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Impact of Geopolitical, Economic Policy and Financial Market Uncertainty on the Realized Volatility of G20 Stock Indices: A Panel QARDL Approach

Khushbu Dhariwal*, Khujan Singh**

Abstract: Amid rising uncertainties, the researcher uses the novel panel quantile autoregressive distributive lag approach to examine the long- and short-term effects of geopolitical, economic policy and financial market uncertainties on the realized volatility of G20 stock indices from April 2015 to March 2024. The findings indicate that overall geopolitical risk (GPR) and geopolitical acts (GPA) have a significant impact on the realized volatility of G20 stock indices but only in the long run, while country-specific GPR (GPRH) has an insubstantial impact across all three quantiles. Conversely, an adverse effect of Global Economic Policy (GEPU) has been observed only in the short run. Among financial market uncertainty proxies, the market-based fear index (VIX) has a more pronounced impact than the news-based fear index on overall economic market volatility (EMV). Resilience has been noticed against GPRH, geopolitical threats (GPT) and GEPU, indicating their potential as diversifiers and hedges. Furthermore, the Pairwise Granger Panel Causality Test reveals interconnections among different uncertainty types. The long-term vulnerability to GPR and GPA suggests a decline in international risk diversification benefits due to increasing geopolitical tensions. The policymakers are thus urged to enhance efforts to mitigate geopolitical conflicts and maintain global economic and financial interconnectedness.

Keywords: uncertainty; geopolitical risk; economic policy uncertainty; quantile model; Panel ECM.

JEL classification: C33; C58; G10; F51; F65.

* Haryana School of Business, Guru Jambheshwar University of Science and Technology, Hisar, Haryana, India; e-mail: *dhariwalkhushbu17@gmail.com* (corresponding author).

** Haryana School of Business, Guru Jambheshwar University of Science and Technology, Hisar, Haryana, India; e-mail: *kh_hsb@yahoo.co.in*.

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1. INTRODUCTION

Ever since the evolution of mean-variance portfolio theory (Markowitz, 1952),, different researchers have extended their work as the theories related to well-diversified portfolios have evolved in recognition of the presence of unknown factors by modelling uncertainty (Delage and Ye, 2010; Denis and Kervarec, 2013; Bielecki *et al.*, 2019; Ismail and Pham, 2019). This highlights the significance of uncertain factors that need to be considered when selecting an optimal portfolio. The above studies mainly revolved around parameter uncertainty and a large amount of research prevails to address various forms of model uncertainty (Pham *et al.*, 2022). In addition to parameter uncertainty, a new strand of literature focused on different types of uncertainty is gaining traction among researchers in the face of increasing global uncertainty.

Uncertainty is a nebulous idea, which can be defined as circumstances in which the potential consequences of a decision, such as an investment choice, or the likelihood distribution associated with it, are unclear or unknown to the parties involved (Bloom, 2014; Himounet, 2022). The factors that affect stock market dynamics extend beyond just economic and financial considerations, as they also encompass uncertainty-induced shocks (Antonakakis *et al.*, 2013). With the ever-evolving technology and increasing globalisation, world has become highly interconnected and as a consequence, uncertainty has become more widespread and consequential than it has ever been in the past (Al-Thaqeb and Algharabali, 2019). It can take on many forms and originate from various sources, resulting in a financial landscape that is both intricate and difficult to forecast.

For instance, Geopolitical Uncertainty may arise due to conflict between nations, political instability, war or terrorist acts (Caldara and Iacoviello, 2022). Economic Policy Uncertainty (EPU) is another type which may occur on account of ambiguity surrounding monetary, fiscal or regulatory policies to be announced by the policymakers (Brogaard and Detzel, 2015). Moreover, tariffs are one of the most direct policy tools, and any updates or changes in trade and tariff policies are often interpreted as policy risk signals by the investors, which can also generate significant uncertainty (Baker *et al.*, 2016; Baker *et al.*, 2019). Furthermore, tariffs not only raise economic uncertainty but may also translate into geopolitical risks (exemplified by the U.S tariffs on Chinese goods during 2018-19, repercussions of which were also noticed in Asian and European markets (Handley and Limão, 2017; Goulard, 2020) and potentially leading to amplified volatility. Likewise, the geopolitical risks can also lead to substantial economic policy uncertainty (Dakhlaoui and Aloui, 2016). Nevertheless, both GPR and EPU have the potential to act as stimuli that influence investor sentiment (Al-Thaqeb and Algharabali, 2019; Bossman *et al.*, 2023). Thus, the combination of all these elements can have wide-ranging effects on overall market stability.

In the highly interconnected global world, rising uncertainties hold a risk of financial fragmentation, as a consequence can result in the weakening of international risk diversification (Catalán and Tsuruga, 2023). For instance, the group of twenty (G20) nations serves as a premier forum for international economic cooperation, aiming to maintain economic stability and growth (Hasnain, 2023). Despite the importance G20 holds in the global economy, it is not free from uncertainties and risks that come with its operation. Brexit, the U.S-China trade tensions, disagreements on global policy issues in the United Nations and the Russia-Ukraine conflict are some enduring shocks that have contributed to sustained uncertainty (Ahir *et al.*, 2022).

Over time, different researchers came up with a number of proxies such as geopolitical risk (GPR), economic policy uncertainty (EPU), market-based fear index (VIX) and news-based NVIX & economic market volatility (EMV) index with respect to distinct types of uncertainty (Baker *et al.*, 2016; Manela and Moreira, 2017; Baker *et al.*, 2019; Caldara and Iacoviello, 2022). Post development of these proxies, many researchers have tried to explore distinct aspects concerning different types of uncertainties such as in relation to GPR and financial development (Alsagr and van Hemmen, 2021), EPU and stock markets (Arouri *et al.*, 2016; Batabyal and Killins, 2021), implied volatility and stock returns (Sarwar and Khan, 2017). The majority of past literature establishes that increased uncertainty often results in increased market volatility and tends to impact volatility more than the returns (Asgharian *et al.*, 2018; Mitsas *et al.*, 2022; Salisu *et al.*, 2023). Moreover, it has also been identified that different assets can behave differently to distinct types of uncertainty (Qin *et al.*, 2020; Dutta and Das, 2022). However, such studies typically restrict their focus to a specific type of uncertainty about a particular class of assets with respect to a specific region or country and do not distinguish between short-term and long-term relationships. Furthermore, the interconnectedness of different types of uncertainty is conjectured but there is a lack of empirical evidence pertaining to the same (Al-Thaqeb and Algharabali, 2019). Understanding the impact of various types of uncertainty on volatility is essential, as it plays a significant role in investment decisions and policy-making, and enables individuals to navigate uncertainty more effectively.

To this end, we propose to explore the influence of distinct types of uncertainty on the realized volatility of G20 stock indices. The G20, consisting of the most significant economies globally, presents a comprehensive and diverse sample for studying the intricate relationship between uncertainty and market volatility. By examining realized volatility, which reflects genuine price variations within particular timeframes, we can attain valuable insights into the practical consequences of uncertainty on market dynamics. In this study, we broadly categorise the distinct types of uncertainty considered in this study into three categories, namely i) Geopolitical Uncertainty, ii) Policy Uncertainty and iii) Financial Market Uncertainty. Wherein four variants of geopolitical uncertainty comprising, global geopolitical risk (GPR), home country GPR (GPRH), decomposed elements of GPR namely, geopolitical threat (GPT) and geopolitical acts (GPA), two proxies representing financial market uncertainty including one options market based implied volatility index (VIX) and one text-based overall economic market volatility index (EMV). Besides, with regard to policy uncertainty, the researcher's initial intent was to consider both global and home country EPU indices but due to the unavailability of home country EPU for all sample entities, only global EPU (GEPU) represented by U.S.'s EPU is considered.

Our study distinguishes itself from prior research on several fronts. First, we examine the impact of various uncertainty types on G20 stock indices' realized volatility across different market conditions (vulnerable or resilient) in both the short and long term. Additionally, we assess whether these global indices lose diversification benefits under different uncertainties. Second, we employ the modified panel quantile autoregressive distributed lags approach proposed by Arshed *et al.* (2022), which offers a more comprehensive analysis of stock volatility under varying market conditions (Peng *et al.*, 2022). Third, we use Pairwise Panel Causality Tests to empirically investigate the relationship between different uncertainty types and the realized volatility of G20 stock indices. To the best of our knowledge, no prior study has explored the behaviour of G20 stock indices concerning distinct uncertainties. Understanding this relationship helps investors develop effective hedging strategies to minimize potential risks.

The results of this study highlight that different types of uncertainty have varying effects on the realized volatility of G20 stock indices across different quantiles. Wherein overall GPR and GPA significantly increase long-run volatility, their short-run impact remains muted, reflecting resilience to immediate shocks. In contrast, GPEU exerts short-lived but sharp effects, which can result in hot money flows. Moreover, VIX has been found to exert a stronger influence than the EMV. Besides, it's also the most influential compared to other uncertainties. The results of pairwise Granger causality showed a mix of no relation, unidirectional and bidirectional causal relations among the variables under consideration. Wherein geopolitical risks have been reported to affect the realized volatility indirectly through uncertainty and volatility channels rather than directly, while evidence of strong bidirectional systemic linkages between geopolitical, policy and financial uncertainties points towards their tight interconnection. For investors, these findings underscore the need to account for long term vulnerability of global portfolios to escalating GPR while recognizing the short-term resilience, which may provide tactical diversification and hedging opportunities. For policymakers, interconnections among uncertainty measures and erosion of diversification benefits highlight the need for stronger international cooperation, clear policy communication and timely actions to curb uncertainty driven volatility.

The remainder of the study has been planned as follows. Section 2 presents a brief overview of related literature. Section 3 details the data and its origin. Section 4 outlines the methodology employed, while section 5 explores the empirical findings. Lastly, section 6 concludes the study and offers recommendations for future research.

2. LITERATURE SURVEY

Based on the selected variables considered in this study, the literature reviewed concerning uncertainty and stock market volatility is presented in three sub-sections (i.e., i) Geopolitical Risk, ii) Economic Policy Uncertainty and iii) Financial Market Uncertainty, which is discussed as follows:

2.1 Geopolitical Uncertainty

Geopolitical risk (GPR) can be referred to as the potential danger linked to conflicts, terroristic acts, and the disruption of international relations that impacts the typical and tranquil progression of international connections (Caldara and Iacoviello, 2022). Geopolitical incidents can cause fluctuations in the market values of all types of assets, asset classes, sectors, and nations (Engle and Campos-Martins, 2020). According to Balcilar *et al.* (2018), GPR significantly affects the volatility of the stock market, particularly in terms of bringing about adverse fluctuations. Utilizing the panel GARCH approach, Bouras *et al.* (2019) highlighted the dominance of shocks induced by global GPR over domestic shocks, suggesting that the global GPR has a stronger impact than the country-specific GPR on the volatility of 18 emerging markets. Besides, just like the conventional stock markets, Islamic equity and bond markets were also found to be affected by GPR, which could be ascribed as a consequence of GPR's effect on the country's political situation, finances and the credit risk of the issuer (Bouri *et al.*, 2019). Further delving deeper into the GPR, Salisu *et al.* (2022) and Yang *et al.* (2021) investigated the decomposed elements of GPR (namely, GPA and GPT) wherein GPA in particular was reported to be a better forecaster of stock market volatility than GPT or the composite GPR itself. In the same conjecture, Mitsas *et al.* (2022) conducted a study concerning commodity futures and the composites of GPR wherein they found a weak positive impact of GPT on corn futures volatility. In another study, Qin *et al.* (2020) reported a positive impact of GPR on crude oil volatility while an insignificant negative impact on gas and heating volatility under different market conditions. On the other hand, employing Markov regime-switching and the GARCH model, Dutta and Dutta (2022) provide empirical evidence of a negative association between the volatility of renewable energy ETFs and the GPR, which could be attributed to the high sensitivity of traditional energy sources to the GPR due to which investors tend to switch towards clean energy. Based on the above literature it can be said that the impact of GPR tends to vary depending on the type of asset class and market conditions (Qin *et al.*, 2020). Recognizing the influence of geopolitical events on volatility could be crucial due to its significant bearing on investment decisions and policy-making processes, and it enables one to evaluate the systemic nature of geopolitical risk (Smales, 2021). Thus, it would be interesting to see how global indices behave in response to GPR. The hypothesis framed concerning geopolitical risks based on the above literature is as follows:

H1*: GPR has a significant positive influence on the realized volatility of G20 stock indices.*

H1a*: GPT has a significant positive influence on the realized volatility of G20 stock indices.*

H1b*: GPA has a significant positive influence on the realized volatility of G20 stock indices.*

H2*: GPRH has a significant positive influence on the realized volatility of G20 stock indices.*

2.2 Economic Policy Uncertainty

Uncertainty regarding government policies and regulatory frameworks in the future can be referred to as policy uncertainty, which poses economic risks (Al-Thaqeb and Algharabali, 2019). Research has repeatedly demonstrated that EPU has a considerable influence on stock market volatility (Sum, 2012, 2013; Brogaard and Detzel, 2015). According to Pástor and Veronesi (2012), the extent and the magnitude of the effect, either good or bad, depends on the certainty associated with the policy changes. In an attempt to measure this particular type of uncertainty, Baker *et al.* (2016) designed an index to measure economic policy uncertainty, encompassing uncertainties derived from news, policy, market indicators, and economic indicators. The recent literature on EPU establishes a positive connection between EPU and volatility (Su *et al.*, 2019; Mishra and Debata, 2020; Kundu and Paul, 2022; Ghani and Ghani, 2024). Delving deeper into this relationship, Asgharian *et al.* (2018) uncovered that US EPU shocks have a positive impact on long-term stock market correlation and volatility in its own stock market as well as the UK Stock market. Additionally, Salisu *et al.* (2023) also discussed the significance of signal quality in predicting stock market volatility, with high-quality signals enhancing the predictive ability of EPU. Moreover, in contrast to André *et al.* (2017); Salisu *et al.* (2023)'s findings, Balcilar *et al.* (2019) and Asgharian *et al.* (2023) suggest that the EPU lacks the predictive ability for stock market volatility. Despite the increasing interest of researchers in this particular area, there is a scarcity of studies exploring alternatives to manage the risks associated with EPU. The researcher intends to explore the impact of GEPU on the volatility of G20 stock returns. The hypothesis formulated for this purpose is as follows:

H3*: GEPU has a significant positive influence on the realized volatility of G20 stock indices.*

2.3 Financial Market Uncertainty

Another strand of literature considered in this study relates to uncertainty associated with financial markets, often proxied by investor sentiments. Sentiment indicators for investors can be broadly categorized into three types, based on the data sources they utilize, namely i) market-based, ii) survey-based and iii) text & media-based (Zhou, 2018). The Chicago Board Options Exchange's Volatility Index (VIX) (i.e., a market-based market sentiment index), frequently referred to as the investor fear gauge, is a widely recognized measure of uncertainty in the past literature (Sarwar, 2012; Zhu *et al.*, 2019; Bossman *et al.*, 2023). This index reflects the US stock market's anticipated short-term volatility, inferred from S&P 500 index option prices (Whaley, 2009). Several authors have explored the relationship between realized volatility and implied volatility (Bekaert and Hoerova, 2014; Liang *et al.*, 2020). In a recent study, Dutta and Das (2022) provided evidence of the positive impact of jumps in the VIX on the realized volatility of the S&P 500 index. According to Wang (2019), the larger VIX can better explain the international stock market volatility. However, VIX classically reflects significant economic changes, with only minimal impact from social media trends or shifts in investor perceptions (Zhu *et al.*, 2019; Dutta *et al.*, 2021). To this end, Manela and Moreira (2017) came up with a text-based implied volatility index (NVIX) utilizing the front-page articles of the Wall Street Journal. In extension, Baker *et al.* (2019) concocted a unique fear index based on 11 major U.S. newspapers, referred to as the Economic Market Volatility (EMV) index, that closely mirrors the behaviour of VIX and the realized volatility of returns on the S&P 500. Among the few studies related to EMV, Dutta *et al.* (2021) document evidence of the asymmetric influence of EMV on crude oil volatility over various states. Comparing the VIX and EMV, Zhu *et al.* (2019) reported that VIX has a larger in-sample influence on the stock market volatility than the EMV. Besides both Dutta *et al.* (2021) and Zhu *et al.* (2019) found EMV trackers to have improved predicting ability than the VIX. However, EMV is relatively a new index as very few studies were found in relation to EMV and stock volatility. Thus, which one is a better representative remains unclear. The hypothesis developed to investigate their impact on the volatility of the G20 stock indices is as follows:

H4*: VIX has a significant positive influence on the realized volatility of G20 stock indices.*

H5*: EMV has a significant positive influence on the realized volatility of G20 stock indices.*

In summary, most of the past studies have typically restricted their focus to a specific type of uncertainty about a particular class of assets with respect to a specific region or country and did not distinguish between short-term and long-term relationships. However, despite the geopolitical and economic importance that the G20 nations hold, the collective behaviour of G20 stock indices with respect to distinct uncertainty types remains understudied. Moreover, the majority of the above-mentioned studies rely on linear frameworks and overlook regime-switching behaviour or quantile-based differences, which are critical for capturing tail-risk events. Thus, by employing the advanced panel QARDL approach, this study proposes to examine the impact of distinct uncertainty types on the realized volatility of G20 stock indices.

Table no. 1 – Sample Description

No.	Region	Country	Global indice name	Symbol
1	America	USA	MSCI USA	MIUS00000PUS
2	America	Argentina	MSCI Argentina	MIAR00000PUS
3	America	Brazil	MSCI Brazil	MIBR00000PUS
4	America	Canada	MSCI Canada Net USD	MICA00000NUS
5	America	Canada	Dow Jones Canada USD	CADOWD
6	America	Mexico	MSCI Mexico	MIMX00000PUS
7	America	Mexico	Dow Jones Mexico USD	MXDOWD
8	Africa	South Africa	Dow Jones South Africa USD	ZADOWD
9	Africa	South Africa	MSCI South Africa NR USD	MIZA00000NUS
10	Asia-Pacific	Australia	Dow Jones Australia USD	AUDOWD
11	Asia-Pacific	Australia	MSCI Australia USD	MIAU00000NUS
12	Asia-Pacific	China	MSCI China Net USD	MICN00000NUS
13	Asia-Pacific	India	MSCI India Net USD	MIIN00000NUS
14	Asia-Pacific	Indonesia	MSCI Indonesia Net USD	MIID00000NUS
15	Asia-Pacific	Indonesia	Dow Jones Indonesia USD	IDDOWD
16	Asia-Pacific	Japan	MSCI Japan Net USD	MIJP00000NUS
17	Asia-Pacific	Japan	Dow Jones Japan USD	JPDOWD
18	Asia-Pacific	South Korea	MSCI Korea Net USD	MIKR00000NUS
19	Asia-Pacific	South Korea	Dow Jones South Korea USD	KRDOWD
20	Europe	France	Dow Jones France USD	FRDOWD
21	Europe	Germany	Dow Jones Germany USD	DEDOWD
22	Europe	Turkey	DJ Turkey Titans 20 TR USD	TR20DT
23	Europe	United Kingdom	Dow Jones UK USD	GBDOWD
24	Europe	Italy	Dow Jones Italy USD	ITDOWD
25	Europe	European Union	MSCI Europe ex UK Net USD	MIUG00000NUS

Source: the author.

3. DATA

Our sample includes 25 global indices representing 18 countries from the G20 nations. It is to be noted that the sample covers approximately 86 per cent of G20 composition, only Russia, Saudi Arabia and the African Union are not included in the sample due to the unavailability of global indices for the same as of 31st March 2024. The reason for choosing global indices in U.S. dollar denomination is to avoid the non-synchronisation between the different stock exchanges, and exchange rate variations. The researcher covers a 10-year tenure from 1st April 2015 to 31st March 2024 in this study. The selection of 2015 as the starting point for this study is driven by the significance of data and elements of global uncertainty. This timeframe marks the onset of major global events that heightened economic, geopolitical and financial unpredictability, such as: The China stock market crash (2015), the rise of trade tensions during the Trump era (from the 2016 onwards), the Brexit referendum and its aftermath (from 2016 onwards), the COVID-19 pandemic (2020) (which changed global volatility patterns) and the ongoing Russia Ukraine conflict (2022). These developments make the years following 2015 especially pertinent for examining how uncertainty affects stock market volatility in the globally interconnected G20 economies.

Following (Qin *et al.*, 2020; Zhang *et al.*, 2023), the sum of squared daily global indices return is used to calculate the realized volatility and then transformed to a monthly frequency on an average basis because the other variables considered in this study are of monthly frequency only. The researcher utilizes the monthly geopolitical risk index (comprising global geopolitical risk, its composites a. geopolitical threat, b. geopolitical actions), country-specific geopolitical risk and global economic uncertainty index as a stand-in for geopolitical and economic policy uncertainty. Following Zhu *et al.* (2019), the researcher uses CBOE-VIX also known as "the fear index" and the U.S overall economic market volatility index which is built on text counts of 11 major U.S. newspapers (containing at least one term each from E (including economic, economy, and financial), M (comprising "stock market", equity, equities, "Standard and Poors") and V (consisting volatility, volatile, uncertain, uncertainty, risk, risky) as a proxy for market sentiments concerning the stock market globally. The historical data for daily prices of the 25 global indices and monthly data for the CBOE-VIX index are collected from Investing.com whereas the data for the geopolitical risk index and economic policy uncertainty index, overall EMV are collected from the official website of Economic Policy Uncertainty (https://www.policyuncertainty.com).

The denotations used are as follows:

Y1 = realized volatility
LX1 = log Global geopolitical risk (GPR)
LX1H = log Country Specific geopolitical risk (GPRH)
LX1T = log Geopolitical Threat (GPT)
LX1A = log Geopolitical Action (GPA)
LX2 = log Overall Economic Market Volatility Index (EMV)
LX3 = log Implied Volatility (VIX)
LX4 = log Global Economic Policy Uncertainty (GEPU)

Table no. 2 exhibits the summary statistics related to the realized volatility and variables concerning various uncertainty representatives namely, global geopolitical risk (GPR) and its composites (i.e., geopolitical threat (GPT), geopolitical acts (GPA), country-specific geopolitical risk (GPRH), overall economic market volatility (EMV), CBOE- volatility index (VIX) and global economic policy uncertainty (GEPU) in this study. The mean values reported were 4.006 for Y1, 4.619 for the LX1, 4.747 for LX1T, 4.397 for LX1A, negative 1.798 for LX1H, 2.551 for LX2, 2.866 for LX3 and 5.360 for the LX4. Among the variables in consideration, Volatility, LX1, LX1T, LX1A and LX3 show positive skewness while LX1H, LX2 and LX4 suggest negative skewness. Meanwhile, only Y1, LX1, LX1T, and LX2 were found to be leptokurtic with a kurtosis value greater than 3. The highest standard deviation observed was for Y1 (46.969) and the lowest for LX1 (0.273). Nevertheless, the Jarque-Bera statistics reported for all the variables were substantially high and statistically noteworthy at a 1 per cent level. Thereby, suggesting that the series were not normally distributed.

Table no. 3 reports the results of correlation analysis, wherein Y1 has been found to have weak insignificant positive correlation with all explanatory variables under consideration. While LX1 has been recorded to have a strong and statistically significant correlation with LX1T (0.8718) and LX1A (0.8001), suggesting potential multicollinearity concerns. In addition, a moderate but statistically significant correlations were also observed between LX3 & LX4 (0.4728) and between LX1H & LX2 (0.3369), reflecting partial co-movements. By contrast, most other correlations were close to zero, implying weak association. The above findings are consistent with econometric literature emphasizing the importance of identifying significant pairwise correlations to avoid the multicollinearity issue (Gujarati and Porter, 2009; Wooldridge, 2016). Therefore, while the majority of variables do not exhibit problematic correlation, as none of the variables in consideration (except for LX1T and LX1A with respect to LX1) were found to have a correlation coefficient greater than 0.8. However, as a precaution (to address the potential multicollinearity concerns), the composites (GPT & GPA) and the global GPR are not considered in the same equation simultaneously.

Table no. 2 – Descriptive Statistics

	Y1	LX1	LX1T	LX1A	LX1H	LX2	LX3	LX4
Mean	4.006	4.619	4.747	4.397	-1.798	2.551	2.866	5.360
Median	1.067	4.627	4.727	4.402	-1.735	2.909	2.802	5.421
Maximum	1532.078	5.765	6.001	5.525	1.365	4.149	3.980	6.067
Minimum	-2.992	4.068	4.159	3.348	-5.508	-5.371	2.252	4.623
Std. Dev.	46.969	0.273	0.293	0.436	1.132	1.575	0.341	0.312
Skewness	25.626	0.943	1.211	0.289	-0.341	-3.252	0.640	-0.333
Kurtosis	715.337	5.128	5.918	2.919	2.949	12.329	3.059	2.534
Jarque-Bera	56488175	895.307	1592.31	37.776	51.927	14323.9	181.587	73.134
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	2658	2658	2658	2658	2658	2658	2658	2658

Source: the author.

Table no. 3 – Correlation Matrix

	Y1	LX1	LX1T	LX1A	LX1H	LX2	LX3	LX4
Y1	1							
LX1	0.0024 (0.9000)	1						
LX1T	0.0034 (0.8600)	0.8718[a] (0.0000)	1					
LX1A	0.0063 (0.7465)	0.8001[a] (0.0000)	0.4224[a] (0.0000)	1				
LX1H	0.0256 (0.1862)	0.1964[a] (0.0000)	0.2114[a] (0.0000)	0.1135[a] (0.0000)	1			
LX2	0.0249 (0.1980)	-0.0519[a] ((0.0074)	-0.0175 (0.3675)	-0.0744[a] (0.0001)	0.3396[a] (0.0000)	1		
LX3	0.0386[b] (0.0464)	-0.0921[a] (0.0000)	0.0950[a] (0.0000)	-0.2581[a] (0.0000)	-0.0085 (0.6626)	0.1273[a] (0.0000)	1	
LX4	0.0269 (0.1651)	-0.0371[c] (0.0557)	0.1902[a] (0.0000)	-0.2494[a] (0.0000)	0.0647[a] (0.0009)	0.1056[a] (0.0000)	0.4728[a] (0.0000)	1

Note: i) The value in the parentheses is the p-value. ii) The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.

Source: the author.

4. METHODOLOGY

The researcher has applied the panel quantile autoregressive distributive lag approach proposed by Cho *et al.* (2015) to investigate the influence of geopolitical risk, overall economic market volatility, CBOE-VIX volatility index, and economic policy uncertainty on the realized volatility of global indices representing G20 nations. The panel QARDL method is preferred in panel models for several reasons. This technique offers several advantages, as it allows the examination of the long-run and short-run effects of explanatory variables across different quantiles (Peng *et al.*, 2022). Additionally, panel QARDL effectively addresses the concerns of serial correlation, miss-specification and non-normality (Arshed *et al.*, 2022) while allowing for the exploration of heterogeneity across entities in the panel data (Du, 2023). Following Tiwari *et al.* (2024), the mathematical equation to apply the panel quantile ARDL framework is as follows:

$$\Delta Y1^{\theta}_{it} = \alpha_{0i} + \alpha_1 \Delta LX1^{\theta}_{it} + \alpha_2 \Delta LX1H^{\theta}_{it} + \alpha_3 \Delta LX2^{\theta}_{it} + \alpha_4 \Delta LX3^{\theta}_{it} + \alpha_5 \Delta LX4^{\theta}_{it} + \beta_1 LX1^{\theta}_{it-1} + \beta_2 LX1H^{\theta}_{it-1} + \beta_3 LX2^{\theta}_{it-1} + \beta_4 LX3^{\theta}_{it-1} + \beta_5 LX4^{\theta}_{it-1} + \varepsilon^{\theta}_{t} \tag{1}$$

$$\Delta Y1^{\theta}_{it} = \alpha_{0i} + \alpha_1 \Delta LX1T^{\theta}_{it} + \alpha_1 \Delta LX1A^{\theta}_{it} + \alpha_3 \Delta LX1H^{\theta}_{it} + \alpha_4 \Delta LX2^{\theta}_{it} + \alpha_5 \Delta LX3^{\theta}_{it} + \alpha_6 \Delta LX4^{\theta}_{it} + \beta_1 LX1T^{\theta}_{it-1} + \beta_1 LX1A^{\theta}_{it-1} + \beta_2 LX1H^{\theta}_{it-1} + \beta_3 LX2^{\theta}_{it-1} + \beta_4 LX3^{\theta}_{it-1} + \beta_5 LX4^{\theta}_{it-1} + \varepsilon^{\theta}_{t} \tag{2}$$

To not encounter any problem of multicollinearity, two separate equations are framed to examine to impact of overall GPR and decomposed elements of GPR (i.e., GPT and GPA). Equation (1) is framed to examine the impact of overall GPR, GPRH, EMV, VIX and GEPU on the realized volatility of G20 stock indices. With other specifications remaining the same, in equation (2) overall GPR is replaced with the decomposed elements. In the above equations, α_i represents the short-run coefficients while long-run coefficients are denoted with β_i and ε^{θ}_{t} denotes the convergence coefficient which should be negative and significant (the value for the same should fall in the range -1 and 0). It is to be noted that the convergence coefficient is the lagged residual of long-run estimates (Arshed *et al.*, 2022). Besides, θ in the above equations represents the quantile level. Following Cho *et al.* (2015), three quantiles (i.e., 0.25, 0.5, 0.75) are used wherein the lower quantile (0.25) represents bearish market conditions, median quantile (0.5) and upper quantile (0.75) represent the normal and bullish market respectively and Schwarz information criterion (SIC) is followed for lag selection criteria (Du, 2023).

All studies that involve time-dependent data in the panel are mandated to go through a series of assessment processes to realize the desired results (Bekele *et al.*, 2024). This involves a thorough examination of cross-sectional dependence, slope homogeneity, and stationarity tests, followed by an investigation of the co-integration relationship among the variables under consideration.

5. EMPIRICAL FINDINGS

The cross-section dependency (CSD) tests have been conducted for country-specific variables only because values for the global variables remain the same across all the cross-sections (Lee *et al.*, 2021). Table no. 4 exhibits the outcomes of cross-sectional dependency tests under which both Realized Volatility and GPRH were found to be statistically significant. Thereby suggesting the existence of cross-sectional dependency in the country-specific variables, which could be ascribed to the economic integration among G20 nations.

Table no. 4 – Cross-sectional Dependence Test

Variable	Breausch Pagan	CD Statistic	Decision
Y1	9454.021[a]	54.45 [a]	Cross-sectionally dependent
LX1H	4531.061 [a]	50.04 [a]	Cross-sectionally dependent

Note: The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.

Source: the author.

Table no. 5 exhibits the results of the slope homogeneity test conducted using the Hsiao method developed by Khouiled (2018). The results revealed that the null hypothesis of uniformity in the slope coefficients cannot be rejected for both panels in consideration.

Table no. 5 – Slope homogeneity test

Hypotheses	Panel A	Panel B
H1	0.685 (0.998)	0.592 (0.999)
H2	0.609 (0.999)	0.516 (1.000)
H3	1.089 (0.348)	1.075 (0.364)

Note: The value in parentheses depicts the p-value corresponding to each value.
Source: the author.

Following the evidence on cross-sectional dependence in the country-specific variables (see Table no. 4), in addition to the first-generation unit root test, the researcher also utilises a second-generation unit root test to ensure the robustness of the results. Table no. 6 presents the unit root test results for both the country-specific variables and global variables, revealing that none of the variables considered in this study were non-stationary or second-order stationary.

Table no. 6 – Panel unit root test

A. Country Specific Variables					
Variable	**Im-Pesaran**		**CIPS Test**		**Order**
	Constant	**Trend**	**Constant**	**Trend**	
Y1	-22.959 [a]	-21.828[a]	-8.134 [a]	-8.099 [a]	I(0)
LX1H	-12.001[a]	-12.660[a]	-3.858 [a]	-4.507[a]	I(0)
B. Global Variables					
Variable	**Im Pesaran**		**Levin-chu**		
	Constant	**Trend**	**Constant**	**Trend**	**Order**
LX1	-9.957[a]	-7.566 [a]	-7.491[a]	-7.619[a]	I(0)
LX1T	-11.292[a]	-10.255[a]	-7.281[a]	-6.282 [a]	I(0)
LX1A	-4.782[a] -34.556[a]	-0.951 -34.299[a]	-7.979[a] -26.034[a]	-10.391[a] -26.873 [a]	I(1)
LX2	-13.652[a]	-11.778[a]	-16.920[a]	-20.247[a]	I(0)
LX3	-7.439[a]	-4.805[a]	-7.661[a]	-7.509[a]	I(0)
LX4	-7.760[a]	-4.357[a]	-6.05[a]	-5.412[a]	I(0)

Note: The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.
Source: the author.

The Koa residual cointegration test results reveal that the null hypothesis of no cointegration among the variables cannot be accepted, as the reported test statistics exhibit statistical significance at a 1 per cent level (see Table no. 7). This indicates the presence of long-run relationships among the variables in both panels.

Table no. 8 presents the outcomes of the panel QARDL approach. In this study, the impact of three distinct categories of uncertainty namely, Geopolitical Uncertainty, Economic policy Uncertainty and Financial Uncertainty on the realized volatility of G20 stock indices over three different market conditions in the long run as well as short-run have been explored wherein (0.5) quantile represents normal market conditions and (0.25 & 0.75) represent bearish and bullish market conditions respectively. Aligning with the conclusions of Salisu *et al.* (2022) and Yang *et al.* (2021), the results report a positive association between the GPR and realized volatility of G20 stock indices. This suggests that an increase in overall GPR leads to a significant increase in the volatility of G20 stock indices in the long run, which could be attributed to the high level of integration among the panel entities (Salisu *et al.*, 2022). Besides, in terms of the magnitude of effect, GPR was least affecting during bearish regimes than bullish or normal market conditions. Though in the short run, GPR was found to have a positive but statistically insubstantial influence on the G20 stock indices volatility. On the other hand, an insignificant negative impact was recorded with respect to GPRH both in the long term as well as short period, suggesting that the realized volatility of G20 stock indices was not much affected by country-specific GPR (Bouras *et al.*, 2019). Thereby portentous that G20 stock indices can used to diversify against country-specific GPR. Moreover, among the decomposed elements of overall GPR (refer to equation 2), contrary to (Mitsas *et al.*, 2022) GPT was observed to have a significant negative association with the dependent variable over all three quantiles in the long period as well as the short period. Conversely, GPA was found to have a significant positive influence on the volatility of G20 stock indices, which was recorded to be more pronounced during the bullish period than normal and bear market conditions in the long run scenario. Meanwhile, in the short run, an insignificant impact of GPA was recorded (see Panel B of Table no. 8).

Table no. 7 – Cointegration test

Kao Residual Cointegration test	Statistic
Panel A	4.671[a]
Panel B	4.669[a]

Note: The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.
Source: the author.

In line with Dutta *et al.* (2021), the impact of the news-based fear index (EMV) was observed to vary depending on different market conditions. As shown in Table no. 8, an increment in the EMV leads to a statistically significant rise in realized volatility of the G20 stock indices during a bearish market, whereas an insignificant positive and a significant negative impact has been recorded over normal and bullish market conditions, respectively. Furthermore, consistent with the findings of Dutta and Das (2022), the options market-based fear index (VIX) was revealed to have a significant positive influence on the realized volatility of G20 stock indices over all three market conditions in both the long run and short run. Another observation could be made from these results, the long-run impact of financial uncertainty happens to be more pronounced than the short-run impact (see Table no. 8).

Regarding the uncertainty associated with global economic policy, G20 stock indices were found not to be affected by the GEPU in the long term across all three market conditions. In contrast, a significant positive relationship with the realized volatility of G20 stock indices was revealed in the short run over all three quantiles. Thereby indicating that an increment in GEPU in the short run would lead to an increase in the realized volatility of G20 stock indices. The insignificant influence in the long period was quite within the expectations of the researcher as the surprise element around the policy announcement is likely to disappear with time (Bernanke, 1983; Pástor and Veronesi, 2012). The above insignificance can also on account of the market's tendency to absorb the uncertainty shocks, adapt to new realities and return to fundamentals, unless they escalate into long-term crises (Bloom, 2009).

Additionally, the convergence coefficient over all quantiles was found to be negative and significant, which reconfirms the results of the cointegration test (see Table no. 7). Hence, there exists a long-run relationship among the variables in both panels in consideration. Besides, any convergence to the long-run equilibrium gets corrected over a month. Furthermore, the results of Panel B for other variables reconfirm the findings of Panel A, as no significant change in the findings related to GPRH, EMV, VIX, or GEPU was recorded.

Table no. 8 – Panel QARDL estimates

Variable	Coefficient	t-Stat	Coefficient	t-Stat	Coefficient	t-Stat
Quantiles	0.25		0.5		0.75	
Panel A						
Long Run Estimates						
LX1	0.165[b]	2.420	0.327[a]	2.942	0.301[b]	2.058
LX1H	-0.001	-0.073	-0.036[c]	-1.888	-0.033	-1.070
LX2	0.115[a]	8.398	0.057	1.547	-0.055[b]	-2.319
LX3	0.780[a]	12.352	1.578[a]	16.772	2.885[a]	18.882
LX4	-0.030	-0.454	-0.092	-1.205	0.069	0.509
C	-2.479[a]	-5.184	-4.537[a]	-6.772	-7.829[a]	-9.905
Short Run Estimates						
Δ(LX1)	0.021	0.257	0.059	0.597	0.068	0.799
Δ (LX1H)	-0.062[c]	-1.874	-0.063[c]	-1.670	-0.051	-1.212
Δ (LX2)	0.284[a]	3.936	0.291[a]	3.557	0.322[b]	2.298
Δ (LX3)	1.101[a]	12.207	1.080[a]	10.002	1.104[a]	6.202
Δ (LX4)	0.508[a]	4.636	0.601[a]	4.562	0.679[a]	6.144
ECT1(-1)	-0.999[a]	-10263.780	-0.999[a]	-7636.063	-0.903[a]	-12.028
Pseudo R-squared	0.639		0.399		0.144	
Adjusted R-squared	0.638		0.398		0.143	
Panel B						
Long Run Estimates						
LX1T	-0.161[b]	-2.309	-0.244[b]	-2.520	-0.665[a]	-3.689
LX1A	0.245[a]	5.934	0.416[a]	7.119	0.739[a]	7.212
LX1H	-0.010	-0.710	-0.022	-1.112	0.002	0.088
LX2	0.116[a]	8.346	0.052	1.440	-0.079[a]	-3.280
LX3	0.833[a]	13.011	1.617[a]	17.969	2.932[a]	16.840
LX4	0.082	1.257	0.033	0.411	0.196	1.248
C	-2.784[a]	-6.176	-4.455[a]	-7.189	-7.230[a]	-8.084
Short Run Estimates						
Δ (LX1T)	-0.252[a]	-2.804	-0.236[b]	-2.230	-0.148[c]	-1.647
Δ (LX1A)	0.081	1.415	0.105[a]	1.527	0.093	1.617
Δ (LX1H)	-0.035	-1.041	-0.035	-0.883	-0.039	-1.216
Δ (LX2)	0.394[a]	6.167	0.396[a]	5.179	0.416[a]	6.199
Δ (LX3)	0.871[a]	9.796	0.878[a]	8.380	0.925[a]	9.494
Δ (LX4)	0.910[a]	7.006	0.964[a]	6.362	1.059[a]	7.727
ECT2(-1)	-0.999[a]	-9806.418	-0.999[a]	-7426.563	-0.924[a]	-290.405
Pseudo R-squared	0.641		0.401		0.146	
Adjusted R-squared	0.640		0.399		0.144	

Note: The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.

Source: the author.

Diagnostic

Table no. 9 details the outcomes of the Variance Inflation Factor (VIF) test, revealing that each variable has a VIF score under 5, thereby indicating that the previously mentioned QARDL estimates are free from multicollinearity concerns (Gujarati and Porter, 2009; Tiwari *et al.*, 2024). Furthermore, in line with the methodologies of Du (2023) and Razzaq *et al.* (2021), the Wald test has been utilized to assess the dependency of long-term and short-term estimates of Panel QARDL. Table no. 10 reveals the results of the Wald test, wherein the null hypothesis of all the long-run parameters (except for GPRH, EMV and GEPU) stands rejected in both panels, as these variables were found to be statistically significant at a 1 per cent level. For short-run dynamics, all the parameters (except for GPR & GPRH) were highly significant, indicating that the significant parameters are nonlinear and symmetric (Du, 2023). Additionally, the error correction terms in both panels prove to be significant at a 1 per cent level. Consequently, the null hypothesis asserting parameter constancy around the quantile grid has been rejected (Razzaq *et al.*, 2021).

Table no. 9 – Variance Inflation Factor (VIF) test

Variance Inflation Factor Test (VIF)					
Panel A			**Panel B**		
Variable	**Coefficient Variance**	**Uncentered VIF**	**Variable**	**Coefficient Variance**	**Uncentered VIF**
D(LX1)	0.0098	1.2445	**D(LX1T)**	0.0104	1.4196
D(LX1H)	0.0014	1.2813	**D(LX1A)**	0.0043	1.2039
D(LX2)	0.0067	1.1422	**D(LX1H)**	0.0014	1.3031
D(LX3)	0.0117	1.0739	**D(LX2)**	0.0056	1.0594
D(LX4)	0.0174	1.0992	**D(LX3)**	0.0091	1.0304
ECT1(-1)	0.0000	1.0429	**D(LX4)**	0.0170	1.0717
			ECT2(-1)	0.0000	1.0382

Source: the author.

Table no. 10 – Wald Test

Panel A			**Panel B**		
Variable	**F-Statistic**	**P-value**	**Variable**	**F-Statistic**	**P-value**
LX1	8.6580[a]	0.0033	**LX1T**	6.3510[a]	0.0118
LX1H	3.5661	0.0591	**LX1A**	50.6859[a]	0.0000
LX2	2.3933	0.1220	**LX1H**	1.2375	0.2661
LX3	281.3069	0.0000	**LX2**	2.0743	0.1499
LX4	1.4522	0.2283	**LX3**	322.8727[a]	0.0000
C	45.8638[a]	0.0000	**LX4**	0.1691	0.6809
D(LX1)	0.3564	0.5506	**C**	51.6885[a]	0.0000
D(LX1H)	2.7878	0.0951	**D(LX1T)**	6.7574[a]	0.0094
D(LX2)	12.6536[a]	0.0004	**D(LX1A)**	17.6987[a]	0.0000
D(LX3)	100.0305[a]	0.0000	**D(LX1H)**	0.7274	0.3938
D(LX4)	20.8111[a]	0.0000	**D(LX2)**	17.9384[a]	0.0000
ECT1(-1)	58309454.0000[a]	0.0000	**D(LX3)**	131.7268[a]	0.0000
			D(LX4)	37.6352[a]	0.0000
			ECT2(-1)	53625662.0000[a]	0.0000

Source: the author.

Robustness Check

Following the evidence on long-run homogeneity in both the panels in consideration (see Table no. 5), the researcher uses PMG ARDL to check the robustness of panel QARDL estimates (Tiwari *et al.*, 2024). Coinciding with the quantile results, Table no. 9 shows that (except for GPRH, GPT and GEPU) all the variables were found to have a significant positive effect on the realized volatility of G20 stock indices in the long run. Nevertheless, in harmony with the short-run QARDL results, realized volatility of the G20 stock indices was found to be not affected by GPR, GPA or the GPRH alongside signs of resilience against GPT. Moreover, EMV and VIX had a significant positive influence in the short run. While GEPU was also recorded to have a positive but insignificant impact in the short run. Nevertheless, the convergence coefficient recorded in the PMG ARDL was also found to be negative and significant when considered collectively or cross-sectionally for the majority. The presence of a long-term relationship among variables in both panels was thereby reaffirmed. Moreover, as per the short run PMG results, most G20 markets were found resilient to immediate uncertainty shocks wherein certain emerging markets (India, South Africa & Turkey) and globally integrated markets (China, Japan & EU) show statistically significant short run-exposure, particularly to country-specific geopolitical risk, geopolitical threats and global policy uncertainty – see Table no. A1 no. A2, provided in Annexes. Thereby suggesting the short-run adjustment paths are market specific, can be ascribed to the degree of market openness & exposure to financial flows. Another interesting observation to be noted with respect to the considered countries, for which two indices have been used (particularly for Australia and South Africa), wherein the MSCI South Africa NR USD & MSCI Australia USD index have been found to be significantly affected by all types of uncertainty in consideration, whereas the Dow Jones South Africa USD & Dow Jones Australia USD were found to have showcase a resilience, which can be attributed to their structural differences (including their construction methodology & investor base). While the PMG estimator provides efficient long run estimates under the assumption of slope homogeneity, it has its own limitations as it does not explicitly control for CSD in residuals. Thus, future studies can use more robust methods such as the common correlated effects mean group method to account for the same.

Furthermore, Pairwise Panel Causality Test has been used to empirically check the interconnection and causal association between different types of uncertainty considered in this study (Gujarati and Porter, 2009). As shown in Table no. 12, neither LX1 nor the LX1H was found to have a causal relation with Y1, thereby indicating that neither global nor country-specific geopolitical risks directly Granger-cause realised volatility, which also corroborates our main findings. Meanwhile, there exists unidirectional causality exists from LX2 (EMV) and LX4 (GEPU) to Y2 (realized volatility) but not the reverse, confirming their predictive power. Based on above findings, two inferences can made, first that EMV can be used to predict realized volatility, second that the GEPU strongly drives realized volatility. While in the case of LX3, it was reported to be the other way around, suggesting that realized volatility may help explain the implied volatility. On the other hand, LX1 was found to have a strong bidirectional causal relation with LX1H, LX2 and LX4. In addition to GPR, LX4 also has a bidirectional relation with LX1H, LX2 and LX3. Moreover, LX3 also granger causes LX2, suggesting that VIX dominates EMV. While the LX1H was not found to have any causal relationship with any other variable in consideration except for LX1 and LX4, suggesting that GPRH, GPR and GEPU of G20 nations are dynamically linked. It is interesting to note that although geopolitical risks were not revealed to directly Granger-cause realized volatility but they were found to interact significantly with VIX, EMV and GEPU, which in turn do drive realized volatility. Therefore, the evidence on bidirectional causal relations across distinct uncertainty types in consideration suggests that the occurrence or rise in one uncertainty type can further lead to another type of uncertainty.

Table no. 11 – PMG ARDL Results

Panel A **Variable**	**Coefficient**	**t-Stat**	**Prob.***	**Panel B** **Variable**	**Coefficient**	**t-Stat**	**Prob.***
	Long Run Equation				Long Run Equation		
LX1	0.485[c]	1.872	0.061	**LX1T**	-1.321[a]	-4.613	0.000
LX1H	0.130	0.909	0.364	**LX1A**	1.047[a]	6.666	0.000
LX2	1.549[a]	4.807	0.000	**LX1H**	0.520[a]	3.581	0.000
LX3	2.014[a]	7.158	0.000	**LX2**	1.588[a]	5.270	0.000
LX4	-1.181[a]	-4.895	0.000	**LX3**	2.383[a]	8.867	0.000
				LX4	-0.829[a]	-3.585	0.000
	Short Run Equation				Short Run Equation		
COINTEQ01	-0.752[a]	-13.484	0.000	**COINTEQ01**	-0.765[a]	-13.215	0.000
Δ (LX1)	-1.234	-0.981	0.327	**Δ (LX1T)**	0.235	0.173	0.863
Δ (LX1H)	1.131	0.962	0.336	**Δ (LX1A)**	-0.265	-1.087	0.277
Δ (LX2)	5.368[a]	3.694	0.000	**Δ (LX1H)**	0.754	0.658	0.510
Δ (LX3)	4.015[b]	2.085	0.037	**Δ (LX2)**	5.321[a]	3.651	0.000
Δ (LX4)	1.403	1.200	0.230	**Δ (LX3)**	3.990[b]	2.061	0.039
C	-0.785	-0.987	0.324	**Δ (LX4)**	1.227	1.046	0.296
				C	0.323	0.398	0.691

Note: The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.

Source: the author.

Table no. 12 – Pairwise Granger Causality Tests

No.	**Null Hypothesis:**	**F-Statistic**	**Prob.**	**Result**
1.	LX1 does not Granger Cause Y2	0.16116	0.85120	No Relationship
	Y2 does not Granger Cause LX1	0.18784	0.82880	
2.	LX1H does not Granger Cause Y2	0.89952	0.40690	No Relationship
	Y2 does not Granger Cause LX1H	0.10068	0.90420	
3.	LX2 does not Granger Cause Y2	2.55381[c]	0.07800	Unidirectional
	Y2 does not Granger Cause LX2	1.35101	0.25920	
4.	LX3 does not Granger Cause Y2	0.29855	0.74190	Unidirectional
	Y2 does not Granger Cause LX3	3.17161[b]	0.04210	
5.	LX4 does not Granger Cause Y2	7.98455[a]	0.00030	Unidirectional
	Y2 does not Granger Cause LX4	0.50680	0.60250	
6.	LX1H does not Granger Cause LX1	2.98062[b]	0.05090	Bidirectional
	LX1 does not Granger Cause LX1H	5.35907[a]	0.00480	
7.	LX2 does not Granger Cause LX1	0.25637	0.77390	Unidirectional
	LX1 does not Granger Cause LX2	6.71677[a]	0.00120	
8.	LX3 does not Granger Cause LX1	9.40174[a]	0.00009	Bidirectional
	LX1 does not Granger Cause LX3	3.17372[b]	0.04200	
9.	LX4 does not Granger Cause LX1	8.59119[a]	0.00020	Bidirectional
	LX1 does not Granger Cause LX4	12.3614[a]	0.00001	
10.	LX2 does not Granger Cause LX1H	9.29028[a]	0.00010	Bidirectional
	LX1H does not Granger Cause LX2	5.26892[a]	0.00520	
11.	LX3 does not Granger Cause LX1H	0.97414	0.37770	No Relationship
	LX1H does not Granger Cause LX3	0.23763	0.78850	
12.	LX4 does not Granger Cause LX1H	12.4223[a]	0.00000	Bidirectional

No.	Null Hypothesis:	F-Statistic	Prob.	Result
	LX1H does not Granger Cause LX4	5.14411[a]	0.00590	
13.	LX3 does not Granger Cause LX2	99.6292[a]	0.00000	Unidirectional
	LX2 does not Granger Cause LX3	2.06929	0.12650	
14.	LX4 does not Granger Cause LX2	16.7831[a]	0.00000	Bidirectional
	LX2 does not Granger Cause LX4	3.73630[b]	0.02400	
15.	LX4 does not Granger Cause LX3	7.20415[a]	0.00080	Bidirectional
	LX3 does not Granger Cause LX4	314.675[a]	0.00000	

Note: The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.

Source: the author.

6. CONCLUSION

Considering the inclined diversification benefit with the global indices, this study provides evidence of how the realized volatility of G20 stock indices responds to distinct types of uncertainty in a highly interconnected world. The result revealed that the realized volatility of G20 stock indices tends to significantly rise with an increase in overall GPR across all three market conditions in the long run, whereas no substantial impact has been observed in the short run over all three quantiles. The lack of significant response concerning GPR in the short run indicates the resilient nature of G20 stock indices to the risks associated with immediate geopolitical events, while the potential long-term impacts cannot be ignored**.** Besides, G20 stock indices were not found to be affected by GPRH. Among the decomposed elements, the realized volatility of G20 stock indices were found to be positively affected by GPA while negatively affected by the GPT. Additionally, the positive impact of GPR and GPA does not prevail in the short run. This signifies their utility as a diversifier and a hedging tool against geopolitical risk, irrespective of their type in the short course during all three market conditions. Conversely, GEPU was reported to have a positive impact only during the short run, which could be attributed to the high degree of uncertainty and surprise element over the short run. Therefore, suggesting that policy surprises (including tariffs, budget shocks and policy shifts) can induce short-lived surges, flight or retrenchment and by paying proper attention to likely policy announcements, investors can capitalize on short-term opportunities. Meanwhile, VIX has been found to have a more pronounced effect on the realized volatility of G20 stock indices than the EMV as well as the other types of uncertainties in consideration. Being the most influential, VIX spikes can increase the risk of high synchronous outflow. Besides, large institutions holding overlapping positions across G20 equities (i.e., common investor effect) have the potential to cause spillover of geopolitical shocks and amplify the hot money flows, which could be further explored in future studies. Thus, policymakers should monitor high-frequency capital flow data and common ownership to gauge propagation risk. Therefore, it can be inferred that the realized volatility of G20 stock indices responds differently to distinct uncertainties across different market conditions in terms of direction as well as magnitude. Moreover, the findings of the pairwise Granger causality test support the idea that one uncertainty type can act as stimuli for another uncertainty type and a threat to global stability. Hence, policymakers are advised to strengthen their endeavours to promote financial stability and interconnectedness to prevent the worsening of international risk diversification.

Scope for Future Research

There is currently no definitive measure for uncertainty, as this study relies on various proxies. Consequently, this study may not be entirely free from limitations stemming from these proxies. In addition, the outcomes of this study apply solely to the realized volatility of G20 stock indices on a global scale. To differentiate the effects among these nations, it is possible to carry out individual analysis at the country level to examine their disparate influence across the panel of G20 countries. Moreover, amidst rising uncertainty around the world, future studies can be conducted about shifting powers around the world and its likely impact on different financial markets. Furthermore, the interconnection between distinct types of uncertainty or any other uncertainty types can be explored further.

ORCID

Khushbu Dhariwal https://orcid.org/0009-0003-4645-6329

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ANNEXES

Table no. A1 (a) – PMG Short run cross-sectional results (Panel A)

1. USA (MSCI USA)				**14.Indonesia (MSCI Indonesia Net USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.824[a]	-97.314	0.000	**COINTEQ01**	-0.775[a]	-81.586	0.000
D(LX1)	0.425	0.240	0.826	**D(LX1)**	0.675	0.176	0.872
D(LX1H)	0.005	0.045	0.967	**D(LX1H)**	-0.343	-2.054	0.132
D(LX2)	2.808	2.359	0.100	**D(LX2)**	3.880	1.398	0.257
D(LX3)	0.564	0.422	0.701	**D(LX3)**	0.510	0.184	0.866
D(LX4)	2.879	1.200	0.316	**D(LX4)**	2.920	0.514	0.643
C	-3.774	-1.356	0.268	**C**	-2.907	-1.102	0.351
2.Argentina (MSCI Argentina)				**15. Indonesia (Dow Jones Indonesia USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.901[a]	-102.617	0.000	**COINTEQ01**	-0.768[a]	-81.176	0.000
D(LX1)	-6.240	-0.149	0.891	**D(LX1)**	0.641	0.195	0.858
D(LX1H)	8.281	0.963	0.407	**D(LX1H)**	-0.307	-2.144	0.121
D(LX2)	9.269	0.369	0.737	**D(LX2)**	3.625	1.526	0.225
D(LX3)	-0.019	-0.001	1.000	**D(LX3)**	0.496	0.207	0.849
D(LX4)	9.993	0.195	0.858	**D(LX4)**	2.546	0.523	0.637
C	0.712	0.177	0.871	**C**	-3.049	-1.180	0.323
3. Brazil (MSCI Brazil)				**16. Japan (MSCI Japan Net USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.843[a]	-97.487	0.000	**COINTEQ01**	-0.754[a]	-93.171	0.000
D(LX1)	0.281	0.022	0.984	**D(LX1)**	0.018	0.087	0.936
D(LX1H)	0.601	0.765	0.500	**D(LX1H)**	-0.172	-4.787	0.017
D(LX2)	5.666	0.655	0.559	**D(LX2)**	0.095	0.653	0.560
D(LX3)	0.896	0.096	0.930	**D(LX3)**	0.001	0.006	0.996
D(LX4)	9.529	0.533	0.631	**D(LX4)**	2.077	8.286	0.004
C	-1.277	-0.400	0.716	**C**	-3.672	-1.777	0.174
4. Canada (MSCI Canada Net USD)				**17.Japan (Dow Jones Japan USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.890[a]	-101.637	0.000	**COINTEQ01**	-0.777[a]	-94.086	0.000
D(LX1)	0.796	0.185	0.865	**D(LX1)**	0.043	0.223	0.838
D(LX1H)	-0.308	-0.316	0.773	**D(LX1H)**	-0.164[a]	-4.796	0.017
D(LX2)	3.392	1.570	0.214	**D(LX2)**	0.100	0.709	0.530
D(LX3)	0.318	0.131	0.904	**D(LX3)**	-0.006	-0.033	0.976
D(LX4)	3.904	0.870	0.449	**D(LX4)**	1.986[a]	8.416	0.004
C	-4.179	-1.415	0.252	**C**	-3.815	-1.750	0.178
5. Canada (Dow Jones Canada USD)				**18. South Korea (MSCI Korea Net USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.892[a]	-101.848	0.000	**COINTEQ01**	-0.865[a]	-98.255	0.000
D(LX1)	0.774	0.195	0.858	**D(LX1)**	0.339	0.259	0.812
D(LX1H)	-0.330	-0.366	0.739	**D(LX1H)**	0.018	0.063	0.953
D(LX2)	3.212	1.609	0.206	**D(LX2)**	1.950	2.336	0.102
D(LX3)	0.280	0.125	0.909	**D(LX3)**	0.055	0.058	0.958
D(LX4)	3.760	0.907	0.431	**D(LX4)**	2.290	1.306	0.283
C	-4.209	-1.423	0.250	**C**	-3.505	-1.327	0.277
6.Mexico (MSCI Mexico)				**19.South Korea (Dow Jones South Korea USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.892[a]	-101.848	0.000	**COINTEQ01**	-0.998[a]	-111.445	0.000
D(LX1)	0.774	0.195	0.858	**D(LX1)**	-26.014	-0.026	0.981
D(LX1H)	-0.330	-0.366	0.739	**D(LX1H)**	-11.759	-0.054	0.960
D(LX2)	3.212	1.609	0.206	**D(LX2)**	16.919	0.027	0.980
D(LX3)	0.280	0.125	0.909	**D(LX3)**	43.236	0.064	0.953
D(LX4)	3.760	0.907	0.431	**D(LX4)**	5.232	0.004	0.997
C	-4.209	-1.423	0.250	**C**	4.786	0.113	0.917

7.Mexico (Dow Jones Mexico USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.576[a]	-95.149	0.000
D(LX1)	-1.325	-0.932	0.420
D(LX1H)	0.530	3.074	0.054
D(LX2)	2.673	2.904	0.062
D(LX3)	1.345	1.287	0.289
D(LX4)	3.902	1.910	0.152
C	-2.229	-1.688	0.190

8.South Africa (Dow Jones South Africa USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.241[b]	-5.209	0.014
D(LX1)	0.838	0.193	0.859
D(LX1H)	0.875[c]	2.527	0.086
D(LX2)	-1.159	-2.033	0.135
D(LX3)	3.152	0.971	0.403
D(LX4)	7.637	1.811	0.168
C	1.979	0.846	0.460

9.South Africa (MSCI South Africa NR USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.059[a]	-38.196	0.000
D(LX1)	-0.197[b]	-3.597	0.037
D(LX1H)	-0.091[a]	-21.136	0.000
D(LX2)	-0.120[a]	-15.421	0.001
D(LX3)	-0.850[a]	-20.671	0.000
D(LX4)	0.494[a]	9.147	0.003
C	0.197[b]	5.488	0.012

10. Australia (Dow Jones Australia USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-1.002[a]	-106.006	0.000
D(LX1)	-1.119	0.000	1.000
D(LX1H)	5.353	0.016	0.989
D(LX2)	15.972	0.009	0.994
D(LX3)	14.863	0.007	0.995
D(LX4)	-12.461	-0.003	0.998
C	6.365	0.055	0.960

11. Australia (MSCI Australia USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.169[a]	-118.557	0.000
D(LX1)	-0.108	-3.026	0.057
D(LX1H)	-0.107[a]	-26.757	0.000
D(LX2)	-0.238[a]	-10.920	0.002
D(LX3)	-1.066[a]	-44.997	0.000
D(LX4)	0.222[b]	4.934	0.016
C	-0.990[a]	-6.393	0.008

12.China (MSCI China Net USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.781[a]	-92.424	0.000
D(LX1)	0.587	0.490	0.658
D(LX1H)	0.048	0.115	0.915
D(LX2)	0.352	0.664	0.554
D(LX3)	-1.717[c]	-3.048	0.056
D(LX4)	3.936[b]	3.619	0.036
C	-3.203	-1.548	0.219

13.India (MSCI India Net USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.781[a]	-94.352	0.000

20.France (Dow Jones France USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-1.006[a]	-105.792	0.000
D(LX1)	7.887	0.014	0.989
D(LX1H)	-4.511	-0.026	0.981
D(LX2)	5.938	0.027	0.980
D(LX3)	4.724	0.020	0.985
D(LX4)	-1.479	-0.003	0.998
C	-0.881	-0.054	0.960

21.Germany (Dow Jones Germany USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-1.003[a]	-106.109	0.000
D(LX1)	7.349	0.002	0.999
D(LX1H)	-1.406	-0.001	0.999
D(LX2)	17.951	0.009	0.993
D(LX3)	16.842	0.008	0.994
D(LX4)	-9.261	-0.002	0.998
C	6.714	0.054	0.960

22.Turkey (DJ Turkey Titans 20 TR USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.227[a]	-59.545	0.000
D(LX1)	-0.432	-4.832	0.017
D(LX1H)	-0.110	-7.738	0.005
D(LX2)	-0.448	-7.959	0.004
D(LX3)	-1.008	-16.127	0.001
D(LX4)	0.048	0.406	0.712
C	-1.396	-4.532	0.020

23.United Kingdom (Dow Jones UK USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-1.002[a]	-106.268	0.000
D(LX1)	-9.256	-0.012	0.991
D(LX1H)	9.975	0.023	0.983
D(LX2)	8.337	0.039	0.971
D(LX3)	4.280	0.018	0.987
D(LX4)	-0.527	-0.001	0.999
C	-1.124	-0.071	0.948

24.Italy (Dow Jones Italy USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.999[a]	-106.044	0.000
D(LX1)	-7.885	-0.002	0.999
D(LX1H)	22.392	0.028	0.980
D(LX2)	28.643	0.009	0.993
D(LX3)	13.876	0.004	0.997
D(LX4)	-14.726	-0.002	0.998
C	10.633	0.052	0.962

25.European Union (MSCI Europe ex UK Net USD)

Variable	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.862[a]	-113.784	0.000
D(LX1)	0.344	0.380	0.729
D(LX1H)	0.118	0.361	0.742
D(LX2)	1.436[b]	3.474	0.040
D(LX3)	-0.502	-1.125	0.342
D(LX4)	3.160[b]	4.280	0.023
C	-4.097	-1.488	0.233

D(LX1)	0.911	0.637	0.569
D(LX1H)	-0.866[b]	-3.232	0.048
D(LX2)	1.630	1.660	0.196
D(LX3)	0.534	0.496	0.654
D(LX4)	2.765	1.387	0.260
C	-3.618	-1.575	0.213

Note: The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.
Source: the author.

Table no. A2 – PMG Short-run cross-sectional results (Panel B)

1. USA (MSCI USA)				**14.Indonesia (MSCI Indonesia Net USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.859[a]	-101.385	0.000	**COINTEQ01**	-0.785[a]	-81.992	0.000
D(LX1T)	0.801	0.555	0.618	**D(LX1T)**	0.730	0.171	0.875
D(LX1A)	0.296	0.296	0.787	**D(LX1A)**	0.478	0.196	0.857
D(LX1H)	-0.196	-1.907	0.153	**D(LX1H)**	-0.451	-2.357	0.100
D(LX2)	2.789[c]	2.465	0.091	**D(LX2)**	3.793	1.382	0.261
D(LX3)	0.322	0.250	0.819	**D(LX3)**	0.545	0.199	0.855
D(LX4)	2.613	1.144	0.336	**D(LX4)**	2.832	0.504	0.649
C	-2.219	-0.936	0.418	**C**	-1.225	-0.569	0.609
2.Argentina (MSCI Argentina)				**15.Indonesia (Dow Jones Indonesia USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.893[a]	-101.267	0.000	**COINTEQ01**	-0.778[a]	-81.625	0.000
D(LX1T)	-4.125	-0.133	0.903	**D(LX1T)**	0.722	0.198	0.856
D(LX1A)	-0.148	-0.004	0.997	**D(LX1A)**	0.465	0.222	0.839
D(LX1H)	7.243	0.599	0.592	**D(LX1H)**	-0.417[c]	-2.532	0.085
D(LX2)	9.574	0.379	0.730	**D(LX2)**	3.542	1.509	0.228
D(LX3)	0.121	0.005	0.997	**D(LX3)**	0.528	0.224	0.837
D(LX4)	9.804	0.189	0.862	**D(LX4)**	2.459	0.512	0.644
C	1.721	0.491	0.657	**C**	-1.388	-0.660	0.557
3.Brazil (MSCI Brazil)				**16.Japan (MSCI Japan Net USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.859[a]	-98.249	0.000	**COINTEQ01**	-0.842[a]	-102.464	0.000
D(LX1T)	0.480	0.043	0.969	**D(LX1T)**	0.625[b]	3.445	0.041
D(LX1A)	0.608	0.082	0.940	**D(LX1A)**	-0.167	-1.620	0.204
D(LX1H)	0.435	0.563	0.613	**D(LX1H)**	-0.346[a]	-9.438	0.003
D(LX2)	5.642	0.667	0.553	**D(LX2)**	-0.028	-0.205	0.851
D(LX3)	0.836	0.091	0.933	**D(LX3)**	-0.248	-1.405	0.255
D(LX4)	9.411	0.535	0.630	**D(LX4)**	1.887[a]	8.172	0.004
C	0.432	0.156	0.886	**C**	-2.919	-1.489	0.233
4.Canada (MSCI Canada Net USD)				**17.Japan (Dow Jones Japan USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.914[a]	-104.548	0.000	**COINTEQ01**	-0.860[a]	-104.057	0.000
D(LX1T)	1.632	0.490	0.658	**D(LX1T)**	0.650[b]	3.769	0.033
D(LX1A)	-0.127	-0.068	0.950	**D(LX1A)**	-0.158	-1.617	0.204
D(LX1H)	-0.581	-0.621	0.579	**D(LX1H)**	-0.339[a]	-9.695	0.002
D(LX2)	3.272	1.560	0.217	**D(LX2)**	-0.018	-0.136	0.901
D(LX3)	0.240	0.102	0.925	**D(LX3)**	-0.241	-1.428	0.249
D(LX4)	3.772	0.869	0.449	**D(LX4)**	1.801[a]	8.313	0.004
C	-2.962	-1.212	0.312	**C**	-3.014	-1.481	0.235
5.Canada (Dow Jones Canada USD)				**18.South Korea (MSCI Korea Net USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.917[a]	-104.900	0.000	**COINTEQ01**	-0.899[a]	-101.818	0.000
D(LX1T)	1.596	0.519	0.640	**D(LX1T)**	0.913	0.740	0.513
D(LX1A)	-0.129	-0.075	0.945	**D(LX1A)**	0.094	0.131	0.904
D(LX1H)	-0.597	-0.692	0.539	**D(LX1H)**	-0.223	-0.729	0.519

D(LX2)	3.091	1.597	0.209	**D(LX2)**	1.930^{c}	2.432	0.093
D(LX3)	0.199	0.091	0.933	**D(LX3)**	-0.091	-0.098	0.928
D(LX4)	3.628	0.906	0.432	**D(LX4)**	2.174	1.296	0.286
C	-2.994	-1.222	0.309	**C**	-2.479	-1.115	0.346
6.Mexico (MSCI Mexico)				**19.South Korea (Dow Jones South Korea USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.846^{a}	-108.103	0.000	**COINTEQ01**	-0.996^{a}	-111.194	0.000
D(LX1T)	0.756	0.589	0.597	**D(LX1T)**	-25.902	-0.026	0.981
D(LX1A)	-0.301	-0.356	0.745	**D(LX1A)**	1.067	0.002	0.999
D(LX1H)	0.323	1.802	0.169	**D(LX1H)**	-10.203	-0.043	0.968
D(LX2)	2.184	2.238	0.111	**D(LX2)**	16.994	0.027	0.980
D(LX3)	-0.519	-0.485	0.661	**D(LX3)**	43.273	0.064	0.953
D(LX4)	4.147	2.033	0.135	**D(LX4)**	4.372	0.003	0.998
C	-1.756	-0.818	0.473	**C**	6.011	0.145	0.894
7.Mexico (Dow Jones Mexico USD)				**20.France (Dow Jones France USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.600^{a}	-93.271	0.000	**COINTEQ01**	-1.008^{a}	-105.824	0.000
D(LX1T)	-0.875	-0.698	0.536	**D(LX1T)**	9.247	0.021	0.984
D(LX1A)	0.110	0.133	0.903	**D(LX1A)**	0.652	0.003	0.998
D(LX1H)	0.401	2.327	0.102	**D(LX1H)**	-5.718	-0.032	0.976
D(LX2)	2.671^{c}	2.942	0.060	**D(LX2)**	5.620	0.025	0.981
D(LX3)	1.317	1.275	0.292	**D(LX3)**	4.695	0.020	0.985
D(LX4)	3.803	1.886	0.156	**D(LX4)**	-2.173	-0.005	0.997
C	-1.253	-1.121	0.344	**C**	0.213	0.014	0.990
8.South Africa (Dow Jones South Africa USD)				**21.Germany (Dow Jones Germany USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.278^{a}	-6.162	0.009	**COINTEQ01**	-1.003^{a}	-106.249	0.000
D(LX1T)	1.044	0.228	0.834	**D(LX1T)**	16.152	0.004	0.997
D(LX1A)	0.041	0.019	0.986	**D(LX1A)**	-2.470	-0.001	0.999
D(LX1H)	0.783	2.192	0.116	**D(LX1H)**	-5.131	-0.004	0.997
D(LX2)	-1.192	-2.108	0.126	**D(LX2)**	16.929	0.008	0.994
D(LX3)	3.077	0.946	0.414	**D(LX3)**	17.436	0.008	0.994
D(LX4)	7.597	1.816	0.167	**D(LX4)**	-9.336	-0.002	0.998
C	2.859	0.741	0.512	**C**	7.874	0.064	0.953
9.South Africa (MSCI South Africa NR USD)				**22.Turkey (DJ Turkey Titans 20 TR USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.045^{a}	-42.080	0.000	**COINTEQ01**	-0.175^{a}	-57.287	0.000
D(LX1T)	-0.003	-0.052	0.962	**D(LX1T)**	-0.219^{c}	-2.753	0.071
D(LX1A)	-0.141^{b}	-5.120	0.014	**D(LX1A)**	-0.055	-1.030	0.379
D(LX1H)	-0.102^{a}	-22.911	0.000	**D(LX1H)**	-0.153^{a}	-10.505	0.002
D(LX2)	-0.111^{a}	-14.930	0.001	**D(LX2)**	-0.414^{a}	-7.245	0.005
D(LX3)	-0.844^{a}	-20.608	0.000	**D(LX3)**	-0.988^{a}	-15.511	0.001
D(LX4)	0.503^{a}	9.264	0.003	**D(LX4)**	0.046	0.380	0.729
C	0.252^{b}	5.741	0.011	**C**	-0.848^{b}	-5.381	0.013
10. Australia (Dow Jones Australia USD)				**23.United Kingdom (Dow Jones UK USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-1.002^{a}	-106.031	0.000	**COINTEQ01**	-1.003^{a}	-106.254	0.000
D(LX1T)	6.532	0.003	0.998	**D(LX1T)**	-2.724	-0.006	0.996
D(LX1A)	-3.852	-0.002	0.998	**D(LX1A)**	-3.556	-0.015	0.989
D(LX1H)	4.500	0.013	0.990	**D(LX1H)**	8.504	0.020	0.986
D(LX2)	16.411	0.009	0.993	**D(LX2)**	8.260	0.039	0.971
D(LX3)	14.765	0.007	0.995	**D(LX3)**	4.319	0.018	0.987
D(LX4)	-12.466	-0.003	0.998	**D(LX4)**	-0.579	-0.001	0.999
C	8.075	0.070	0.949	**C**	-0.269	-0.018	0.987
11. Australia (MSCI Australia USD)				**24.Italy (Dow Jones Italy USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.128^{a}	-113.122	0.000	**COINTEQ01**	-0.999^{a}	-105.940	0.000

D(LX1T)	-0.002	-0.062	0.954	**D(LX1T)**	-4.115	-0.001	0.999
D(LX1A)	-0.062[c]	-3.107	0.053	**D(LX1A)**	-0.596	0.000	1.000
D(LX1H)	-0.134[a]	-32.949	0.000	**D(LX1H)**	22.129	0.026	0.981
D(LX2)	-0.209[a]	-9.394	0.003	**D(LX2)**	28.939	0.009	0.993
D(LX3)	-1.036[a]	-42.474	0.000	**D(LX3)**	13.848	0.004	0.997
D(LX4)	0.242[b]	5.158	0.014	**D(LX4)**	-15.219	-0.002	0.998
C	-0.525[a]	-7.540	0.005	**C**	12.217	0.060	0.956
12.China (MSCI China Net USD)				**25.European Union (MSCI Europe ex UK Net USD)**			
Variable	Coefficient	t-Statistic	Prob. *	**Variable**	Coefficient	t-Statistic	Prob. *
COINTEQ01	-0.760[a]	-87.262	0.000	**COINTEQ01**	-0.893[a]	-117.062	0.000
D(LX1T)	0.092	0.073	0.946	**D(LX1T)**	0.649	0.882	0.443
D(LX1A)	0.822	1.763	0.176	**D(LX1A)**	0.141	0.455	0.680
D(LX1H)	0.230	0.454	0.681	**D(LX1H)**	-0.017	-0.052	0.962
D(LX2)	0.379	0.703	0.533	**D(LX2)**	1.374[b]	3.417	0.042
D(LX3)	-1.689[c]	-2.942	0.060	**D(LX3)**	-0.607	-1.402	0.256
D(LX4)	3.717[b]	3.321	0.045	**D(LX4)**	2.987[b]	4.206	0.025
C	-2.393	-1.565	0.216	**C**	-2.884	-1.256	0.298
13.India (MSCI India Net USD)							
Variable	Coefficient	t-Statistic	Prob. *				
COINTEQ01	-0.781[a]	-95.526	0.000				
D(LX1T)	1.235	1.041	0.374				
D(LX1A)	0.360	0.417	0.705				
D(LX1H)	-1.084[b]	-4.041	0.027				
D(LX2)	1.612	1.672	0.193				
D(LX3)	0.499	0.470	0.671				
D(LX4)	2.644	1.348	0.271				
C	-2.441	-1.362	0.267				

Note: The significance levels of 1%, 5%, and 10% are depicted through a, b and c, respectively.

Source: the author.