Gillas, Konstantinos Gkillas; Gupta, Rangan; Konstantatos, Christoforos et al.

Book

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Reference: Gillas, Konstantinos Gkillas/Gupta, Rangan et. al. (2021). Exchange rate jumps and geopolitical risks. Pretoria, South Africa : Department of Economics, University of Pretoria.
http://www.up.ac.za/media/shared/61/WP/wp_2021_71.zp211550.pdf.

This Version is available at:
http://hdl.handle.net/11159/7060

University of Pretoria
Department of Economics Working Paper Series

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Konstantinos Gkillas
University of Patras
Rangan Gupta
University of Pretoria
Christoforos Konstantatos
University of Patras
Dimitrios Vortelinos
University of Lincoln and Hellenic Mediterranean University
Working Paper: 2021-71
October 2021

Department of Economics
University of Pretoria
0002, Pretoria
South Africa
Tel: +27 12 420 2413

Exchange Rate Jumps and Geopolitical Risks

Konstantinos Gkillas[a,*], Rangan Gupta[b], Christoforos Konstantatos[c] and Dimitrios Vortelinos[d]

This version

October 21, 2021

[a,*] Corresponding author. Department of Management Science & Technology, University of Patras, Megalou Aleksandrou 1, Koukouli, 26334 Patras, Greece. E-mail: gillask@upatras.gr

[b] Department of Economics, University of Pretoria, Pretoria, 0002, South Africa. E-mail: rangan.gupta@up.ac.za

[c] Department of Business Administration, University of Patras, University Campus – Rio, P.O. Box 1391, Patras 26504, Greece. E-mail: ckonstanta@upatras.gr

[d] Lincoln Business School, University of Lincoln, LN6 7TS, the UK; Hellenic Mediterranean University, Greece. E-mail: dvortelinos@lincoln.ac.uk

Abstract

We study the causal relation as well as the Granger-causality and causality-in-quantiles of geopolitical risks in foreign exchange (FX) price jumps, for the period that spans from July 1, 2003, to August 28, 2015. Extended series of different currencies and quantiles are investigated considering seven exchange rates (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). We show that geopolitical risks (GPRs) help to predict FX jumps as our results demonstrate a statistically significant and of considerable magnitude relation between geopolitical risks and jumps in the foreign exchange market. The acts of geopolitical risk more severely cause FX total, upside and downside jumps; with the threats of geopolitical risk second, and the geopolitical risk last. In the highest quantiles, NZD is the currency with the highest causalities between geopolitical risks and FX jumps; the highest and lowest causalities are for geopolitical risk (GPR) and geopolitical acts (GPA), respectively. Moreover, the GPR has the highest dispersion of causalities for all FX jumps.

Keywords: Causality; Quantile; Jumps; Foreign Exchange; Geopolitical risks

JEL Codes: C22, G10, Q02.

1. Introduction

The hedging opportunities in the foreign exchange (FX) market are many. These opportunities are mostly employed in the concept of "global currency hedging" (Campbell et al., 2010). This strategy refers to invest in currencies in order to reduce the diversifiable risk of portfolios. Is this asset allocation framework, the accurate estimation of the variance-covariance matrix is of main importance. This estimation relies on the FX volatility and correlation dynamics. Considering FX volatility of each asset is much higher in-magnitude than covariances, as well as the complexity of volatilities is higher than correlations; the importance of the former is much higher than the latter. The importance of FX volatility is revealed by the fact that its increase leads to decreased other assets' correlations in asset allocation (Mun, 2007). Also, the inclusion of FX volatility series in asset allocation significantly changes the portfolio weights (Kim et al., 2016). The importance of FX variances in estimating the variance-covariance matrix has recently been researched (Cho et al., 2020). It is revealed by investigating the FX volatility and dynamic conditional correlation (DCC). The importance of FX volatility is also evident as they found that FX volatility is much more important than US stock market volatility.

Nevertheless, FX returns, and volatilities share common distributional properties (non-normal distribution, no unit root, long-memory, and autocorrelation, see Cho et al., 2020, among others). These properties have been researched homogeneously (within the price process). Many studies have demonstrated the importance of discontinuities (jumps) of the FX market. This latent process of the jumps of FX has not been extensively researched, and importantly better understanding of what triggers those movements is always challenging. One of the reasons is that jumps are generally associated with the concept of "bad" volatility (see Giot et al., 2010), which, reflects the discontinuous and jump property of volatility. This paper tries to deepen our knowledge and expand the literature in the latent process of the discontinuities (jumps) of FX, as well as whether geopolitical events can trigger jumps in FX markets.

In recent economic history the Great Depression of 1930, Black Monday of 1987, and the Asian financial crisis of 1997 provide evidence that a large negative events or rare disasters have major effects on economy indicating the link between rare disasters and economy (for disaster risk literature see, Lucas, 1978; Mehra and Prescott, 1985; and Reitz, 1988). Recently, the research focus on disaster risk (see Gabaix, 2012) associated with volatility (see Barro, 2006; Wachter, 2013; Tsai and Wachter, 2015). Demirer et al. (2018) and Gupta et al. (2018) found a causality from rare disaster risks to volatility of oil, bonds, and FX for the period from 1918 to 2013. Jumps propagates as shocks across the time associated with events, market news announcements or large arbitrage hedging activities (Merton, 1976; Lee, 2008; Boudt and Pertitjean, 2014). The existing literature researched the importance of geopolitical risks on both assets' return and volatility. Both have been heavily researched in energy markets. The impact of geopolitical acts in returns was significantly positive, while the impact of geopolitical threats was non-significant (Antonakakis et al., 2017; Su et al., 2019; Bouiyor et al., 2019). This positive relation also holds between geopolitical risks and volatility (Wang and Yang, 2018; Demiter et al., 2019; Mei et al., 2020). Geopolitical risks (GPRs) are considered as rare events (i.e., geopolitical risk denoted as GPR, geopolitical threats GPT and geopolitical acts GPA). Such events should act as breaks in any latent process. The impact of geopolitical risks is more important to the latent volatility series, as the literature suggests. But the literature has mainly researched this relation with the use of linear methods (ordinary least squares or vector autoregressive, etc.). GPRs have important role in both economic activity and government spending, internationally (Bloomberg et al., 2004). These risks relate to terrorist acts, tensions, and wars that affect financial markets (Caldara and Iacoviello, 2018). GPRs mostly affect financial markets as reactions to rare events in both return and volatility series (Mei et al., 2020). Following these results, the explanatory power of GPRs may be higher for the discontinuities (jumps) of the volatility series (Gkillas et al., 2020b). This is to research in the current analysis.

Existing studies have tried to model different properties of the volatility in relation to GPRs. One of the properties is heteroskedasticity (Liu et al., 2019), while the second, and most important one is the heterogeneity, which was found to be more important in the mixed data sampling models (see Mei et al., 2020). The jumps property of volatility is also important in volatility prediction, but it has not so far been examined in relation to GPRs. The relation can be captured by employing quantile regressions (Baur, 2013; Qin et al., 2020, among others) under different market conditions (You et al., 2017; Demiralay and Kilincarslan, 2019). Following the latter stream of literature, this paper tries to facilitate a better understanding of jump causes in the FX market.

The aforementioned relation is best revealed by the nonparametric causality-in-quantiles test, as suggested in Balcilar et al. (2018a). This test combines the nonlinear causality test (as suggested in Nishiyama et al., 2011; and applied in Wen et al., 2018, among others) and the causality-in-quantiles test (as suggested in Jeong et al., 2012; and applied in Nusair and Olson, 2019, among others). Moreover, the test can be employed in both causality-in-mean and causality-in-variance, as well as causality in the tails of the joint distribution of variables. The latter is particularly useful in in the process; and in a greater extent, when this process incorporates discontinuities (jumps). Its importance in jumps series is evident because only the tails can explain in total, the breaks (jumps) series. This is reinforced since the 2008 financial crisis and the European debt crisis, as jumps became more important for all financial markets. Both 2008 financial crisis as well as the more recent European debt crisis, the direct (nonparametric) assess of the tails of jumps is another goal of this paper, similar research question has been examined in a parametric framework for bitcoin by Gronwald (2019). Motivated by the basic idea of strong efficient market hypothesis, the tails of FX jumps should not be affected by geopolitical risks. It is also examined whether such effect adds to asset pricing finance. If such effect is significant, geopolitical risks should be incorporated into asset pricing, as one factor of the Multi-factor Capital Asset Pricing Model.

After the analysis of the relation between geopolitical risks and financial markets, comes predictability. The importance of geopolitical risks in predicting the first and second moments of financial time series has been revealed in literature. The role of geopolitical risks in point and density forecasting has well researched in Plakandaras et al. (2019), among others. However, Liu et al. (2019), Asai et al. (2020) and Gkillas et al. (2020a) were the first to signify the importance of geopolitical risks in financial volatility forecasting. Moving a step further, this study researches the importance of geopolitical risks in forecasting the FX discontinuities (jumps). Our contribution, to the literature may lies on the predictive power of GPRs on FX jumps adopting a causality-in-quantile method. This method has the following two key novelties. First, it is robust to misspecification errors as it detects the underlying dependence structure between the examined time series, makes it crucial as the FX jumps are nonlinearly associated both with the GPRs, an expected result since Jiménez-Rodríguez (2015) found clear evidence that financial market variables being nonlinearly related to their predictors. Second, by using the causality-in-quantile, we test both the causality-in-mean (see, Heimstra and Jones, 1994; Diks and Panchenko, 2005, 2006), and the causality that may exist in the tails of the joint distribution of the variables since our dependent variable, i.e., FX jumps, are shown to exhibit heavy tailed behaviour – a feature that also outlined in Bollerslev et al., (2013).

As there is evidence that volatility in markets is related to the GPRs (Gkillas et al.; 2018), a research question arises “Do the GPRs can trigger jumps in FX markets?” Consequently, we investigate the casual relation between geopolitical risks and FX jumps. To this end, we use the nonparametric causality-in-quantiles test of Jeong et al., (2012) to detect directional predictability of FX jumps due to geopolitical risks. To our best knowledge this is the first study that examines the directional predictability of GPRs on FX jumps. From a practical point of view, we consider market participants are exposed to FX jump risk as our we find strong evidence of directional predictability of FX jumps due to geopolitical risks.

The remainder of the paper is organized, as follows: Section 2 presents data and descriptive statistics of jumps series. Section 3 lays out the econometric methods for jump detection and causality-in-quantiles. Section 4 reports results for causality, effects and robustness. Finally, Section 5 presents implications and concluding remarks.

2. Data and summary statistics

This section discusses the data used in this study. First, we present the geopolitical risk index used in our analysis (see Caldara and Iacoviello; 2018) and the exchange rates considered. These are: (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). Second, we present some basic descriptive statistics of these series.

2.1. Data

Following Caldara and Iacoviello (2018) we collect the daily data of geopolitical risk (GPR). The GPR index is based on automated text-search results of the electronic archives of 3 national newspapers: The Chicago Tribune, The New York Times, and The Washington Post. The index of Caldara and Iacoviello (2018) counts the number of articles related to geopolitical risk in each newspaper for each day (as a share of the total number of news articles) and normalized to average a value of 100 in the 2000-2009 decade, the present data is available for download from:

https://www.matteoiacoviello.com/gpr.htm#data. Based on Caldara and Iacoviello (2018) the automated text-search identifies articles containing references to six groups of words as follows, Group 1 incorporated from words associated with explicit mentions of geopolitical risk, as well as mentions of military related tensions involving large regions of the world and a US involvement. Group 2 includes words directly related to nuclear tensions. Groups 3 and 4 incorporated from words related to war threats and terrorist threats, respectively. Finally, Groups 5 and 6 captures press coverage of actual adverse geopolitical events (as opposed to just risks) which can be reasonably expected to lead into increases in geopolitical uncertainty, such as terrorist acts or the beginning of a war. We adopt the disentanglement between the direct effect of adverse global geopolitical events and the effect of pure geopolitical risks following Caldara and Iacoviello (2018). To do so they constructed two indices: First, the Geopolitical Threats (GPT) index, which includes words belonging to search groups 1 to 4, and second the Geopolitical Acts (GPA) index includes words belonging to Search groups 5 and 6.

We use intraday – 5min FX to arrive at the daily jump values. FX intraday data are obtained from the (Pi-Trading Inc) The exchange rates under consideration are, (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). The sample covers the period July 1, 2003 to August 28, 2015 (3,775 Observations). Figure 1 depicts the geopolitical risks (GPRs) and FX jumps. Panel A depicts the three GPRs indices and Panel B depicts the FX jumps.

Both foreign exchange (FX) returns, and volatilities share similar properties. The Jarque-Berra test rejects the null hypothesis of normal distribution for all exchange rates. Also, the null of a unit root is rejected for all exchange rates, according to the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. Moreover, the null hypothesis of no autocorrelation is rejected for all exchange rates, based on the Q-square (20) Ljung-Box test to squared returns. These results are available upon request. Results for the descriptive statistics are similar to the ones of excess currency returns of Cho et al. (2020). Such properties drive us to further research foreign exchange FX dynamics.

The US dollar has not included in the dataset, as it does not adhere to the purposes of the study. US FX volatility increases the FX volatility of other countries, in an asset allocation framework (Cho et al., 2020). This contagion effect from US FX volatility diminishes the importance of US FX inclusion in asset allocation. This is the reason why US FX volatility has not been researched. Apart from US dollar, Euro, Swiss Franc and Japanese Yen are important, and considered as safe havens, as they move against world equity markets (Cho et al., 2020). Since the 2008 financial crisis, the Japanese Yen increased its importance; while, the US dollar and Euro had their importance decreased. The importance of non-safe currencies (like AUD, CAD, and GBP) increased significantly, since 2008 financial crisis (Cho et al., 2020). Swiss Franc and Japanese Yen are the most important currencies in an asset allocation framework (Ranaldo and Söderlind, 2010; and Min et al., 2016).

2.2. Summary statistics

Tables 1 and 2 report descriptive statistics for FX (total) jumps (see sub-section 3.1) and geopolitical risks, respectively. Jumps concern AUD, GBP, EUR, NZD, CAD, JPY, and CHF. Geopolitical risks concern three indicators: geopolitical risk (GPR), geopolitical threats (GPT), and geopolitical acts (GPA). Panel A reports the descriptive statistics: mean, median, maximum, minimum, standard deviation, skewness, and kurtosis. Also, it is reported the statistic value and p-value of the Jarque-Berra test with null hypothesis of normal distribution. The ADF and PP tests with the null hypothesis of a unit root (non-stationarity) follow in Panels B and C, respectively. The PP test makes a non-parametric correction to the t-test statistic. The test is robust with respect to unspecified autocorrelation and heteroscedasticity in the disturbance process of the test equation. Davidson and MacKinnon (2004) stated that the Phillips–Perron test performs worse in finite samples than the augmented ADF test.

The highest mean, maximum and dispersion of FX jumps are for NZD, while the lowest are for GBP. Skewness and kurtosis values are much higher than 0 and 3, respectively; indicating non-normal distribution for all FX jumps series. This complies to the Jarque-Berra test results; for which, the null hypothesis of normal distribution is rejected for all FX. We also observe that in Panel B and Panel C both in Table 1 and Table 2 a rejection of the null hypothesis that a time series has a unit root.

3. Methods

This section presents the econometrics methods. First, we describe in detail the construction of FX jumps as in Andersen et al. (2012), Bekaert and Hoerova (2014) and Duong and Swanson (2015). Second, we describe the the quantile-based methodology based on the framework of Jeong et al. (2012) to test the causality to detect directional predictability of FX jumps due to geopolitical risks (GPRs) in the following quantiles $0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9$ and 0.95.

3.1. Jump detection

Following Aït-Sahalia and Jacod (2009), assume the log price process $p_t = log(P_t)$ follows an Itô-semimartingale,

$$p_t = p_0 + \int_0^t b_s ds + \int_0^t \sigma_s dB_s + \sum_{s \le t} \Delta p_s \tag{1}$$

The first three terms on the right side of the equation make the continuous semi-martingale component, while the last term on this side is the discontinuities (jumps) process. The jump part is a compound Poisson process (CPP) that allows N_t which is the number of jumps in the time interval of $[0, t]$ to follow a Poisson process. As far as our sample has equally spaced time intervals, denoted by Δ_n, that is 5 minutes; and n is the number of observations (once every 5 minutes) within a day (i.e., 288). The intraday log return is,

$$r_{i,n} = p_{i\Delta_n} - p_{(i-1)\Delta_n} \tag{2}$$

The volatility of returns is latent, and unobservable. It can be approximated by Quadratic variation (QV_t),

$$QV_t = \int_0^t \sigma_s^2 ds + \sum_{t-1 \le s < t} \Delta p_s^2 \tag{3}$$

where the first part is integrated volatility $IV_t = \int_0^t \sigma_s^2 ds$ and the second is the price jump component (QJ_t). The processes QV_t and IV_t are not observable. They can only be approximated by employing the strength of high frequency data. The non-parametric realized volatility (RV_t) is the best non-parametric estimator that uniformly converges in probability to Quadratic variation (QV_t), as $n \to \infty$,

$$RV_t \to_u QV_t = IV_t + QJ_t \tag{4}$$

IV_t is best estimated by realized bi-power variation (Li et al., 2017), which is the realized volatility estimator least affected by microstructure noise. QJ_t is approximated by the estimate of jumps,

$$RV_{t,n} = \sum_{i=1}^{n} (i\Delta_n p)^2 \tag{5}$$

Barndorff-Nielsen et al. (2006) first proposed the so-called bi-power variation (BV_t) that continuously estimates the integrated variance in the presence of jumps in the underlying price process,

$$BV_{t,n} = (\mu_1)^{-1} \sum_{i=2}^{n} |i\Delta_n p||(i-1)\Delta_n p| \tag{5}$$

where $\mu_1 = E|Z| = 2^{1/2}\Gamma(1)/\Gamma(1/2)$ and Z is a standard normal random variable.

3.2. Jumps

Jumps may be considered as time series, dependent from other financial markets; as the mere existence of jumps at the market or portfolio level refutes the conjecture that jump risk is entirely asset specific (Bollerslev et al., 2013). This is the reason why, jumps series incorporate information non-existent to other financial assets, and very important for the purposes of both asset allocation and asset's time series properties. As Duong and Swanson (2011) among others, did; we follow the jump test methodology of Huang and Tauchen (2005) as well as Barndord-Nielsen and Shephard (2006). This jumps detection scheme test for the presence of jumps by looking at the difference between total quadratic variation (as estimated by realized volatility) and its continuous component (as estimated by bipower variation). The relative jump measure of Hung and Tauchen (2005) (RJ_t) is the contribution of jumps (defined as the difference between realized volatility and bi-power variation) to total variation. As $n \rightarrow \infty$, $RJ_t > 0$ only on days for which there are at least one jump. Barndord-Nielsen and Shephard (2006) showed that the joint distribution of RV_t and BV_t, conditional on the volatility path is mixed normal for $n \rightarrow \infty$,

$$n^{1/2}\left[\int_{t-1}^{t}\sigma^4(s)ds\right]^{-1/2}\begin{pmatrix} RV_t - \int_{t-1}^{t}\sigma^2(s)ds \\ BV_t - \int_{t-1}^{t}\sigma^2(s)ds \end{pmatrix}\xrightarrow{D} N\left(0,\begin{bmatrix} v_{qq} & v_{qb} \\ v_{qb} & v_{bb}\end{bmatrix}\right) \tag{6}$$

where $v_{qq} = 2$, $v_{qb} = 2$, and $v_{bb} = (\pi/2)^2 + \pi - 3 \approx 2.6090$. Huang and Tauchen (2005), among others, found that tri-power quarticity is the best jumps-robust estimator of integrated quarticity, defined as,

$$TP_t = \mu_{4/3}^{-3} n\left(\frac{n}{n-2}\right)\sum_{i-2}^{n}\left|r_{t,i-2}\right|^{4/3}\left|r_{t,i-1}\right|^{4/3}\left|r_{t,i}\right|^{4/3} \tag{7}$$

where $\mu_{4/3} = 2^{2/3}\Gamma(7/6)/\Gamma(1/2) \approx 0.8309$ and $\lim_{n\to\infty} TP_t = \int_{t-1}^{t}\sigma^4(s)ds$. A standardized version of the aforementioned ratio statistic RJ_t (Barndorff-Nielsen and Shepahrd, 2004). This test statistic closely approximates a standard normal distribution, with the null hypothesis of no jumps, $z_t \xrightarrow{D} N(0,1)$. the adjustment in the denominator relates to Jensen's inequality adjustment for the (asymptotic) relation between TP_t and BV_t^2. This jumps detection scheme is applied for 0.01 significance level.

3.2.1. Upside and downside jumps

The best way to investigate the upside and downside jumps is nonparametric. This is because it is the only way to directly research the asymptotic properties of jumps. Parametric (like GARCH, BEKK, or DCC) models allow jumps to be employed in accurately estimating variance-covariance matrix in an asset allocation framework (Engle, 2009). Though, in such parametric framework, jumps cannot be researched as an individual upside or downside jumps. After jumps detection and in a nonparametric framework; Andersen et al.(2007) define the continuous and jumps components of realized volatility (the estimate of Quadratic variation). The former is defined as the realized measure of variation of continuous component; $RVJ_t = max\{0, RV_t - \widehat{IV}_t\} * I_{jump,t}$. The latter is defined as the realized measure of variation of jump component $RV\ _t = RV_t - RV\ _t$. Considering an indicator function equals to 1 $\left(I_{jump,t} = 1\right)$ if jumps occur at day t; and, $\left(I_{jump,t} = 0\right)$, otherwise. The application of limit theorem in financial econometrics make it feasible to retrieve jump variations of spectrum of jump power variations, as power transformation of absolute log price jumps ($|\Delta p_s|^q$) (Aït-

Sahalia and Jacod, 2012). Aït-Sahalia and Jacod (2009) suggested the use of realized measures of jumps variations. The jump power variation is defined as,

$$JP_{q,t} = \sum_{0<s\leq t} |\Delta p_s|^q \tag{8}$$

In accordance with this, the upside and downside jump power variations, as retrieved by Duong and Swanson (2015), are defined as,

$$JPV_{q,t}^{+} = \sum_{0<s\leq t} |\Delta p_s|^q \, I_{\Delta p_s>0} \tag{9}$$

$$JPV_{q,t}^{-} = \sum_{0<s\leq t} |\Delta p_s|^q \, I_{\Delta p_s<0} \tag{10}$$

when $q = 2$, the upside and downside jump power variations are estimated by the RS_t^- and RS_t^+ semi-variances (Barndorff-Nielsen et al., 2010).

$$RS^{+} = \sum_{i=1}^{n} \left(r_{i,n}\right)^2 I_{\{r_{i,n}>0\}} \tag{11}$$

and,

$$RS^{-} = \sum_{i=1}^{n} \left(r_{i,n}\right)^2 I_{\{r_{i,n}<0\}} \tag{12}$$

The former (latter) semi-variance contain positive (negative) intra-daily returns, as they converge uniformly in probability to semi-variances.

$$RS^{+} \rightarrow_u \frac{1}{2}\int_0^t \sigma_s^2 ds + \sum_{i=1}^{n} (\Delta p_s)^2 I_{\{\Delta p_s>0\}} \tag{13}$$

And,

$$RS^{-} \rightarrow_u \frac{1}{2}\int_0^t \sigma_s^2 ds + \sum_{i=1}^{n} (\Delta p_s)^2 I_{\{\Delta p_s<0\}} \tag{14}$$

$\int_0^t \sigma^2(s)ds$ is replaced by the estimate of IV_t. In its turn, IV_t is estimated by bi-power variation (Patton and Sheppard, 2015).

$$\sum_{i=1}^{n} \left(r_{i,n}\right)^2 I_{\{r_{i,n}>0\}} - \frac{1}{2}\widehat{IV_t} \to_u \sum_{i=1}^{n} (\Delta p_s)^2 I_{\{\Delta p_s>0\}} \tag{15}$$

and,

$$\sum_{i=1}^{n} \left(r_{i,n}\right)^2 I_{\{r_{i,n}<0\}} - \frac{1}{2}\widehat{IV_t} \to_u \sum_{i=1}^{n} (\Delta p_s)^2 I_{\{\Delta p_s<0\}} \tag{16}$$

Based on semi-variances, Patton and Sheppard (2015) suggested the realized downside and upside power variations:

$$RJ_{q,t}^{+} = \sum_{i=1}^{n} \left|r_{i,n}^{+}\right|^q \text{ and } RJ_{q,t}^{-} = \sum_{i=1}^{n} \left|r_{i,n}^{-}\right|^q \tag{17}$$

where $r_{i,n}^{+}$ and $r_{i,n}^{-}$ are positive and negative intraday returns, respectively. When q = 2, both continuous and jumps components contribute to the limit of $RPV_{q,t}$ (Todorov and Tauchen, 2010) ($RPV_t \overrightarrow{\ ucp\ } QV_t$). According to Patton and Sheppard (2015), the jump power variation is $RPV_t = \sum_{i=1}^{n} \left|r_{i,n}\right|^q$. Duong and Swanson (2015) suggested the downside and upside power variations should be multiplied by jumps indicator $\left(I_{jump,t}\right)$. The indicator function equals to 1 $\left(I_{jump,t} = 1\right)$ if jumps occur at day t; and, $\left(I_{jump,t} = 0\right)$, otherwise. The realized power variation is defined as,

$$RPV_{q,t} = I_{jump,t} * \left\{\sum_{i=1}^{n} \left|r_{i,n}\right|^q\right\} \tag{18}$$

The realized upside jump is defined as,

$$RJ_{q,t}^{+} = I_{jump,t} * \left\{\sum_{i=1}^{n} \left|r_{i,n}^{+}\right|^q\right\} \tag{19}$$

and the realized downside jump is defined as,

$$RJ_{q,t}^{-} = I_{jump,t} * \left\{\sum_{i=1}^{n} \left|r_{i,n}^{-}\right|^q\right\} \tag{20}$$

Also, the 'signed' jump power variation is defined as,

$$RJA_{q,t} = I_{jump,t} * \left\{RJ_{q,t}^{+} - RJ_{q,t}^{-}\right\} \tag{21}$$

For the purposes of realized volatility prediction, Patton and Sheppard (2015) suggest $q = 2$. For the purposes of the present study ($q = 2$), the realized upside $\left(RJ_{2,t}^{+}\right)$ and downside $\left(RJ_{2,t}^{+}\right)$ jumps are estimated as: $RJ_{2,t}^{+} = I_{jump,t} * \left\{\sum_{i=1}^{n}\left|r_{i,n}^{+}\right|^2\right\}$and $RJ_{2,t}^{-} = I_{jump,t} * \left\{\sum_{i=1}^{n}\left|r_{i,n}^{-}\right|^2\right\}$.

3.3. Causality in mean and quantiles

Granger (1969) formalized the causality between two time series $\{X_t\}$ and $\{Y_t\}$. The time series $\{Y_t\}$ does not strictly Granger cause $\{X_t\}$ if,

$$F(X_t|I_{t-1}) = F\left(X_t\left|\left(I_{t-1} - Y_{t-L_y}^{L_y}\right)\right.\right), t = 1,2, \dots \tag{21}$$

where $F(X_t|I_{t-1})$ is the conditional probability of X_t with a bivariate information set I_{t-1} with L_x length lagged vector of X_t $\left[X_{t-L_x}^{L_x} \equiv \left(X_{t-L_x}, X_{t-L_x+1}, \dots, X_{t-1}\right)\right]$ and L_y-length lagged vector of $Y_t\left[Y_{t-L_y}^{L_y} \equiv \left(Y_{t-L_y}, Y_{t-L_y+1}, \dots, Y_{t-1}\right)\right]$. If this equality holds, past Y series help predict current and future X series. This means that Y strictly cause X.[1] Granger causality has extensively analyzed the Granger causality in financial markets (Hiemstra and Jones, 1994). The linear Granger causality test only tests causality-in-mean (Granger and Newbold, 1986).

Given that a distribution is completely determined by its quantiles, Granger non-causality in distribution can also be expressed in terms of conditional quantiles (see, Balcilar et al., 2017a; Balcilar et al., 2017b; Balcilar et al., 2017c; Balcilar et al., 2018b; Gupta and Yoon, 2018). In particular, let the variables $Y_{t-1} \equiv (y_{t-1}, \dots, y_{t-p})$, $X_{t-1} \equiv (x_{t-1}, \dots, x_{t-p})$, $Z_t = (X_t, Y_t)$, whereas let $F_{y_t|Z_{t-1}}(y_t, Z_{t-1})$ and $F_{y_t|Y_{t-1}}(y_t, Y_{t-1})$ be the functions of the conditional distribution of the dependent variable y_t, given Z_{t-1} and Y_{t-1}, respectively. By representing $Q_\theta(Z_{t-1}) \equiv Q_\theta(y_t|Z_{t-1})$ and $Q_\theta(Y_{t-1}) \equiv Q_\theta(y_t|Y_{t-1})$, we have the function $F_{y_t|Z_{t-1}}\{Q_\theta(Z_{t-1})|Z_{t-1}\} = \theta$ with probability being equal to one. Consequently, the existence of (non)causality in the θ-th quantile hypotheses to be tested is given as follows:

$$\begin{aligned} &H_0: P\left\{F_{y_t|Z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} = \theta\right\} = 1 \\ &H_1: P\left\{F_{y_t|Z_{t-1}}\{Q_\theta(Y_{t-1})|Z_{t-1}\} = \theta\right\} < 1 \end{aligned} \tag{22}$$

we make use of distance measure $J = \{\varepsilon_t E(\varepsilon_t|Z_{t-1}) f_z(Z_{t-1})\}$ suggested Jeong et al. (2012) for the marginal density function of Z_{t-1}, symbolized by $f_z(Z_{t-1})$. ε_t denotes

[1] There is also instantaneous causality; though, it is not empirically applied because of difficulties in distinguishing between instantaneous and causality and feedback.

the regression error term that arises from the above null hypothesis. This hypothesis can only be true if and only if $E[1\{y_t \leq Q_\theta(Y_{t-1})|Z_{t-1}\}] = \theta$ or, equivalently, when the indicator function $1\{y_t \leq Q_\theta(Y_{t-1})\}$ is equal to $(\theta + \varepsilon_t)$. According to Jeong et al. (2012), the feasible kernel-based sample analogue of J is given by:

$$\hat{J}_T = \frac{1}{T(T-1)h^{2p}} \sum_{t=p+1}^{T} \sum_{s=p+1, s\neq t}^{T} K\left(\frac{Z_{t-1} - Z_{s-1}}{h}\right) \hat{\varepsilon}_t \hat{\varepsilon}_s \tag{23}$$

where $K(\cdot)$ represents the kernel function with bandwidth h, T corresponds to the sample size, p stands for the lag order, while $\hat{\varepsilon}_t$ is estimated from $1\{y_t \leq Q_\theta(Y_{t-1})\} - \theta$. Additionally, an estimate of the θ-th conditional quantile of y_t, given Y_{t-1}, is represented by $\hat{Q}_\theta(Y_{t-1})$ and can be estimated by means of a nonparametric kernel method, with the use of the Nadarya-Watson kernel estimator as follows:

$$\hat{Q}_\theta(Y_{t-1}) = \hat{F}^{-1}_{y_t|Y_{t-1}}(\theta|Y_{t-1}) \tag{24}$$

where $\hat{F}_{y_{t|Y_{t-1}}}(y_t|Y_{t-1})$ is given by $\frac{\sum_{s=p+1,s\neq t}^{T} L\left(\frac{(Y_{t-1}-Y_{s-1})}{h}\right) 1(y_s \leq y_t)}{\sum_{s=p+1,s\neq t}^{T} L\left(\frac{(Y_{t-1}-Y_{s-1})}{h}\right)}$, with h is for the bandwidth and $L(\cdot)$ for the kernel. For each quantile, we define bandwidth h by using the leave-one-out least-squares cross-validation method, as in Li and Racine (2004), and Racine and Li (2004). Lag order p is selected with the use the Akaike Information Criterion (AIC) and is equal to 12. Lastly, in line with Jeong et al. (2012), for $K(\cdot)$ and $L(\cdot)$ we make the use of Gaussian-type kernels.

4. Results

In this section, we present our empirical results. First, we report the results of causality in-mean and in-quantiles test to detect directional predictability of FX jumps due to geopolitical risk. Focusing on jumps, upside jumps, and downside jumps of exchange rates considered. Second, we provide the robustness results of our study by testing the directional predictability of FX jumps due to geopolitical risk (GPR), geopolitical threats (GPT) and geopolitical acts (GPA).

We present the results in a set of Tables 3-7 and a set of Figures 2-4. Table 3 concerns the Granger-causality in-mean test of GPR, GPT and GPA to total, upside and downside foreign exchange (FX) jumps as reported in the aforementioned table in Panels A, B and C accordingly. They report the statistic- and p-values of the Granger causality test between GPR, GPT or GPA to total, upside and downside FX jumps. The null hypothesis indicates any of the three GPRs does not Granger cause total, upside and downside FX jumps.

The group of Tables 4-7 concerns the causality-in-quantile test of GPR,GPT, and GPA as reported in Table 4, Table 5 and Table 6 respectively, to total, upside and downside FX jumps as reported in the aforementioned tables in Panels A, B and C accordingly. Tables 7A, 7B and 7C summarize results. They report the statistic values of the causality-in-quantile test of GPR, GPT or GPA to total, upside and downside FX jumps. Nineteen quantiles (from 0.05 to 0.95) are considered. The null hypothesis of the Jeong et al. (2012) causality-in-quantile test indicates GPR, GPT or GPA does not cause FX jumps. Seven exchange rates are considered: (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF).

Last, Figure 2-4 refer to causality-in-quantiles test from geopolitical risks to FX jumps (total), upside jumps, and downside jumps, respectively. In each figure, the vertical red lines denote the value of the standardized test statistics of Jeong et al. (2012) with respect to different quantiles (x-axis). The dotted (red) lines depict the critical values of this test at 1%, 5% and 10% level of significant with corresponding values 2.575, 1.96 and 1.645, respectively. A line above the red dotted line leads to a rejection of the null hypothesis of no-causality-in-quantiles from GPRs index to FX jumps. In each figure, Panel A refers to AUD, Panel B refers to GBP, Panel C refers to EUR, Panel D refers to NZD, Panel E refers to CAD, Panel F refers to JPY, Panel G refers to CHF. Nineteen quantiles are depicted again as follows Jumps are in low levels (events associated with its left tail and large negative values of the variable) indicating that $\theta \in \{0.05, \dots, 0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (events associated with its right tail and large positive values of the variable) indicating that $\theta \in \{0.55, \dots, 0.95\}$.

4.1. Causal effects in-mean

In Table 3 and Panel A it can been seen that for all FX jumps other than CHF the casual in-mean effect of GPR are positive insignificant to zero. This suggest causality in-mean of GPR on CHF jumps. While in Panel B (Panel C) we observe causality in-mean effects of GPR on upside (downside) jumps for CAD (CAD and CHF) exchange rate. On Table 3 we observe a similarity of Panel A to Panel B suggesting that GPR and GPT casual in-mean effects on FX jumps. Table 3, Panel C reveals the casual in-mean effect of GPA on jumps of AUD, EUR and CHF exchange rates in Panel A; and the on downside jumps of CHF exchange rate in Panel C. In all other results we observe no causality in mean from GPRs to FX jumps (both upside and downside).

4.2. Causal effects in-quantile of GPR on FX jumps

In Table 4, Panel A reports the causality in-quantile test results of GPR on FX jumps by highlighted the test of null hypothesis of not casual in-quantile relation of GPR on FX jumps. Align to Panel A the null hypothesis is rejected for AUD, EUR, GBP, CAD, CHF and JPY exchange rates in $\theta \in \{0.05, 0.1\}$ quantiles, suggesting causality in-quantiles in these FX markets. Over the quantile range 0.15 to 0.5 the null hypothesis is also rejected for all FX we considered. For $\theta \in \{0.55\}$ quantile the null hypothesis is rejected for AUD, EUR, GBP, NZD, CAD and CHF exchange rates. For $\theta \in \{0.6, 0.65, 0.7, 0.75, 0.8\}$ quantiles the null hypothesis is rejected for AUD, EUR, GBP and NZD exchange rates. In upper quintiles $\theta \in \{0.85, 0.9\}$ the null hypothesis is rejected for AUD, GBP and NZD exchange rates. Last, the null hypothesis is rejected for NZD exchange rate in $\theta \in \{0.95\}$ quantile.

4.2.2. Causal effects in-quantile of GPR on upside FX jumps

Based on Table 4 and Panel B which reports the causality in-quantile test results of GPR on upside jumps of exchange rates the following results are retrieved. Over the quantile range 0.15 to 0.55 the null hypothesis is rejected for all FX considered. For $\theta \in \{0.6, 0.65, 0.7\}$ quantiles the null hypothesis is rejected for AUD, EUR, GBP, NZD, CAD and CHF exchange rates. In upper quintiles $\theta \in \{0.75, 0.8, 0.85, 0.9\}$ the null hypothesis is rejected for AUD, EUR, NZD, CAD and CHF exchange rates. While the null hypothesis is rejected for AUD, EUR, NZD and CAD exchange rates in $\theta \in \{0.95\}$ quantile.

4.2.3. Causal effects in-quantile of GPR on downside FX jumps

Turning to Table 4 and Panel C which reports the causality-in-quantile test results of null hypothesis of not casual in-quantile relation of GPR on downside FX jumps we are led to these results. Over the quantile range 0.05 to 0.75 the null hypothesis is rejected for all FX we considered. Also, in quintiles $\theta \in \{0.8, 0.85, 0.9\}$

the null hypothesis is rejected for AUD, GBP, NZD, CAD and CHF FX. Last, the null hypothesis is rejected for AUD, GBP, NZD and CAD FX in $\theta \in \{0.95\}$ quantile.

4.3. Robustness analysis

For robustness purposes we investigate the causal effects of GPT and GPA on FX jumps by test the causality-in-quantiles to detect directional predictability of FX jumps due to GPT and GPA geopolitical risks. Table 5 and Table 6 reports the results for the causality-in-quantiles test due to GPT and GPA, respectively.

4.3.1. Threats of GPRs (GPT)

In Table 5, Panel A reports the causality-in-quantiles test of GPT on jumps of exchange rates focusing on the test of null hypothesis of not casual in-quantile relation of GPT on jumps of exchange rates. In quintiles $\theta \in \{0.05,0.1\}$ the null hypothesis is rejected for AUD, EUR, GBP, CAD, CHF and JPY exchange rates. Over the quantile range 0.15 to 0.5 the null hypothesis is rejected for all exchange rates we considered. For $\theta \in \{0.55\}$ quantile the null hypothesis is also rejected for AUD, EUR, GBP, NZD, CAD and CHF exchange rates. Also, for $\theta \in \{0.6,0.65,0.7,0.8\}$ quantile the null hypothesis is also rejected for AUD, EUR, GBP and NZD exchange rates. Last, the null hypothesis is rejected for AUD and NZD exchange rates in $\theta \in \{0.85,0.9\}$ quantile.

An examination of Panel B which reports the test results of null hypothesis of not casual in-quantile relation of GPT on upside jumps of exchange rates the following results are retrieved. Over the quantile range 0.05 to 0.55 the null hypothesis is rejected for all exchange rates we considered. For $\theta \in \{0.6,0.65,0.7\}$ quantile the null hypothesis is also rejected for AUD, EUR, GBP, NZD, CAD and CHF exchange rates. Also, the null hypothesis is rejected for AUD, EUR, NZD, CAD and CHF exchange rates in $\theta \in \{0.75,0.8,0.85,0.9\}$ quantiles. Last, the null hypothesis is rejected for AUD, EUR, NZD and CAD exchange rates in $\theta \in \{0.95\}$ quantile.

Turning to Panel C which reports the test results of null hypothesis of not casual in-quantile relation of GPT on downside jumps of exchange rates led to the following results. Over the quantile range 0.05 to 0.75 the null hypothesis is also rejected for all exchange rates. For $\theta \in \{0.8,0.85,0.9\}$ quantile the null hypothesis is also rejected for AUD, GBP, NZD, CAD and CHF exchange rates. Last, in $\theta \in \{0.95\}$ quantile the null hypothesis is rejected for AUD, GBP, NZD and CAD exchange rates.

4.3.2. Acts of GPRs (GPA)

In Table 6, Panel A reports the causality-in-quantiles test results of GPA on jumps of exchange rates aiming on the test of null hypothesis of not casual in-quantile relation of GPA on jumps of exchange rates. In $\theta \in \{0.05, 0.1, 0.15\}$ quantiles the null hypothesis is rejected for AUD, EUR, GBP, CAD, CHF and JPY exchange rates. For quantiles $\theta \in \{0.2, 0.25, 0.3, 0.35, 0.4, 045, 0.5\}$ the null hypothesis is also rejected for all exchange rates. In $\theta \in \{0.55\}$ quantile the null hypothesis is also rejected for AUD, EUR, GBP, NZD, CAD and CHF exchange rates. Over the quantile range 0.6 to 0.8 the null hypothesis is also rejected for AUD, EUR, GBP and NZD exchange rates. For $\theta \in \{0.85, 0.9\}$ quantiles the null hypothesis is also rejected for AUD, GBP, NZD, CAD and CHF exchange rates. Last, the null hypothesis is rejected for NZD exchange rate in $\theta \in \{0.95\}$ quantile.

Looking on Panel B which reports the test results of null hypothesis of not casual in-quantile relation of GPT on upside jumps of exchange rates the following results are observed. Over the quantile range 0.05 to 0.5 the null hypothesis is also rejected for all exchange rates. For quantiles $\theta \in \{0.55, 0.6, 0.65, 0.7\}$ the null hypothesis is also rejected for AUD, EUR, GBP, NZD, CAD and CHF exchange rates. Also, in $\theta \in \{0.75\}$ quantile the null hypothesis is also rejected for AUD, EUR, NZD, and CHF exchange rates. In $\theta \in \{0.8\}$ quantile the null hypothesis is also rejected for EUR, NZD, and CHF exchange rates. We observe the null hypothesis is rejected for NZD exchange rate in $\theta \in \{0.85\}$ quantile. In $\theta \in \{0.85\}$ quantile the null hypothesis is also rejected for AUD and CAD exchange rates. Last, the null hypothesis is rejected for AUD exchange rate in $\theta \in \{0.95\}$ quantile

Align to Panel C which reports the test results of null hypothesis of not casual in-quantile relation of GPA on downside jumps of exchange rates we observe the results as follows. For quantiles $\theta \in \{0.05, 0.1, 0.15\}$ the null hypothesis is also rejected for AUD, EUR, GBP, CAD, CHF and JPY exchange rates. Over the quantile range 0.2 to 0.7 the null hypothesis is also rejected for all exchange rates. In $\theta \in \{0.75\}$ quantile the null hypothesis is also rejected for AUD, EUR, NZD, CHF and JPY exchange rates. For $\theta \in \{0.8\}$ quantile the null hypothesis is also rejected for EUR, NZD and CAD exchange rates. null hypothesis is rejected for AUD, NZD and CAD exchange rate in $\theta \in \{0.85\}$ quantile. Last, the null hypothesis is rejected for AUD and CAD exchange rate in $\theta \in \{0.9\}$ quantile.

4.4. Summarize results and discussion

We now provide the summarized results obtain from the sub-section above for causality-in-quantiles of geopolitical risk on the jumps of exchange rate, we consider the three categories of volatility discontinuities as follows jumps, upside jumps and downside jumps. We highlight the results motivated by the directional predictability of geopolitical risks on exchange rates jumps.

Table 7A, 7B and 7C report the summarized results of causality-in-quantile test of each of the geopolitical risks (GPRs) (i.e. GPR, GPT, GPA) for FX total, upside and downside jumps, in Table 7A, Table 7B and Table 7C respectively. The reported causality-in-quantile of GPRs to total, upside and downside jumps of each exchange rate concerns only statistically significant results. The exchange rate with the highest causality effect on FX, the minimum (Min), maximum (Max), average (Average) and dispersion of causality effects across all seven exchange rates for each quantile. Quantiles are split into low, mid, high and highest with 0.05-0.15, 0.20-0.45, 0.50-0.70, and 0.75-0.95 respectively. We observe that the GPA is the most important category of geopolitical risks. Across the board of all quantiles and all (total, upside and downside) FX jumps; GPA, GPT and GPR is the ranking of causality, in a descending order; based on maximum causalities.

The NZD is the currency with the highest causality in highest quantiles. Across the board of all quantiles, EUR and GBP are the currencies with highest causality-in-quantile for total and downside (former) and upside (latter). For the FX total jumps, in lowest, mid, and highest quantiles, CHF, EUR and NZD currencies have the highest causality, respectively. For the FX upside jumps, in lowest, mid, and highest quantiles, JPY, GBP and NZD currencies have the highest causality, respectively. For the FX downside jumps, in lowest and mid quantiles, EUR currency has the causality; while in highest quantiles, NZD currency has the highest causality.

Across the board of all quantiles, GPR (and secondly GPT) have the lowest minimum causalities, and more significantly in lowest to mid quantiles. For highest quantiles, the lowest causalities are for GPA. The higher the quantiles, the lower the causality-in-quantile. Also, across the board of all quantiles, GPR (and secondly GPT) have the lowest minimum causalities, and more significantly in lowest to mid quantiles. For highest quantiles, the highest causalities are for GPR. Based on average values;

GPA has the highest causalities, across all causalities. For the highest quantiles, GPR has the highest causality to upside and downside jumps.

For total jumps, GPA (GPR) has the highest causality in low, high and highest (mid) quantiles. Though, for upside and downside FX jumps GPA (GPR) has the highest causalities in low and high (mid and highest) quantiles. As for the highest quantiles, NZD currency has the highest causality. For highest quantiles, the highest and lowest causalities are for GPR and GPA, respectively. In highest quantiles, the GPR has the highest dispersion of causalities for total, upside and downside jumps. The higher the quantiles, the lower the causality-in-quantile.

The nature of the exchange rate volatility as a measure of risk, along with its levels, is crucial for currency market participants. From a practical aspect, such evidence is particularity important for portfolio managers and investors dealing with large price fluctuations. Several theoretical studies have connected FX volatility to trade and welfare (see e.g., Clark et al., 2004). Here we provide clear evidence of directional predictability originating from the geopolitical risk onto FX jumps, contrary to what we found by using the linear Granger causality test. In other words, the estimation and testing the results for FX jumps lead to that the GPR can be an important predictor of jumps occurring in exchange markets regardless of the (conditional) size of jumps, as captured by different quantiles of its conditional distribution.

5. Conclusions

In this study our objective is to provide evidence of the causal in-quantile effects of the geopolitical risk on discontinues movements of FX markets. Literature has been focused on macroeconomic background as causes to discontinuities. We contribute to this issue by investigating the directional predictability of geopolitical risk on FX jumps of seven exchange rates to US Dollar considering, (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). Our data covers the period that spans from July 1, 2003 to August 28, 2015 incorporating various markets phases, such as booms and crashes.

In order to detect the directional predictability of geopolitical risk on FX jumps, we first use Granger causality (in-mean) test to investigate the existence of standard linear cause relation, which failed to detect any evidence of geopolitical risk causing jumps with an exception to Swiss Franc (CHF). As the standard linear causality test is not sufficient to reveal any evidence of geopolitical risks (GPRs) causing FX jumps due to potential nonlinearity and structural breaks among the FX jumps. Indicating that linear Granger causality test results cannot be relied on, our results of revealing the nonlinear causality of geopolitical risks (GPRs) on FX jumps. Thus, we use of the causality-in-quantiles test proposed by Jeong et al. (2012) which allowed us to capture nonlinear dynamic causal effects between GPRs and FX jumps across the entire conditional distribution of FX jumps. We found evidence that geopolitical risk (GPR) cause jumps over a wide range of quantiles. Specifically, we found that lowest considered conditional quantile mostly rejecting the null hypothesis that GPR do not have causality effect on FX jumps. To further corroborate and robust our results, we apply causality-in-quantiles test (Jeong et al., 2012) to detect the predictability of the Geopolitical Threats (GPT) index and Geopolitical Acts (GPA) index on FX jumps.

For economic aspect our evidence is particularity important for diversification practices to currency risk managers and jump risk premia to investors in periods of geopolitical risk fluctuations.

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Tables

Table 1. Summary statistics of FX jumps

	AUD	GBP	EUR	NZD	CAD	JPY	CHF
Panel A. Summary statistics for exchange rates							
Mean	9.46E-07	1.82E-07	3.03E-07	2.20E-06	3.68E-07	4.86E-07	4.15E-07
Median	0	0	0	0	0	0	0
Maximum	7.93E-05	1.78E-05	1.91E-05	0.000284	6.26E-05	6.70E-05	6.78E-05
Minimum	0	0	0	0	0	0	0
Std. Dev.	2.62E-06	7.04E-07	8.10E-07	8.39E-06	1.38E-06	1.84E-06	1.85E-06
Skewness	14.1182	11.4994	8.8411	18.8317	26.7713	21.0729	24.2548
Kurtosis	318.6017	203.9172	142.2986	503.8013	1114.879	620.5927	782.6389
Jarque-Bera	15779808	6427594	3098817	39640660	1.95E+08	60225793	95901535
p-value	[0]	[0]	[0]	[0]	[0]	[0]	[0]
Obs	3775	3775	3775	3775	3775	3775	3775
Panel B. Unit root test (ADF test)							
ADF test (without trend)							
Test Statistic	-15.2763***	-17.2734***	-11.5273***	-6.4758***	-58.7542***	-60.7993***	-60.4396***
Critical Value	-3.4319	-3.4319	-3.4319	-3.4319	-3.4319	-3.4319	-3.4319
p-value	[0]	[0]	[0]	[0]	[0.0001]	[0.0001]	[0.0001]
ADF test (including trend)							
Test Statistic	-17.1219***	-21.1733***	-39.2716***	-14.1274***	-59.2445***	-61.1736***	-60.6578***
Critical Value	-3.9604	-3.9604	-3.9604	-3.9604	-3.9604	-3.9604	-3.9604
p-value	[0]	[0]	[0]	[0]	[0]	[0]	[0]
Panel C. Unit root test (PP test)							
PP test (without trend)							
Test Statistic	-63.6054***	-63.7802***	-66.7390***	-6.4758***	-59.5085***	-61.2573***	-61.1378***
Critical Value	-3.4318	-3.4318	-3.4318	-3.4318	-3.4318	-3.4318	-3.4318
p-value	[0.0001]	[0.0001]	[0.0001]	[0]	[0.0001]	[0.0001]	[0.0001]
PP test (including trend)							
Test Statistic	-57.9277***	-63.4403***	-60.8461***	-14.1274***	-59.4397***	-61.2726***	-61.0293***
Critical Value	-3.9604	-3.9604	-3.9604	-3.9604	-3.9604	-3.9604	-3.9604
p-value	[0]	[0]	[0]	[0]	[0]	[0]	[0]

Note: This table reports basic statistics for the jumps of seven exchange rates. The following seven exchange rates are considered: (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). Panel A reports the following descriptive statistics of the data: mean, median, maximum, minimum, standard deviation, skewness and kurtosis. The null hypothesis that the data is normally distributed is tested by the Jarque-Bera test. Panel B reports unit root test statistics for testing whether a time series is non-stationary and possesses a unit root. Two unit root tests in two different cases (without and with trend) are considered: The Augmented Dickey-Fuller (ADF) test in Panel B and the Phillips–Perron (PP) test in Panel C for the null hypothesis of a unit root which is present in a time series. The critical values at 1%, 5% and 10% level of significance and the p-values (in brackets) of these tests are also given. ***, ** and * leads to a rejection of the null hypothesis that a time series has a unit root.

Table 2. Summary statistics of geopolitical risks (GPRs)

	GPR	GPRT	GPRA
	Panel A. Summary statistics for GPRs		
Mean	79.4134	80.5483	72.4275
Median	68.8241	68.3298	47.0646
Maximum	487.3361	559.3745	871.9737
Minimum	0	0	0
Std. Dev.	52.3635	57.0524	88.7237
Skewness	1.9058	2.1035	2.1453
Kurtosis	9.4329	10.8941	10.6323
Jarque-Bera	10348.11	14809.42	14188.66
p-value	[0]	[0]	[0]
Obs	3775	3775	3775
	Panel B. Unit root test (ADF test)		
	ADF test (without trend)		
Test Statistic	-12.6413***	-12.9194***	-14.5359***
Critical Value	-3.4316	-3.4316	-3.4316
p-value	[0]	[0]	[0]
	ADF test (including trend)		
Test Statistic	-12.6399***	-12.9471***	-19.4387***
Critical Value	-3.9601	-3.9601	-3.9601
p-value	[0]	[0]	[0]
	Panel C. Unit root test (PP test)		
	PP test (without trend)		
Test Statistic	-64.2569***	-63.8954***	-74.2875***
Critical Value	-3.4316	-3.4316	-3.4316
p-value	[0.0001]	[0.0001]	[0.0001]
	PP test (including trend)		
Test Statistic	-64.2546***	-63.8834***	-71.0351***
Critical Value	-3.9601	-3.9601	-3.9601
p-value	[0]	[0]	[0]

Note: This table reports basic statistics for three geopolitical risks (GPRs). The following three GPRs are considered: (i) the geopolitical risk (GPR), (ii) the Threats of GPRs (GPT), (iii) the Acts of GPRs (GPA). Panel A reports the following descriptive statistics of the data: mean, median, maximum, minimum, standard deviation, skewness and kurtosis. The null hypothesis that the data is normally distributed is tested by the Jarque-Bera test. Panel B and Panel C reports unit root test statistics for testing whether a time series is non-stationary and possesses a unit root. Two unit-root tests in two different cases (without and with trend) are considered: The Augmented Dickey-Fuller (ADF) test in Panel B and the Phillips–Perron (PP) test in Panel C for the null hypothesis of a unit root which is present in a time series. The critical values at 1%, 5% and 10% level of significance and the p-values (in brackets) of these tests are also given. ***, ** and * leads to a rejection of the null hypothesis that a time series has a unit root.

Table 3. Granger causality test between GPRs and FX jumps

		AUD	**GBP**	**EUR**	**NZD**	**CAD**	**JPY**	**CHF**
					Panel A. Jumps			
GPR	Test Statistic	1.2230	0.2186	0.1572	1.5230	1.1335	1.0596	6.8448***
	p-value	[0.2944]	[0.8036]	[0.8545]	[0.2182]	[0.3220]	[0.3467]	[0.0011]
GPRT	Test Statistic	1.0279	0.6450	0.1084	2.8351	2.2593	0.4608	6.6443***
	p-value	[0.3579]	[0.5247]	[0.8972]	[0.0588]	[0.1046]	[0.6308]	[0.0013]
GPRA	Test Statistic	3.8021**	0.2934	4.8275***	3.9549	0.9568	1.1864	4.1606**
	p-value	[0.0224]	[0.7457]	[0.0081]	[0.0192]	[0.3842]	[0.3054]	[0.0157]
					Panel B. Upside jumps			
GPR	Test Statistic	1.0800	1.1362	0.4974	0.6322	3.3714**	0.7387	0.6274
	p-value	[0.3397]	[0.3211]	[0.6081]	[0.5314]	[0.0344]	[0.4778]	[0.5340]
GPRT	Test Statistic	0.8634	1.6621	0.8679	0.5559	2.9533*	1.6855	1.6154
	p-value	[0.4218]	[0.1899]	[0.4199]	[0.5736]	[0.0523]	[0.1855]	0.1989
GPRA	Test Statistic	0.4679	1.6842	0.4620	0.3794	0.2593	1.4015	0.3472
	p-value	[0.6263]	[0.1857]	[0.6300]	[0.6843]	[0.7716]	[0.2464]	[0.7067]
					Panel C. Downside jumps			
GPR	Test Statistic	1.2835	0.6350	0.4150	0.6323	3.3053**	9.1342	2.5049***
	p-value	[0.2772]	[0.5300]	[0.6604]	[0.5314]	[0.0368]	[0.4053]	[0.0092]
GPRT	Test Statistic	1.0747	1.1393	0.5767	0.5560	3.1269**	0.7071	4.8823***
	p-value	[0.3415]	[0.3201]	[0.5618]	[0.5735]	[0.0440]	[0.4931]	[0.0076]
GPRA	Test Statistic	0.4999	0.9193	1.0413	0.3794	0.2476	1.2774	7.4944***
	p-value	[0.6066]	[0.3989]	[0.3531]	[0.6842]	[0.7807]	[0.2789]	[0.0006]

Note: This table reports Granger causality test statistics for testing casual relation between geopolitical risks (GPRs) (i.e. GPR, GPT, GPA) and jumps of exchange rates. The following seven exchange rates are considered: (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). The null hypothesis of Granger causality test that geopolitical risks (GPRs) do not cause on jumps of exchange rates. Panel A refers to the jumps of exchange rates. Panel B refers to the upside jumps of exchange rates. Panel C refers to the downside jumps of exchange rates. ***, ** and * leads to a rejection of the null hypothesis of no-causality at the 1%, 5%, and 10% level, respectively; the p-values (in brackets) of these tests are also given.

Table 4. Causality-in-Quantiles' test results for FX jumps due to GPR

	Quantile																		
	0.05	**0.1**	**0.15**	**0.2**	**0.25**	**0.3**	**0.35**	**0.4**	**0.45**	**0.5**	**0.55**	**0.6**	**0.65**	**0.7**	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
Panel A. Jumps																			
AUD	1408.16***	814.37***	546.83***	385.26***	274.95***	194.91***	135.37***	90.88***	56.86***	32.74***	15.55***	6.22***	5.84***	5.32***	5.73***	4.62***	3.17***	2.26**	0.74
EUR	3384.03***	2019***	1387.32***	998.74***	728.95***	529.54***	377.23***	259.30***	168.94***	100.63***	52.65***	21.78***	5.55***	2.91***	2.66***	2.38**	1.45	0.60	0.24
GBP	1130.97***	670.63***	464.24***	339.2***	252.95***	189.18***	140.14***	101.60***	71.09***	47.08***	28.64***	15.21***	6.59***	2.90***	2.51**	2.04**	1.98**	2.08**	1.43
NZD	1.32	1.60	2.01**	98.71***	65.49***	42.15***	25.65***	14.38***	7.45***	4.39***	4.54***	4.47***	4.12***	3.48***	3.14***	3.58***	3.71***	3.19***	1.73*
CAD	2787.06***	1618.46***	1077.69***	746.62***	519.10***	353.79***	230.82***	139.48***	73.58***	29.57***	5.70***	0.44	0.41	0.37	0.30	0.19	0.24	0.18	0.21
CHF	3646.76***	2185.91***	1485.42***	1046.14***	738.63***	511.71***	340.47***	211.32***	116.31***	50.82***	12.39***	0.20	0.12	0.05	0.03	0.03	0.03	0.02	0.02
JPY	2840.12***	1653.91	1086.27***	733.22***	489.84***	314.59***	187.37***	97.30***	38.23***	6.81***	0.29	0.36	0.32	0.23	0.19	0.22	0.10	0.12	0.05
Panel B. Upside jumps																			
AUD	454.68***	266.12***	181.00***	129.49***	94.24***	68.58***	49.35***	34.82***	24.02***	16.36***	10.92***	9.66***	8.09***	5.63***	4.74***	4.53***	4.59***	3.72***	3.01***
EUR	490.88***	292.50***	203.19***	148.99***	111.60***	84.00***	62.84***	46.29***	33.30***	23.21***	15.63***	10.34***	7.99***	8.19***	6.44***	4.61***	3.71***	3.07***	2.54**
GBP	2563.40***	1515.10***	1044.80***	759.94***	563.57***	418.56***	307.20***	219.89***	151.00***	97.05***	55.92***	26.41***	8.09***	1.31***	0.92	0.93	0.68	0.78	0.90
NZD	2.78***	3.56***	4.11***	56.77***	38.89***	26.33***	17.46***	11.42***	7.73***	6.13***	6.49***	6.63***	6.36***	6.35***	6.34***	5.74***	5.44***	4.04***	2.81***
CAD	539.64***	311.42***	208.66***	146.58***	104.18***	73.41***	50.43***	33.18***	20.48***	11.63***	6.27***	4.27***	4.55***	3.92***	3.57***	3.55***	3.87***	4.32***	2.76***
CHF	1265.87***	723.55***	481.05***	335.20***	235.89***	163.97***	110.34***	70.12***	40.50***	19.87***	7.33***	2.51**	2.28**	1.91*	2.09**	2.28**	2.53**	2.07*	0.79
JPY	2796.77***	1623.29***	1063.32***	715.78***	476.66***	304.84***	180.42***	92.67***	35.50***	5.63***	0.30***	0.54	0.59	0.40	0.21	0.21	0.11	0.16	0.16
Panel C. Downside jumps																			
AUD	777.31***	444.64***	295.08***	205.12***	144.13***	100.36***	68.23***	44.76***	28.28***	17.78***	10.46***	9.15***	7.10***	4.13***	3.04***	2.39**	3.26***	4.04***	2.09***
EUR	2149.94***	1260.87***	859.34***	615.64***	447.91***	324.68***	230.94***	158.58***	102.85***	60.91***	31.10***	12.63***	4.76***	4.33***	2.98***	1.32	1.08	1.14	1.18
GBP	495.75***	296.31***	206.51***	151.96***	114.27***	86.38***	64.92***	48.05***	34.72***	24.24***	16.22***	10.42***	6.75***	5.28***	4.80***	4.17***	3.79***	3.50***	2.93***
NZD	2.83***	3.66***	4.03***	56.47***	38.70***	26.23***	17.42***	11.42***	7.75***	6.16***	6.72***	6.67***	6.34***	6.49***	6.35***	6.30***	5.33***	4.06***	2.94***
CAD	705.50***	405.76***	270.77***	189.23***	133.57***	93.21***	63.10***	40.55***	24.00***	12.53***	5.68***	3.16***	3.35***	2.90***	2.79***	3.14***	3.18***	4.15***	2.79***
CHF	682.78***	397.57***	269.02***	191.17***	137.78***	98.76***	69.32***	46.85***	29.87***	17.47***	9.16***	4.78***	4.69***	4.10***	3.36***	3.24***	3.06***	2.89***	1.53
JPY	1971.31***	1107.40***	711.89***	472.79***	311.36***	197.12***	115.50***	58.75***	22.55***	4.59***	2.93***	3.11***	3.14***	2.67***	1.72*	0.83	0.51	0.49	0.38

Note: This table reports the estimates for the causality-in-quantiles test to detect causality of geopolitical risk (GPR) on jumps of seven exchange rates in different quantiles. The following seven exchange rates are considered: (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. The null hypothesis that GPR does not causes upside jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The standardized value of this test with respect to different quantiles is reported. ***, ** and * indicate the rejection of the null hypothesis of no-causality-in-quantiles from GPR to exchange rates for various quantiles at 1%, 5% and 10% levels of significance, respectively. The corresponding critical values are: 2.575, 1.96, and 1.645, respectively. Panel A refers to the jumps of exchange rates. Panel B refers to the upside jumps of exchange rates. Panel C refers to the downside jumps of exchange rates.

Table 5. Causality-in-Quantiles' test results for FX jumps due to GPT

	Quantile																		
	0.05	**0.1**	**0.15**	**0.2**	**0.25**	**0.3**	**0.35**	**0.4**	**0.45**	**0.5**	**0.55**	**0.6**	**0.65**	**0.7**	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
Panel A. Jumps																			
AUD	1404.58***	811.37***	544.12***	382.77***	272.69***	192.88***	133.56***	89.31***	55.53***	31.79***	14.90***	5.98***	5.56***	4.98***	5.08***	4.24***	2.72***	2.19***	0.78
EUR	3383.71***	2018.16***	1385.96***	997.00***	726.95***	527.40***	375.03***	257.16***	166.98***	98.90***	51.26***	20.71***	4.89***	2.46**	2.28**	2.02**	1.39	0.57	0.21
GBP	1142.42***	677.29***	468.71***	342.33***	255.14***	190.68***	141.10***	102.14***	71.31***	47.05***	28.42***	14.87***	6.19***	2.51**	2.11**	2.05**	1.59	1.60	0.70
NZD	1.21	1.46	2.08**	100.11***	66.41***	42.73***	25.99***	14.57***	7.56***	4.49***	3.99***	4.33***	4.09***	3.70***	3.12***	3.09***	2.75***	2.31***	1.46
CAD	2790.34***	1620.39***	1078.64***	746.86***	518.84***	353.20***	230.05***	138.65***	72.83***	29.03***	5.50***	0.60	0.43	0.48	0.36	0.25	0.24	0.17	0.16
CHF	3644.34***	2184.05***	1483.93***	1044.91***	737.62***	510.87***	339.80***	210.78***	115.91***	50.54***	12.21***	0.12	0.06	0.04	0.02	0.01	0.01	0.01	0.01
JPY	2833.71***	1649.49***	1082.91***	730.59***	487.75***	312.96***	186.14***	96.44***	37.72***	6.64***	0.37	0.48	0.47	0.36	0.30	0.33	0.14	0.15	0.06
Panel B. Upside jumps																			
AUD	452.83***	264.68***	179.68***	128.23***	93.03***	67.42***	48.24***	33.77***	23.04***	15.42***	10.03***	9.05***	7.87***	5.62***	4.91***	4.62***	4.74***	3.97***	2.91***
EUR	496.79***	295.99***	205.50***	150.56***	112.64***	84.64***	63.16***	46.37***	33.18***	22.94***	15.24***	9.86***	7.90***	7.98***	6.09***	4.66***	3.62***	3.70***	2.76***
GBP	2587.05***	1529.11***	1054.27***	766.60***	568.29***	421.83***	309.38***	221.23***	151.70***	97.29***	55.85***	26.18***	7.84***	1.21***	0.87	0.68	0.68	0.82	0.85
NZD	2.54**	3.38***	4.22***	58.96***	40.53***	27.57***	18.40***	12.14***	8.30***	6.60***	6.43***	6.19***	6.27***	5.63***	5.30***	4.27***	4.33***	3.58***	2.52***
CAD	546.32***	315.35***	211.28***	148.36***	105.37***	74.15***	50.82***	33.30***	20.38***	11.37***	5.88***	4.00***	4.79***	4.13***	3.50***	3.26***	3.33***	3.29***	1.90*
CHF	1257.71***	717.23***	475.67***	330.47***	231.72***	160.31***	107.19***	67.51***	38.46***	18.46***	6.63***	2.60***	2.41**	2.56**	2.14**	2.16**	1.35	1.31	0.75
JPY	2789.57***	1618.42***	1059.62***	712.87***	474.34***	303.02***	179.05***	91.70***	34.93***	5.45***	0.43***	0.72	0.74	0.50	0.27	0.20	0.11	0.15	0.14
Panel C. Downside jumps																			
AUD	773.40***	441.67***	292.54***	202.87***	142.12***	98.58***	66.68***	43.45***	27.23***	16.96***	9.66***	8.50***	6.51***	3.82***	2.39**	2.43**	3.61***	4.55***	2.09**
EUR	2149.93***	1259.87***	857.82***	613.81***	445.90***	322.60***	228.87***	156.59***	101.02***	59.32***	29.84***	11.80***	4.21***	4.00***	2.64***	0.84	0.60	0.81	0.97
GBP	507.31***	303.47***	211.59***	155.75***	117.16***	88.58***	66.58***	49.29***	35.61***	24.86***	16.61***	10.63***	6.84***	5.29***	4.72***	4.79***	3.95***	3.01***	2.43**
NZD	2.36**	3.40***	4.31***	58.66***	40.34***	27.46***	18.36***	12.14***	8.31***	6.63***	6.89***	6.65***	6.59***	5.77***	5.40***	4.70***	4.03***	3.59***	2.69***
CAD	712.99***	409.98***	273.49***	191.04***	134.74***	93.91***	63.45***	40.63***	23.88***	12.28***	5.35***	3.13***	3.54***	2.91***	2.80***	2.71***	2.70***	2.81***	1.68*
CHF	675.91***	393.14***	265.59***	188.33***	135.35***	96.65***	67.48***	45.27***	28.54***	16.40***	8.36***	4.32***	4.40***	3.98***	2.80***	2.60***	2.21**	2.60***	1.44
JPY	1965.58***	1102.32***	707.14***	468.34***	307.30***	193.51***	112.46***	56.38***	20.99***	3.98***	2.87***	3.15***	3.26***	2.80***	1.91*	0.96	0.59	0.65	0.28

Note: This table reports the estimates for the causality-in-quantiles test to detect causality of Threats of GPRs (GPT) on jumps of seven exchange rates in different quantiles. The following seven exchange rates are considered: (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (left tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. The null hypothesis that GPT does not causes upside jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The standardized value of this test with respect to different quantiles is reported. ***, ** and * indicate the rejection of the null hypothesis of no-causality-in-quantiles from GPR to exchange rates for various quantiles at 1%, 5% and 10% levels of significance, respectively. The corresponding critical values are: 2.575, 1.96, and 1.645, respectively. Panel A refers to the jumps of exchange rates. Panel B refers to the upside jumps of exchange rates. Panel C refers to the downside jumps of exchange rates.

Table 6. Causality-in-Quantiles' test results for the upside jumps of exchange rate due to GPA

	Quantile																		
	0.05	**0.1**	**0.15**	**0.2**	**0.25**	**0.3**	**0.35**	**0.4**	**0.45**	**0.5**	**0.55**	**0.6**	**0.65**	**0.7**	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
Panel A. Jumps																			
AUD	1664.62***	986.94***	676.54***	486.16***	354.20***	256.87***	183.30***	126.86***	82.81***	50.59***	27.21***	11.58***	10.24***	9.75***	9.65***	7.34***	4.94***	2.76***	0.88
EUR	3460.38***	2077.47***	1435.17***	1038.85***	762.87***	558.24***	401.36***	279.33***	185.71***	113.62***	62.27***	28.29***	9.14***	5.11***	4.63***	3.51***	2.64***	1.28	0.21
GBP	1866.18***	1150.04***	814.50***	605.41***	458.13***	347.39***	260.94***	192.06***	136.73***	92.46***	57.66***	31.39***	13.21***	3.16***	2.76***	2.43**	1.45	0.51	0.34
NZD	0.22	0.34	0.70	369.72***	257.62***	175.44***	114.05***	68.46***	35.81***	14.45***	13.27***	13.18***	11.03***	9.80***	9.90***	8.86***	8.27***	5.35***	2.47**
CAD	2769.18***	1609.61***	1072.24***	742.86***	516.32***	351.64***	229.14***	138.17***	72.62***	28.97***	5.53***	0.51	0.57	0.58	0.36	0.22	0.23	0.17	0.23
CHF	3647.16***	2186.35***	1485.84***	1046.53***	738.98***	512.02***	340.76***	211.57***	116.54***	51.02***	12.56***	0.35	0.43	0.27	0.16	0.18	0.12	0.07	0.02
JPY	2859.17***	1668.38***	1097.92***	742.77***	497.65***	320.88***	192.28***	100.91***	40.58***	7.92***	0.52	0.58	0.62	0.52	0.34	0.16	0.08	0.03	0.00
Panel B. Upside jumps																			
AUD	1177.18***	718.31***	500.72***	364.56***	268.78***	197.25***	142.12***	99.11***	65.68***	40.29***	21.97***	17.76***	13.74***	5.99***	2.32**	1.36	1.50	2.03***	2.49***
EUR	1566.33***	973.37***	692.83***	516.97***	392.56***	298.70***	225.23***	166.55***	119.32***	81.44***	51.59***	28.97***	16.61***	15.03***	8.48***	3.24***	1.04	0.95	1.42
GBP	2725.13***	1623.68***	1127.66***	826.08***	617.34***	462.49***	342.97***	248.72***	173.79***	114.53***	68.64***	34.83***	12.56***	2.07**	0.89	0.82	0.41	0.61	0.67
NZD	0.39	0.51	0.57	364.70***	254.77***	174.01***	113.52***	68.44***	35.95***	14.43***	9.32***	7.12***	7.35***	5.60***	5.12***	3.38***	1.94*	1.30	0.59
CAD	985.41***	586.85***	398.77***	281.78***	200.25***	140.16***	94.78***	60.40***	34.89***	16.99***	6.02***	2.54**	2.37**	2.43**	1.33	1.19	1.57	2.13***	1.36
CHF	1582.57***	939.48***	639.57***	454.13***	325.19***	230.14***	158.09***	103.10***	61.74***	31.94***	12.58***	3.24***	2.73***	2.75***	2.81***	2.06**	1.17	0.74	0.49
JPY	2822.16***	1642.33***	1078.58***	728.26***	486.87***	313.06***	186.84***	97.38***	38.56***	7.04***	0.41	0.33	0.39	0.37	0.20	0.08	0.05	0.02	0.03
Panel C. Downside jumps																			
AUD	1279.78***	768.19***	526.99***	376.99***	272.32***	195.00***	136.33***	91.57***	57.95***	33.81***	17.75***	15.09***	10.45***	5.52***	2.81***	1.38	1.85*	2.07**	1.49
EUR	2359.41***	1400.78***	965.09***	699.33***	515.48***	379.58***	275.44***	194.24***	130.82***	82.05***	46.07***	21.92***	9.24***	7.95***	5.37***	2.81***	1.12	0.77	0.69
GBP	1615.57***	1004.67***	715.44***	534.02***	405.61***	308.67***	232.75***	172.08***	123.19***	83.93***	52.92***	29.34***	12.80***	3.31***	1.64	1.24	0.88	0.68	1.49
NZD	0.32	0.57	0.60	364.66***	254.74***	174.00***	113.52***	68.44***	35.95***	14.43***	8.79***	7.08***	7.02***	5.44***	3.90***	3.31***	1.68*	1.21	0.66
CAD	1061.58***	630.07***	426.78***	300.56***	212.75***	148.19***	99.55***	62.85***	35.77***	16.96***	5.69***	2.08**	2.06**	1.84*	1.36	1.65*	1.79*	2.32***	1.53
CHF	1255.75***	759.86***	525.96***	380.12***	277.87***	201.75***	143.31***	97.93***	62.88***	36.51***	17.85***	6.54***	5.15***	4.56***	2.61***	1.47	0.94	1.15	0.63
JPY	2095.61***	1191.73***	775.32***	522.09***	349.94***	226.99***	137.97***	74.72***	32.62***	9.18***	3.40***	3.02***	2.95***	2.76***	1.67*	1.06	0.58	0.23	0.25

Note: This table reports the estimates for the causality-in-quantiles test to detect causality of Acts of GPRs (GPA) on jumps of seven exchange rates in different quantiles. The following seven exchange rates are considered: (i) Australian Dollar (AUD), (ii) British Pound (GBP), (iii) Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY) and (vii) Swiss Franc (CHF). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95\}$. Jumps are in low levels (left tail and large negative values of the variable) indicating that $\theta \in \{0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95\}$. The null hypothesis that GPA does not causes upside jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The standardized value of this test with respect to different quantiles is reported. ***, ** and * indicate the rejection of the null hypothesis of no-causality-in-quantiles from GPR to exchange rates for various quantiles at 1%, 5% and 10% levels of significance, respectively. The corresponding critical values are: 2.575, 1.96, and 1.645, respectively. Panel A refers to the jumps of exchange rates. Panel B refers to the upside jumps of exchange rates. Panel C refers to the downside jumps of exchange rates.

Table 7A. Key comparisons FX jumps

		0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
FX	**GPR**	CHF	CHF	CHF	CHF	CHF	EUR	EUR	EUR	EUR	EUR	EUR	EUR	GBP	AUD	AUD	AUD	NZD	NZD	NZD
	GPT	CHF	CHF	CHF	CHF	CHF	EUR	EUR	EUR	EUR	EUR	EUR	EUR	GBP	AUD	AUD	AUD	NZD	NZD	NZD
	GPA	CHF	CHF	CHF	CHF	EUR	EUR	EUR	EUR	EUR	EUR	EUR	GBP	GBP	AUD	NZD	NZD	NZD	NZD	NZD
Min	**GPR**	1.32	1.60	2.01	98.71	65.49	42.15	25.65	14.38	7.45	4.39	0.2900	0.2000	0.1200	0.0500	0.0300	0.0300	0.0300	0.0200	0.0200
	GPT	1.21	1.46	2.08	100	66.41	42.73	25.99	14.57	7.56	4.49	0.3700	0.1200	0.0600	0.0400	0.0200	0.0100	0.0100	0.0100	0.0100
	GPA	0.2200	0.3400	0.7000	370	258	175	114	68.46	35.81	7.92	0.5200	0.3500	0.4300	0.2700	0.1600	0.1600	0.0800	0.0300	0.0000
Max	**GPR**	3,647	2,186	1,485	1,046	739	530	377	259	169	101	52.65	21.78	6.59	5.32	5.73	4.62	3.71	3.19	1.73
	GPT	3,644	2,184	1,484	1,045	738	527	375	257	167	98.90	51.26	20.71	6.19	4.98	5.08	4.24	2.75	2.31	1.46
	GPA	3,647	2,186	1,486	1,047	763	558	401	279	186	114	62.27	31.39	13.21	9.80	9.90	8.86	8.27	5.35	2.47
Average	**GPR**	2,171	1,281	864	621	439	305	205	131	76.07	38.86	17.11	6.95	3.28	2.18	2.08	1.87	1.53	1.21	0.6314
	GPT	2,171	1,280	864	621	438	304	205	130	75.41	38.35	16.66	6.73	3.10	2.08	1.90	1.71	1.26	1.00	0.4829
	GPA	2,324	1,383	940	719	512	360	246	160	95.83	51.29	25.57	12.27	6.46	4.17	3.97	3.24	2.53	1.45	0.5929
Dispersion	**GPR**	2,578	1,545	1,049	670	476	345	249	173	114	68.05	37.02	15.26	4.57	3.73	4.03	3.25	2.60	2.24	1.21
	GPT	2,576	1,543	1,048	668	475	343	247	172	113	66.76	35.98	14.56	4.33	3.49	3.58	2.99	1.94	1.63	1.03
	GPA	2,579	1,546	1,050	479	357	271	203	149	106	74.74	43.66	21.95	9.04	6.74	6.89	6.15	5.79	3.76	1.75

Note: This table reports the summarized results of causality-in-quantile test of each of the geopolitical risks (GPRs) (i.e., GPR, GPT, GPA) for foreign exchange (FX) (total) jumps. The reported causality-in-quantile of GPRs to total, upside and downside volatility jumps of each exchange rate concerns only statistically significant results. The exchange rate with the highest causality effect on FX , the minimum (Min), maximum (Max), average (Average) and dispersion of causality effects across all seven exchange rates for each quantile. The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Abbreviations: Australian Dollar (AUD), British Pound (GBP), Euro (EUR), New Zealand Dollar (NZD), Canadian Dollar (CAD), Japanese Yen (JPY), and Swiss Franc (CHF).

Table 7B. Key comparisons FX upside jumps

		0.05	**0.1**	**0.15**	**0.2**	**0.25**	**0.3**	**0.35**	**0.4**	**0.45**	**0.5**	**0.55**	**0.6**	**0.65**	**0.7**	**0.75**	**0.8**	**0.85**	**0.9**	**0.95**
FX	**GPR**	JPY	JPY	JPY	GBP	GBP	GBP	GBP	GBP	GBP	GBP	GBP	GBP	EUR	EUR	EUR	EUR	NZD	CAD	AUD
	GPT	JPY	JPY	JPY	GBP	GBP	GBP	GBP	GBP	GBP	GBP	GBP	GBP	EUR	EUR	EUR	EUR	AUD	AUD	AUD
	GPA	JPY	JPY	GBP	GBP	GBP	GBP	GBP	GBP	GBP	GBP	GBP	GBP	EUR	EUR	EUR	EUR	NZD	CAD	AUD
Min	**GPR**	2.78	3.56	4.11	56.77	38.89	26.33	17.46	11.42	7.73	5.63	0.3000	0.5400	0.5900	0.4000	0.2100	0.2100	0.1100	0.1600	0.1600
	GPT	2.54	3.38	4.22	58.96	40.53	27.57	18.40	12.14	8.30	5.45	0.4300	0.7200	0.7400	0.5000	0.2700	0.2000	0.1100	0.1500	0.1400
	GPA	0.3900	0.5100	0.5700	282	200	140	94.78	60.40	34.89	7.04	0.4100	0.3300	0.3900	0.3700	0.2000	0.0800	0.0500	0.0200	0.0300
Max	**GPR**	2,797	1,623	1,063	760	564	419	307	220	151	97.05	55.92	26.41	8.09	8.19	6.44	5.74	5.44	4.32	3.01
	GPT	2,790	1,618	1,060	767	568	422	309	221	152	97.29	55.85	26.18	7.90	7.98	6.09	4.66	4.74	3.97	2.91
	GPA	2,822	1,642	1,128	826	617	462	343	249	174	115	68.64	34.83	16.61	15.03	8.48	3.38	1.94	2.13	2.49
Average	**GPR**	1,159	677	455	328	232	163	111	72.63	44.65	25.70	14.69	8.62	5.42	3.96	3.47	3.12	2.99	2.59	1.85
	GPT	1,162	678	456	328	232	163	111	72.29	44.28	25.36	14.36	8.37	5.40	3.95	3.30	2.84	2.59	2.40	1.69
	GPA	1,551	926	634	505	364	259	181	121	75.70	43.81	24.36	13.54	7.96	4.89	3.02	1.73	1.10	1.11	1.01
Dispersion	**GPR**	1,976	1,145	749	497	371	277	205	147	101	64.64	39.33	18.29	5.30	5.51	4.41	3.91	3.77	2.94	2.02
	GPT	1,971	1,142	746	500	373	279	206	148	101	64.94	39.19	18.00	5.06	5.29	4.12	3.15	3.27	2.70	1.96
	GPA	1,995	1,161	797	385	295	228	175	133	98.22	76.01	48.25	24.40	11.47	10.37	5.85	2.33	1.34	1.49	1.74

Note: This table reports the summarized results of causality-in-quantile test of each of the geopolitical risks (GPRs) (i.e., GPR, GPT, GPA) for foreign exchange (FX) upside jumps. The reported causality-in-quantile of GPRs to total, upside and downside jumps of each exchange rate concerns only statistically significant results. The exchange rate with the highest causality effect on FX , the minimum (Min), maximum (Max), average (Average) and dispersion of causality effects across all seven exchange rates for each quantile. The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Abbreviations: Australian Dollar (AUD), British Pound (GBP), Euro (EUR), New Zealand Dollar (NZD), Canadian Dollar (CAD), Japanese Yen (JPY), and Swiss Franc (CHF).

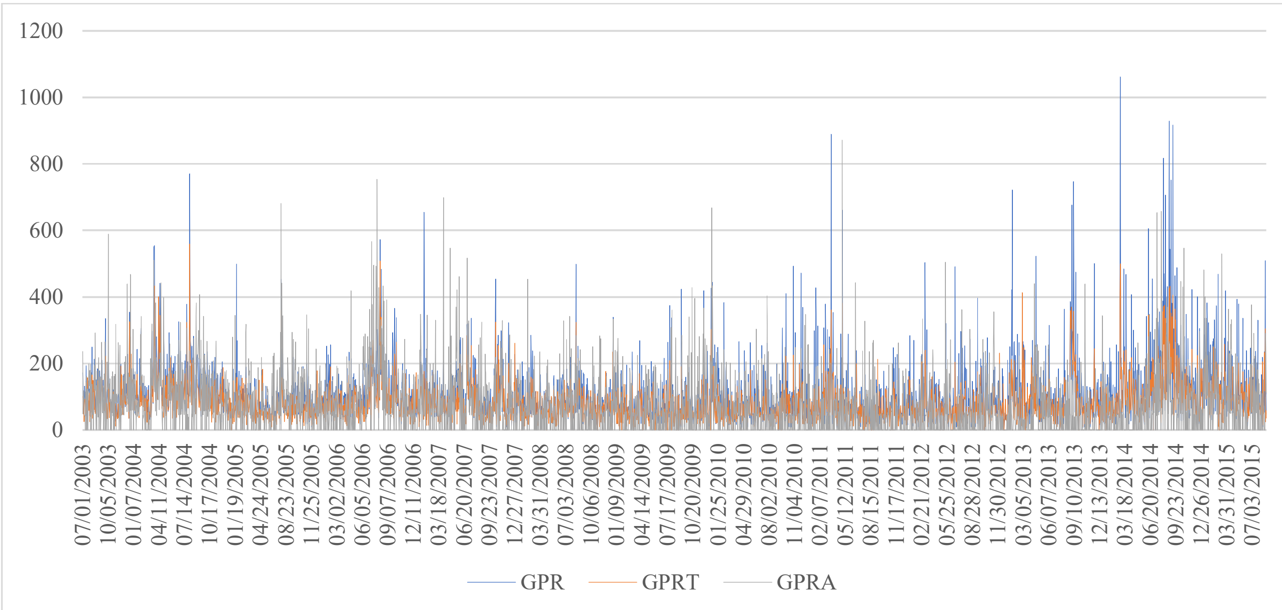
Table 7C. Key comparisons FX downside jumps

		0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.85	0.9	0.95
FX	**GPR**	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	GBP	NZD	NZD	NZD	NZD	CAD	NZD
	GPT	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	GBP	NZD	NZD	GBP	NZD	AUD	NZD
	GPA	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	EUR	GBP	GBP	GBP	GBP	EUR	EUR	EUR	AUD	CAD	CAD
Min	**GPR**	2.83	3.66	4.03	56.47	38.70	26.23	17.42	11.42	7.75	4.59	2.93	3.11	3.14	2.67	1.72	0.8300	0.5100	0.4900	0.3800
	GPT	2.36	3.40	4.31	58.66	40.34	27.46	18.36	12.14	8.31	3.98	2.87	3.13	3.26	2.80	1.91	0.8400	0.5900	0.6500	0.2800
	GPA	0.3200	0.5700	0.6000	301	213	148	99.55	62.85	32.62	9.18	3.40	2.08	2.06	1.84	1.36	1.06	0.5800	0.2300	0.2500
Max	**GPR**	2,150	1,261	859	616	448	325	231	159	103	60.91	31.10	12.63	7.10	6.49	6.35	6.30	5.33	4.15	2.94
	GPT	2,150	1,260	858	614	446	323	229	157	101	59.32	29.84	11.80	6.84	5.77	5.40	4.79	4.03	4.55	2.69
	GPA	2,359	1,401	965	699	515	380	275	194	131	83.93	52.92	29.34	12.80	7.95	5.37	3.31	1.85	2.32	1.53
Average	**GPR**	969	559	374	269	190	132	89.92	58.42	35.72	20.53	11.75	7.13	5.16	4.27	3.58	3.06	2.89	2.90	1.98
	GPT	970	559	373	268	189	132	89.13	57.68	35.08	20.06	11.37	6.88	5.05	4.08	3.24	2.72	2.53	2.57	1.65
	GPA	1,381	822	562	454	327	233	163	109	68.45	39.55	21.78	12.15	7.10	4.48	2.77	1.85	1.26	1.20	0.9629
Dispersion	**GPR**	1,518	889	605	395	289	211	151	104	67.25	39.82	19.92	6.73	2.80	2.70	3.27	3.87	3.41	2.59	1.81
	GPT	1,519	888	604	393	287	209	149	102	65.56	39.13	19.07	6.13	2.53	2.10	2.47	2.79	2.43	2.76	1.70
	GPA	1,668	990	682	282	214	164	124	92.91	69.44	52.86	35.02	19.28	7.59	4.32	2.84	1.59	0.90	1.48	0.9051

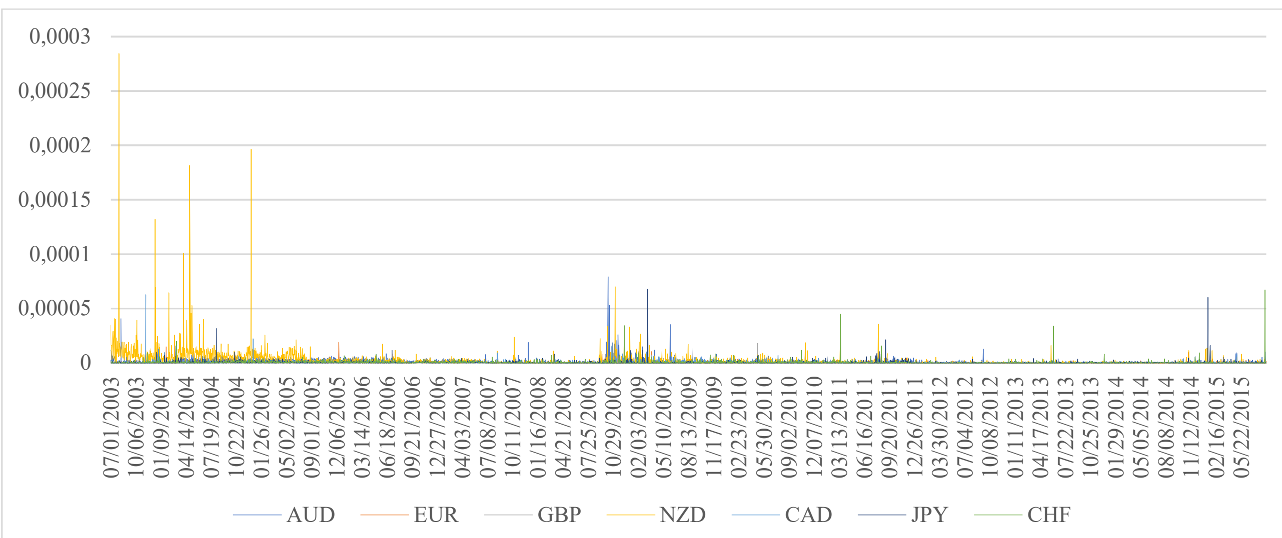
Note: This table reports the summarized results of causality-in-quantile test of each of the geopolitical risks (GPRs) (i.e. GPR, GPT, GPA) for foreign exchange (FX) downside jumps. The reported causality-in-quantile of GPRs to total, upside and downside jumps of each exchange rate concerns only statistically significant results. The exchange rate with the highest causality effect on FX, the minimum (Min), maximum (Max), average (Average) and dispersion of causality effects across all seven exchange rates for each quantile. The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Abbreviations: Australian Dollar (AUD), British Pound (GBP), Euro (EUR), New Zealand Dollar (NZD), Canadian Dollar (CAD), Japanese Yen (JPY), and Swiss Franc (CHF).

Figure 1. Data graphs

Panel A. Geopolitical risk indices



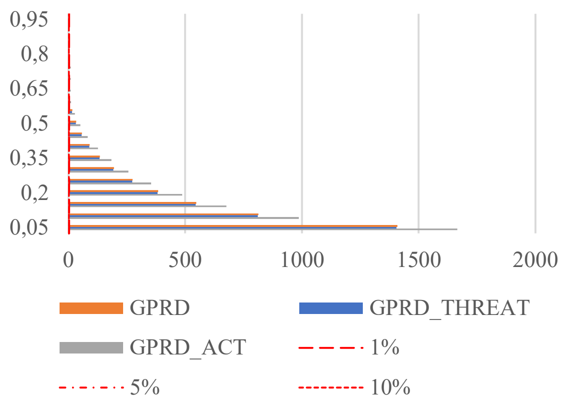
Panel B. Exchange rates jumps



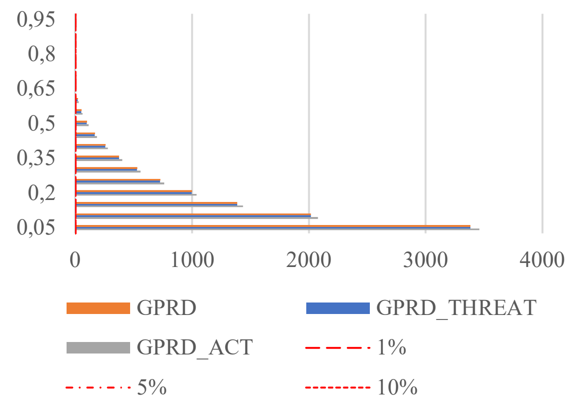
Note: This figure depicts the geopolitical risks (GPRs) and jumps of the exchange rates. Panel A depicts the three GPRs indices. The GPRs indices under consideration are: (i) the geopolitical risk (GPR), (ii) the Threats of GPRs (GPT), (iii) the Acts of GPRs (GPA). Panel B depicts the jumps of seven exchange rates. The exchange rates jumps under consideration are: (i) the Australian Dollar (AUD), (ii) the British Pound (GBP), (iii) the Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY), (vii) Swiss Franc (CHF).

Figure 2. Causality-in-quantiles test results for FX jumps

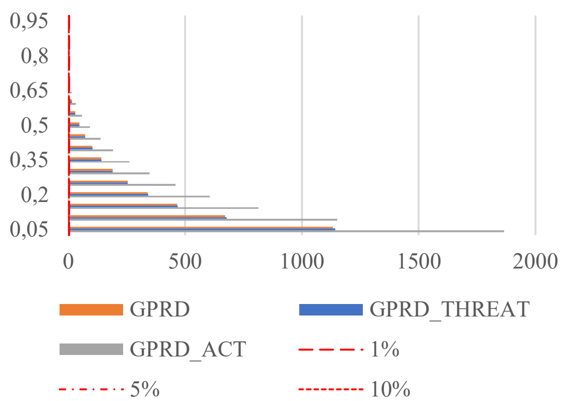
Panel A. Australian Dollar (AUD)



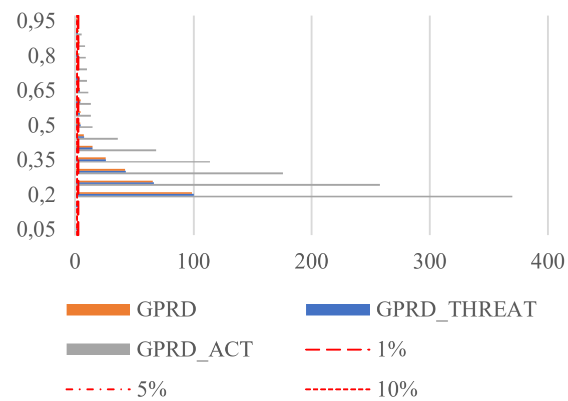
Panel C. Euro (EUR)



Panel B. British Pound (GBP)



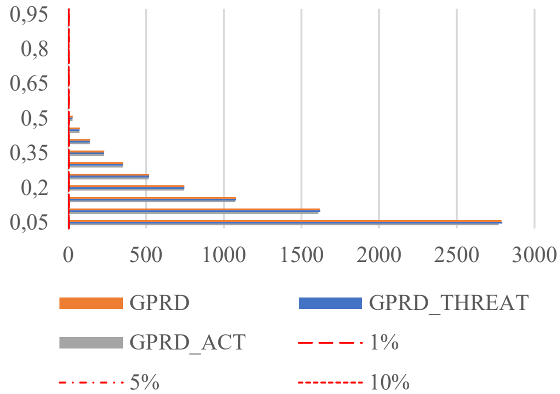
Panel D. New Zealand Dollar (NZD)



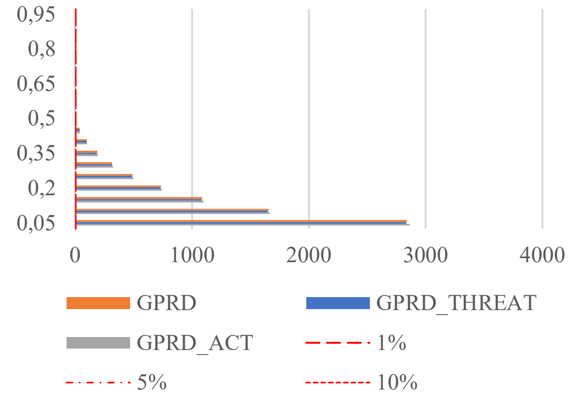
Note: This figure represents the estimates for the causality-in-quantiles test to detect directional predictability of jumps of exchange rates of seven exchange rates in different quantiles (see the estimation results in Panel A of set of Tables 4-6) due to geopolitical risks (GPRs). The following seven exchange rates are considered: (i) the Australian Dollar (AUD), (ii) the British Pound (GBP), (iii) the Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY), (vii) Swiss Franc (CHF). While three GPRs are considered: (i) the geopolitical risk (GPR), (ii) the Threats of GPRs (GPT), (iii) the Acts of GPRs (GPA). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (left tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. The null hypothesis of no-causality-in-quantiles from geopolitical risks (GPRs) to jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The vertical *red lines* the value of the standardized test statistics of Jeong et al. (2012) with respect to different quantiles (x-axis) The *dotted (red) lines* depicts the critical values of this test at 1%, 5% and 10% level of significant with corresponding values 2.575, 1.96 and 1.645, respectively. A line above the *red dotted* line leads to a rejection of the null hypothesis of no-causality-in-quantiles from GPRs index to jumps of exchange rate. Panel A refers to Australian Dollar (AUD), Panel B refers to British Pound (GBP), Panel C refers to Euro (EUR) and Panel D refers to New Zealand Dollar (NZD).

Figure 2. Causality-in-quantiles test results for FX jumps

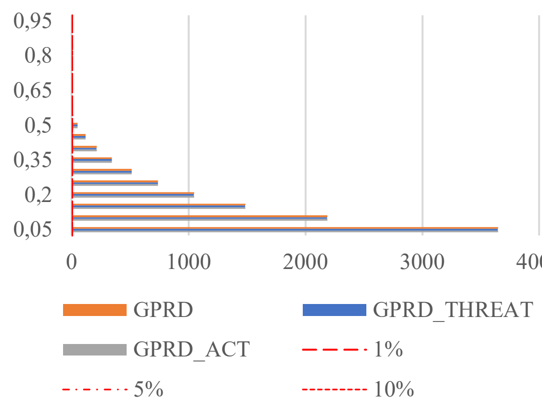
Panel E. Canadian Dollar (CAD)



Panel F. Japanese Yen (JPY)



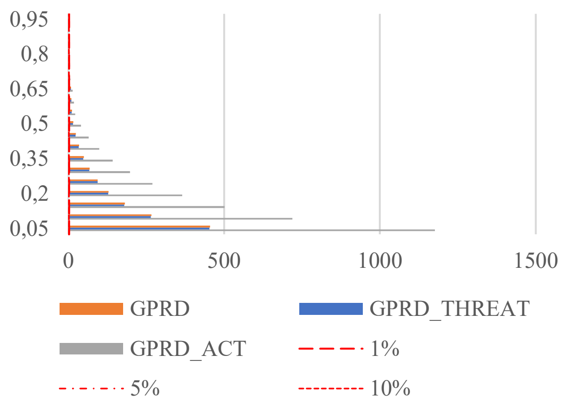
Panel G. Swiss Franc (CHF)



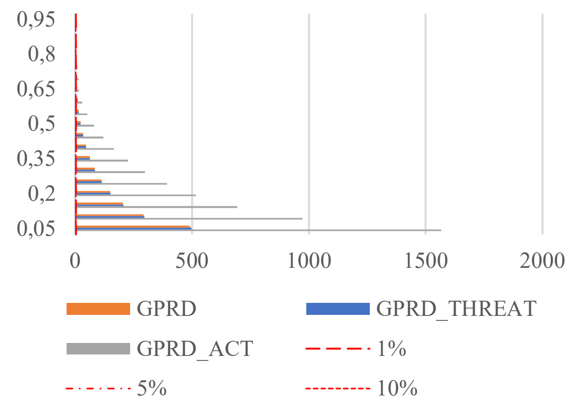
Note: This figure represents the estimates for the causality-in-quantiles test to detect directional predictability of jumps of exchange rates of seven exchange rates in different quantiles (see the estimation results in Panel A of set of Tables 4-6) due to geopolitical risks (GPRs). The following seven exchange rates are considered: (i) the Australian Dollar (AUD), (ii) the British Pound (GBP), (iii) the Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY), (vii) Swiss Franc (CHF). While three GPRs are considered: (i) the geopolitical risk (GPR), (ii) the Threats of GPRs (GPT), (iii) the Acts of GPRs (GPA). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (left tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. The null hypothesis of no-causality-in-quantiles from geopolitical risks (GPRs) to jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The vertical *red lines* the value of the standardized test statistics of Jeong et al. (2012) with respect to different quantiles (x-axis) The *dotted (red) lines* depicts the critical values of this test at 1%, 5% and 10% level of significant with corresponding values 2.575, 1.96 and 1.645, respectively. A line above the *red dotted* line leads to a rejection of the null hypothesis of no-causality-in-quantiles from GPRs index to jumps of exchange rate. Panel E refers to Canadian Dollar (CAD), Panel F refers Yen (JPY) and Panel G Swiss Franc (CHF).

Figure 3. Causality-in-quantiles test results for the upside FX jumps

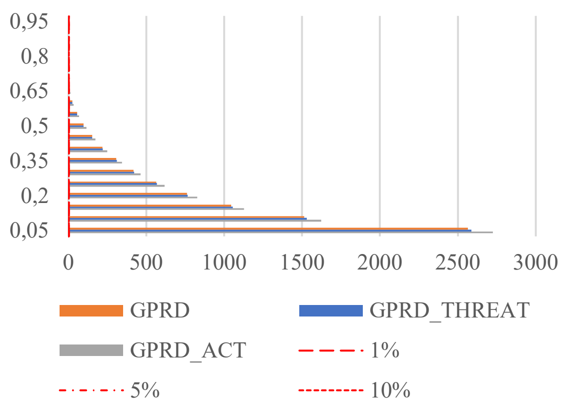
Panel A. Australian Dollar (AUD)



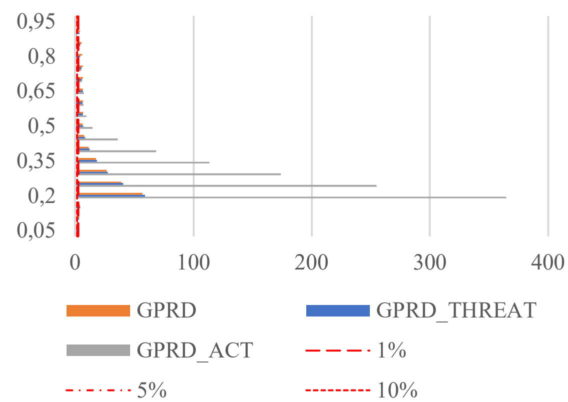
Panel C. Euro (EUR)



Panel B. British Pound (GBP)



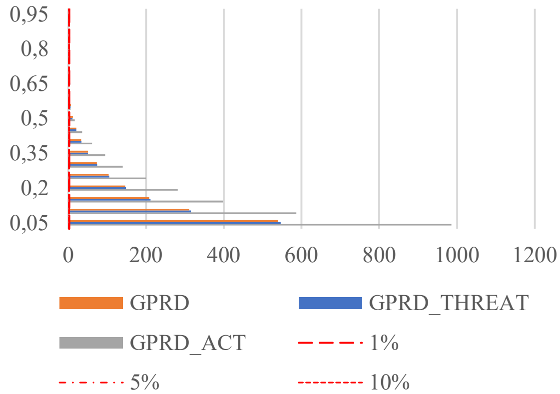
Panel D. New Zealand Dollar (NZD)



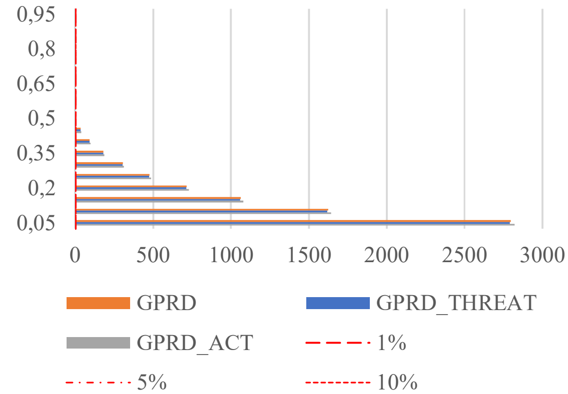
Note: This figure represents the estimates for the causality-in-quantiles test to detect directional predictability of upside jumps of exchange rates of seven exchange rates in different quantiles (see the estimation results in Panel B of set of Tables 4-6) due to geopolitical risks (GPRs). The following seven exchange rates are considered: (i) the Australian Dollar (AUD), (ii) the British Pound (GBP), (iii) the Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY), (vii) Swiss Franc (CHF). While three GPRs are considered: (i) the geopolitical risk (GPR), (ii) the Threats of GPRs (GPT), (iii) the Acts of GPRs (GPA). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (left tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. The null hypothesis of no-causality-in-quantiles from geopolitical risks (GPRs) to upside jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The vertical *red lines* the value of the standardized test statistics of Jeong et al. (2012) with respect to different quantiles (x-axis) The *dotted (red) lines* depicts the critical values of this test at 1%, 5% and 10% level of significant with corresponding values 2.575, 1.96 and 1.645, respectively. A line above the *red dotted* line leads to a rejection of the null hypothesis of no-causality-in-quantiles from GPRs index to jumps of exchange rate. Panel A refers to Australian Dollar (AUD), Panel B refers to British Pound (GBP), Panel C refers to Euro (EUR) and Panel D refers to New Zealand Dollar (NZD).

Figure 3. Causality-in-quantiles test results for FX jumps

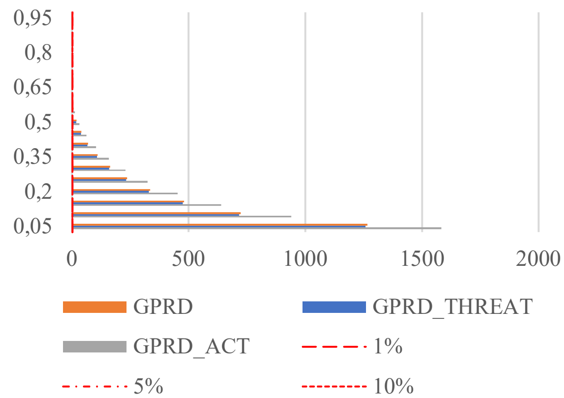
Panel E. Canadian Dollar (CAD)



Panel F. Japanese Yen (JPY)



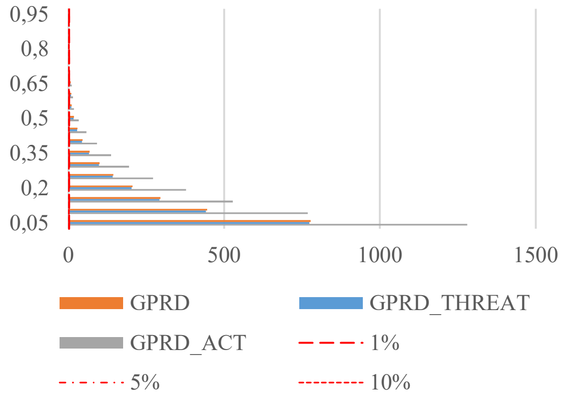
Panel G. Swiss Franc (CHF)



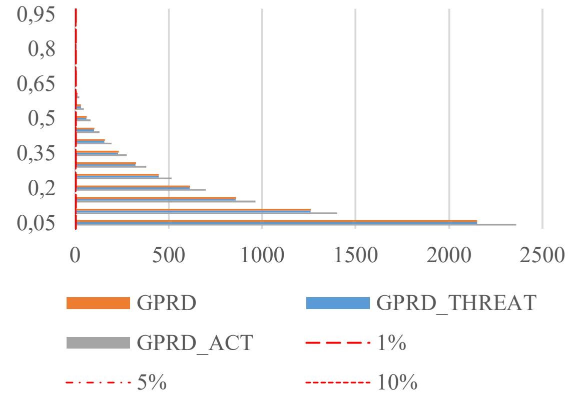
Note: This figure represents the estimates for the causality-in-quantiles test to detect directional predictability of upside jumps of exchange rates of seven exchange rates in different quantiles (see the estimation results in Panel B of set of Tables 4-6) due to geopolitical risks (GPRs). The following seven exchange rates are considered: (i) the Australian Dollar (AUD), (ii) the British Pound (GBP), (iii) the Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY), (vii) Swiss Franc (CHF). While three GPRs are considered: (i) the geopolitical risk (GPR), (ii) the Threats of GPRs (GPT), (iii) the Acts of GPRs (GPA). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (left tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. The null hypothesis of no-causality-in-quantiles from geopolitical risks (GPRs) to upside jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The vertical *red lines* the value of the standardized test statistics of Jeong et al. (2012) with respect to different quantiles (x-axis) The *dotted (red) lines* depicts the critical values of this test at 1%, 5% and 10% level of significant with corresponding values 2.575, 1.96, and 1.645, respectively. A line above the *red dotted* line leads to a rejection of the null hypothesis of no-causality-in-quantiles from GPRs index to jumps of exchange rate. Panel E refers to Canadian Dollar (CAD), Panel F refers Yen (JPY) and Panel G Swiss Franc (CHF).

Figure 4. Causality-in-quantiles test results for the downside FX jumps

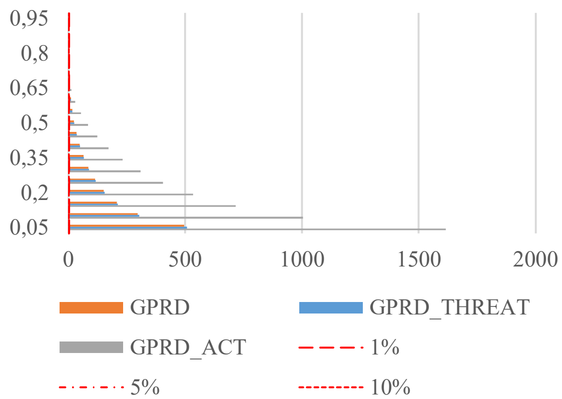
Panel A. Australian Dollar (AUD)



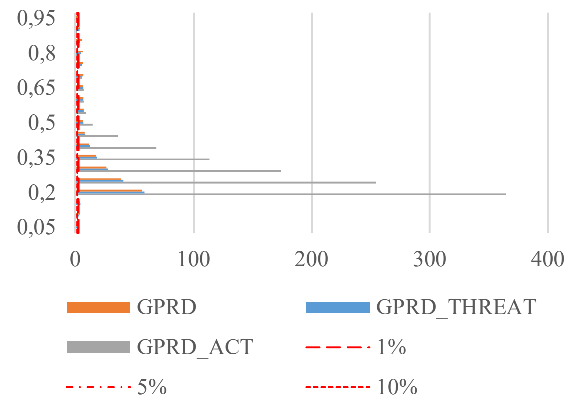
Panel C. Euro (EUR)



Panel B. British Pound (GBP)



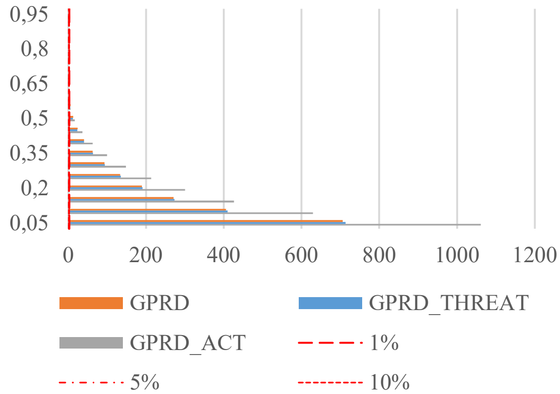
Panel D. New Zealand Dollar (NZD)



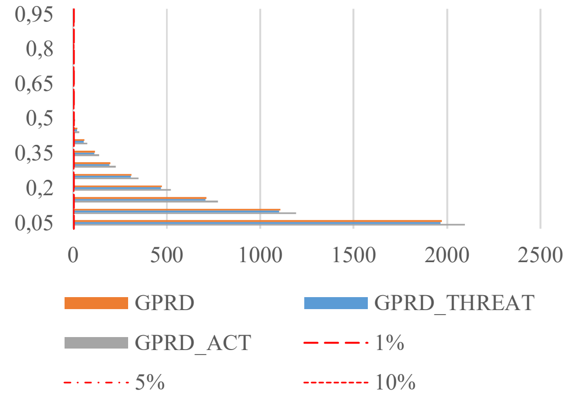
Note: This figure represents the estimates for the causality-in-quantiles test to detect directional predictability of downside jumps of exchange rates of seven exchange rates in different quantiles (see the estimation results in Panel C of set of Tables 4-6) due to geopolitical risks (GPRs). The following seven exchange rates are considered: (i) the Australian Dollar (AUD), (ii) the British Pound (GBP), (iii) the Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY), (vii) Swiss Franc (CHF). While three GPRs are considered: (i) the geopolitical risk (GPR), (ii) the Threats of GPRs (GPT), (iii) the Acts of GPRs (GPA). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (left tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. The null hypothesis of no-causality-in-quantiles from geopolitical risks (GPRs) to downside jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The vertical *red lines* the value of the standardized test statistics of Jeong et al. (2012) with respect to different quantiles (x-axis) The *dotted (red) lines* depicts the critical values of this test at 1%, 5% and 10% level of significant with corresponding values 2.575, 1.96, and 1.645, respectively. A line above the *red dotted* line leads to a rejection of the null hypothesis of no-causality-in-quantiles from GPRs index to jumps of exchange rate. Panel A refers to Australian Dollar (AUD), Panel B refers to British Pound (GBP), Panel C refers to Euro (EUR) and Panel D refers to New Zealand Dollar (NZD).

Figure 4. Causality-in-quantiles test results for the downside FX jumps

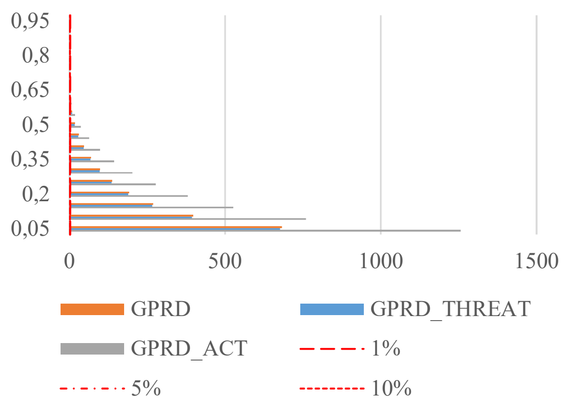
Panel E. Canadian Dollar (CAD)



Panel F. Japanese Yen (JPY)



Panel G. Swiss Franc (CHF)



Note: This figure represents the estimates for the causality-in-quantiles test to detect directional predictability of downside jumps of exchange rates of seven exchange rates in different quantiles (see the estimation results in Panel C of set of Tables 4-6) due to geopolitical risks (GPRs). The following seven exchange rates are considered: (i) the Australian Dollar (AUD), (ii) the British Pound (GBP), (iii) the Euro (EUR), (iv) New Zealand Dollar (NZD), (v) Canadian Dollar (CAD), (vi) Japanese Yen (JPY), (vii) Swiss Franc (CHF). While three GPRs are considered: (i) the geopolitical risk (GPR), (ii) the Threats of GPRs (GPT), (iii) the Acts of GPRs (GPA). The first line corresponds to the quantile θ considered. Nineteen quantiles are considered as follows $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45,0.5,0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. Jumps are in low levels (left tail and large negative values of the variable) indicating that $\theta \in \{0.05,0.1,0.15,0.2,0.25,0.3,0.35,0.4,0.45\}$. Jumps are in median level indicating that $\theta \in \{0.5\}$. Jumps are in high levels (right tail and large positive values of the variable) indicating that $\theta \in \{0.55,0.6,0.65,0.7,0.75,0.8,0.85,0.9,0.95\}$. The null hypothesis of no-causality-in-quantiles from geopolitical risks (GPRs) to downside jumps of exchange rates is test by the Jeong et al. (2012) causality-in-quantiles test. The vertical red lines the value of the standardized test statistics of Jeong et al. (2012) with respect to different quantiles (x-axis) The dotted (red) lines depicts the critical values of this test at 1%, 5% and 10% level of significant with corresponding values 2.575, 1.96, and 1.645, respectively. A line above the red dotted line leads to a rejection of the null hypothesis of no-causality-in-quantiles from GPRs index to jumps of exchange rate. Panel E refers to Canadian Dollar (CAD), Panel F refers Yen (JPY) and Panel G Swiss Franc (CHF).