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Testing the role of gold in crisis: a global perspective

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Abstract

During the period of extreme financial turmoil, investors will include hedge and safe-haven assets in their portfolios. The present study looked at the dynamic link between gold return and the world stock return during crises. The study examined the conditional correlation between world stock and gold return. It investigated the usefulness of gold as a safe haven for stocks in the bear markets from January 2001 to June 2021 using daily MSCI stock index and gold price data. The crisis period is defined as the bear stock market in the present study, and bear markets were identified using the algorithm of Pagan and Sossounov (2003). Seven bear markets were identified for the purpose of the study. A combination of the DCC-GARCH model and OLS regression were employed to determine the relationship between gold and the MSCI world stock index. The study found that the dynamic conditional correlations are primarily negative in the bear markets under investigation. Gold performs the role of a safe haven for all bear markets except for the bear market from 2004-02-27 to 2004-06-30. It was concluded that gold acts as a robust, safe haven during turmoil and safe haven property depends on the severity of stock price changes. The findings have implications for policymakers and investors.

Keywords: *Gold, Stock market, bear market, DCC GARCH, crisis*

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1. Introduction

The world economy has witnessed exceptional growth in interdependence and market integration over the past few years. The parallel growth of the global stock market in terms of value and volume is remarkable. The significant expansion of the financial market has elevated the volatility and risk associated with the market. The global stock market has beheld many crises and widespread effects during the last two decades, with Covid-19 being the most recent. Thus, unlike before, it is more critical for investors to develop an immediate risk-minimizing investment strategy (Ji et al., 2020). During the period of extreme financial turmoil, investors will search for diversifiers in their investment portfolio. Exploring safe-haven assets is paramount to policymakers and investors amid crises. Generally, a haven is considered a place for the safety of investors' capital during emergencies. In the investment context, an asset is called a safe haven when "the asset that is negatively correlated or uncorrelated with another asset or portfolio in specific periods only, such as crisis times" (Baur & Lucey, 2010). Equity investors traditionally opted for safe-haven assets to avoid impending financial losses during a period of intense uncertainty. (Baur & McDermott, 2010; Baur & Lucey, 2010).

In the past, gold was considered a store of value, a portfolio stabilizer, and a source of liquidity during uncertain market episodes (Chemkha & Tayachi, 2021). Gold is identified as a universal, highly liquid, durable, and tangible commodity and is often perceived as a potential safe haven candidate. It is a versatile asset with many characteristics. According to Hoang et al., 2016, gold is a hedge against inflationary pressure. The counter-cyclical reaction of gold to macroeconomic news (Elder et al.,2012) is another peculiar feature of the asset. It works differently from other assets during nomadic market episodes, especially stocks. Gold retains its value even when the stock prices fall. Figure 1 depicts the evolution of the price of gold and the Morgan Stanley Capital International (MSCI) World Equity index from 1st January 2001. It could be observed that gold price is performing well compared to the MSCI world index. As compared to the loss suffered by the stock in the financial market during the financial crisis of 2007-09, the performance of the price of gold is much remarkable. Gold is considered as a currency, commodity, and tool for risk aversion. Gold has been retained by a group of investors known as "gold bugs," reckoning it as a vital safe, and liquid asset (Simon, 2013). Physical gold possesses no default risk. (He et al., 2020). Since the last two decade has been marked by the global crises, it is relevant to identify whether gold offers diversification benefits during the period. It is imperative to know the role of gold as a safe haven instrument during major global crises, which will be significant to the investors for arranging their investment strategies accordingly.

Figure 1. Price of Gold and MSCI index in US dollar

2. Literature Review

Studies have focused more on the risk aversion attribute of the gold, acting as a hedge, portfolio diversifier, and haven in the period of economic uncertainties and turbulent market environments (Baur & Mcdermott,2010; Robiyanto, 2013; Wen et al., 2018; Ang & Weber, 2017; Ghorbel et al., 2021; Akhtaruzzaman et al., 2021; Yousaf et al., 2021). But the results are mixed in nature. Some studies provide evidence of the hedge and safe haven properties of Gold (Baur and Lucey, 2010; Ibrahim, 2011; Almudhaf, 2012; Robiyanto, 2013; Beckmann et al., 2015; Seetharam, 2015; Liu et al., 2016; Mensi et al., 2015; Kumar, 2020; Ghorbel & Jeribi, 2021) whereas a strand of literature rejects these findings (Chen & Wang, 2017; Ang & Weber, 2017; Rahim et al., 2018; Corbet et al., 2020; Manohar & Raju, 2021). There is a lack of concord among the researchers about the investment role of gold. Baur and Glover (2012) opined that there is a likelihood of deterioration in the hedging potential of gold as it is being traded extensively for investment and speculation purposes. Klein (2017) shows that the precious metal plays the role of a hedging instrument in European and US markets, but it has significantly reduced after 2013. In this context, it is essential to study the role played by gold during the crisis period. Hence, the present study investigates the role of gold as an investment asset during the crisis by examining the relationship between gold and the MSCI world index.

The existing literature mainly uses the quantile GARCH method to find out the diversification property of gold during the period of crisis. In this literature, arbitrary

quantiles are used to define the crisis period as "an asset's returns being in the bottom 5% or 1% quartile of the sample" (Baur & Lucey, 2010), then examine the relationship between gold and the base asset in that quantile (Baur & Lucey, 2010). Further, most studies are conducted at the country level or based on a group of countries. Hence the contribution of the present study can be mainly in three ways. First, the study defines the crisis period as the bear stock market in lieu of extreme market movements. Second, the present study explicitly employed the Pagan and Sossounov (2003) algorithm to date the bear stock market. Finally, the study examined the investment role of gold during the crisis period from a global perspective.

3. Data and Research methodology

The present study tests the dynamic relationship between MSCI World Equity Index and Gold globally. The study period is from 1 January 2001 to 30 June 2021, marked by four major global crises: the Sovereign debt crisis, Dot-com Bubble, Global financial crisis, and Covid 19 crisis. Daily prices of gold were collected from the website of the World Gold Council, and daily prices of the MSCI index were collected from the website of the MSCI index solution.

3.1 Methodology

The study is based on the definition of Lucey and Baur (2010). Accordingly, “a hedge (safe-haven) asset is an asset that is uncorrelated or negatively correlated with another asset or portfolio on average (in times of market stress or turmoil)." The study found a dynamic conditional correlation (DCC) between MSCI world equity and gold returns in the bear markets. If the correlation between gold and MSCI stock return is zero or negative in a bear market, then gold can be considered a haven in that bear market. For this purpose, the study will determine the contemporaneous dynamic correlation between the variables to examine the time-dependent relationship between the return of stock and gold. DCC-GARCH model of Engle (2002) is employed for estimating the dynamic correlation. Since the model will provide a dynamic correlation between two or more time series, it is more suitable for the present study as compared to other GARCH models. There are two steps involved in estimating the DCC-GARCH model. Parameters of the GARCH model will be computed firstly, and subsequently, dynamic conditional correlation (DCC) will be estimated. The equation for the same is

$$H_t = D_t R_t D_t \quad (1)$$

H_t represents n × n matrix of conditional covariance; R_t represents the matrix of conditional correlation and diagonal matrix with dynamic standard deviations provided by matrix Dt

$$D_t = diag\left(h_{1,t}^{\frac{1}{2}}, \dots h_{n,t}^{\frac{1}{2}}\right) \quad (2)$$

$$R_t = diag\left(q_{1,t}^{\frac{-1}{2}}, \dots q_{n,t}^{\frac{-1}{2}}\right) Q_t diag\left(q_{1,t}^{\frac{-1}{2}}, \dots q_{n,t}^{\frac{-1}{2}}\right) \quad (3)$$

The symbol h represents univariate GARCH models. For the GARCH (1,1) model, htis represented by the following equation:

$$h_{i,t} = \mathrm{c} + \alpha\, \mathrm{u}^2{}_{i,t} + \beta\, h_{i,t} \quad (4)$$

$h_{i,t}$ is the conditional variance, u is the residual term. c is constant, α is the parameter that capture the ARCH effect and β is the parameter that capture the GARCH effect. where Qt stands for symmetric non-negative definite matrix

$$Q_t = (1 - \theta_1 - \theta_2)\bar{Q} + \theta_{1z_t - 1z'_{t-1}} + \theta_2 Q_t - 1 \quad (5)$$

Where Q be a symbol of n × n matrix of unconditional correlation of the standardized residuals. The parameters θ1 represents the effect of previous shocks on current DCC and θ2is an indicator of effect of previous DCC on current DCC. The model determines only these parameters, which seems to be one of the merits of this model to arrive at an optimum solution.

Following the DCC GARCH model estimation, the dynamic correlations Qt are extracted from equation (5) into a time series representing DCC between the Gold and MSCI index.

After estimating dynamic conditional correlation, the next step is to run a regression with dummy variables representing the bear markets to ascertain the safe-haven role of gold in the bear market.

The ordinary least-square regressions of the estimated DCCs and binary variables are given as

$$p_{12,t} = \gamma_{0+}\gamma_1 D + \varepsilon_t \quad (6)$$

Where D represents the dummy variable representing bear markets which will take the value equal to 1 in the bear markets; otherwise, 0, if the value of D is significantly negative, the gold is a safe haven in that bear market. According to Baur and Lucey (2010), if the value is positive and significant, it is a diversifier. For the purpose of full sample analysis, the present study followed the method of Ratner and Chiu (2013), wherein the equation 7, D is a dummy variable representing extreme movement in the 10%,5%, and 1% quantiles of return distribution which takes the value of 1 if the return is below 10%,5% and 1% and otherwise zero.

4. Data analysis and empirical findings

The study aims to examine the time-varying relationship between gold returns and the returns of MSCI stocks. The descriptive statistics of the variables and the results of stationarity tests are given in Table1. The summary statistics of the returns and the unit root test are provided in Panel A and B of Table 1, respectively. The coefficient of skewness indicates that the distribution of returns for both variables was negatively skewed, and kurtosis coefficients show that both time series' returns

were not normally distributed. Furthermore, the JB test confirms that the distribution is not normal as the null hypothesis is rejected at a 1% significant level for both variables.

Table 1. Descriptive statistics (1 January 2001 to 30 June 2021) and unit root test for return series

PANEL A		
Descriptive statistics	Gold return	Stock return
Mean	.000348	1.000295
Median	0.000040	1.000659
Max	.0684	1.0931
Min	-0.095962	0.904982
Std.Dev	0.010812	0.010084
Skewness	-0.314701	-0.457790
Kurtosis	5.610	11.174986
JB	7086.2*	27957*
Observation	5348	5348
PANEL B		
Unit root tests	Gold return	MSCI return
ADF	-73.39100*	-66.08850*
PP	-73.39562*	-66.06140*
DF-GLS	-73.32551*	-66.02463*

Note. *Significant at 1%

The results of the stationary tests, ADF, PP, and DF-GLS tests, indicate the significant test statistics at a 1% significance level, which means the rejection of the null hypothesis. It means that the variables are stationary and thus appropriate for further econometric analysis.

There will be issues related to serial correlation in time series data. Under such a situation, the most appropriate model is GARCH. Table 2 provides the test statistics for serial correlation and for heteroscedasticity. It was found that serial correlation is present in the gold and stock index return. In addition, the Engle (2002) test was significant. It indicates the presence of heteroscedasticity in returns. The presence of serial correlation and ARCH effects give the reason for choosing the GARCH model to study the dynamic link between world stock indexes and gold.

Table 2. ARCH and Ljung-Box Q test

	Q(13)	ARCH(1)	ARCH(5)	ARCH(10)
Gold return	23.649*	42.67190*	52.11222*	34.71085*
MSCI return	100.35*	469.0659*	390.8752*	218.8743*

Note. *Significant at 1% level

Before estimating the dynamic link between gold and the MSCI index in bear markets, it is essential to understand the role of gold during the full sample period. Table 3 provides the result of quantile regression where the quantiles (10%,5%,1%) represent the crisis period.

Table 3. Relationship between gold and MSCI world index in the full sample period

Regression results	Gold return
Diversifier (m_0)	0.20045*
10% MSCI index quantile(m_1)	0.11596*
5% MSCI index quantile(m_2)	0.05727*
1% MSCI index quantile(m_3)	-0.442267*

* Significant at 1% level

The results indicate that during normal conditions, gold is a diversifier with no risk reduction ability against the MSCI stock index and the two assets comove with each other implied by the positive coefficient m0. Gold is a safe haven in extreme price changes indicated by the 1% MSCI index quantile. As the severity of price changes decreases, the gold lost its safe-haven property against the MSCI index.

4.1 Identification of bear markets

According to Chen and Liu (2014), the bear market is a "period when the stock market is down for more than 20% from its most recent highs to its corresponding relative minima" (Chen & Lin, 2014). The study provides a financial definition of the crisis period using the MSCI stock bear markets period computed by implementing the Pagan and Sossounov (2003) algorithm. By employing the methodology of Pagan and Sossounov (2003), it is possible to reproduce and revise the bear market dates derived by the authors. Since the study is from a global perspective, it is crucial to focus on the bear market in the worldwide stock market represented by the MSCI index. The dating methodology could not be applied to higher frequency data; hence the study employed a monthly MSCI index. Therefore, it reduces the risk of noise in the daily data and handles the limitation associated with the arbitrary choices of bear market dates in defining the crisis period.

Table 4. MSCI bear stock markets from 1 January 2001 to 30 June 2021

	Period	Duration	Amplitude	Origin
Bear market I	2002-03-29 to 2002-08-30	6	-23	Dotcom bubble, September 11 attack
Bear market II	2004-02-27 to 2004-06-30	5	-3	Madrid Terrorist attack
Bear market III	2007-10-31 to 2009-01-30	16	-53	Global financial crisis
Bear market IV	2011-04-29 to 2011-08-31	5	-19	European sovereign debt crisis
Bear market V	2014-08-29 to 2016-01-29	18	-9	Chinese stock market turbulence
Bear market VI	2018-01-31 to 2018-11-30	11	-10	Cryptocurrency crash
Bear market VII	2019-12-31 to 2020-02-28	3	-20	Covid-19 Pandemic

Table 4 shows the bear market period since 2001, the reason for the origin of the bear market, its duration, and its amplitude. There exist seven bear markets during the last 20 years of MSCI stock market data. The bear market is more severe during the global financial crisis, as indicated by its amplitude, and less intense during the bear market II.

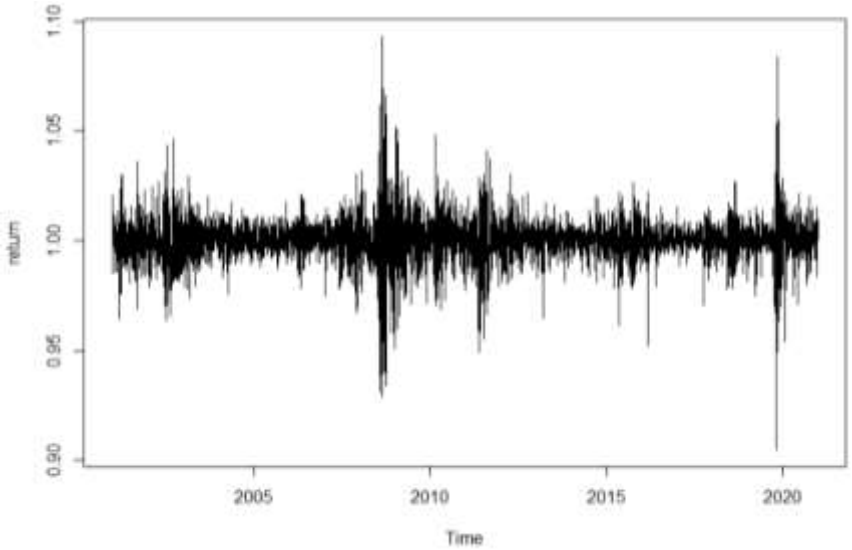

Figure 2. Return of MSCI index (1 January 2001 to 30 June 2021)

Source: Authors' data analysis

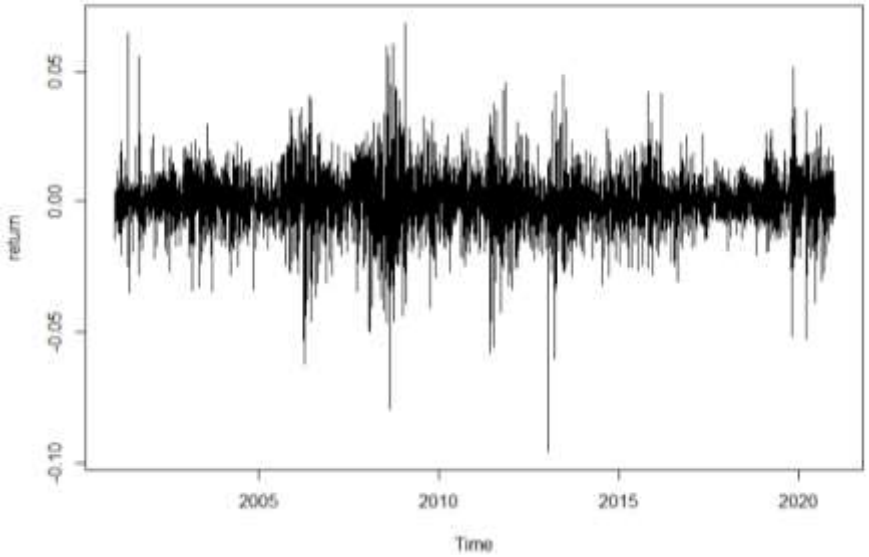

Figure 3. Return of gold index (1 January 2001 to 30 June 2021)

Source: Authors' data analysis

The changes in the volatility of returns are depicted by time-series graphs of returns (figure 2). There is volatility clustering present in each time series, which again provides evidence of ARCH effects in each series. The confirmed conditional heteroscedasticity also validates the use of GARCH (1,1) to depict the volatile nature of the returns. Hence all these results confirm that the GARCH model is appropriate

After identifying the bear market, the next step is to estimate the parameters of the GARCH (1,1) model to compute the dynamic variance of the return series; The computed parameters are provided in Table 5. The parameter of ARCH and GARCH estimated is α and β, respectively. The results indicate a high level of persistence as interpreted from the addition of the parameters α and β, which is close to unity for both contemporaneous and lagged relationships. This also indicates the goodness of fit of the models. It was also observed that α has a low value and β has a high value, which shows the resistance of correlation to shocks, and it relapses to mean very quickly. This is an indication of a stable correlation among variables. The value of the β for both the variables were 0.87 and 0.94. This indicates the high persistence of volatility over the period.

Table 5. Parameters of univariate GARCH (1,1) model

Variable	Parameters	coefficient	Std. Error	t value	Prob.
Gold-MSCI contemporaneous relationship					
Gold return	C	0.000001	0.000003	0.45806	0.646907
	α	0.049262	0.030609	1.60941	0.107527
	β	0.940350*	0.034061	27.60743	0.000000
MSCI return	C	0.000001	0.000002	0.69241	0.488678
	α	0.118295*	0.038390	3.08140	0.002060
	β	0.871054*	0.037206	23.41184	0.000000
Gold-MSCI lagged relationship					
Gold return	C	0.000001*	0.000003	0.39834	0.015341
	α	0.049152	0.036205	1.35760	0.174591
	β	0.940124*	0.040304	23.32592	0.000000
MSCI return	C	0.000001	0.000002	0.71461	0.474847
	α	0.118316*	0.037506	3.15454	0.001608
	β	0.870864*	0.036379	23.93872	0.000000

Note *significant at 1% level.

4.2. Contemporaneous relationship between gold and MSCI world index in the bear markets

The present study estimated the DCC-GARCH model with a multivariate student t distribution to consider the non-normality in the return distribution. Table 6 provides the parameter estimates of the DCC GARCH model. As implied by the parameters θ1 and θ2, the correlation was persistent in the estimated DCC model. The sum of θ1

and θ2 was closer to unity, indicating that the dynamic correlation was more apparent and stronger. The value of DCC coefficients fluctuates between −1 and +1.

Table 6. Parameter estimates of model

Variable	Parameters	coefficient	Std. Error	t value	Prob.
MSCI return-gold return	θ1	0.029581*	0.007394	4.00082	0.000063
	θ2	0.957881*	0.012729	75.25104	0.000000

Note. *significant at 1% level

A closer coefficient to -1 indicates a strong and negative correlation between the stock and gold index. Coefficient more relative to +1 implies a stronger positive correlation between stock index and gold. A coefficient equal to 0 means there is no association between gold and stock. The DCCs are primarily positive for 72% (3877/5348) of the observations for the sample period. This indicates that an increase in the price of gold is often associated with an increase in the value of the MSCI stock index. Thus, it is evident that including gold in a portfolio of the MSCI stock index will not reduce the portfolio risk the majority of the time.

Table 7. The estimates of regression analysis between the MSCI index (Contemporaneous) and gold

	Bear market						
	I	II	III	IV	V	VI	VII
Gold-MSCI	-0.3125*	0.2093*	-0.0549*	-0.0763*	-0.0960*	-0.0595 *	-0.4075*

Note. *Significant at 1%

The coefficients of regression analysis between DCC and dummy variables for bear markets indicate that Gold and MSCI return correlate negatively and significantly in six out of seven bear markets. The result shows that gold is a safe haven during most bear markets identified except bear market II. The finding is consistent with Baur and Lucey (2010) and Coudert and Raymond (2011), where gold is a safe haven in bear markets. In bear market II, gold acts as a diversifier positively and significantly correlate with the MSCI index. When the results are compared with the amplitude and duration of bear stock markets, bear market II is characterized by low amplitude. It could be inferred that gold does not perform the role of a safe harbor in a bear market with low amplitude. Since amplitude is an indicator of changes in the price of a particular security over time, it could be inferred that gold does not perform the role of a safe harbor for the bear market caused by minor price changes. Bear market II originated from the terrorist attack for a short duration, after which the effect disappeared even though the market took more time to recover. This indicates the short-lived property of gold as a safe haven (Baur & Lucey, 2010). Further, it is possible to infer that the safe-haven property of gold varies with the nature of crises. Although gold performed as a safe-haven role during financial crises, it was not so during the terrorist attack of 2004. The DCC of stock and gold is given in figure 4, which shows that the correlation alters between negative and positive values over time.

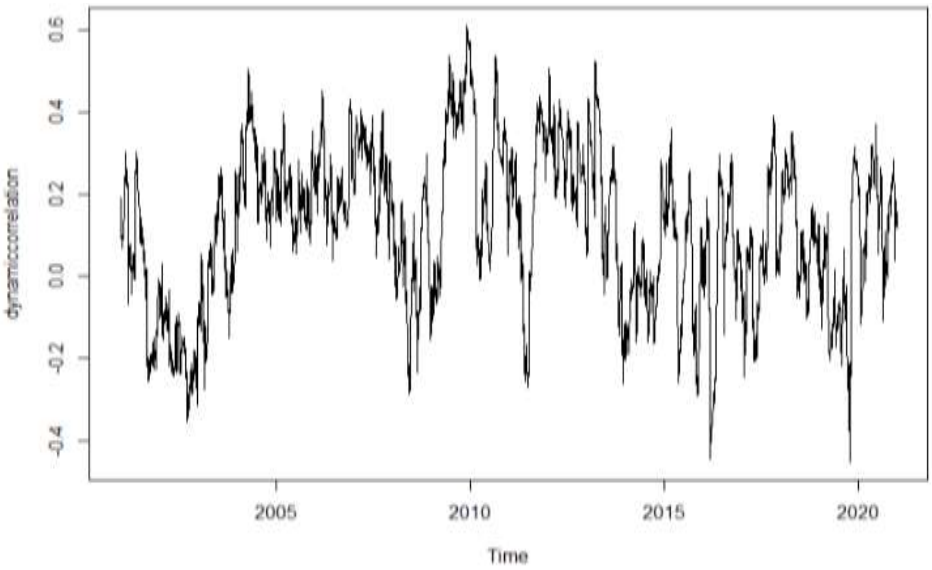

Figure 4. DCC between Gold and MSCI stock index (contemporaneous)
Source: Authors' data analysis

4.3 Relationship between gold and one period lagged MSCI stock index in the bear market

The market players are looking to identify the ability of one asset's price movement to disseminate useful information for the movement of other asset prices in the future (Filis and Floros, 2011). According to Ciner et al. (2013) the return of gold depends on the contemporary and one period lagged return on stocks. The analysis of the relationship between gold and contemporaneous return on MSCI stock was conducted, and the results are depicted in the previous section. This section deals with analyzing the relationship between gold return and one period of lagged return of stocks in the bear market. The current model framework shown by equation (4) remains the same for this analysis. The only change is the dynamic correlation between the gold asset's log return of the current date and the MSCI stock market log return of the previous date was taken for the analysis.

Table 8. Parameter estimates of the model (lagged relationship)

Variable	Parameters	coefficient	Std. Error	t value	Prob.
Gold-MSCI return	θ1	0.001678	0.001188	1.41227	0.157870
	θ2	0.996168*	0.002155	462.21837	0.000000

Note. *significant at 1% level

It was found that the dynamic conditional correlation is also primarily positive for the whole study period, which implies that an increase in the price of MSCI is related to the increase in the lagged price of the MSCI stock index. It suggests that including

gold in the portfolio of the MSCI index will not provide diversification benefits all the time. Having found this, it would be beneficial to the investors to understand the protection provided by gold during the lagged bear stock market. Table 9 depicts the estimates of regression analysis between the lagged value of MSCI stock returns and gold returns.

Table 9. The estimates of regression analysis between the MSCI index (lagged) and gold

	Bear market						
	I	II	III	IV	V	VI	VII
Gold-MSCI	-0.0193*	0.0243*	0.0330*	0.0069*	-0.0112*	-0.0100*	-0.0310*

Note. *significant at 1% level

From Table 9, it is clear that gold is not a safe haven in all the bear markets. It was a safe haven in four out of seven bear markets when considering the previous stock return and current gold return.

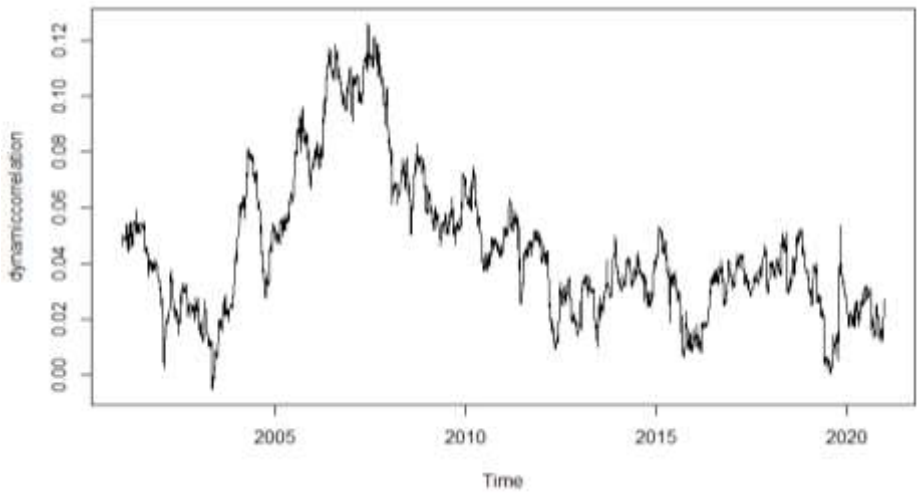

Figure 5. DCC between gold and MSCI stock index (lagged)

Source: Authors' data analysis

5. Conclusion

The present study investigated the dynamic link between the world stock markets and gold globally. The study examined the dynamic correlations between the return of stock and gold and checked the usefulness of gold as a diversifier for stock in the bear markets from January 2001 to June 2021 using daily MSCI stock index and gold data. The crisis period is defined as the bear stock market in the present study, and bear markets were identified using the algorithm of Pagan and Sossounov (2003). Seven bear markets were identified for the purpose of the study. DCC-GARCH model was employed, and it was found that the dynamic conditional correlations are

primarily negative in the bear markets under investigation. Gold provides diversification benefits for all bear markets except for the market from 2004-02-27 to 2004-06-30. It was concluded that the gold is a robust safe haven during the crisis period and this property of safe haven depends on the severity of price changes. The study further estimated the lagged relationship between the return series and found out that gold is a safe haven in the majority of bear markets. The findings have implications for policymakers and investors. The results will shed light on formulating the appropriate investment strategies for investment in gold during the crisis period. If there are minor price changes in the stock market with regard to amplitude and duration, it signals the absence of the safe-haven property of gold. The present study is limited to the bear stock market. Future studies can be extended to other contexts, periods, and non-bear stock markets to study the role of gold as an investment instrument.

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