Dialogue Social Science Review (DSSR)
www.journalforeducationalresearch.online

ISSN Online: 3007-3154
ISSN Print: 3007-3146

DIALOGUE SOCIAL SCIENCE REVIEW

Vol. 2 No. 5 (December) (2024)

Hedge, Diversifier and Safe Heaven Properties of Precious Metals against UK Stocks During COVID-19 Pandemic

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Abstract
This research study examines the hedging, safe haven, also diversification properties of precious metals, specifically silver, gold, and platinum, in relation to the UK stock market. To evaluate the hedging and safe haven qualities of precious metals, this research paper uses a multivariate vine copula-based GARCH model. To investigate the diversification ability of precious metals, a Bivariate Value at Risk-based copula (BiVaR) method are utilized. According to our empirical findings, which are in line with earlier research, gold, a precious metal, offers the UK the best safe haven property during the COVID-19 pandemic. Gold may thus be used to counteract equities market losses during turbulent times. Nevertheless, since silver is supplementary lightly traded, commanding it most illiquid and volatile, it is not seen as a safe haven asset for the other UK stock markets. Regarding platinum, it is a poor hedge and a gold mine for the UK stock market. Additionally, consistent with previous research, our analysis indicates that gold maintains a powerful hedging ability in established stock markets. The findings suggest that platinum and silver might function as weak hedging assets. Lastly, all precious metals show diversification advantages for investors in UK stock markets, according to the BiVaR analysis's findings. Overall, our findings may be quite advantageous to investors.
Keywords: UK stock markets, Precious metals, safe haven, BiVaR, diversification, hedge, vine copula

Introduction

Precious metal prices have risen because of raising interest in holding them after the Global Financial Crisis. The significance of precious metals—virtually gold—as significant value repositories and risk diversifiers is what has sparked this interest (Lucey and Tully, 2006; Adrangi et al., 2003). One of the areas of the financial literature that has grown the fastest over the previous ten years of instability is the literature on the safehaven and hedging potential of valuable metals, particularly gold. By investigating the safehaven, hedge, as well as diversification qualities of valuable metals—specifically, silver, gold, and platinum—for the UK utilising more adaptable models based on copula, known

ISSN Online: 3007-3154
ISSN Print: 3007-3146

as vine copula, which enable a better analysis, the study seeks to advance the scholarly discussion on the association among stock markets and precious metals. Additionally, we use the BiVaR approach to further analyze our findings.
Gold could be used as a safe haven throughout periods of instability and as a hedging asset against the stock market during normal times, agreeing to the literature currently in publication (Baur and Lucey, 2010; Ciner et al., 2013; Baur & McDermott, 2010; Beckmann et al., 2015; Reboredo, 2013; among others). Additional valuable metals, which frequently share characteristics with gold, have recently gained more attention than gold. Exchange rates (Reboredo, 2013b; Cinder et al., 2013; Bedoni et al., 2019; Naguyen et al., 2020), inflation (Salisu et al., 2019; Hoang et al., 2016), prices of oil (stated by Rahman et al., 2018), and indices of stock market (Hood & Maalik, 2013; Ali et al., 2020; Mensi et al., 2015) are just a few of the market risks that Precious metals may function as a hedging asset against. Other research (Laucey and Li, 2015; Talbi et al., 2020; Balcilar and Ozdemir, 2019) have established the volatility spillover, dynamic interlinkages, and stochastic features of precious metals. These studies are crucial for providing investors with information on hedging tactics.
Precious metals have a varied function in preventing equities volatility, according to earlier research on their safe-haven and hedging qualities for stock markets. Gold, which is frequently refer to as a safehaven and hedge asset, has been the subject of many studies, including those by Baur and Lucey (2010), Hood and Maalik (2013), Baur and McDermott (2010), Bredin et al. (2015), Cinder et al. (2013), and Shahzad et al. (2017). The list of possible safe havens and hedges has been extended to include additional precious metals in recent research (e.g., Laucey and Li 2015; Li and Laucey 2017; Low et al., 2016; Ali et al., 2020). Overall, even though the influence of precious metals has been recorded in the literature, the outcomes vary greatly depending on the market. Given the utilization of various market factors, different nations, diverse time periods, and different methodology, this is partly to be anticipated. This encourages us to investigate this subject more. Numerous econometric techniques have been employed to investigate the relationships among valuable metals and stock markets. These techniques can be categorized as wavelet models (Bredin et al. 2015), vector autoregression (VAR) models (Wan and Kao 2015), biivariate copulas (Naguyen et al. 2016), quantile regression procedures (Shehzad et al. 2017; Ali et al.,2020).
Specifically, this study's contribution is comprised of three primary elements. In order to determine if valuable metals are a good or weak safehaven and hedge for the stock market, foremost we expand the examination of their hedging as well as safehaven characteristics by the multivariate dependency modeling utilizing a GARCH model based on vine copula. Standard multivariate copulas, like the multivariate Gaussian or Student-t copulas, have trouble modeling the dependence structure among greater numbers of variables and have a problem with parameter constraints, which prevents them from allowing for unlike dependency structures among pairs of variables. This makes utilizing copulas in higher dimensions difficult.
Therefore, by offering a variable and restricted dependency structure relating the variables, the usage of vine-copulas circumvents the limiting features of bivariate copula (Ji et al. 2018; Brechmann & Czado 2013). As a result, risk management,

ISSN Online: 3007-3154
ISSN Print: 3007-3146

time series models, and other related fields have made extensive use of the vine copula technique. However, in this analysis, we evaluate the safe haven and hedging features of precious metals applying the knowledge of dependency on standard and in intervals of severe market circumstances supplied by the vin-copula. Second, we provide a fresh interpretation of the term "strong safe haven" attribute. Since the copula offers a non-zero likelihood of dramatic price fluctuations to test for un-correlated sequences, it can really only test for weak safe havens. Therefore, in order to get over this restriction, we suggest calculating the tail-correlation utilizing modeled data from the greatest-fitting copula model in order to thoroughly test for the strong safehaven quality of valuable metals. Lastly, a BiVaR innovative approach put out by Bedoui et al. (2018) will be used to determine if precious metals provide UK investors the possibility of diversification. To our best knowledge, we are the first to apply the copula approach based on BiVaR. This parameter is still important when combining the VaR and copula approaches. Actually, by using copulas, it is possible to create a bydimensional Value at Risk level graph and analyze the "Marginl Rate Of Substittutions" (TMS) among the stock index and the Value at Risk of precious metals for a risk level.

This chapter's remaining sections are organized as follows: The literature review is displayed in Section 2. The data and technique are developed in Section 3. The empirical findings of our investigation are reported and discussed in Section 4. Section 5 comes to a conclude the research.

Literature review

The significance of valuable metals like gold and others as safe havens, hedges, and diversifier assets for stock markets is the subject of a growing body of contemporary study. Despite the abundance of research on precious metal markets, the most in-depth analysis has been done on the gold market.

According to the first operational definition of safe haven and hedge given by Baur and Laucey (2010), an asset is deemed a strong (weak) hedging instrument if it has an average negative correlation (un-correlated) with another asset. When an asset is negatively correlated (uncorrelated) amid severe market circumstances, it is regarded as a strong (weak) safe haven instrument. These theories, however, are predicated on linear-models, which typically examine linear-correlation and are unable to account for uncommon occurrences on distribution tails.

In order to assess gold as a safehaven also hedge , they use daily data from 1995 to 2005 to analyze the static and time-fluctuating relationships between the stock returns of the UK, US, and Germany and gold. They discover that gold is a useful instrument for stock hedging and may act as a refuge during volatile stock market times. Corresponding to the work of Baur & Laucey (2010) and Baur & McDermott (2010) use multiple-frequency data from 1978 to 2009 to observe the connection amongst gold and stock markets in industrialized and developing nations. They analyze the time-varying link between the global portfolio index and gold return using rolling window regression. They uncover that gold is only a safehaven as well as hedge in the US and European markets, not in the markets of the BRIC countries (Japan, Canada, and Australia). Hood and Malik (2013), using the same methodology, investigate the role of platinum, gold, and silver as

ISSN Online: 3007-3154
ISSN Print: 3007-3146

safe havens and hedges against the US stock market in relation to the Volatility Index (VIX). They discover that, in contrast to gold, platinum as well as silver do not behave as safe havens or hedges against the US stock market. In a comparable vein, Araouri et al. (2015) examine volatility and return spillovers among global gold prices and the Chinese stock market using a bivariate VAR-GARCH model from March 23, 2005 to March 31, 2011. They discover strong cross-effects between the variables in terms of volatility and return, suggesting gold could be a safehaven for the Chinese stock market.

Using bivariate copula-based GARCH models, Shen et al. (2013) examine the dependency formation between the price of gold, the stock price indexes of gold extracting enterprises, also the Shenghai Composite Index of China. They discover that, in contrast to other research, the price of gold has a positive correlation with stock market returns.

The volatility and mean transmission among the Indian industrial sectors and gold are examined by Kumar (2014). He uses an extended "VAR-ADCC-BVGARCH" model to find uni-directional and large return spill over from gold to stock segments. According to him, gold is a useful asset class that may act as a hedge against different markets and enhance the risk-adjusted implementation of a sound-diversified stock portfolio.

Lucey and Li (2015) use daily data from 1988 to 2013 to explore the safe haven characteristics of four valuable metals (gold, platinum, silver, as well as palladium) employing the Dynamic Conditional Corelation (DCC) and Multivarite GARCH Model. They discover proof that platinum and silver may behave as safe havens at certain times when gold does not, and that the impact can sometimes be more pronounced.

The UK, Philippines, Malaysia, Indonesia, US, Singapore, Japan, and Thailand are the seven nations where Nguyen et al. (2016) look at the function of gold as a safe haven. Using bivariate copulas, they discover that, in the case of the US, Malaysia, UK, Singapore, and Thailand markets, gold may be a safehaven asset throughout a market meltdown, but not for the Japanese, Indonesian, or Philippine markets.

Building on the work of Li and Lucey (2017) and Laucey and Li (2015), use daily data started from January 1995 to July 2017 to compare the safe haven qualities of precious metals vs changes in stock markets across a broad range of nations. Every metal could act as a safe haven for the stock market throughout tail events, agreeing to Baur and Laucey (2010) and Bauur and McDermott (2010) who both provide the typical methodology.

Klein (2017) uses daily data from January 2000 to December 2016 to investigate the relationship between developed markets and valuable metal prices. Applying the DCC-GARCH model, researchers observes that although platinum acts as a substitute for physical time safe haven under severe market situations, silver and gold behave as safe-haven assets.

Gold's status as a safe haven asset for US and UK investors is reexamined by He et al. (2018). Using a "Markov-switching-Capital Asset Pricing Model" (CAPM) technique, they discover that although gold is a reliable hedge, there isn't a clear safe haven state between it and the US or UK stock markets.

The ability of oil and gold to hedge against risk in stock market during financial crises is examined by Junttila et al. (2018). They discover that during financial

Dialogue Social Science Review (DSSR)
www.journalforeducationalresearch.online

ISSN Online: 3007-3154
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crises, there is a inverse correlation relating the gold and stock markets. As a result, the gold market offers a more effective hedge against stock market risks than the oil market.
The safe-haven, hedging, and potentials for varied diversification of 23 goods, including valuable metals—for 48 global stock markets have recently been reexamined by Ali et al. (2020). They discover that gold, in particular, and precious metals in general provide robust safehavens for both established and frontier stock markets employing the cross-quantilogram technique, which examines quantile dependency over the whole quantile range.

Methodology

Data explanation

Data on daily prices for stock indexes and precious metals are taken into account in this research. The London Bullion Market (LBMA) sets the price of silver in US dollars per kilogram, the PM fixing of the price of London platinum in US dollars per Troy ounce, and the PM fixing of the price of gold in US dollars per Troy ounce. The FTSE 100 (UK) stock market indexes are taken into consideration. The research period, which spans the COVID-19 pandemic, goes from January 1, 2013, to February 5, 2022. All information was priced in US dollars and taken from DataStream, Thomson Reuters subsidiary. In order to get Rt=ln(Pt)-ln(Pt-1), where Rt is the return at time t and (Pt) and (Pt-1) are the current price and one-period lagged price, respectively, all variables are converted to log of returns, that are well-distinct as the first difference in x the natural log of the prices on daily basis.

Vine copulas

Copulas have been effectively used to represent joint distributions of random variables in a number of empirical publications. Every n-dimensional multivariate distribution may be broken down into a unique copula and n marginal distributions and, according to Sklar's (1959) theorem. Formally speaking:

$$F(x_1, x_2, \ldots\ldots\ldots, x_d) = C(F_1(x_1)F_2(x_2)\ldots\ldots\ldots, F_n(x_n)) \quad (1)$$

where Fi=,Fi(xi) is the marginal distribution for i=1, 2,...n, and F is a joint distribution of x1,x2,.....xn. Assume that C and Fi can be distinguished from one another. The joint density function is therefore described as follows:

$$f(x_1, x_2, \ldots\ldots\ldots, x_d) = \Pi_{i=1}^{n} f_i(x_i)C(F_1F_2(x_2)\ldots\ldots\ldots, F_n(x_n)) \quad (2)$$

where C is the copula's density and Fi=,Fi(xi) is the (unconditional) density of Fi. Therefore, the marginal distributions of every variable also the copula that joins these marginal distributions into a combined distribution are the two contributions that the copula-function pulls from the combined distribution. This is because the copula transforms the marginal distributions into a combined distribution.
They can only explain the dependency structure among variables using one or two parameters due to the wide range of bivariate copulas. The dependency in the multivariate scale is therefore not well captured by multivariate Elliptical or

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Archimedean copulas, despite their ease of generation. Consequently, we may use the vine copula technique, a more adaptable alternative extent to represent the dependency structure across assets, to go beyond these conventional multivariate copulas. (Aas et al., 2009; Kurowicka & Cooke, 2006; Bedford & Cooke, 2001, 2002; Joe, 1997). The technical definition of a vine copula is the construction of a multivariate joint allocation from a sequence of conditional and un-conditional bi-variate copulas. A vine copula is defined technically as a series of nonconditional as well as conditional bi-variate copulas from which a multivariate joint distribution is constructed.

$$f(x_1, x_2, \ldots\ldots\ldots, x_d) = \Pi_{i=1}^{n} f_i(x_i) C(F_1, F_2(x_2) \ldots\ldots\ldots, F_n(x_n)) \quad (3)$$

Two varieties of vine copulas were presented by Bedford & Cooke (2002): drawable vine copulas (D-vine) and canonical vine copulas (C-vine). One variable is crucial to the C-Vine copula. One way to express the universal n-dimensional C-vine copula is:

$$C(x_1, \ldots\ldots, x_n) = \quad C_{i,i+j}|1, \ldots i-1(F(x_1, \ldots x_{i-1}), F(x_{i+j}|x_1, \ldots\ldots, x_{i-1}) \quad (4)$$

The reasoning functions for the margin technique, a two-step separation process, is used to estimate vine copulas. It suggests that the copula log-likelihood is as follow, and the joint log-likelihood is just the sum of the univariate log-likelihoods:

$$l(x) = \sum_{i=1}^{n} \ln\left(f_i(x_i)\right) + \ln\left(c(F_1(x_1), \ldots\ldots, F_n(x_n))\right) \quad (5)$$

A two-step process is used to estimate the Vine copula-based GARCH model. Firstly, we use the maximum likelihood approach to assess the parameters for the univariate marginal models in Equations. Second, we use the sequential maximum likelihood estimation procedure, to determine the parameters of the vine copula. This procedure entails estimating pair-copula parameters in a sequential manner, conditioning on the parameters of the previous levels of the vine structure, and selecting the best pair-copulas based on the AIC and BIC information criteria.

Examining for safe haven and hedge properties

Regardless of how the marginal distributions are modeled, the inclusion of copulas is essential since it provides information about both the average dependency and the dependence during periods of severe market volatility. On the one hand, correlation measurements (Kendall's tau/Spearman's rho) derived from the copula's reliance parameter provide the average dependence. Conversely, the copula tail dependency coefficients provide the reliance in terms of severe market fluctuations.

Through the utilization of copula dependence data, we are able to ascertain the conditions under that the valuable metal is categorized as either a strong or weak hedge also a strong or weak safehaven for the stock index that are the subject of the inquiry.

Discussions and empirical findings

The study's empirical findings are covered in this section. The findings of the

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ISSN Online: 3007-3154
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preliminary analysis are first shown. Next, we go over our key findings on the potential of precious metals as a safe haven, hedge, and diversification tool for the UK stock markets.

Results of initial analysis

Table 1 presents the descriptive data for the daily-returns of equities indexes and valuable metals.

The findings indicate that all series are around the mean since the means are all around zero and the standard deviation are low. Silver is the most volatile of the precious metals, as shown by the fact that it has the largest standard deviation and gold the lowest. Furthermore, for every series, there were fat tails and asymmetry in the returns.

Table 1: Descriptive Statistics

	Gold	Silver	Platinum
Mean	.05	.026	.018
SD	.01	.03	.015
Max	.08	.16	.04
Min	-.078	-.07	-.15

Main results

Since the copula model requires identically distributed and independent (i.i.d.) uniform data, we first filter the returns employing the GARCH model with the goal of obtaining the residuals. Next, we use the t-distribution to filter the standard innovation. The converted standardized residuals of each asset return are then subjected to the vine copula, namely the D-vine and C-vine copulas. Table 2 presents the empirical estimations of the marginal model for returns. The estimates' of volatility findings demonstrate that the coefficients measuring the process's volatility persistence and adjustment to previous shocks are significant for every series, indicating that the conditional volatility is past-dependent and determined over time. Significant GARCH effects characterize all series, as expected. According to the Ljung-Box (Q statistic) and ARCH (LM statistic) statistics, the residuals for the marginal models did not retain either autocorrelation or ARCH effects. By applying the Kolmogorov-Smirnov test to compare the theoretical and empirical distribution functions, we were also able to assess the suitability of the Student-t distribution model and test the null hypothesis that the standardized model residual were uniform (0,1).

Table 2: Selection of Vine Copula Models

Country	Criteria	C-vine	D-vine	Choice
UK	LL	1768.073	1781.164	D-vine
	AIC	-3564.187	-3569.87	
	BIC	-3476.854	-3591.86	

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ISSN Online: 3007-3154
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Table 3: Estimated parameter results for D-vine copulas

Tree	Block	Family	T	θ	DF	λ_L	λ_U
1	$C_{P,S}$	t-Student	0.39	0.586	8.71	0.148	0.148
2	$C_{G,S}$	t-Student	0.43	0.565	10.78	0.156	0.156
3	$C_{G,I}$	t-Student	0.021	0.039	7.434	0.026	0.026
4	$C_{P,G/S}$	t-Student	0.25	0.389	11.81	0.039	0.039
5	$C_{S,I/G}$	t-Student	0.06	1.069	0	0.078	0
6	$C_{P,I/SG}$	t-Student	0.11	0.174	20.12	0.008	0.008

P= platinum, S=silver, G=gold, and I= stock index. $C_{P,S}$ represents copula among platinum and silver. $C_{G,S}$ represents copula among silver and gold,t is the Kendall's tau of the indicated copula θ is the parameter of copula and DF is the degree of freedom

Since the copula model needs data that is independent as well as identically distributed (i.i.d.), the initial step involves filtering the returns utilizing the GARCH model in order to get the residuals. The t-distribution is then used to filter the standard innovation. The converted standardized residuals of each asset return are then subjected to the vine-copula, namely the D-vine and C-vine copulas. The experimental estimations of returns using the marginal model are shown in Table 2. The findings of the volatility estimates demonstrate that the coefficients assessing the volatility persistence of the process and its adjustment to prior shocks are significant for all series, indicating that the conditional volatility is past-dependent and persistent across time. As usual, all series are characterized by significant GARCH impacts. The Ljung-Box (Q statistic) as well as ARCH (LM statistic) revealed no auto-correlation or ARCH consequences in the residuals of the marginal models. Furthermore, we put the null hypothesis to the test that the standardized model residuals were uniform (0,1) by relating the theoretical and empirical distribution functions utilizing the Kolmogorov-Smirnov test. This enabled us to evaluate the appropriateness of the Student-t distribution model.

To determine whether valuable metals are strong safehaven assets or only poor safehaven assets for the stock-market under investigation, we next evaluate the tail correlation among returns on stock market indexes and precious metals. Using N = 105 Monte Carlo simulations from the mutual allocations

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www.journalforeducationalresearch.online

ISSN Online: 3007-3154
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characterized by the optimal copula functions for UK country, we were able to demonstrate that precious metals are poor safehaven assets. Next, at the 1% tail return of stock market, we calculate the connection amongst index returns and precious metals.

Table 4: Correlation (1% tail of stock returns) relating the returns of stocks and precious metals

UK	**Copula**	**Tail-correlation**	**Concluding remarks**
Gold	Gausian	-0.00001	Safe haven (Strong)
Platinum	Rotated-Joe	0.0032	Safe haven (Weak)

Only gold and silver have a negative tail association, as Table 4 illustrates. Gold may thus serve as a powerful safe haven tool against severe losses in UK stock markets, according to our definition of a asset that is a strong safe haven. But in the UK, platinum is a poor safe-haven investment against severe losses.

Table 5: A overview of the results of the hedge and safe haven analysis

	Copula	Hedge	Safe-haven
Gold	Gausian	Strong	Strong
Silver	Student-t	Weak	No
Platinum	Rotated-Joe	Weak	Weak

The BiVaR curves at the 95% level, which compare precious metals at various levels are shown in Figure 5. As we can see, the empirical copula's 95% level curve is confined to the multiplication or independence level of curve, indicating that there is no correlation relating the stock market's and precious metals' losses.
As previously anticipated, the diversification qualities of metals are supported by the minimal correlations relating stock market indexes and valuable metals. Therefore, it is recommended to include both equities and precious metal indexes in the same portfolio to provide the advantage of diversification.

Discussion

With a focus on the useful functions of precious metals—specifically, silver, gold as well as platinum as hedges, safe havens, and assets comprised of diversification—this research leads to new insights into the literary discussion on the association among precious metals and stock markets. In fact, the copulas and VaR approaches are combined in this work. In order to offer a updated description of strong safe haven assets, we compute the tail-correlation by utilizing simulated data from the copula model that appears to be the most

ISSN Online: 3007-3154
ISSN Print: 3007-3146

appropriate fit. On the one side, we use vine copulas to evaluate the hedging and safe haven qualities of valuable metals for the UK stock markets. According to our estimate findings, gold is a weak safe haven and a strong hedge for the UK. These findings align with previous studies (Bredin et al., 2015; Baur & McDermott, 2010).

For a number of reasons, gold is regarded as a safe haven asset. First of all, gold has been used as money throughout history and continues to be a financial asset now. Secondly, it is the utmost easily traded and valuable metal in liquid form. Furthermore, our findings support the notion that gold and equities do not mix well in volatile markets. Finally, it's a worldwide asset whose worth is not contingent on a state's course of action.

Given that silver is less expensive than gold, our findings suggest that it may serve as a weak hedge for the stock markets in the UK, making it a viable and reasonably priced alternative safe haven. However, because to its low trading, which makes it more volatile and illiquid, silver is not seen as a safe haven asset for the other UK stock markets. In the case of platinum, the UK stock markets find it to be a wise haven and a weak hedge. We are aware that when an asset's market is very liquid, it is seen as a safe haven; platinum's market is comparatively illiquid. This may help to explain why the UK stock markets cannot find refuge in platinum. It is a less expensive substitute for gold, however, and investors might benefit when the gold's price keeps rising. Conversely, we analyze the potential for diversification of precious metals using a new technique called the BiVaR based copula approach.

According to our research, precious metals provide UK investors a practical way to diversify their holdings. In conclusion, investors may discover a beneficial investment advantage in platinum and silver to varying levels (strong or weak), despite this gold serves as a superior safe haven and hedge for the UK market for stocks.

Conclusions

In this research, we examine how precious metals, explicitly silver, gold, and platinum, might be used as a safe haven, hedge, as well as diversification tool for the stock markets in the United Kingdom. In fact, the hedge and safe haven hypotheses are tested using the vine copula approach, while the advantages of precious metal diversification are evaluated using the BiVaR. In line with earlier research, our observed outcomes exhibit that gold, a precious commodity, offers the UK the best safe haven property during the COVID-19 pandemic. As a consequence, gold might be used to counteract stock market losses during volatile times. However, because to its low trading, which makes it more volatile and illiquid, silver is not seen as a safe haven asset for the other UK stock markets. In the case of platinum, the UK stock markets find it to be a wise haven and a weak hedge. Additionally, our research indicates that the gold gains a high hedging characteristic in sophisticated stock markets, which is consistent with previous findings. The findings indicate that platinum and silver can function as weak hedging assets. Lastly, the BiVaR analysis's findings support the claim that all precious metals provide investors in the UK stock market diversification advantages. Our research has significant practical implications for UK investors as they develop their investment plans. We propose that investors may use these

ISSN Online: 3007-3154
ISSN Print: 3007-3146

precious metals to hedge their equities investments during normal times and gold to protect their portfolios from losses during turbulent times.
The sample not present in the prediction of projected returns in valuable metals as well as the appropriate placement of precious metal investments in a diversified portfolio should be examined in future studies.

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