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GLOBAL RISK SPILLOVERS TO INTERNATIONAL EQUITY MARKETS: AN APPLICATION TO NON-PARAMETRIC CAUSALITY IN QUANTILES

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Rukhsana Bibi

COMSATS University, Islamabad., Pakistan

National University of Modern Languages, Pakistan

rukhsana.pide@gmail.com,

Muhammad Abdullah Masood

Comsats University, Pakistan

abdullahmasood2229@gmail.com

Naveed Raza,

Assistant Professor, Comsats University, Pakistan
naveedrazza@comsats.edu.pk

ABSTRACT

Purpose: This study examines the global risk spillover to International Equity Markets e.g., gold volatility index (GVX), crude oil volatility index (OVX), Volatility Index (VIX), Treasury Bills (TVX), Volatility of volatility index (VVIX), and Èconomic Ṕolicy Ůncertainty index (EPU).

Design/Methodology: Following non-parametric causality in quantiles method we utilize weekly data of Canada, Japan, the UK, and the USA from June 12, 2008, till September 29, 2018. The Granger causality in quantiles detects and quantifies both linear and non-linear causal effects between random variables.

Findings: Results of the study shows strong correlations between volatility of volatility index and stock markets. whereas weak correlation exist between Èconomic Ṕolicy Ůncertainity and stock markets. Increase in uncertainty indices cause a decline in equity stock markets. Uncertainty indices does not cause volatility in stock returns of TSX, TSE, LSE and NYSE. VVIX granger cause volatility of Japanese stock market returns. There is no evidence of risk spillover from uncertainty to international equity markets. uncertainty do not cause volatility in stock market returns of Canada, Japan, UK and USA.

Originality: The results provide important insights for asset allocation, investment portfolio, and risk management to minimize the effect of volatility spillovers. As

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financial spillover amplifies in the absence of monetary stabilization, both conventional and unconventional monetary easing can increase spillover. Thus, the

study would also benefit the policymakers in devising monetary policies which mitigate the influence of risk spillovers to international equity markets. The findings of the study have important implications for market regulators.
Keywords: *Global risk spillover, non-parametric causality in quantiles, Granger causality in quantiles, equity markets*

Paper type: Research Paper

INTRODUCTION

Spillover means the impact of an occasion in one nation can have on the other economies. Although spillover has a positive impact, it is usually referred to as the negative impact of a local event on economies. Investors behave differently to market conditions (Reyes, 2019). Financial spillover is caused due to ripple effect of an event in one country to other countries which are usually dependent. Spillover also takes place when fluctuation in asset prices in one country causes fluctuation in the asset pricing of the same or another country. Whereas, risk spillover is the shift in risk from one region to another region. It may be a local risk spillover or global risk spillover. The effect of local risk spillover is limited to the region whereas global risk spillover affects more than one country or globally. Portfolio adjustments are necessary with the risk spillover from either market (Ṇaeem ėt ał., 2022; Mensi ėt al., 2021).

High integration among financial systems induce financial risk spillover. The global spillover effect can be originated by stock market recessions such as financial crisis-2008, Russia-Ukraine war-2014, stock market crash-2015, COVID-19, commodity price uncertainty, trade policies (Croitorov ėt ał., 2020; Zhang ėt ał., 2020). Financial spillover risk increases with the lack of monetary stabilization and its consequences can be positive or negative. It is usually termed as negative due to the negative effects of a local event on other economies. Equity markets play a crucial role in the economic development of a country. Therefore, any shift in the equity market influence other economies on a large scale. As happened in COVID-19 economies faced economic down in operating activities and stagflation whose effects were experienced globally. Several studies examine the influence of risk spillover in stock markets (Bouri ėt ał., 2021; Su ėt ał., 2020; Kang ėt ał., 2019; Jitmaneeroj., 2018, Lien ėt ał., 2018; Sita & Abdullah, 2014; Zhang ėt ał., 2024). There exist theoretical and empirical research on the importance of crisis in spillover, this study considers major events that effect equity stock markets.

Previous studies examined the asymmetric correlation among oil and energy markets (Xia ėt ał., 2019 & Maghyereh ėt ał., 2019). Zhang et al (2024) analyze asymmetric intertemporal risk spillovers in global stock markets. First this study will add up empirical and theoretical basis on the matter of extreme events in global risk spillover to the international equity market. We examine the impact of extreme events (Financial crisis 2008-2009, oil price 2014 and Sovereign debt crisis 2010-2012) on equity markets spillover to international markets. The selection of four equity markets (Canada, Japan, UK and USA) depends on its high liquidity and trading volume in

the world. The selected countries represent stock markets of Europe, Asia and America due to their large spillover impacts and economic volumes (Zhang-Xu ėt ał., 2024). Second, we extend our analysis to analyze the non-parametric causality in quantiles effect of global risk spillover to the international equity market. It better detects causality in the tails of the joint distribution of uncertainty measures and selected stock markets successfully used by previous studies (Mensi ėt ał., 2020; Das ėt ał., 2019, 2020; Demirer ėt ał., 2018; Apergis ėt ał., 2018; Balcilar ėt ał., 2016, 2018; Raza ėt ał., 2018; MO-Bin ėt ał., 2024). The dataset is not normal therefore the non-parametric technique is best to use. Non-parametric techniques can assess the median rather than the mean. It is better to study because the mean is not always a suitable measure of central tendency for a sample, which adds significance to the existing literature. This study measures Granger causality in quantiles which detect and quantify both linear and non-linear causal effects between random variables. These measures are based on non-parametric quantile regressions and quantifies the degree of predictability of the quantiles. Further, we contribute to the literature by clarifying the effect of the financial crisis of 2008-2009, the oil price downturn in mid-2014, and the Sovereign crisis of 2010-2012 on their correlation between global spillover to international equity markets.

Following the non-parametric causality quantiles test, this study addresses the following research questions: To what extent global risk spillover influences international equity markets? Does non-parametric causality in quantiles assess the causal relationship between global risk factors and international equity markets? The weekly data from 12th June 2008 to 29th September 2018 is collected for gold volatility index (GVX), Crude oil volatility index (OVX), Volatility index (VIX), T-bill volatility index (TVX), Volatility of volatility index (VVIX) and Ėconomic Ṕolicy Ůncertainity Index (EPU).

Findings highlight that TSX, TSE, LSE and NYSE, the uncertainty indices do not granger cause stock market returns-volatility of Canada, Japan, UK and USA. Whereas there exists granger causality between VVIX, and the volatility of stock market returns of Japan. The findings are in line with Al-Yahyaee, K.H. et al. (2019) who found that the Ů.S. Financial Ůncertainty index does not granger cause the volatility of equity markets. It is also documented from results that there is no risk spillover to equity markets or uncertainty does not cause volatility in returns of stock markets of Canada, Japan, UK and the USA. The insights would be beneficial for asset allocation, risk management and policymaking to acquire knowledge of global risk spillover on international equity markets using Granger causality in quantiles. The findings will also help in mitigating the influence of risk spillover on international equity markets. As financial risk spillover amplifies in the absence of monetary stabilization and both conventional and unconventional monetary easing can increase spillovers hence the current study also benefit the policy-making institutions to develop a keen focus on the part played by financial risk spillovers on the international equity market based on empirical evidence. It will also help them in

devising monetary policies that would mitigate the influence of financial risk spillovers to international equity market. It also gives implementations for a financial analyst to conduct an in-depth analysis of non-parametric causality in quantiles effect of global risk spillover (Gold volatility index (GVX), Crude oil volatility index (OVX), Volatility Index (VIX), T-bill volatility index (TVX), Volatility of volatility index (VVIX) and Èconomic Ṗolicy Ưncertainity Index (EPU)) to the international equity market. The study is noteworthy for equity market regulators as with the knowledge of global risk spillover to the international equity market they can formulate suitable policies while contributing to the overall economy.

Literature Review

Spillover and Dynamic Behaviour

This section covers the related literature on risk spillover to international equity markets. several studies measure risk spillover and its dependencies across equity stock markets and countries (Antonakakis ėt ał., 2016, Tao and Green, 2012; Wu ėt ał., 2005) with commodity markets (Kang and Yoon, 2016; Liu and An, 2011; Li and Zhang, 2009; Li, Z ėt ał., 2020). The link between oil and commodity assets, oil and gold etc. is examined by (Yip ėt ał., 2020; Lovcha and Perea- Laborda, 2020; Wang ėt ał., 2019, 2020; Zhang & Broadstock, 2020). Individual asset spillover within the countries are studied by (Alsubaie and Najand, 2009; Bhol and Henke, 2003; Gallo and Pacini, 2000). Spillover among oil and stock indices (Okorie and Lin, 2020; Choi and Hong, 2020; Malik and Umar, 2019; Singh ėt ał., 2018; Phan ėt ał., 2016; Olson ėt ał., 2014; Malik and Ewing, 2009). Moreover, the recent studies on the dynamic relation between assets (commodity markets and stocks, and foreign exchange markets and stock) (Bouri ėt ał., 2021a; Nekhili ėt ał., 2021; Bahloul and Khemakhem, 2021; Nasreen ėt ał., 2020; Rehman ėt ał., 2018). Man et al (2024) studied risk spillover and shocks impacts to Chinese-Carbon energy-Finance markets (CCEFM). Whereas Zhang et al (2024) decompose risk spillover impact in five internation markets (China, Japan, Germany, America and Britian) for the period of 2003-2022. There exist an asymmetric risk spillover in international stock markets and among these markets America and Europe are the found as risk transmitters. Yoon ėt ał., (2019) examine directional market connectedness and pairwise spillover across four asset classes. The Dynamic connectedness amid the Èconomic Ṗolicy Ưncertainity index studied by Kang (2019). Spillover indices highlight 67.4% connectedness among nine uncertainty indexes. Uncertainty is the major component of interconnectedness among stock indexes. Liow ėt ał., (2018) examine volatility spillover in different stocks and uncertainty among seven countries. Financial risk and uncertainty arise due to spillover. International spillover exists in multi-country financial markets' systematic risk.

The relationship between assets and volatility is determined by (Balcilar, 2016; Raza ėt ał., 2018). The study employs a non-parametric causality approach and shows

uncertainty causes gold returns and volatility. Bahloul (2018) determine uncertainty measures can predict returns of commodities at quantities of returns. Berger and Uddin (2016) analyze strong dependence among commodity futures, uncertainty, and equity futures in recession periods. There is significant volatility spillover among the international crude oil and commodity markets of China. There exists a volatility spillover effect on commodity markets highly linked to uncertainty measures Su (2020). Luo ėt ał., (2024) found risk spillover from international oil markets to financial markets of China. Raddant (2021) studied the dependencies of 4000 stocks in the financial markets of the world using the GARCH model. There is a significant role of global sectoral components in the connectedness of stock markets. Dependencies are relatively volatile and arise due to heterogeneous stocks, an important part of volatility.

Croitorov (2020) analyzes spillover and global risk of economies. Financial uncertainty is the source of spillover with international financial integration and in normal conditions, it is zero. International synchronization is captured by uncertainty measures. Spillover is minimized at zero-low bounds and at general risk. The rise in equity price synchronizations of financial cycles among economies is forced by world uncertainty (Jorda et al. (2019). Return variability of risk financial assets is featured by global risk factors associated with market volatility and risk (Miranda-Agrippino and Rey, 2015). This study extends the existing literature on the effect of global risk spillover (Gold volatility index (GVX), Crude oil volatility index (OVX), Volatility Index (VIX), T-bill volatility index (TVX), Volatility of volatility index (VVIX) and Èconomic Ṕolicy Ưncertainity Index (EPU)) to international equity markets. Using non-parametric quantiles approach, detect and quantify the linear and nonlinear effect between random variables.

2.2. Model Specification

Several methods followed to examine risk spillover between financial markets and commodity-oil which includes GARCH, VAR (Vector Autoregressive, SVAR (Structural Vector Autoregressive), Conditional VAR, GARCH-SK-TVP-VAR-DY model (Jin ėt ał., 2022; Luo ėt ał., 2024; Lyu ėt ał., 2017; Jin ėt ał., 2023; Tiwari ėt ał., 2020). However, this study employ quantile on quantile method which is advanced form of quantile approach merged with non-parametric approach to uncovers the dynamic association over the quantiles, followed by literature (Jiang ėt ał., 2021; Naifar ėt ał., 2020; MO-Bin ėt ał., 2024). It investigates how the quantiles of one variable impacts the conditional quantiles of the other variables, suggested by Sim and Zhou (2015). Non-parametric causality approach is suggested by (Balcilar ėt ał., 2016). In this study, we follow a non-parametric quantiles approach. It overcomes the simple and quantile regression. Quantile on Quantile (QOQ) model depict the impact of dependent variables (TSX, TSE, LSE, NYSE) on selected independent variables (GVX, OVX, TVX, VIX, VVIX, EPU) under different market conditions e.g., Bullish (upper), Normal (middle) and Bearish (lower). Next, it investigates the causality in

quantiles between dependent and independent variables (Balcilar et al., 2017). Heterogeneity is the characteristics of time series, and tradition causality methods are unable to provide a clear causal relationship (Balcilar ėt ał., 2016 and 2017; Man ėt ał., 2024; Huang and Lul, 2020). To analyze causality in quantiles we choose six indices' variables (GVX, OVX, TVX, VIX, VVIX, EPU) impact on internal equity markets of Canada, Japan, UK and USA. Equation 1, 2, 3 and 4 explains quantile on quantile model:

$$TSX_t = \beta_1 GVX_t + \beta_2 OVX_t + \beta_3 TVX_t + \beta_4 VIX_t + \beta_5 VVIX_t + \beta_6 EPU_t + \varepsilon_t \quad (1)$$
$$TSE_t = \beta_1 GVX_t + \beta_2 OVX_t + \beta_3 TVX_t + \beta_4 VIX_t + \beta_5 VVIX_t + \beta_6 EPU_t + \varepsilon_t \quad (2)$$
$$LSE_t = \beta_1 GVX_t + \beta_2 OVX_t + \beta_3 TVX_t + \beta_4 VIX_t + \beta_5 VVIX_t + \beta_6 EPU_t + \varepsilon_t \quad (3)$$
$$NYSE_t = \beta_1 GVX_t + \beta_2 OVX_t + \beta_3 TVX_t + \beta_4 VIX_t + \beta_5 VVIX_t + \beta_6 EPU_t + \varepsilon_t \quad (4)$$

Where TSX_t represents Toronto Stock Exchange returns, TSE_t Tokyo Stock Exchange returns, LSE_t London Stock Exchange returns, $NYSE_t$ New York Stock Exchange returns and t shows the time period. GVX_t represents Gold Volatility Index, OVX_t Oil Volatility Index, TVX_t T-Bill Volatility Index, VIX_t Volatility Index, $VVIX_t$ Volatility of Volatility Index, EPU_t Èconomic Ṕolicy Ůncertainity Index and ε_t is the model error. The findings of equations 1 to 4 are shown in table **3.**

Hypotheses

This study investigates the impact of global risk spillover to international equity markets with respect to non-parametric causality in quantiles. It address either risk spillover influences international equity markets using random variables, gold volatility index (GVX), Crude oil volatility index (OVX), T-bill volatility index (TVX), Volatility of volatility index (VVIX), Volatility index (VIX) and Èconomic Ṕolicy Ůncertainity Index (EPU). It also address the global risk spillover causal relationship with international equity markets.

H_1: Global risk spillover has negative influence on international equity markets.
H_2: Global risk spillover has causal relationship with equity market.

3. Data

The weekly data is extracted from June 12, 2008, till September 29, 2018 i.e., a total of 537 weekly observations. The data of other variables is in logarithmic form as they are stationary at levels whereas the stock market returns of Canada, Japan, UK and USA are calculated as the natural logarithmic first difference of closing prices. The data is in logarithmic form to show the percent change and to respond skewness towards large values in the data. The selection of these equity markets is meaningful for the study due to large trading volumes and high liquidity. These four countries represent stock markets of Europe, Asia and America with large economic volumes and impacts globally (Zhang-Xu ėt ał., 2024).

EPU index is commonly used in surveys that assess uncertainty effects on commodity and financial markets (Baker et al., 2016). This study considers some important events e.g., the 2008- 2009 Financial crisis, mid 2014 oil price downfall and the 2010-2012 Eurozone Sovereign Debt Crisis to analyze the global risk spillover to international equity markets.

Results

Table 1: Descriptive Statistics

	Mean	Min	Max	S. D	Skew	Kurt	J-B
Bullish	0.3640	0.1775	0.6328	0.0814	0.1629	2.6331	4.3538
Bearish	0.3309	0.1505	0.7027	0.0909	0.7277	3.3713	40.798
GVX	21.438	12.410	58.250	7.6844	2.1198	8.2999	832.99
OVX	38.163	15.140	100.40	15.146	1.1758	4.9149	166.32
VIX	21.109	10.320	80.860	10.344	2.3397	9.7113	1210.4
TVX	6.6641	3.9000	14.110	2.1032	1.3205	4.4889	166.22
VVIX	88.102	62.160	145.12	13.171	0.8871	4.1121	79.290
EPU	103.51	20.300	402.91	66.290	1.7241	6.7923	475.1
TSX	0.00002	-0.1912	0.1250	0.0262	-1.3180	13.253	2022.1
TSE	0.00042	-0.1972	0.0988	0.0329	-0.7864	6.6876	289.97
LSE	0.00056	-0.1188	0.0843	0.0250	-0.7385	6.1976	223.83
NYSE	0.00109	-0.2026	0.1652	0.0275	-1.5164	17.871	4156.2

Table 1 shows that in the case of uncertainty indices TVX has the lowest volatility whereas EPU index has the highest volatility. The uncertainty indices show positive skewness and highly skewed however, in case of VVIX the distribution is moderately skewed. The kurtosis of the uncertainty indices is more than three which means that it is leptokurtic distribution or heavy tailed distribution. The results of Jarque Bera (J-B) test for normality rejects null hypothesis for the uncertainty indices at 5% level of

significance. In other words, the data is not normally distributed. Similarly, in case of equity markets LSE has the lowest volatility whereas TSE has the highest volatility, and the equity markets show negative skewness and are highly skewed. However, in case of TSE and LSE the distribution is moderately skewed. The kurtosis is more than three for the equity markets which means that it is leptokurtic distribution or heavy tailed distribution. The results of Jarque Bera (J-B) test for normality confirms the rejection of null hypothesis for the equity markets at 5% level of significance. The data is not normally distributed.

Table 2: Correlation

Dependent Variables	Independent Variables							
	Bullish	Bearish	GVX	OVX	VIX	TVX	VVIX	EPU
TSX	0.1777	-0.1815	-0.1409	-0.0962	-0.2108	-0.1058	-0.2782	-0.0728
TSE	0.2578	-0.2676	-0.1502	-0.1349	-0.2500	-0.1432	-0.3086	-0.1059
LSE	0.1863	-0.1922	-0.1352	-0.0746	-0.2027	-0.1103	-0.3325	-0.0361
NYSE	0.2155	-0.2106	-0.1575	-0.1315	-0.2567	-0.1358	-0.3342	-0.1042

Table 2 illustrates the co-efficient of correlation between the uncertainty indices and the equity markets. It can be observed that there exists an overall inverse relationship between the uncertainty indices and the equity markets. The correlation is strongest between Volatility of Volatility Index (VVIX) and TSX, TSE, LSE and NYSE and the correlation is weak among Ėconomic Ṕolicy Ůncertainity Index (EPU) and TSX, TSE, LSE and NYSE. It means that any increase or decrease in the uncertainty indices will have a negative impact on the equity markets therefore, a unit rise in the uncertainty indices will cause a decline in the equity markets and vice versa.

Table 3: Linear Granger-Causality Analysis

	TSX	TSE	LSE	NYSE
Bullish	0.0387	0.8071	0.6162	0.2455
P-value	0.8441	0.3695	0.4329	0.6205
Bearish	0.1532	1.6006	0.2211	1.2237
P-value	0.6957	0.2065	0.6384	0.2692

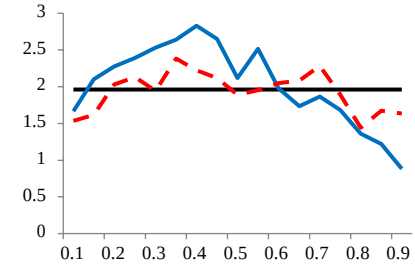
GVX	1.7766	2.3742	0.0033	2.8215
P-value	0.1833	0.1241	0.9543	0.0937
OVX	0.0796	1.7811	0.3162	1.0207
P-value	0.7780	0.1827	0.5742	0.3129
VIX	0.0458	2.8746	0.5240	0.6223
P-value	0.8307	0.0907	0.4695	0.4306
TVX	0.2968	1.6072	0.0024	1.3209
P-value	0.5862	0.2056	0.9608	0.2511
VVIX	0.7408	4.1739	0.0779	3.0694
P-value	0.3899	0.0417	0.7803	0.0805
EPU	0.0038	0.5837	0.3825	0.5776
P-value	0.9510	0.4453	0.5366	0.4477

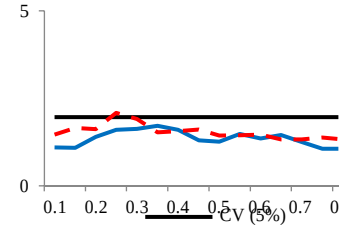
Table 3 illustrates the causality among the variables in time series. The approach used in this study is a probabilistic causality. The data set is used to find the correlation among variables. Granger causality test is used to examine the relationship between the variables. It is observed that in case of TSX, TSE, LSE and NYSE the *p-values* are greater than 0.05 hence, the null hypothesis is acceptable at 5% level of significance. It means that the uncertainty indices do not granger cause the volatility of stock market returns of Canada, Japan, UK and USA.

However, in case of VVIX the *p-value* is less than 0.05 therefore, the null hypothesis reject at 5% level of significance which shows, there exists granger causality between VVIX, and volatility of stock market returns of Japan. These finding are in line with Al-Yahyaee, K.H. et al. (2019) who found that U.S. financial uncertainty index does not granger cause the volatility of equity markets for all economies and for most quantiles. However, the findings of the current study are contrary to the findings of Li, Z. et al. (2021). Which states that the causality-in-quantiles approach highlights that, mostly global financial assets have different power for the selected stock markets. Particularly around the median quantile, the power was strong. From these results this study documents that there does not exist risk spillover to equity markets or uncertainty does not cause volatility in returns of stock markets of Canada, Japan, UK and USA.

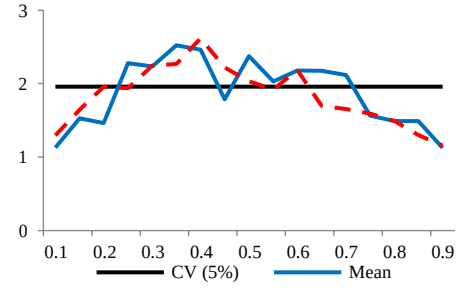
Figure 1: Graphical Representation Bullish sentiments

a). Canada b). Japan





c). UK



d). USA

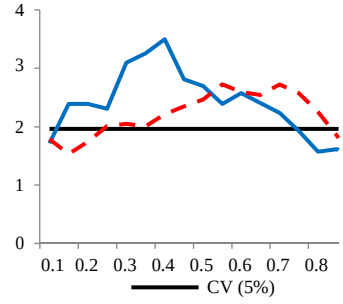
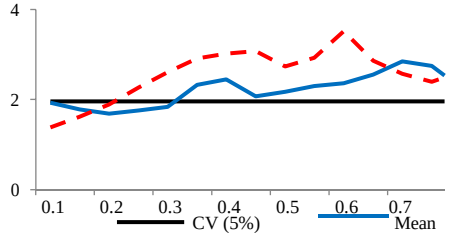
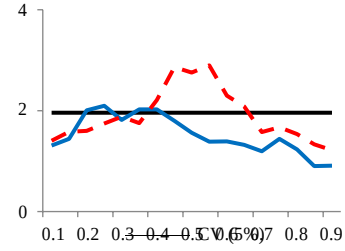


Figure 2: Bullish sentiments

a). Canada

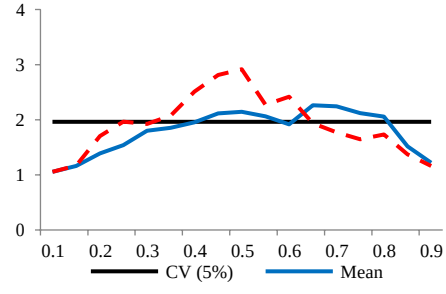
b). Japan





c). UK

d). USA



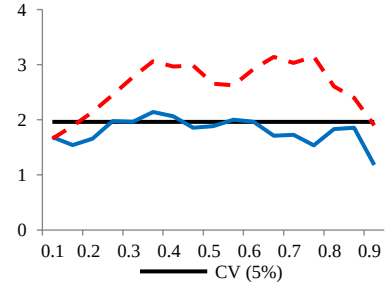
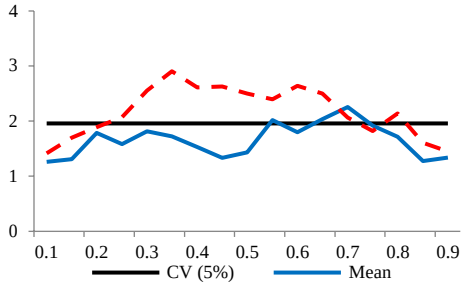
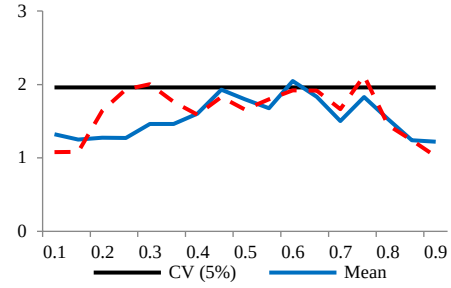


Figure 3: Gold volatility index (GVX)

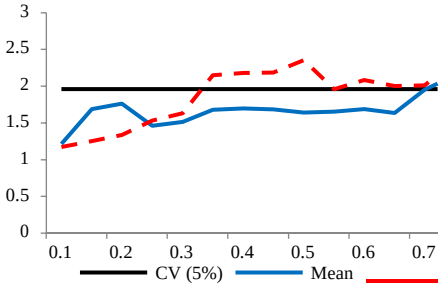
a). Canada



b). Japan



c). UK



d). USA

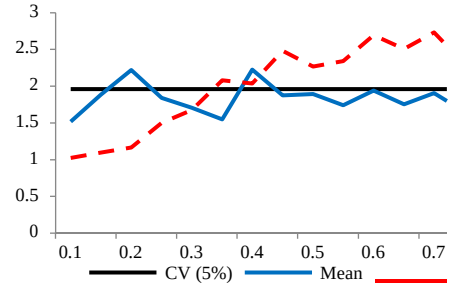
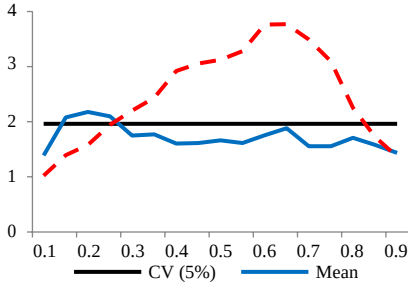
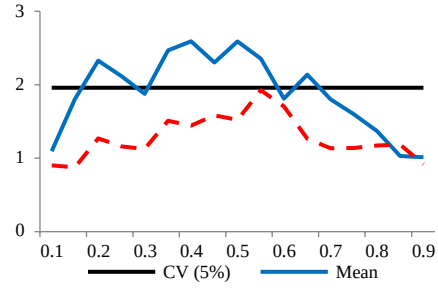


Figure 4: Oil volatility index (OVX)

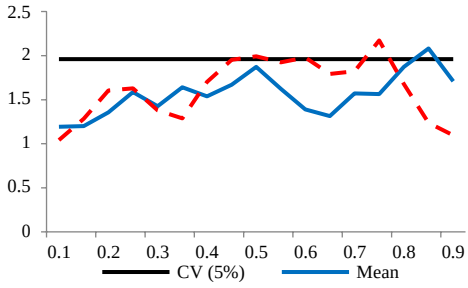
a). Canada



b). Japan



c). UK



d). USA

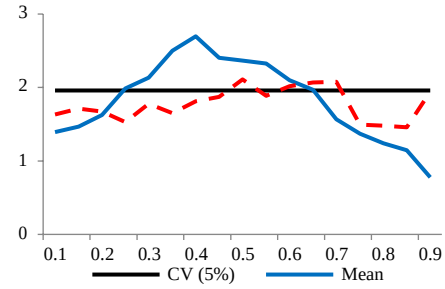
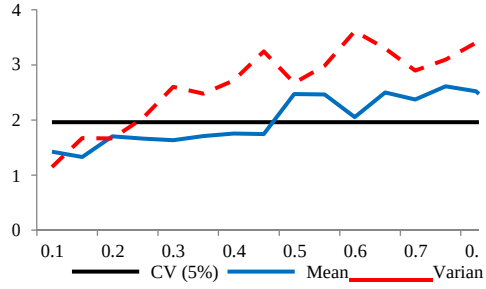
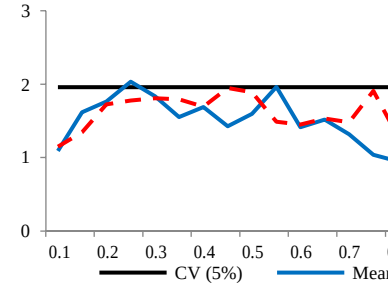


Figure 5: Stock volatility index (OVX)

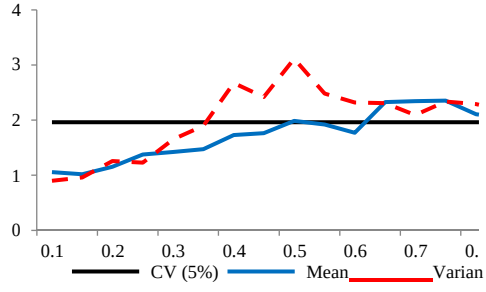
a). Canada



b). Japan



c). UK



d). USA

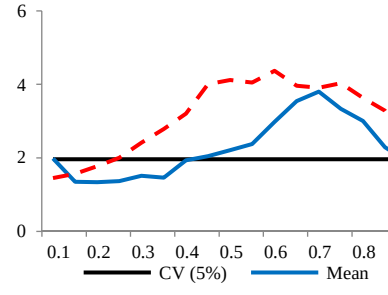
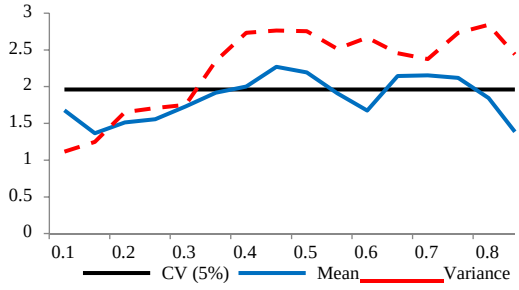
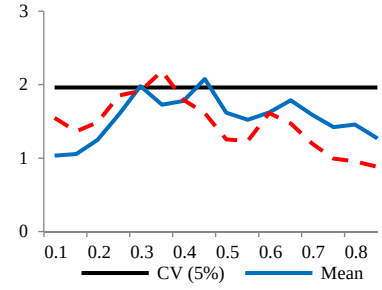


Figure 6: Treasury Bills volatility index (TVX)

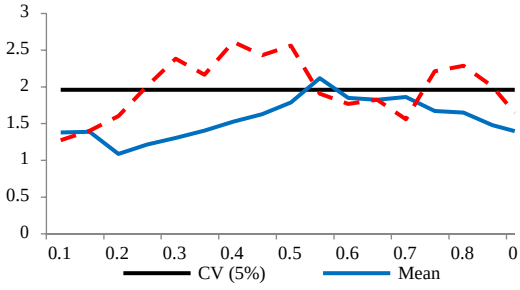
a). Canada



b). Japan



c). UK



d). USA

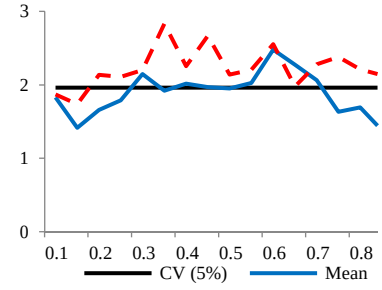
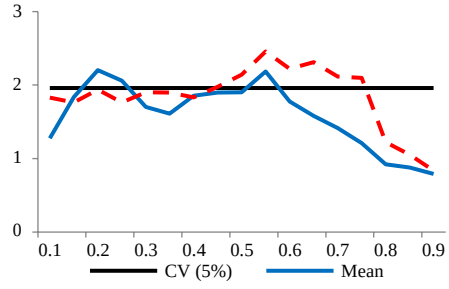
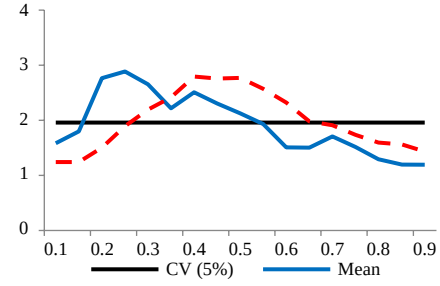


Figure 7: Volatility of volatility index (VVIX)

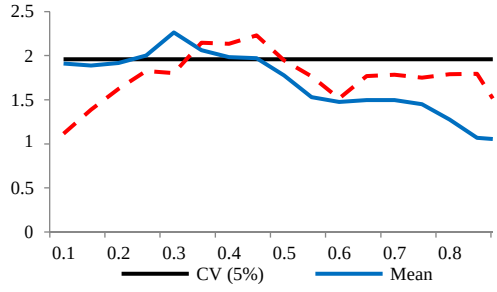
a). Canada



b). Japan



c). UK



d). USA

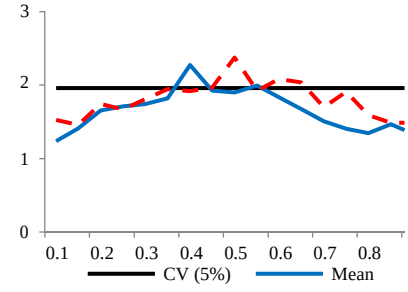
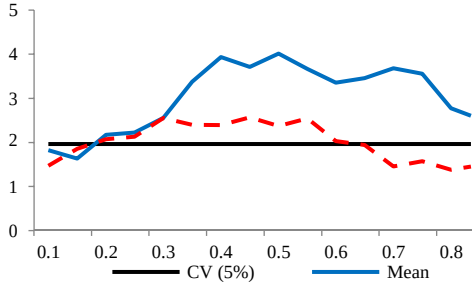
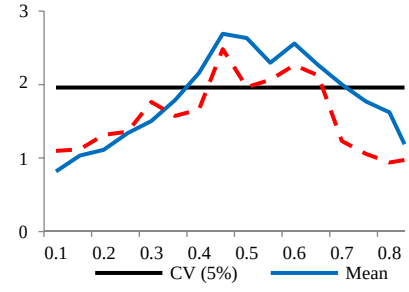


Figure 8: Èconomic Policy Uncertainity index (EPU)

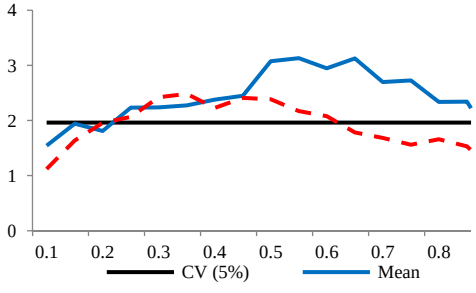
a). Canada



b). Japan



c). UK



d). USA

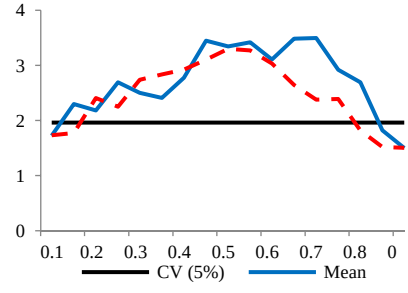


Figure 1 represents the non-parametric causality in mean and variance from uncertainty Indices to stock market returns of Canada, Japan, UK and USA. These figures plot the test statistics on *y-axis* and the range of quantiles on *x-axis* using the non-parametric causality tests. The test statistics examine the causality in mean shown by solid line and causality in variance shown by dash line. The results are significant when higher than the critical values (i.e., 2) represents 5% level of significance.

Figure 2 report the graphical representation of results for better understanding. It illustrates the curves for causality in mean and causality in variance respectively from the uncertainty indices to the stock market returns of Canada, Japan, UK and USA. It represents that in the majority cases the causality in mean curve is not the same from the causality in variance. There exists no significant causality in mean across all quantiles from uncertainty indices to the stock market returns of Canada, Japan, UK and USA. However, in some cases there exists significant evidence of causality in mean such as Oil Volatility Index (OVX) to stock market returns of Japan and USA, Volatility Index (VIX) to stock market returns of Canada and USA, Volatility of Volatility Index (VVIX) to stock market returns of Japan and Èconomic Ṕolicy Ưncertainity Index (EPU) to stock market returns of Canada, Japan, UK and USA respectively. Overall, it is observable that the uncertainty indices do not influence the stock market returns of Canada, Japan, UK and USA by representing causality at the mean.

In case of causality in variance, it can be observed that there exists different causality in variance for uncertainty indices to stock market returns volatility. There exists weak evidence of causality in variance across majority of the quantiles from uncertainty indices to the stock market returns volatility of Canada, Japan, UK and USA. However, in some cases there exists strong evidence of causality in variance such as Gold Volatility Index (GVX), Volatility Index (VIX), T-bill Volatility Index (TVX) to stock market returns volatility of Canada, UK and USA respectively. There exists strong evidence of causality in variance from Oil Volatility Index (OVX) to stock market returns volatility of Canada, Volatility of Volatility Index (VVIX) to stock market returns volatility of Japan and Èconomic Ṕolicy Ưncertainity Index (EPU) to stock market returns volatility of USA respectively. More precisely, the null hypothesis of Granger causality, in variance from uncertainty indices to volatility of stock market returns of all countries is accepted. Therefore, the uncertainty indices do not granger cause the volatility of stock market returns at majority of the quantiles for Canada, Japan, USA and UK.

Conclusion

Based on the empirical results it concludes that an investor who is risk averse may want to consider stocks with a historically low degree of volatility relative to the return in relation to the overall market and vice versa. The results are consistent with

previous studies with respect to empirical and theoretical framework. Moreover, the results have important implications for equity market traders and policy makers. From the perspective of equity market traders, they can use the uncertainty index level to forecast the volatility of stocks. Which helps in risk management and portfolio allocation. Because uncertainty causes turbulence in financial markets and is a driving force behind investor's behavior. With the perspective of policy makers, they should realize that uncertainty dampen economic growth and increase equity market volatility. Clarity in economic policy decisions can lead to better economic performance and more stable financial markets, during recession. During an uncertain policy environment, regulatory bodies may look to intervene to stabilize the equity market's ability to cope-up movements in capital flow and inflation. This research findings help the investors in portfolio investment and risk management to make portfolios to observe the effects of volatility spillovers to international markets.

Limitations of the Study

This study also has limitations like many other studies. The sample being deployed for this study is limited to 537 weekly observations which is determined by the limited amount of available data from the research information base.

Future Recommendation

This research study is limited to the non-parametric causality in quantiles effect of global risk spillover (Gold volatility index (GVX), Crude oil volatility index (OVX), T-bill volatility index (TVX), Volatility of volatility index (VVIX), Volatility index (VIX) and Èconomic Ṕolicy Ůncertainity Index (EPU)) to international equity markets. In the future research can be extended to determine non-parametric causality in quantiles using other variables. Recent crises can be included e.g., COVID-19.

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