Does Gold Retain its Hedge and Safe Haven Role for Energy Sector Indices During COVID-19 Pandemic? A Cross-quantilogram Approach

Jambotkar Mrunali Manohar[1], Guntur Anjana Raju[2]*

[1]Ph.D. Research Scholar, Goa Business School, Goa University, Goa, India, [2]Professor Program Director of Ph.D. (Commerce), Goa Business School; Goa University, Goa, India. *Email: rajuanjana@gmail.com

ABSTRACT

The Outbreak of the COVID-19 Pandemic has caused unprecedented risk and uncertainty in the global financial markets. The shattered investor's faith in the Global Financial system has stimulated the need to explore safe haven assets to mitigate risk and safeguard wealth during such turmoil. Therefore, this paper addresses the widely mooted hedge and safe haven property of gold against extreme downturns in the stock market energy sector indices during COVID-19 distress. The sample countries considered comprises of the USA, Saudi Arabia, UAE, Russia, Canada, India and China being strategically linked to gold and oil commodities. Splitting the sample period into Pre-COVID period from 30th June 2019 to 30th December 2019 and During-COVID period from December 31, 2019 to June 30, 2020 the study employs bivariate cross-quantilogram of (Han et al., 2016) to examine directional predictability in quantiles between gold and energy sector indices. The results confirm the inability of gold to showcase its pronounced hedge and safe haven role before the COVID-19 crises. Specifically, Countries such as Saudi Arabia, Russia and Canada show a significant negative predictability from energy sector indices to gold thereby indicating its safe haven role during COVID-19 crises.

Keywords: Gold, Safe Haven, COVID-19, Cross-quantilogram, Energy Sector Indices
JEL Classifications: G01, G11, G15, Q40.

1. INTRODUCTION

The rapid escalation of the global COVID-19 pandemic has caused havoc and fragility worldwide. Being substantially distinctive and complicated from previous outbreaks, it is often stated by (Gates, 2020) as "once-in-a-century pathogen." While, World Health Organisation officially announced it as a global pandemic as on March 11, 2020. In 2003, it was projected that Severe acute respiratory syndrome (SARS) cost the world around $30-$100 billion (Smith, 2006). A much extreme and wide-ranging economic impact is expected from COVID-19 distress. An economic slowdown of 2.8% on average and 15% in severe cases further projected by (Fernandes, 2020). a much larger impact on financial Recently, extensive literature by (Goodell, 2020), pointed out

unprecedented economic destruction with sectors namely the stock market, banking and insurance owing to the COVID-19 pandemic.

The financial market being no longer an exception has faced enormous risks on account of such worldwide crises. A dramatic hit of four circuit breakers in 10 days was triggered first time in US stock markets since its inception in 1987. Further, equity markets in Asia and Europe plunged along with the US market crash. The unprecedented risk in global stock markets posed by COVID-19 turmoil has further led to varying inter-market linkages (Zhang et al., 2020). The shrinkage of economic activities owing to COVID-19 created one of the biggest oil shocks in the energy market since 1973. For Instance, the crude oil prices dropped below $20 per barrel a historic low since the beginning of the new century. Surprisingly,

20th April 2020 was marked with an unprecedented event wherein WTI crude oil futures exhibited a negative value per barrel. In response to contain the spread of such deadly coronavirus, the majority of the countries across the world also adopted extensive actions such as partial/full lockdown, shutting of cross-borders, confinement etc. Notwithstanding, it has caused a severe suspension in economic activities and lessening in demand for oil and oil products. COVID-19 epidemic and thereby a spectacular fall in oil prices further triggered the major event of Russia-Saudi Arabia oil price war on account of lack of consensus in an OPEC+ agreement on cuts in oil production. This further worsens the situation and led to the collapse of crude oil and worldwide stock markets.

The Shattered investor's faith and disastrous losses in global financial markets therefore stimulate the need to explore alternative safe haven assets for both practitioners and policymakers. From the conventional view point, Gold has proven its hedge and safe haven property against stock market risk (Baur and Lucey, 2010; Baur and McDermott, 2010; Bhanja and Dar, 2015) foreign exchange risk (Capie et al., 2005; Joy, 2011; Reboredo, 2013) inflation (Kuan-Min Wang et al., 2011; Salisu et al., 2019) and also against oil price fluctuations (Reboredo, 2013) during the episodes of market crash or crises. Further, safe haven assets behave quite differently under different crises periods. Moreover, the outbreak of COVID-19, a current health crisis is distinct from all other previous crises and may have different implications. Therefore, the purpose of the study is to reassess the ability of gold to provide shelter during periods of extreme COVID-19 turmoil.

The rest of the paper is structured out as follows: Section 2 reviews the literature. Section 3 outlines the details of the dataset and Methodology adopted while Section 4 discusses the empirical results. Finally, Section 5 summarises findings and provides concluding remarks.

2. LITERATURE REVIEW

The concept of hedge and safe haven assets was first coined in the academic literature by (Baur and Lucey, 2010). Accordingly, "a hedge (safe haven) is an asset that is uncorrelated (negatively correlated) with another asset or portfolio on average (only in times of market stress or turmoil)." To ensure the safety of wealth and certainty of investment, there has been a quest to sought safe haven assets in times of turbulent periods. Naturally, gold often provide a shield against heightened downside risk on account of its special characteristics. As gold is well known to be easily standardised, highly durable, universally acceptable, portable, easily divisible (Baur, 2013) and an asset with zero-beta (McCown and Zimmerman, 2006). Some of the most prominent research articles which have highlighted the value diversifying and hedging ability of gold against various risks are (Capie et al., 2005; Baur and Lucey, 2010; Baur and McDermott, 2010; Joy, 2011; Ciner et al., 2012; Hood and Malik, 2013; Gurgun and Unalmış, 2014; Li and Lucey, 2017; Iqbal, 2017; Shakil et al., 2018; Ghazali et al., 2018; Bouoiyour et al., 2019; Beckmann et al., 2019; Reboredo, 2013; Kuan-Min and Lee, 2016; Kuan-Min Wang et al., 2011; Joscha and Czudaj, 2013; Georgios and Panagiotidis, 2015; Aye et al., 2017).

Gold can also offer protection against extreme oil movements. Accordingly, (Reboredo, 2013) carried out a study by applying the copula approach and exhibited inability of gold to hedge extreme risks in oil prices. While tail independence enumerated effective safe haven status of gold against severe changes in oil prices. Through a comparative analysis of safe haven assets, (Selmi et al., 2018) tested a hedge, a safe haven and a diversifier property against extreme oil price fluctuations. The result depends upon the state of Bitcoin and gold markets and their ability to act as a hedge and a safe haven against downside oil price risk appears to be more pronounced for Bitcoin than for gold. However, contrasting results of the study conducted by (Das et al., 2019), indicated that Bitcoin is not the superior asset over other assets to hedge oil-related uncertainties. Further, investors may choose varied investment instruments based on the economic and market situation since hedging potential differs for different assets based upon the nature of oil risks and market conditions. More recently, (Salisu and Adediran, 2020) considered a disaggregated dataset by (Baumeister and Hamilton, 2019) and alternative empirical techniques for robustness analysis. They found that irrespective of the nature of oil shock and techniques adopted gold fails to hedge oil shock risks.

Majority of Previous studies focussed on hedge and safe haven ability of gold against equity market-wide indices. While, equity sector indices might have different inferences on account of a heterogeneous nexus with varied hedge and safe haven assets namely crude oil and other commodities (Arouri, 2012)[1]. Further, there exist a few strands of literature on safe haven assets against equity sector indices. For instance, (Baumöhl and Lyócsa, 2017) analysed the dependence in quantiles from gold to US stock market sector indices. The directional predictability is tested during pre-crisis and post-crisis periods. The findings confirmed that safe haven property is largely challenged for most of the sectors except industrials during both periods on account of restricted quantile dependence. While, analysis of the full sample indicates an effective safe haven behaviour of gold for only three sectors namely IT, Healthcare and Telecommunication. Specifically, focussing on two clean energy stock indices over a data period ranging from 2003 to 2018 (Elie et al., 2019), investigated the ability of safe haven assets namely gold and crude oil during severe market downturns. It proposed the blended copula approach to model dependence amongst assets. Finally, the results exhibited a prominent haven role of crude oil for extreme movements in WilderHill Clean Energy Index. While, the superiority of gold is exemplified for the S&P Global Clean Energy Index. Similarly, by using different Copulas (Beckmann et al., 2019), found weak and significant tail dependence between gold and sector-specific stocks of China which enumerated gold's ability to reduce risk in dip times. The robustness checks further confirmed the superior efficiency of gold rather than oil in diversifying a stock portfolio. (Hung, 2020), identified interconnectedness between commodity and financial sector, which provides ready opportunities for risk minimisation through a discretionary portfolio. Following Cross-quantilogram, (Bouri et al., 2020) conducted a tail analysis to examine the hedge and safe haven potential of Cryptocurrencies against US-Market wide and sectoral equity indices. The multifaceted findings support that Stellar, Bitcoin, Ripple and to a minor level

---

1 (Arouri, 2012) specified that "the equity sector indices are more beneficial as market aggregations may conceal the characteristics of various sectors."

Monero and Litecoin show comparatively similar safe haven ability against Equity Indices. Moreover, Ethereum, Dash and Nem act as a hedge only for selected sectors.

Safe haven assets are particularly pertinent during the episodes of market crash or crises. The profusion of some studies by (Baur and McDermott, 2010; Bhanja and Dar, 2015; Lucey and Li, 2015; Bredin et al., 2015; Baur and McDermott, 2016; Aftab et al., 2019) has considered a string of crises such as a Stock market crash in 1987, Asian Crisis in 1997, Dotcom bubble crises, Global financial crises in 2007-2008, European Sovereign debt crises and so on to assess the safe haven property. The safe haven assets behave quite differently under different crises periods. Moreover, the outbreak of COVID-19, a current health crisis may have different implications and is further worthy of exploration. Few Studies by (Ji et al., 2020) re-evaluated the effectiveness of traditional safe haven assets against equity index during outbreak of COVID-19 distress. The findings of sequential surveillance tests and robustness analysis through cross-quantilogram implied weak safe haven ability of bitcoin, forex currencies and crude oil futures. Moreover, gold and soybean commodity futures validate as a strong safe haven asset during the COVID-19 pandemic. Additionally, (Conlon and McGee, 2020) conducted a timely test on the safe haven potential of bitcoin against the S&P 500 during Covid-19 bear market situations. The empirical results doubt the safe haven property of bitcoin in times of market turmoil as a slight allocation to bitcoin increases the downside risk of a portfolio. The findings are in line with (Conlon et al., 2020), who find that Bitcoin and Ethereum will not provide shelter against downside risk in international equity indices during COVID-19 turmoil.

The study contributes to the hitherto literature in the following manner. The literature by (Reboredo, 2013), highlights the theoretical underpinnings on how gold hedges and safe havens oil risks through macroeconomic variables. Higher oil prices affect economic activity and reduce asset value and therefore investors opt for gold as an alternative asset to safeguard their wealth. Further, an increase in oil prices increases the gold portfolio in external reserves of oil exporting countries (Melvin and Sultan, 1990). Additionally, the safe haven property is only exhibited during periods of crises. COVID-19 pandemic being one of the recent crises has significantly affected the oil and energy sector. So, examining the safe haven property of the traditional asset class offers additional insight. Therefore, the purpose of the study sits well as we have examined the safe haven property of gold against energy sector indices of countries which are strategically linked to both gold and crude oil (being major oil exporting/oil importing and major gold consuming/ gold producing) and also severely hit by COVID-19 turmoil.

3. DATA AND METHODOLOGY

3.1. Dataset
The study relies on a dataset that comprises daily observations of gold prices and energy sector stock indices of USA, Saudi Arabia, UAE, Russia, Canada, India and China[2]. The data for gold spot prices were obtained from the World Gold Council (WGC) and is expressed in Indian rupee, Chinese renminbi, US Dollar, Saudi riyal, UAE dirham, Russian ruble and Canadian dollar respectively. Daily closing prices of energy sector indices

of respective countries are all denominated in their local currency. Moreover, two subsamples were adopted. The first subsample is the span before COVID-19 crises and ranges from June 30, 2019 to December 30, 2019. The cluster of COVID-19 cases was first stated in December 2019, so the second sub sample is COVID-19 period that spans from December 31, 2019 to June 30, 2020. The dating of subsamples highly resembles the dating applied by (Ji et al., 2020) with the same number of observations in both the sub sample periods. For each data series, returns were calculated by taking natural logarithms of the proportion of two consecutive daily prices. Prices of non-trading days are best adjusted by considering prices of the last trading days.

3.2. Methodology
As formerly noted, the analysis is built upon a Cross-quantilogram by (Han et al., 2016) - a methodological approach which emphases on the tails of the return distribution. It measures the directional predictability and lead/lag dependence with range of quantiles and lags. The long-held definitional view of (Baur and Lucey, 2010), sets out the framework for defining safe haven assets. Accordingly, an asset is considered as hedge (safe haven) if there is no (negative) predictability in the tails of returns distribution.

Let us assume that $Y_{i,t}$ where i=1,2 and t=1,2…T, as two stationary time series. Wherein, $Y_{1,t}$ and $Y_{2,t}$ represents returns of gold and returns of energy sector indices respectively. The unconditional distribution and unconditional density function of $Y_{i,t}$ is given as F(i.) and f(i.) respectively. While, the unconditional quantile function of $Y_{it,}$ is expressed as $q_i(\tau) = \inf \{u: F_i(u) \geq \tau\}$, for $\tau \in [0,1]$. The Cross-quantilogram with k lags and τ quantiles is defined as:

$$\rho_\tau(k) \equiv \rho_{\tau 1 \ \tau 2}(k) = \frac{E[\ \psi_{\tau 1}\ (y_{1,t}\ -\ q_1\ (\tau_1))\ \psi_{\tau 2}\ (y_{2,t}\ -\ q_2\ (\tau_2))\ ]}{\sqrt{E[\ \psi_{\tau 1}^2\ (y_{1,t}\ -\ q_1\ (\tau_1))]}\ \sqrt{E[\psi_{\tau 2}^2\ (y_{2,t}\ -\ q_2(\tau_2))]}} \quad (1)$$

Where, $\psi_\tau(u) \equiv 1$ (u < 0) signifies an indicator function 1(.). While $\psi_i^\tau(Y_{i,t} - q_1(\tau_i))$ denotes quantile exceedance process. Eq.1 shows the serial dependence between two time series at distinct quantiles. When k =1, $\rho\tau(1)$ represents cross dependence among quantile $q_1(\tau_1)$ of $Y_{1,t}$ (energy sector index) at time t and quantile $q_2(\tau_2)$ of $Y_{2,t}$ (gold) at time t+1. This gives an estimate of 1-day directional predictability among $Y_{1,t}$ and $Y_{2,t}$. $Y_{2,t}$ act as a hedge if there is no or zero predictability from quantile τ_1 (energy sector index) to the quantile τ_2 (gold) i.e. $\rho\tau(1) = 0$. When $\rho\tau(1) \neq 0$ and if there is negative predictability then $Y_{2,t}$ act as a safe haven. The following Eq. 2 estimate the sample counterpart of cross-quantilogram at an unconditional estimate of sample quantile $\hat{q}_i(\tau_1)$ as:

$$\hat{\rho}\tau(k) = \frac{E[\ \psi_{\tau 1}\ (y_{1,t}\ -\ \hat{q}_1\ (\tau_1))\ \psi_{\tau 2}\ (y_{2,t}\ -\ \hat{q}_2\ (\tau_2))\ ]}{\sqrt{E[\ \psi_{\tau 1}^2\ (y_{1,t}\ -\ \hat{q}_1\ (\tau_1))]}\ \sqrt{E[\psi_{\tau 2}^2\ (y_{2,t}\ -\ \hat{q}_2\ (\tau_2))]}} \quad (2)$$

The quantile version of Ljung Box test statistic to test null hypothesis (H_0) of no directional predictability as proposed by (Han et al., 2016) is as:

[2]While the insertion of sample countries is self-evident, being major gold consuming countries (India, China, UAE, Russia, USA, Saudi Arabia) and major gold producing countries (USA, Canada) as per WGC Classification. Further, selection criteria is also justified with the fact that UAE, Russia, USA, Saudi Arabia and Canada are amongst the top ten oil exporting countries with a significant contribution to energy sector while India and china together account for half of the global oil demand growth based on World oil review 2019 see: https://www.eni.com/assets/documents/documents-en/WORLD-OIL-REVIEW-2019-Volume-1.pdf.

$$\hat{Q}_\tau^H = \frac{T \ (T+2) \sum_{k=1}^{H} \hat{\rho}_\tau^2 \ (k)}{T-k} \tag{3}$$

The pivotal distribution of cross-quantilogram contains noise in H_0 of no cross dependence. Therefore, (Han et al., 2016) recommended stationary bootstrapping to approximate distribution under H_0 and to arrive at both critical values and confidence intervals.

4. EMPIRICAL ANALYSIS

The descriptive statistics of gold and energy sector indices returns for the full sample period, Pre-COVID and During COVID crisis period revealed in Table 1. In Panel A and Panel C, energy sector indices across countries offer negative returns for a higher quantum of risk (except Saudi Arabia in a full sample period) than gold investments. In a full sample period (Panel A), the gold mean returns of the USA, Saudi Arabia and UAE is 0.0922% for unstable volatility of 1.0795%, 1.0808% and 1.0793%. However, for a higher level of risk taken, the gold investment in countries such as Russia, Canada, China and India offer positive returns

ranges between 0.1048% and 0.1403%. During the normal period (Panel B), the mean returns and standard deviation (SD) of gold and energy sectors are positive but substantially low as compared to other periods (except the USA, China and India energy sector indices exhibited negative returns).

During COVID period the energy sector index of the USA, Canada and China worst affected from the crisis as it shows the highest negative returns of −0.3557%, −0.3016% and −0.1988% for risk of 4.6709%, 4.3325% and 1.3549%. In particular, initially although this crisis rooted in China its noise has spread world-wide rapidly and affected most of the economies. In view of this, most of the investors started protecting their wealth making an investment in a safe asset such as gold. Therefore, during ongoing pandemic gold displayed positive and extremely higher returns in all selected countries as compared to energy sector indices. In all seven markets gold retained its prominent and safe heaven role which can be justified with positive returns of above 0.1190% upto 0.2246% for a less quantum of risk. Russia, India, Canada and China gold investment give potential returns of 0.2246%, 0.1622%, 0.1567% and 0.1308% respectively during the crisis period as compared to the normal period. The returns distributions of gold and energy sectors are mostly negatively skewed during the full sample period and during the crisis period. In a normal period in most of cases it is positively skewed. The Kurtosis value with a fat tail and above three also highlighted the characteristics of non-normality in returns series.

Correlation analysis is a qualitative approach to evaluate the degree of association between the variables. Table 2 gives the picture of correlation dynamics for a Full sample period, Pre-COVID period and During COVID period. During the Full sample

Table 1: Summary statistics of gold returns and energy sector indices returns

| Countries	Gold returns				Energy sector equity returns			
	Mean	**SD**	**Skewness**	**Kurtosis**	**Mean**	**SD**	**Skewness**	**Kurtosis**
Panel A: Full sample analysis								
USA	0.0922	1.0795	−0.1825	8.1206	−0.1898	3.4118	−1.3569	13.9280
Saudi Arabia	0.0922	1.0808	−0.1776	8.1178	0.0296	1.5057	−0.3056	13.9109
UAE	0.0922	1.0793	−0.1824	8.1191	−0.0656	1.5701	−1.7910	12.9234
Russia	0.1403	1.3595	0.8908	6.9746	−0.0535	1.8570	−0.7503	13.8452
Canada	0.1070	1.0999	0.1338	7.3669	−0.1286	3.1304	−2.0981	22.0938
China	0.1048	1.1032	−0.0470	6.6926	−0.1297	1.1246	−1.6624	16.3081
India	0.1269	1.1233	0.1179	5.7314	−0.0396	1.9438	−0.6412	10.3707
Panel B: Pre-COVID analysis								
USA	0.0661	0.7867	0.5687	4.2302	−0.0305	1.2592	−0.2171	3.7462
Saudi Arabia	0.0662	0.7874	0.5748	4.2284	0.1310	1.1718	−0.1330	3.6490
UAE	0.0661	0.7865	0.5688	4.2269	0.0021	0.8929	0.4524	4.4730
Russia	0.0555	0.9735	1.0193	6.4472	0.0718	0.8775	0.2778	3.3280
Canada	0.0634	0.8302	0.7768	4.8035	0.0428	0.9594	0.1848	5.6746
China	0.0820	0.8632	0.7957	4.9001	−0.0645	0.8378	−0.1308	5.3757
India	0.0920	0.8818	0.7913	4.9826	−8.91E−05	1.1348	0.0911	3.7193
Panel C: During-COVID analysis								
USA	0.1190	1.3147	−0.3659	6.9632	−0.3557	4.6709	−0.9642	7.8577
Saudi Arabia	0.1189	1.3165	−0.3612	6.9574	−0.0744	1.7816	−0.2331	13.6015
UAE	0.1190	1.3145	−0.3658	6.9618	−0.1337	2.0402	−1.6053	8.7813
Russia	0.2246	1.6623	0.6793	5.4387	−0.1793	2.4797	−0.5150	8.6346
Canada	0.1567	1.3189	−0.1095	6.4843	−0.3016	4.3325	−1.4859	11.9219
China	0.1308	1.3058	−0.3240	6.0013	−0.1988	1.3549	−1.7907	14.4890
India	0.1622	1.3277	−0.1327	5.0032	−0.0768	2.5147	−0.5714	7.3003

Source: Authors Compilation

period, the correlation coefficient between gold and energy sector indices of all countries noted to be negative. Further, there is a high degree of association among gold and energy sector indices of all the selected countries except Saudi Arabia. For instance, gold and energy sector of China, Russia, Canada and the USA shares the highest negative correlation of 0.8712, 0.7993, 0.7938 and 0.7628 respectively. With the exception of Saudi Arabia, all other sample country's gold and energy sector indices exhibit a negative correlation in Pre-COVID period. But the extent of the relationship is remarkably low. As we move forward with COVID crises period, the negative degree of association between gold and energy sector indices has heightened as compared to the normal period except for the USA.

The stationarity of variables is preliminary requisite in a time series analysis. Assuming this phenomenon, under unit root test we have

estimated Augmented Dickey Fuller (ADF) and Phillips- Perron (PP) statistics to examine stability in data series. The results of the ADF and PP test in Table 3 indicates that the null hypothesis is rejected at 5% significant level. Therefore, all log return series are stationary at level.

To validate the directional predictability from gold to stock market energy sector indices during the Pre-COVID-19 and COVID-19 period, the study applied the Cross-quantilogram method. Figures 1 and 2 illustrate the lead-lag effects estimated with lag h = 10 and by considering the lowest quantile of τ = 0.05. Additionally, dark blue bars on the plots indicate the time-varying cross quantilogram. While, dotted dark red lines represent the bootstrap 95% confidence interval with the null hypothesis of no predictability among energy sector equity returns and safe-haven assets. Conclusive evidence of strong safe haven property is

Figure 1: Results of Cross-quantilogram – Pre-COVID period (a) USA (b) Saudi Arabia (c) UAE (d) Russia (e) Canada (f) China (g) India Cross-quantilogram showing directional predictability from stock markets energy sector indices to gold upto 10 lags on horizontal axis at τ =0.05 quantile level
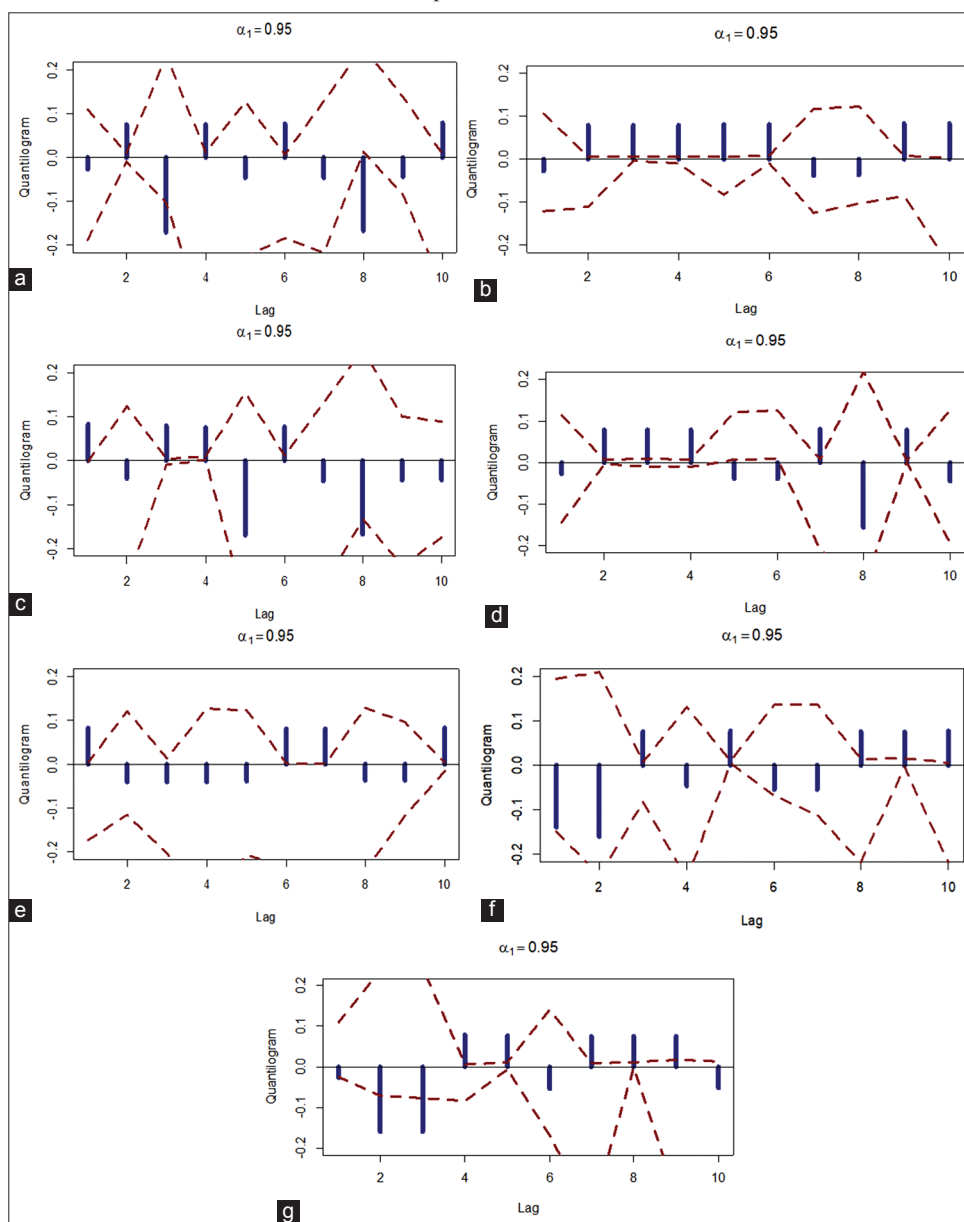
exhibited when the dark blue bars cross the lower bounds of dark red lines. Interestingly, a heterogeneous result across the range of countries was revealed.

Table 2: Correlation coefficient between gold and energy sector indices

Countries	Full sample analysis	Pre-COVID analysis	During-COVID analysis
USA	−0.7628	−0.7032	−0.4361
Saudi Arabia	−0.1296	0.1361	−0.2520
UAE	−0.6797	−0.0963	−0.3883
Russia	−0.7993	−0.3004	−0.8837
Canada	−0.7938	−0.3348	−0.7640
China	−0.8712	−0.4158	−0.7924
India	−0.6664	−0.2245	−0.4410

Source: Authors compilation

Figure 1 depicts the results of Pre-COVID Analysis. For all the sample countries (USA, Saudi Arabia, UAE, Russia, Canada, China and India) a higher positive directional predictability is indicated between safe haven asset and energy sector indices. This often confirms the inability of gold to showcase its pronounced hedge and safe haven role before the COVID-19 crises. Moreover, Figure 2. Shows the results of Cross-quantilogram during the COVID-19 crises period. Specifically, Countries such as Saudi Arabia, Russia and Canada show a significant negative predictability from energy sector indices to gold. This implies that when the energy sector indices of respective countries exhibit a huge loss then gold will experience huge gains in the next days. Therefore, during periods of COVID-19 turmoil investors can offset their losses in the energy sector indices through investment in gold. As for countries namely the USA, UAE and China, Gold

Figure 2: Results of cross-quantilogram – During-COVID period (a) USA (b) Saudi Arabia (c) UAE (d) Russia (e) Canada (f) China (g) India Cross-quantilogram showing directional predictability from stock markets energy sector indices to gold upto 10 lags on horizontal axis at $\tau = 0.05$ quantile level
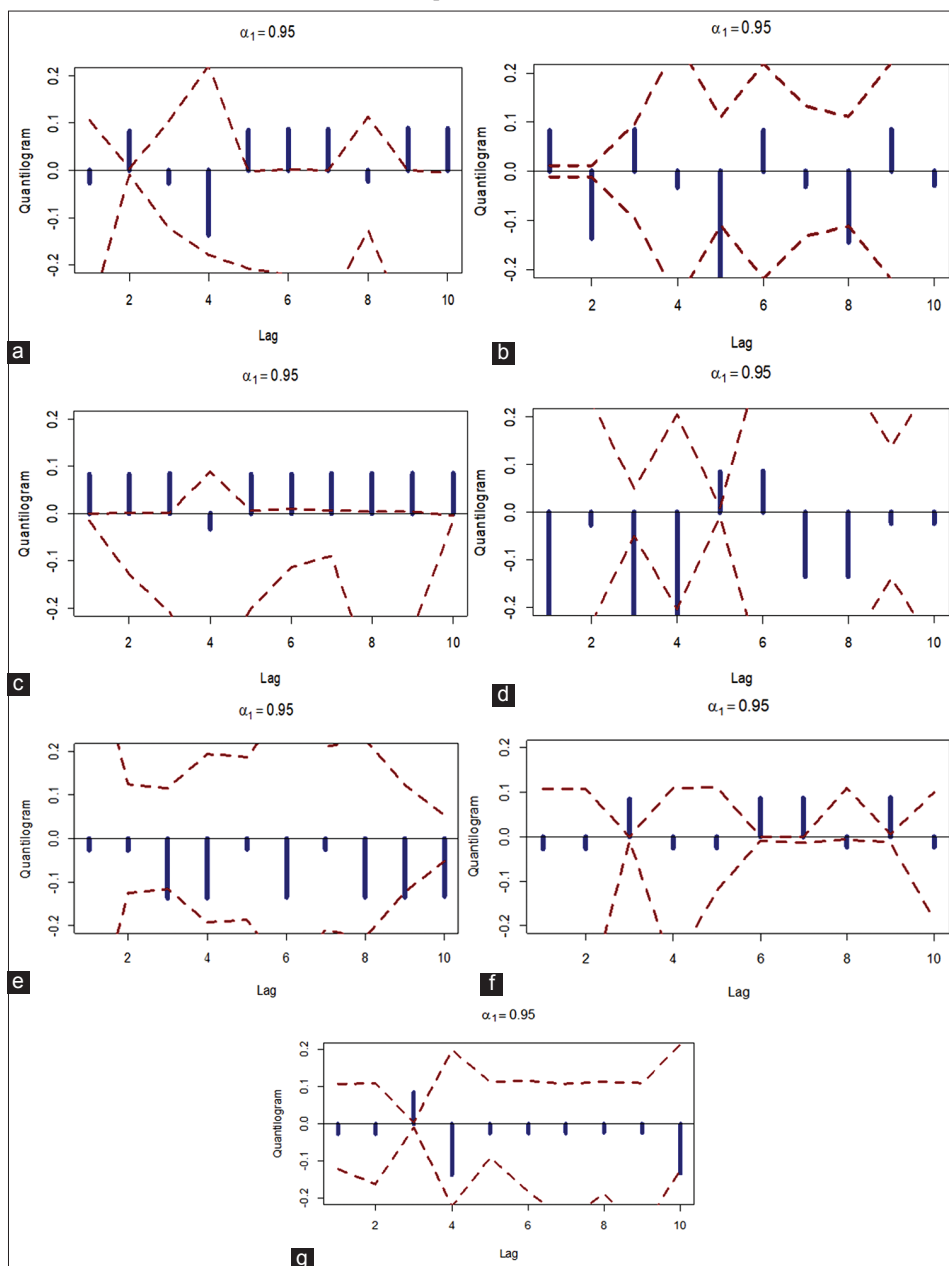
Table 3: Stationarity analysis of gold and equity energy sector indices

Countries	Variables	Panel A: Full sample analysis		Panel B: Pre-COVID analysis		Panel C: During-COVID analysis	
		ADF	PP	ADF	PP	ADF	PP
USA	Gold	−10.0548**	−17.2073**	−12.2071**	−12.6984**	−6.5201**	−11.7897**
	Energy Sector	−4.4066**	−18.1711**	−10.8442**	−10.8385**	−13.1293**	−12.9908**
Saudi Arabia	Gold	−10.0347**	−17.2098**	−12.2355**	−12.7197**	−6.5037**	−11.7799**
	Energy Sector	−13.4840**	−16.6384**	−9.6742**	−9.5606**	−10.5275**	−12.9231**
UAE	Gold	−10.0536**	−17.2050**	−12.2061**	−12.6977**	−6.5190**	−11.7880**
	Energy Sector	−14.7768**	−14.7886**	−12.4090**	−12.5971**	−10.0479**	−10.0170**
Russia	Gold	−15.0457**	−15.0374**	−11.5473**	−11.5595**	−10.3715**	−10.5384**
	Energy Sector	−15.4517**	−15.8419**	−9.9265**	−9.8697**	−11.0550**	−11.2617**
Canada	Gold	−16.7225**	−17.4689**	−11.5689**	−12.0949**	−11.8820**	−13.0212**
	Energy Sector	−4.1694**	−18.9230**	−10.5272**	−10.5017**	−13.6463**	−13.4318**
China	Gold	−9.9267**	−16.6382**	−11.1284**	−11.1286**	−6.5594**	−11.9354**
	Energy Sector	−16.3452**	−16.3452**	−10.7762**	−10.7737**	−11.9379**	−12.0218**
India	Gold	−15.6110**	−15.6164**	−11.2099**	−11.2405**	−10.8648**	−10.8698**
	Energy Sector	−5.6106**	−18.8752**	−11.074**	−11.0021**	−14.3211**	−13.9716**

**Indicates rejection of the null hypothesis at 5 %. Critical values of ADF and PP test @ 5% Significance level for Full Sample, Pre-COVID and During-COVID period are −3.4272, −3.4450 and −3.4450 respectively

does not exhibit its role as a hedge or safe haven for energy sector indices. Only incase of India hedging potential of gold was revealed on account of no significant predictability among gold and energy sector indices.

5. CONCLUSION

Safe haven status of potential candidate assets is largely challenged in periods of crises. The global COVID-19 pandemic, being one of the recent crises has led to the collapse of crude oil and worldwide stock markets. To shield the investors from such a disastrous loss there arises an urgent need to re-evaluate the safe haven ability of traditional assets namely gold. Therefore, the present study investigates the safe haven ability of gold against extreme downturns in the stock market energy sector indices during COVID-19 distress. Motivated by rich prior literature, the study conducted a tail analysis by using a Cross-quantilogram approach by (Han et al., 2016). The methodological approach provides comprehensive scrutiny of safe haven property by considering potential heterogeneity across a range of quantiles. Daily data of gold and energy sector indices of range of countries that are strategically linked to major commodities i.e. gold and oil and also majorly hit by COVID-19 were analysed.

The results confirmed that during Pre-COVID crises, gold is no longer a hedge or safe haven against the energy sector indices of selected countries. While as we move from Pre-COVID to COVID crises period significant negative predictability among gold and energy sector indices was revealed for Saudi Arabia, Russia and Canada. These Countries are among the major oil exporting countries and a significant contribution to their revenue comes from the energy sector. On account of COVID-19 Pandemic the energy sector of these countries was severely affected and investors opted for the traditional candidates of safe haven asset namely gold.

REFERENCES

Aftab, M., Shah, S.Z., Ismail, I. (2019), Does gold act as hedge in the currency and stock markets in Asia? Global Business Review, 20(1), 105-118.

Arouri, M. (2012), Stock Returns and Oil Price Changes in Europe: A Sector Analysis. The Manchester School, 80(2), 237-261.

Aye, C.G., Carcel, H., Gil-Alana, L.A., Gupta, R. (2017), Does gold act as a hedge against inflation in the UK? Evidence from a fractional cointegration approach over 1257 to 2016. Resources Policy, 54, 53-57.

Baumeister, C., Hamilton, J.D. (2019), Structural interpretation of vector autoregressions with incomplete identification: Revisiting the role of oil supply and demand shocks. American Economic Review, 109(5), 1873-1910.

Baumöhl, E., Lyócsa, Š. (2017), Directional predictability from stock market sector indices to gold: A cross-quantilogram analysis. Finance Research Letters, 23, 152-164.

Baur, D.G. (2013), Gold-Fundamental Drivers and Asset Allocation. Available from: http://www.papers.ssrn.com/sol3/papers.cfm?abstract_id=2240831.

Baur, D.G., Lucey, B.M. (2010), Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. The Financial Review, 45(2), 217-229.

Baur, D.G., McDermott, T.K. (2010), Is gold a safe haven? International evidence. Journal of Banking and Finance, 34(8), 1886-1898.

Baur, D.G., McDermott, T.K. (2016), Why is gold a safe haven? Journal of Behavioral and Experimental Finance, 10, 63-71.

Beckmann, J., Berger, T., Czudaj, R. (2019), Gold price dynamics and the role of uncertainty. Quantitative Finance, 19(4), 663-681.

Beckmann, J., Berger, T., Czudaj, R., Hoang, T.H.V. (2019), Tail dependence between gold and sectorial stocks in China: Perspectives for portfolio diversification. Empirical Economics, 56, 1117-1144.

Bhanja, N., Dar, A. (2015), The beauty of gold is, it loves bad news-evidence form three major gold consumers. Economic Change and Restructuring, 48(3), 187-208.

Bouoiyour, J., Selmi, R., Wohar, M.E. (2019), Safe havens in the face of Presidential election uncertainty: A comparison between Bitcoin, oil and precious metals. Applied Economics, 51(58), 6076-6088.

Bouri, E., Shahzad, S.J., Roubaud, D. (2020), Cryptocurrencies as hedges and safe-havens for US equity sectors. The Quarterly Review of Economics and Finance, 75, 294-307.

Bredin, D., Conlon, T., Potì, V. (2015), Does gold glitter in the long-run? Gold as a hedge and safe haven across time and investment horizon. International Review of Financial Analysis, 41, 320-328.

Capie, F., Mills, T., Wood, G. (2005), Gold as a hedge against the dollar. Journal of International Financial Markets, Institutions and Money, 15, 343-352.

Ciner, C., Gurdgiev, C., Lucey, B.M. (2012), Hedges and safe havens: An examination of stocks, bonds, gold, oil and exchange rates. International Review of Financial Analysis, 29, 202-211.

Conlon, T., Corbet, S., McGee, R.J. (2020), Are cryptocurrencies a safe haven for equity markets? An international perspective from the COVID-19 pandemic. Research in International Business and Finance, 54, 101248.

Conlon, T., McGee, R. (2020), Safe haven or risky hazard? Bitcoin during the Covid-19 bear market. Finance Research Letters, 35, 101607.

Das, D., Roux, C.L., Jana, R.K., Dutta, A. (2019), Does Bitcoin hedge crude oil implied volatility and structural shocks? A comparison with gold, commodity and the US Dollar. Finance Research Letters, 36, 101335.

Elie, B., Naji, J., Dutta, A., Uddin, G.S. (2019), Gold and crude oil as safe-haven assets for clean energy stock indices: Blended copulas approach. Energy, 178, 544-553.

Fernandes, N. (2020), Economic Effects of Coronavirus Outbreak (COVID-19) on the World Economy. Available from: https://www.papers.ssrn.com/sol3/papers.cfm?abstract_id=3557504.

Gates, B. (2020), Responding to Covid-19-a once-in-a-century pandemic? The New England Journal of Medicine, 382(18), 1677-1679.

Georgios, B., Panagiotidis, T. (2015), Are gold and silver a hedge against inflation? A two century perspective. International Review of Financial Analysis, 41, 267-276.

Ghazali, M.F., Lean, H.H., Bahari, Z. (2018), Gold investment in Malaysia: Refuge from stock market turmoil or inflation protector? The Journal of Social Sciences Research, 2, 214-224.

Goodell, J.W. (2020), COVID-19 and finance: Agendas for future research. Finance Research Letters, 35, 101512.

Gurgun, G., Unalmış, I. (2014), Is gold a safe haven against equity market investment in emerging and developing countries? Finance Research Letters, 11, 341-348.

Han, H., Linton, O., Oka, T., Whang, Y.J. (2016), The cross-quantilogram: Measuring quantile dependence and testing directional predictability between time series. Journal of Econometrics, 193(1), 251-270.

Hood, M., Malik, F. (2013), Is gold the best hedge and a safe haven under changing stock market volatility? Review of Financial Economics, 22(2), 47-52.

Hung, N.T. (2020), Analysis of the time-frequency connectedness between gold prices, oil prices and Hungarian financial markets. International Journal of Energy Economics and Policy, 10(4), 51-59.

Iqbal, J. (2017), Does gold hedge stock market, inflation and exchange rate risks? An econometric investigation. International Review of Economics and Finance, 48, 1-17.

Ji, Q., Zhang, D., Zhaoc, Y. (2020), Searching for safe-haven assets during the COVID-19 pandemic. International Review of Financial Analysis, 71, 101526.

Joscha, B., Czudaj, R. (2013), Gold as an inflation hedge in a time-varying coefficient framework. North American Journal of Economics and Finance, 24, 208-222.

Joy, M. (2011), Gold and the US dollar: Hedge or haven? Finance Research Letters, 8, 120-131.

Kuan-Min Wang, Y.M., Lee, T.B., Thi, N. (2011), Time and place where gold acts as an inflation hedge: An application of long-run and short-run threshold model. Economic Modelling, 28, 806-819.

Kuan-Min, W., Lee, Y.M. (2016), Hedging exchange rate risk in the gold market: A panel data analysis. Journal of Multinational Financial Management, 35, 1-23.

Li, S., Lucey, M.B. (2017), Reassessing the role of precious metals as safe havens-what colour is your haven and why? Journal of Commodity Markets, 7, 1-14.

Lucey, B.M., Li, S. (2015), What precious metals act as safe havens, and when? Some US evidence. Applied Economics Letters, 22(1), 35-45.

McCown, J.J., Zimmerman, J.R. (2006), Is Gold a Zero-beta Asset? Analysis of the Investment Potential of Precious Metals. Working Paper No. 920396. Available from: http://www.papers.ssrn.com/sol3/papers.cfm/Abstract_id=920496.

Melvin, M., Sultan, J. (1990), South African political unrest, oil prices, and the time varying risk premium in the gold futures market. The Journal of Futures Markets, 10(2), 103-111.

Reboredo, J.C. (2013), Is gold a hedge or safe haven against oil price movements? Resources Policy, 38, 130-137.

Reboredo, J.C. (2013), Is gold a safe haven or a hedge for the US dollar? Implications for risk management. Journal of Banking and Finance, 37, 2665-2676.

Salisu, A.A., Adediran, I. (2020), Gold as a hedge against oil shocks: Evidence from new datasets for oil shocks. Resources Policy, 66, 101606.

Salisu, A.A., Ndako, U.B., Olokod, T.F. (2019), Assessing the inflation hedging of gold and palladium in OECD countries. Resources Policy, 62, 357-377.

Selmi, R., Mensi, W., Hammoud, S., Bouoiyour, J. (2018), Is Bitcoin a hedge, a safe haven or a diversifier for oil price movements? A comparison with gold. Energy Economics, 74, 787-801.

Shakil, M.H., Muhammad, I.M., Tasnia, M., Saiti, B. (2018), Is gold a hedge or a safe haven? An application of ARDL approach. Journal of Economics, Finance and Administrative Science, 22(44), 60-76.

Smith, R.D. (2006), Responding to global infectious disease outbreaks: Lessons from SARS on the role of risk perception, communication and management. Social Science and Medicine, 63(12), 3113-3123.

Zhang, D., Hu, M., Ji, Q. (2020), Financial markets under the global pandemic of COVID-19. Finance Research Letters, 36, 101528.