyzed using the first-difference of the natural logarithm, while the Geopolitical Risk Index data was analyzed using natural logarithm. Thus, it was possible to obtain stationary data.[3] Based on data availability, the starting dates of the variables vary, however the end date is April, 2018.

Table 1. Developing Countries used in the study

Country	**Country**	**Country**
Turkey	Saudi Arabia	Malaysia
Mexico	South Africa	Philippines
Korea	Argentina	Israel
Russia	Colombia	Indonesia
India	Venezuela	Ukraine
Brazil	Thailand	China

[3] Complete details of stationary tests are available upon request from the authors.

5.1. Empirical Results

We used the Nonparametric Causality-In-Quantiles Test method in this study in order to measure the effects of Geopolitical Risks on stock market indices and foreign exchange returns and volatility. The estimations were performed over the quantile range of 0.05-0.95. We rejected the null hypothesis of non-causality at a quantile when the statistical value of the test calculated for each quantile was higher than 1.96 at a significance level of 0.05. Table A2 in the Appendix shows the effect of geopolitical risks on stock returns. A closer look at Table 2 shows that Geopolitical Risks affect the stock index returns at several quantiles in 8 nations (Turkey, India, Indonesia, South Africa, Argentina, Colombia, Israel, and the Philippines). Table A3 in the Appendix, on the other hand, shows the effect of Geopolitical Risks on exchange rate returns and it can be observed that Geopolitical Risks affect exchange returns at several quantiles in 9 nations (India, Brazil, Indonesia, South Africa, Colombia, Venezuela, Ukraine, Israel, and the Philippines) Table A4 in the Appendix shows the effect of Geopolitical Risks on stock index volatility and Table 5 in the Appendix shows the effect of Geopolitical Risks on exchange rate volatility. A closer look at these tables shows that the Geopolitical Risks observed in nations affect both the stock index volatility and the exchange rate volatility in these nations.

6. CONCLUSION

The factors affecting the returns and/or volatility of the assets traded in financial markets are of utmost importance for many stakeholders like investors, academicians and economists. Geopolitical risk is one of these factors. In order to explore the effect of geopolitical risks on stock markets and foreign exchange markets, this study used a Nonparametric Causality-In-Quantiles Testing method. Analyses were performed within the quantile range between 0.05 and 0.95 based on the monthly data showing the performance of national currencies against USD, geopolitical risk index and stock market index of each nation.

Results showed that GPR has a significant effect on both the returns and volatility of stocks and the exchange rate. So many countries are exposed to their geopolitics while managing their economies. This conclusion is compliance with works of Christofis et al. (2013), Aksoy (2014), Apergis et al. (2017), Balcilar et al. (2018) in the literature. However, the results conflict with the work of Antonakakis et al. (2017). According to the study of Antonakakis et al. (2017) geopolitics of the countries have fewer impacts on the stock markets and money markets.

This finding is further proof that policy-makers, investors, exporters, importers must consider geopolitical risks involved when making decisions about portfolio management, budgeting, loan agreements and investments etc. Many developing countries have more fragile economics due to their geopolitics. Therefore, their countries must be more creative in order to handle this negative side.

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Table A2. Nonparametric Causality-In-Quantiles Test Results for Stock Exchange Index Returns

Quantiles	Turkey	Mexico	Korea	Russia	India	Brazil	China	Indonesia	Saudi Arabia	South Africa	Argentina	Colombia	Venezuela	Thailand	Ukraine	Israel	Malaysia	Philippines
0,05	1,3217	0,0718	0,0168	0,3067	0,3370	0,0704	0,0333	0,4065	0,1618	1,7432	0,7063	1,1773	0,0261	0,0844	0,0833	0,3109	0,0030	0,2453
0,1	1,4749	0,2613	0,0411	0,6846	0,8472	0,1023	0,0224	1,8920	0,1184	**2,1891**	0,9230	0,9304	0,1082	0,1567	0,2538	0,8618	0,0079	0,6309
0,15	1,7202	0,4326	0,0927	0,8579	1,1632	0,1120	0,0978	**2,4694**	0,1185	**3,4038**	0,8112	1,1248	0,1454	0,4308	0,5483	0,9377	0,0109	1,2261
0,2	**2,0106**	0,4533	0,0774	0,9105	1,5634	0,2116	0,0280	1,7951	0,0951	**3,6335**	0,9967	1,6445	0,2320	0,4111	0,6323	1,4343	0,0125	1,7389
0,25	1,8983	0,6698	0,0183	1,0734	**2,5717**	0,2863	0,0697	**2,1057**	0,1675	**3,6531**	1,2044	1,5617	0,2681	0,4119	0,5882	1,5513	0,0054	1,6977
0,3	**2,2482**	0,8121	0,0345	0,8364	**2,3273**	0,5544	0,0349	**2,5541**	0,1348	**3,5016**	1,6202	1,6649	0,4845	0,4455	0,5808	1,0808	0,0086	1,7711
0,35	**2,2732**	0,9329	0,1157	1,1211	1,6586	0,3893	0,0529	**2,4182**	0,1382	**3,1674**	**2,0880**	1,6769	0,4279	0,5185	0,5042	1,6631	0,0359	**3,1081**
0,4	1,9569	0,7462	0,0856	1,1770	1,8309	0,7089	0,0600	**2,3528**	0,1723	**3,2188**	**2,6135**	1,7562	0,7379	0,4022	0,4625	1,8910	0,0129	**3,0963**
0,45	1,8410	0,9225	0,1071	0,8159	1,8851	0,8635	0,1132	**2,5287**	0,1313	**3,5178**	**2,6639**	1,8501	0,4427	0,2995	0,5444	1,8448	0,0272	**2,6241**
0,5	**2,1509**	0,9774	0,1370	0,5081	1,7614	0,5743	0,0890	**3,0908**	0,1307	**2,8810**	**2,7885**	**2,0626**	1,0092	0,2497	0,4392	**2,2006**	0,1228	**2,8574**
0,55	**2,1145**	0,9309	0,1355	0,3236	**2,8939**	0,4900	0,2230	**2,9298**	0,1219	**2,6886**	**2,9549**	**2,1661**	1,2031	0,2403	0,8176	**2,2631**	0,0565	**2,5870**
0,6	**2,4980**	0,9112	0,1733	0,5634	**2,4864**	0,3560	0,3047	**2,8965**	0,0799	**2,5228**	**2,9530**	1,6395	1,1074	0,3886	0,7818	1,7750	0,0455	**2,1265**
0,65	**2,3481**	0,8506	0,1673	1,1978	**3,0834**	0,3402	0,1152	**2,7759**	0,0396	**2,0525**	**2,8623**	**2,1868**	1,4792	0,3075	0,9112	1,6216	0,0424	**2,8371**
0,7	1,7910	0,8376	0,3061	0,7317	**2,1204**	0,3345	0,1830	**2,7115**	0,1024	1,6406	**2,2343**	1,8586	1,2230	0,2442	0,7524	1,2923	0,0151	**2,7896**
0,75	**2,2755**	0,5128	0,2191	1,4643	1,3337	0,3251	0,0975	**2,2497**	0,0666	1,7801	1,2919	1,6975	0,9394	0,2569	0,4880	1,3331	0,0270	1,7192
0,8	**2,0136**	0,2966	0,2683	1,4704	1,1261	0,3654	0,1391	1,9326	0,1234	1,3430	1,0189	1,3110	0,6202	0,3750	0,3584	0,8860	0,0300	**2,1287**
0,85	1,4936	0,2111	0,3377	0,6889	1,0676	0,1934	0,0432	1,2408	0,0853	1,0625	0,8650	0,8305	0,3053	0,1049	0,3625	0,3676	0,0301	1,4158
0,9	1,5134	0,0658	0,1898	0,3676	0,6094	0,1442	0,0316	0,9968	0,0792	0,7554	0,5987	0,9434	0,2243	0,2916	0,0932	0,2962	0,0096	0,6466
0,95	0,6026	0,0419	0,1233	0,0460	0,3188	0,1456	0,0191	0,4635	0,0548	0,4713	0,3600	0,4219	0,2240	0,0915	0,0804	0,1766	0,0176	0,2690

Note: Those written in bold indicate the rejection of the null of non-causality at 5% level of significance (i.e., 1.96).

Table A3. Nonparametric Causality-In-Quantiles Test Results for Exchange Rate Returns

Quantiles	Turkey	Mexico	Korea	Russia	India	Brazil	China	Indonesia	Saudi Arabia	South Africa	Argentina	Colombia	Venezuela	Thailand	Ukraine	Israel	Malaysia	Philippines
0,05	0,9936	0,0199	0,0663	0,1978	0,1851	0,8100	0,0358	0,3372	0,4265	1,0704	0,0703	0,1850	0,1222	0,0242	0,2425	0,4500	0,1283	0,5502
0,1	1,0102	0,0161	0,1289	0,3456	0,6935	1,0740	0,2534	0,2042	0,6375	1,0715	0,2482	0,6756	1,5569	0,0282	0,3402	1,2184	0,2526	1,4268
0,15	1,0613	0,0277	0,1685	0,5106	0,9097	**1,9678**	0,3341	0,4962	0,7617	1,9320	0,2519	0,7135	**4,7627**	0,0434	0,6687	1,4980	0,2414	**2,0948**
0,2	1,3254	0,0315	0,2136	0,5374	1,2418	1,5422	0,2647	0,6115	0,6323	1,8235	0,3534	0,9557	**3,8368**	0,0432	0,7998	1,5254	0,2435	**3,0098**
0,25	1,1527	0,0628	0,1284	0,4948	1,1715	1,6777	0,4948	0,7602	0,5860	1,6767	0,3794	1,8683	**5,2849**	0,0476	1,1299	1,8912	0,3016	**3,2351**
0,3	1,2658	0,0604	0,0612	0,5109	1,1259	1,9588	0,3233	0,9860	0,5691	**1,9922**	0,2642	**2,2999**	**4,2679**	0,1783	1,4673	**2,5548**	0,3691	**3,1165**
0,35	1,3961	0,0860	0,0546	0,5868	0,8709	**2,1096**	0,3823	1,3755	0,5040	**2,0824**	0,2963	**2,5168**	**3,9485**	0,1827	1,4737	**2,4699**	0,3550	1,8815
0,4	1,3935	0,0851	0,0578	0,6499	0,7317	**2,2441**	0,4138	1,8731	0,5416	**2,2299**	0,2757	**2,0792**	1,5820	0,2656	1,8879	**3,1326**	0,3177	1,5284
0,45	1,4380	0,0830	0,0627	0,6039	0,9872	1,9420	0,4490	**2,4763**	0,7105	**2,1236**	0,2719	**2,2352**	1,4951	0,3116	1,2785	**3,3421**	0,3344	1,7374
0,5	1,6273	0,0741	0,1759	0,8405	1,1302	1,7917	0,6295	**2,4969**	0,6066	**2,4633**	0,2131	1,5761	1,2101	0,4158	**2,1055**	**2,7569**	0,1914	1,0650
0,55	1,5377	0,0771	0,1835	0,7889	1,2437	1,4623	0,7903	**2,1847**	0,5924	**2,2867**	0,3165	1,2040	1,2628	0,4807	**2,7172**	**2,0127**	0,2251	0,9494
0,6	1,6520	0,0624	0,1940	0,6281	1,7342	1,5046	0,7062	1,6221	0,5860	**2,3900**	0,5326	1,3970	1,1794	0,5120	**2,6172**	1,8230	0,1285	0,9322
0,65	1,4289	0,0582	0,1152	1,0302	**2,0041**	1,2018	0,4944	1,3741	0,5402	**2,0047**	0,3795	1,0992	1,1032	0,4917	1,8650	1,5965	0,2642	0,8581
0,7	1,2275	0,0455	0,1536	0,8056	1,4686	1,3422	0,4543	1,2187	0,4903	1,7816	0,2205	0,9111	**2,6858**	0,2043	1,8875	1,1326	0,4890	0,6487
0,75	1,3449	0,0312	0,1244	0,9713	1,3633	0,9613	0,3597	0,9736	0,4158	1,5439	0,2144	0,7711	**2,5498**	0,1660	1,5850	0,7930	0,2388	0,5384
0,8	1,1185	0,0417	0,1216	0,8331	1,2798	0,8041	0,4719	0,9669	0,3069	1,8129	0,0802	0,8401	1,8187	0,2622	1,2540	0,6882	0,1628	0,6954
0,85	1,1589	0,0178	0,1249	0,4192	1,0641	0,6526	0,1899	0,8962	0,4680	1,6110	0,0750	0,8125	1,3236	0,1278	1,3199	0,5879	0,2531	0,4581
0,9	0,8497	0,0058	0,0984	0,2621	0,8981	0,4351	0,1361	0,6460	0,2318	1,2421	0,0510	0,6662	0,1297	0,0690	0,2682	0,5736	0,1061	1,0606
0,95	0,5249	0,0068	0,0125	0,0794	0,3767	0,3947	0,0866	0,3401	0,2189	1,0250	0,0379	0,4107	0,3306	0,0426	0,1521	0,3366	0,1423	0,5248

Note: Those written in bold indicate the rejection of the null of non-causality at 5% level of significance (i.e., 1.96)

Table A4. Nonparametric Causality-In-Quantiles Test Results for Stock Exchange Index Volatility

Quantiles	Turkey	Mexico	Korea	Russia	India	Brazil	China	Indonesia	Saudi Arabia	South Africa	Argentina	Colombia	Venezuela	Thailand	Ukraine	Israel	Malaysia	Philip pines
0,05	**3,8332**	**3,2931**	**2,2454**	**2,7325**	**2,4616**	**2,8499**	**2,3502**	**2,6469**	1,5287	**3,1398**	**2,9526**	**2,2533**	1,1469	1,9268	**2,2340**	1,1900	1,4452	**2,1178**
0,1	**5,0716**	**3,9258**	**3,2993**	**3,7289**	**3,2136**	**3,7045**	**3,1608**	**3,4970**	**2,1214**	**3,6735**	**3,5663**	**2,9364**	1,4455	**2,7852**	**2,9029**	1,6598	**1,9987**	**3,3348**
0,15	**5,4006**	**4,6409**	**3,4708**	**4,0883**	**3,5541**	**4,4920**	**3,9638**	**4,3158**	**2,4065**	**4,3967**	**4,2891**	**3,3662**	1,3961	**3,2495**	**3,4101**	**2,0911**	**2,5227**	**3,6314**
0,2	**5,7091**	**5,0758**	**4,3133**	**4,5851**	**4,1521**	**4,9936**	**4,4636**	**4,8802**	**2,8054**	**5,0276**	**4,3747**	**3,7292**	1,6709	**3,7097**	**3,9009**	**2,3903**	**2,3934**	**3,8330**
0,25	**6,1143**	**5,4484**	**5,1045**	**4,4681**	**4,1926**	**5,3577**	**4,9423**	**5,2996**	**3,1780**	**5,1758**	**4,5862**	**3,7661**	1,7894	**4,0299**	**4,4213**	**2,8396**	**2,7352**	**4,0492**
0,3	**6,3202**	**5,7400**	**5,0504**	**4,3622**	**4,4899**	**5,7262**	**5,4905**	**5,4462**	**3,3810**	**5,4797**	**4,9557**	**3,8442**	1,9548	**4,1766**	**4,6703**	**3,3926**	**2,8815**	**3,9693**
0,35	**6,4513**	**5,8854**	**5,6126**	**4,6869**	**4,6565**	**5,8177**	**5,6508**	**5,4752**	**3,4311**	**5,5660**	**5,1342**	**3,9604**	**2,0747**	**4,3391**	**4,7277**	**3,4273**	**3,0068**	**4,2086**
0,4	**6,5598**	**5,9190**	**6,0699**	**4,9408**	**4,9848**	**5,8216**	**5,6929**	**5,5521**	**3,4430**	**5,6755**	**5,2015**	**4,0407**	**2,0792**	**4,1510**	**4,6058**	**3,2571**	**2,8842**	**4,2959**
0,45	**6,7027**	**5,9797**	**6,0291**	**4,9498**	**5,0182**	**5,9673**	**5,7160**	**5,6011**	**3,8377**	**5,7071**	**5,2170**	**4,0842**	**2,2507**	**4,1405**	**4,6988**	**3,5187**	**3,1085**	**4,5433**
0,5	**6,6915**	**5,9006**	**5,6181**	**4,9595**	**4,8874**	**5,7779**	**5,7161**	**5,5684**	**3,6455**	**5,7039**	**5,1278**	**3,9489**	**3,1249**	**4,0912**	**4,6584**	**3,4608**	**3,1141**	**4,4452**
0,55	**6,5899**	**5,8121**	**5,4505**	**4,7392**	**4,5726**	**5,3995**	**5,5866**	**5,5281**	**3,8137**	**5,5389**	**4,9931**	**3,8623**	**3,4107**	**4,3905**	**4,6056**	**3,4512**	**3,1201**	**4,4979**
0,6	**6,3992**	**5,6278**	**5,3206**	**4,7084**	**4,4681**	**5,3203**	**5,3929**	**5,4930**	**3,9799**	**5,4593**	**4,6815**	**3,8990**	**3,5671**	**4,2421**	**4,5729**	**3,5052**	**2,6483**	**4,3695**
0,65	**6,1652**	**5,3809**	**5,3606**	**4,4061**	**4,1379**	**5,0205**	**5,2988**	**5,2471**	**3,9314**	**5,2380**	**4,3508**	**3,6812**	**3,6407**	**4,0541**	**4,4160**	**3,2099**	**2,5594**	**4,2507**
0,7	**5,6763**	**5,0490**	**4,8378**	**3,8542**	**4,0476**	**4,8789**	**4,9374**	**4,6966**	**3,5426**	**4,9207**	**4,3267**	**3,4115**	**3,1572**	**3,7769**	**3,9438**	**2,9003**	**2,2015**	**4,0374**
0,75	**5,2473**	**4,8288**	**4,5172**	**3,3662**	**3,7716**	**4,4445**	**4,4166**	**4,2636**	**3,2331**	**4,6100**	**3,9307**	**3,1418**	**3,0264**	**3,4206**	**3,7245**	**2,8517**	**2,2474**	**3,5486**
0,8	**4,9277**	**4,3067**	**3,5482**	**2,9112**	**3,3604**	**4,2534**	**4,1847**	**4,0692**	**2,9014**	**4,1956**	**3,5043**	**2,6997**	**2,2449**	**2,8513**	**3,4860**	**2,4733**	**2,0418**	**3,3885**
0,85	**4,1608**	**3,6740**	**3,1905**	**2,6812**	**2,9045**	**3,7414**	**3,4063**	**3,4969**	**2,6085**	**3,7619**	**2,6440**	**2,5351**	1,8806	**2,5319**	**2,8533**	**2,3040**	1,8423	**2,9764**
0,9	**2,9898**	**2,9723**	**2,7637**	**2,0917**	**2,6666**	**3,0955**	**2,9501**	**2,5415**	**2,0294**	**2,8301**	**2,0621**	1,8936	1,3654	1,7721	**2,0652**	1,8747	1,6639	**2,3276**
0,95	1,6889	**2,3060**	1,5740	1,2448	1,7467	1,9551	1,6120	1,6394	1,5471	**2,0009**	1,2699	1,7247	0,7682	1,2006	1,3048	1,1689	1,0125	1,3675

Note: Those written in bold indicate the rejection of the null of non-causality at 5% level of significance (i.e., 1.96).

Table A5. Nonparametric Causality-In-Quantiles Test Results for Exchange Rate Volatility

Quantiles	Turkey	Mexico	Korea	Russia	India	Brazil	China	Indonesia	Saudi Arabia	South Africa	Argentina	Colombia	Venezuela	Thailand	Ukraine	Israel	Malaysia	Philippines
0,05	1,6470	1,2546	**2,0663**	**3,1669**	1,9465	1,4739	**6,9550**	**2,7476**	**3,1669**	**2,0848**	1,4551	**3,2621**	1,5558	1,0672	1,2151	1,3115	1,2676	**2,5243**
0,1	**3,5290**	**2,0701**	**2,8188**	**4,0879**	**3,0071**	**2,2840**	**6,1993**	**3,7995**	**4,0879**	**3,1040**	**2,4148**	**4,0352**	**2,4014**	1,6909	1,6499	1,8937	**1,9807**	**3,2689**
0,15	**4,6009**	**2,4510**	**3,8576**	**4,9434**	**4,2370**	**2,9878**	**6,2775**	**4,7001**	**4,9434**	**3,7815**	**2,8262**	**4,7816**	**3,0061**	**1,9988**	**2,3056**	1,7819	**2,2893**	**3,8600**
0,2	**5,0994**	**2,8167**	**4,2461**	**5,5457**	**4,9548**	**2,8860**	**6,3729**	**5,3953**	**5,5457**	**3,6007**	**2,9793**	**5,2541**	**4,1799**	1,8781	**2,1551**	**2,3552**	**2,1770**	**4,0377**
0,25	**5,6448**	**3,0112**	**4,6760**	**5,7131**	**5,3209**	**4,8159**	**6,2378**	**5,7584**	**5,7131**	**4,1484**	**3,1826**	**5,7747**	**3,7682**	**2,1630**	**2,5939**	**2,6966**	1,8544	**4,3257**
0,3	**7,2842**	**2,9800**	**4,9019**	**5,6830**	**5,0891**	**4,6954**	**6,2986**	**6,1156**	**5,6830**	**4,2793**	**3,2391**	**6,0805**	**4,1700**	**2,7511**	**2,6019**	**2,5367**	**2,3374**	**4,4429**
0,35	**8,2157**	**3,6286**	**5,1408**	**5,8428**	**5,4356**	**4,5395**	**6,0114**	**5,9908**	**5,8428**	**4,6971**	**3,5857**	**6,2228**	**4,8432**	**2,9111**	**2,6655**	**2,3971**	**2,4827**	**4,5308**
0,4	**8,0756**	**4,3614**	**5,3333**	**5,8544**	**5,1222**	**5,0583**	**5,9834**	**6,2434**	**5,8544**	**4,4664**	**3,2112**	**6,2129**	**4,3860**	**2,6436**	**3,4626**	**2,5859**	**2,7197**	**4,4905**
0,45	**8,0924**	**4,3685**	**5,4039**	**5,9460**	**5,1511**	**4,9164**	**5,4707**	**6,4030**	**5,9460**	**4,5725**	**3,4584**	**6,3762**	**4,6463**	**2,6476**	**3,8808**	**2,2680**	**2,4742**	**4,6714**
0,5	**7,9288**	**4,0767**	**5,3768**	**5,8464**	**5,3512**	**4,8704**	**4,9799**	**6,1801**	**5,8464**	**4,5415**	**3,1742**	**6,5459**	**4,5547**	**2,7424**	**3,7385**	**2,2905**	**2,4364**	**4,5435**
0,55	**7,1381**	**3,8357**	**5,4670**	**5,7342**	**5,4708**	**4,6078**	**4,3262**	**6,2213**	**5,7342**	**4,4702**	**2,8473**	**6,4650**	**4,6918**	**3,3680**	**3,6515**	**2,1197**	**2,3286**	**4,6952**
0,6	**7,6702**	**3,5983**	**5,3621**	**5,4967**	**5,6250**	**4,2928**	**3,7277**	**6,1417**	**5,4967**	**4,2883**	**2,5396**	**6,2493**	**4,7117**	**3,1036**	**3,8621**	1,8652	**2,1375**	**4,7791**
0,65	**6,9067**	**3,4292**	**5,2711**	**5,2558**	**4,9537**	**4,3399**	**3,4377**	**5,7020**	**5,2558**	**4,2593**	**2,3936**	**5,9134**	**5,3245**	**2,8900**	**3,6994**	**2,1242**	**2,1507**	**4,4975**
0,7	**5,9471**	**3,1797**	**4,9263**	**4,8768**	**4,4433**	**4,4754**	**3,2402**	**5,5246**	**4,8768**	**4,1722**	**2,3713**	**5,6860**	**4,8756**	**2,3398**	**3,3072**	**2,1819**	**2,0519**	**4,2859**
0,75	**4,7799**	**3,0107**	**4,5965**	**4,4884**	**4,0633**	**3,8284**	**2,8410**	**5,0215**	**4,4884**	**3,9550**	**2,1306**	**5,1064**	**4,4447**	1,8908	**3,2293**	**2,3037**	**2,0386**	**4,1083**
0,8	**3,6113**	**2,8037**	**4,2344**	**3,8664**	**3,7070**	**3,5675**	**2,8879**	**4,6732**	**3,8664**	**3,6473**	**2,1357**	**4,6440**	**3,6623**	1,5306	**2,4902**	**2,4137**	**2,0614**	**3,5210**
0,85	**2,5399**	**2,3289**	**3,8296**	**3,3655**	**3,1653**	**2,5264**	1,9426	**4,1024**	**3,3655**	**2,9052**	**2,0399**	**4,0847**	**2,8765**	1,3141	**2,1988**	**2,0111**	1,4258	**3,1724**
0,9	1,6858	1,4784	**2,8881**	**2,6917**	**2,3233**	1,7194	1,5305	**3,0429**	**2,6917**	**2,0180**	1,9214	**3,1583**	1,7491	1,0874	1,3184	1,5380	1,1807	**2,5977**
0,95	0,8760	0,7673	1,9222	1,3228	1,5208	0,7909	0,9635	1,9224	1,3228	1,2468	1,0491	**2,0693**	1,1103	0,9955	0,8207	1,1478	0,8581	**2,1102**

Note: Those written in bold indicate the rejection of the null of non-causality at 5% level of significance (i.e., 1.96).