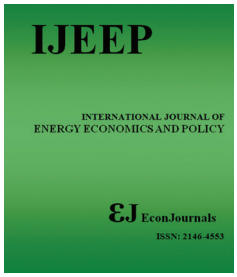

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Safe Haven for Crude Oil: Bitcoin or Precious Metals? New Insight from Time Varying Coefficient-Vector Autoregressive Model

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ABSTRACT

This paper investigates the safe haven property of Bitcoin and the main precious metals in a state of crisis. This study focuses mainly on two critical periods, namely the COVID-19 health crisis and the Russian-Ukraine conflict. To achieve this objective, we first use the DCC-GARCH model to study the dynamic correlation between the returns of oil and the main precious metals. Then, we use a bivariate specification and a Bayesian specification to estimate the time-varying coefficient vector autoregressive model. The results of this study indicate the existence of similarity between Gold and Bitcoin in hedging capabilities. In fact, both have been weak havens during the COVID-19 health crisis and strong havens during the Russian-Ukrainian war period. On the other hand, the results suggest that ruthenium and iridium yields are uncorrelated or negatively correlated with Brent yields. In this respect, investors are called upon to keep their treasury in the form of iridium and ruthenium during this period of war. Similarly, investors were required to invest in these two assets during the COVID-19 period.

Keywords: Brent, Safe Haven, Bitcoin, Precious Metals, Spillover, Dynamic Conditional Correlation, Time Varying Coefficient-Vector Autoregressive Model
JEL Classifications: C11, C15, G1 and O13

1. INTRODUCTION

Barely emerging from Covid-19 crisis, the global financial system experienced a second financial shock due to the Russian-Ukraine conflict. The lesson taught from the pandemic crisis encouraged investors, in this beginning of the war, to protect their investment funds against the downside risk on the oil market by investing in other financial assets such as gold and Bitcoin (Ren et al., 2022; Wang and Lee, 2021; Syuhada et al., 2021; Choi and Shin, 2021; Selmi et al., 2018). In comparison with gold, Bitcoin is an emerging asset that is attracting more and more investors' attentions to hedge against losses caused by the risks incurred (Wen et al., 2022; Guo et al., 2021; Shahzad et al., 2019). Due to its durable characteristics and independence from inflation and country economies, it has become an eminent safe haven (Pho et al, 2021; Selmi et al., 2018). In this context, Wen et al. (2022) state that before the pandemic, Gold and Bitcoin admit similar refuge characters. Nevertheless, during the crisis gold represents a better hedge. Moreover, gold's safe haven for the stock market and oil strengthens as the pandemic spreads. However, Ren et al. (2022) and Pho et al. (2021) suggest that Bitcoin is the better safe-haven asset and it gets progressively stronger as the pandemic intensifies. Gold, on the other hand, acts as a diversifier and its role is weakening as the pandemic intensifies. This comes down to the fact that the relationship between the gold and oil markets varies with the changing severity of the pandemic.

In light of the mixed evidence on the safe-haven properties of gold and Bitcoin, a re-examination of their safe-haven quality

is required. Likewise, the framework of a political-economic conflict, such as the Russian-Ukrainian conflict, is very interesting and even captivating. This conflict derives its importance from the fact that specialists, academics and especially investors fear an oil crisis, similar to that of 1973, or at least an economic and financial boomerang on the countries of the European Union. Furthermore, we note that the works on this topic have ignored precious metals, other than gold, such as silver, iridium, palladium, platinum, rhodium and ruthenium. However, these metals can be safe haven assets for investors fleeing the turbulence of the oil market. Thus, we evaluate in this paper their usefulness as a means of value storage.

This study makes several contributions to current research. Firstly, it focuses on the safe-haven properties of Bitcoin and the major precious metals. Secondly, it looks at the period of the pandemic and the period of the Russian-Ukrainian conflict. Third, it examines the spillover effects of volatility between the oil market and the Bitcoin and precious metals markets. Fourthly, it uses a Bayesian model, namely the time varying coefficient-vector autoregressive (TVC-VAR) model. This model is more compatible with the current context insofar as it instantly integrates the new information available in the series of returns. In other words, its character of non-frequency probabilistic predictions allows it to update the probabilities following the obtaining of new data or information.

Thus, this paper is linked to several strands of recent literature, such as the safe-haven property of Bitcoin and gold in a state of crisis, the correlation and volatility spillovers between commodity markets and the Bitcoin market. This paper is structured as follows. Section 2 summarizes the related literature. Section 3 presents the model and the methodology used. Section 4 describes the data, descriptive statistics and discusses the empirical results. Section 5 is devoted to the conclusion.

2. LITERATURE REVIEW

Since its inception, Bitcoin has provided a solid shelter against fluctuating commodity prices and currencies (Corbet et al., 2020a; Corbet et al., 2020b); Urquhart and Zhang (2019) and Fang et al. (2019). Similarly, gold is considered a tool for diversifying portfolios and serves, above all, to improve their risk-adjusted return Selmi et al. (2018); Chkili (2016) and Jaffe (1989). In addition, gold can act as a safe-haven asset against extreme volatility on the oil and stock markets. However, Cui et al. (2023) analyzed the impact of the COVID-19 pandemic on gold prices to assess whether or not gold retains its safe-haven properties during the pandemic period. To do this, they studied the relationship, in the short and long term, between gold prices and the volatility of oil, gold and precious metal prices. The results of this study indicate that, in the long term, gold price volatility and oil price volatility have a positive impact on gold prices. Whereas, silver price volatility has a negative impact on gold prices. In the short term, gold price volatility has a negative impact on gold prices, but deaths due to COVID-19 have a positive impact on gold prices in both the long and short term. Furthermore, and in continuation of the work of Das et al. (2020) and Wen et al. (2022), Ren et al. (2022) investigated the changing refuge role of Bitcoin and gold to oil price volatility in the COVID-19 pandemic framework. The estimation results of the variable coefficient quantile approach suggest that Bitcoin admits a safe haven role and becomes progressively stronger as the pandemic intensifies. Gold, on the other hand, acts as a diversifier, and its role weakens as the virus spreads. This comes down to the fact that the relationship between the gold and oil markets varies according to the changing severity of the pandemic.

Similarly, it can be affected by the behavior of investors who perceive it as an investment asset Choudhry et al. (2015) and Baur and Glover (2012). In the same spinning mill, Wen et al. (2022) examined whether gold or Bitcoin can be considered a safe haven for oil and stock markets during the COVID-19 pandemic. In order to address this query, researchers utilized the TVP-VAR model to investigate the dynamic spillover effects of gold and Bitcoin prices on the stock and oil markets. The outcomes of this exploration indicate that prior to the COVID-19 outbreak, gold and Bitcoin proved to be effective hedging instruments for oil. However, only gold can be considered a hedge for the stock market during the COVID-19 pandemic, and its safe-haven value becomes stronger as the pandemic spreads. In a similar vein, Chemkha et al. (2021) reassessed the hedging and safe-haven properties of Bitcoin and gold in the context of COVID-19. The results of this study show the effectiveness of Bitcoin and gold as diversification assets to reduce the risk of international portfolios. They also show that gold is a weak safe-haven for the assets considered (SP500, ES50, N225, F100, EUR, JPY and GBP). In contrast, Bitcoin cannot provide shelter during the pandemic due to its increased volatility.

Furthermore, Al-Nassar et al. (2022) examined the hedging and safe-haven potentials of the Oil Price Volatility Index (OVX), oil, gold, and Bitcoin against the risks of the Saudi stock market and its constituent sectors. The results of this study indicate that Gold and OVX represent strong hedges and could have served as weak safe havens for investors during the early stages of COVID-19. Bitcoin and oil, on the other hand, can only be used as portfolio diversifiers. These results are consistent with those of Chkili et al. (2021), who studied the role of Bitcoin and gold as hedges and safe havens for Islamic stock markets before and during the covid-19 health crisis. Empirically speaking, they examined the dynamic relationship between gold, bitcoin and the six global and regional Islamic indices of the Dow jones indices. The results show that Bitcoin offers a better diversification opportunity to reduce the risks of the main Islamic stock markets.

On the other hand, and following the ruble's plunge, Azhar (2022) focused on the Russian-Ukrainian conflict and examined investors' panic over the ruble's safety. The results of this study show that investors invested in USD, yen, silver, Brent, WTI and natural gas to avoid the risk of the ruble. In summary, we note the existence of three strands of studies on the subject of the safe market. These three sections have focused on gold and bitcoin, and their role as safe havens for stock market indices, commodities and currencies. In this context, we cite the work of Cui et al. (2023); Ren et al. (2022); Al-Nassar et al. (2022); Akhtaruzzaman et al. (2021); Salisu et al. (2021); Ji et al. (2020); Selmi et al. (2018) Beckmann

et al. (2015); Gözde & Ünalmış (2014); Baur and Lucey (2010) and Jastram (2009). Pho et al. (2021), Long et al. (2021), Klein et al. (2018), Chkili (2016), Lean and Wong (2015) and Jaffe (1989) point out that in times of stress, investors should invest in gold and reduce their holdings of stocks and oil. However, other studies, such as the studies by Corbet et al. (2020a), Corbet et al. (2020b), Fang et al. (2019), Adams and Glück (2015), Baur and Glover (2012) and Bekiros et al. (2017) report that the hedging property of gold appears to be invalid and Bitcoin is the best safe haven. What is even more disconcerting is that there are other studies that have shown that crypto-currencies admit a safe-haven property similar to gold following the example of the work of Shahzad et al. (2019), Selmi et al. (2018), Bouri et al. (2017) and Dyhrberg (2016b). This literature review, summarized in Table 1, shows that the results are mixed and that there is a lack of literature on the safe-haven properties of precious metals, other than gold, and on politico-economic conflicts such as the Russia-Ukraine conflict.

3. DATA AND METHODOLOGY

This paper investigates the safe haven property of Bitcoin and the main precious metals in a state of crisis. This study covers the period from February 03 2012 to January 24 2023 and is mainly interested in two critical periods, namely the COVID-19 health crisis and the Russian-Ukraine conflict. The dataset used in this study contains time series of daily closing prices of Brent, Bitcoin and the major precious metals, namely; gold, silver, iridium, palladium, platinum, rhodium and ruthenium. We collect Brent and Bitcoin data from the investing website. At the same time, we obtain precious metals data from the open catalyst database.

First, we study the dynamic correlation between the series of daily returns, $R_t = \log (P_t/P_{t-1})$, via the DCC-GARCH model of Engle (2002) to test the existence of a contagion. The choice of this model can be justified by the fact that it detects possible changes in conditional correlations over time. This therefore makes it possible to detect the dynamic behavior of investors in response to news and innovations. In addition, the number of parameters estimated in the DCC-GARCH model's correlation process is independent of the number of series to be estimated, which represents a significant computational advantage for estimating large covariance matrices (Engle, 2002). This model was presented by Engle (2002) as follows:

$$y_t = \mu_t + \varepsilon_t \qquad \varepsilon_t \backslash F_{t-1} \sim N(0,H_t)$$

$$\varepsilon = H_t^{1/2} u_t \qquad u_t \sim N(0,1)$$

$$H_t = D_t R_t D_t$$

Where F_{t-1} is the set of information available up to t-1, y_t is the time series, μ_t is the conditional mean, ε_t is the error term and u_t is the standardized error term. H is the conditional covariance matrix and R is the conditional correlation matrix. D represents univariate GARCH models and it can be written as:

$$D_t = (\sqrt{h_{it}})$$

Where, $h_{it} = \grave{u}_i + \sum_{p=1}^{p} \alpha_{ip} \Upsilon^2_{it-p} + \sum_{q=1}^{q} \beta_{iq} h_{it-q}$

Subsequently, we use the Bayesian TVC-VAR model formalized by Swamy et al. (2010). This theorem represents a generalization of VAR models in which the coefficients can change over time.

$$Y_t = \alpha_0 + \alpha_{1t} X_{1t} + \ldots + \alpha_{K-1,t} X_{K-1,t} + \varepsilon_t \ (t = 1,\ldots,T)$$

In this way, and as an example, a TVC-VAR(1) will be in the following form:

$$Y_t = \alpha_0 + \alpha_1 X_{t-1} + \varepsilon_t$$

Where ε_t is Gaussian white noise with zero mean and time-varying covariance matrix. This empirical study covers a total of 2863 observations. The data are divided into three parts. The first part is dedicated to the period before COVID-19. The second and third parts are devoted respectively to the period of health crisis and the period of the Russian-Ukraine conflict.

4. EMPIRICAL RESULTS AND DISCUSSION

The descriptive statistics presented in Table 2 panel A show that average returns, over the entire study period, are positive for all variables except Brent, silver and platinum. They also show that the deviations of Bitcoin and Brent yields from their averages are the largest. This result suggests that investors can do well by speculating cautiously on these two assets. In contrast, precious metals are intended for investors seeking to preserve the value of their investment funds. Furthermore, the results of the Jarque-Bera test show that the normal distribution hypothesis is not valid for all the variables studied. The positive asymmetry value for iridium, rhodium and ruthenium indicates an asymmetrical distribution to the right. On the other hand, the asymmetry value is negative for Brent, Bitcoin, gold, silver, palladium and platinum, which indicates a left-skewed distribution. However, the existence of fatty tail distribution characteristics is demonstrated by the positive kurtosis values for all the studied variables. Before proceeding to the empirical modeling, we first study the static correlation between the variables as well as the stationarity of the return series. The correlation matrix presented in panel B of Table 2 shows the absence of strong correlation between the variables. In addition, the correlation coefficients show the existence of negative relationship between Brent and iridium, rhodium and ruthenium. On the other hand, the correlation coefficient between Brent and Bitcoin, Gold, silver, palladium and platinum is positive. The Dickey-Fuller Augmented Unit Root (ADF) test, or even the Phillips-Perron (PP) test, summarized in Table 3, show that all the yield series are stationary at the 1% threshold.

Next, we use the DCC-GARCH model to study the dynamic correlation between the returns on oil and the main precious metals. This model is estimated in two stages, the first of which consists in estimating the univariate GARCH series, and the second in estimating the correlation.

Table 1: Summary of main papers

Paper	Empirical model used	Principle results
Panel A. Stocks and indices		
Baur and McDermott (2010)	Quantile regression	Gold is a solid hedge for the European and US stock markets. On the other hand, it is a way of diversification for the BRICS market and Australia, Canada and Japan.
Baur and Lucey (2010)	Quantile regression	The study conducted by Baur and Lucey (2010) found a positive correlation between gold and oil prices, with gold prices responding to changes in oil prices within 5 days. The authors posit that this is due to the impact of oil price shocks on the global economy, which in turn affects precious metals.
Coudert and Raymond-Feingold (2011)	Bivariate ARMA-GARCH-X model	The covariance between gold and equity returns is negative or zero. This indicates that gold is a safe haven for the stock indices of the G7 countries.
Hood and Malik (2013)	Quantile regression	Using data from the US stock market, Hood and Malik (2013) analyzed the usefulness of gold and other precious metals as a hedge and safe haven in comparison to the Volatility Index (VIX). According to the findings, gold, unlike other precious metals, is a weak hedge for the US stock market.
Gurgun and Unalmis (2014)	Quantile regression	The findings reveal that gold is both a hedge and a safe haven for national investors on the majority of the advanced economies' financial markets.
Chkili (2016)	ADCC-GARCH	Using data from the BRICS countries, Chkili (2016) investigated the dynamic link between gold and stock markets. According to the findings of this study, gold can be used as a safe haven against high market volatility.
Chkili (2017)	The Markov switching approach	According to the findings of this study, gold can operate as powerful safe haven against excessive volatility in Islamic stock markets.
Mensi et al. (2018)	Wavelet approach	Mensi et al. (2018) examined the co-movements between five stock markets of the BRICS group and the prices of crude oil, BRENT and WTI, and gold. Using the wavelet approach, they showed that there is no co-movement between the BRICS stock markets and the gold price. This indicates that gold can serve as a hedge or safe-haven asset for the BRICS against extreme market volatility.
Khan et al. (2023)	Wavelet approach	According to the findings of this study, there is a positive correlation between gold prices and Islamic stocks, a negative correlation between gold prices and Islamic stocks due to global political uncertainty, a negative correlation between gold prices and oil prices in the medium term during times of crisis, and a positive correlation between oil prices and Islamic equities.
Maghyereh et al. (2019)	DCC-GARCH and Wavelet Approach	Maghyereh et al. (2019) studied time-frequency co-movements between Islamic stock returns and gold prices. The results reveal that the combination of gold and oil could better hedge and diversify Islamic equity portfolios.
Akhtaruzzaman et al. (2021)	DCC-GARCH	Akhtaruzzaman et al. (2021) looked at the markets of the United States, Japan, China and EURO stoxx. The results revealed that gold serves as a safe haven for the stock market during the first phase of the COVID-19 pandemic, but loses its safe haven property during the second phase.
Salisu et al. (2021)	VARMA-CCC-GARCH and the DCC-GARCH variant model.	According to the findings of this study, the use of gold in an equity portfolio could improve the risk-adjusted performance of stocks during the COVID-19 pandemic.
Chemkha et al. (2021)	A-DCC-GARCH	The empirical analysis in this study provides evidence that during the COVID-19 pandemic, gold is a weak safe haven for the assets under consideration (SP500, ES50, N225, F100, EUR, JPY and GBP), while Bitcoin cannot provide shelter due to its increased variability.
Chkili et al. (2021)	DCC-FIGARCH	Bitcoin offers a better diversification opportunity to reduce the risks of major Islamic stock markets.

(*Contd...*)

Table 1: (*Continued*)

Paper	Empirical model used	Principle results
Panel B. Commodities		
Mensi et al. (2018)	Wavelet approach	Mensi et al. (2018) examined the co-movements between five stock markets of the BRICS group and the prices of crude oil, BRENT and WTI, and gold. Using the wavelet approach, they showed that there is no co-movement between the BRICS stock markets and the price of gold, indicating that gold can act as a hedge or safe-haven asset for the BRICS against extreme market volatility.
Dutta et al. (2020)	DCC-GARCH	According to the results of the correlation study, gold is a safe-haven asset for global crude oil markets during COVID-19. Bitcoin, on the other hand, is exclusively used to diversify crude oil. The findings also demonstrate that when investors include oil and gold in their portfolios rather than holding assets in the oil and bitcoin markets, portfolio risk is reduced.
Wen et al. (2022)	TVP-VAR	Both gold and Bitcoin served as effective hedging instruments for oil prior to the onset of the COVID-19 pandemic. However, during the pandemic, gold emerged as a secure refuge for the stock markets and short-term oil trading, while Bitcoin failed to provide a similar level of safety and security.
Ren et al. (2022)	Variable coefficient quantile regression.	Ren et al. (2022) showed that Bitcoin acts as a safe haven for oil-linked portfolios, while gold can act as a weak diversifier.
Cui et al. (2023)	ARDL and Non-ARDL	● In the long term, gold price volatility and oil price volatility have a positive impact on gold prices, while silver price volatility has a negative impact on gold prices. ● In the short term, gold price volatility has a negative impact on gold prices, but COVID-19 fatalities have a positive impact on gold prices in both the long and short term.
Mensi et al. (2023)	The quantile regression approach.	● Gold and silver (platinum, treasury bonds and US dollar index) are net issuers (receivers) of short- and long-term returns. ● Crude oil and Treasuries are not a safe haven for US equity investors.
Panel C. Currencies		
Wang et al. (2021)	DCC GARCH model	Wang et al. (2021) found that the degree of connectivity between hedges and stock markets varied over time and across time horizons. More specifically, and for short-term investments, gold offers better hedging efficiency, particularly for emerging stock markets and the United States stock market. For medium and long-term investments, the USD performs better, particularly in developed markets outside the US and in emerging stock markets.
Azhar (2022)	DCC-GARCH and TVP-VAR	During the 24 h before and 24 h after the invasion, USD, Yen, Silver, Brent, WTI and Natural Gas behave as safe havens.

Table 4 summarizes the estimation results of the DCC (1,1) with univariate GARCH model. The results presented in Table 4 show that the sum of the two parameters α and β is less than one. This indicates that the conditional correlation in the models is not constant over time. In addition, these results show that the volatility of gold and palladium returns positively feeds, in both the short and long term, the volatility of Brent returns. In other words, the impact of the short-term volatility of gold and palladium persists over the long term on the volatility of Brent returns. This therefore suggests that the volatility of gold and palladium yields can be used as a basis for forecasting the volatility of Brent yields. On the other hand, Ruthenium dampens Brent's short-term volatility, so it can serve investors as a short-term diversifier. Moreover, we notice that the co-movements persist in the long term between the returns of Brent and the returns of Bitcoin, silver, iridium, platinum and rhodium. Secondly, we use a Bivariate VAR (1) specification and a Bayesian specification to estimate the TVC-VAR model. Unlike switching VAR, which deals with occasional discrete changes, TVC-VAR deals with regular changes. It admits two equations; one of observation and one of process. In the first equation, the TVC-VAR model defines the period-specific coefficients, while in the second equation it specifies the law of motion of the coefficients.

The lag of the TVC-VAR model is set to 1 based on the Schwarz Criterion (SC) and Hannan Quinn (HQ) criteria. The estimation results, presented in Figure 1 panel A, show that before the COVID-19 pandemic Iridium and Ruthenium admit neutral positions toward the volatility of Brent returns. This indicates that these two markets can constitute safe haven markets. In addition, and in accordance with the work of Ren et al. (2022) and Wen et al. (2022), Bitcoin can be an excellent hedging tool for oil. However, we suspect that Palladium and Rhodium may provide a weak shelter for investment funds. In this respect, it is essential to examine the impulse response. The results of the impulse study

Table 2: Descriptive statistics and correlation matrix

Variable / Statistics	BR	BIT	GO	SIL	IRI	PAL	PLT	RHO	RUT
Panel A									
Mean	−0.0092	0.2871	0.0033	−0.0130	0.0505	0.0312	−0.0151	0.0739	0.0488
Median	0.0347	0.0867	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Maximum	19.0774	38.0489	5.6317	10.4046	14.3101	15.1125	11.8140	23.6389	17.8692
Minimum	−27.9762	−48.0904	−9.5920	−24.7241	−11.1226	−14.9532	−19.1121	−21.3574	−11.7783
Standard deviation	2.3603	5.0212	0.9298	1.7080	1.0201	2.0259	1.4697	1.9199	1.1414
Skewness	−1.0030	−0.5802	−0.6754	−1.1023	3.0054	−0.4591	−0.7058	0.3761	2.9078
Kurtosis	21.5068	13.5224	12.1135	21.5856	77.1357	10.4052	16.0092	42.8315	72.7158
Jarque-Bera	41337.640	13368.68	10125.54	41786.11	659948.10	6642.11	20426.40	189329.60	583826.20
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	2863	2863	2863	2863	2863	2863	2863	2863	2863
Panel B									
BR	1								
BIT	0.0572	1							
GO	0.0618	0.0776	1						
SIL	0.1332	0.0807	0.7961	1					
IRI	−0.0171	0.0193	0.0076	−0.0019	1				
PAL	0.1760	0.0513	0.3796	0.4314	0.0335	1			
PLT	0.1621	0.0706	0.6151	0.6493	0.0149	0.5548	1		
RHO	−0.0259	−0.0190	0.0630	0.0941	0.0420	0.1840	0.1433	1	
RUT	−0.0054	0.0190	0.0171	0.0021	0.1121	0.0074	0.0028	−0.0073	1

The abbreviations BR, BIT, GO, SIL, IRI, PAL, PLT, RHO and RUT denote the returns of Brent, Bitcoin, Gold, Silver, Iridium, Palladium, Platinum, Rhodium and Ruthenium respectively.

Table 3: Unit root test

Variable	Unit root test table (PP) At level			Unit root test table (ADF) At level		
	With Constant	With Constant and Trend	Without Constant and Trend	With Constant	With Constant and Trend	Without Constant and Trend
	t-Statistic	t-Statistic	t-Statistic	t-Statistic	t-Statistic	t-Statistic
BR	−52.514 (***)	−52.521 (***)	−52.523 (***)	−52.508 (***)	−52.515 (***)	−52.516 (***)
BIT	−53.498 (***)	−53.477 (***)	−53.568 (***)	−53.246 (***)	−53.305 (***)	−53.082 (***)
GO	−52.971 (***)	−53.024 (***)	−52.979 (***)	−52.967 (***)	−53.010 (***)	−52.976 (***)
SIL	−53.889 (***)	−53.919 (***)	−53.895 (***)	−53.880 (***)	−53.906 (***)	−53.887 (***)
IRI	−61.124 (***)	−60.786 (***)	−61.290 (***)	−7.961 (***)	−9.332 (***)	−7.909 (***)
PAL	−51.322 (***)	−51.312 (***)	−51.302 (***)	−51.093 (***)	−51.084 (***)	−51.090 (***)
PLT	−52.771 (***)	−52.798 (***)	−52.768 (***)	−52.623 (***)	−52.628 (***)	−52.627 (***)
RHO	−28.227 (***)	−27.902 (***)	−28.722 (***)	−24.261 (***)	−24.317 (***)	−24.183 (***)
RUT	−53.400 (***)	−53.215 (***)	−53.482 (***)	−12.726 (***)	−12.837 (***)	−12.684 (***)

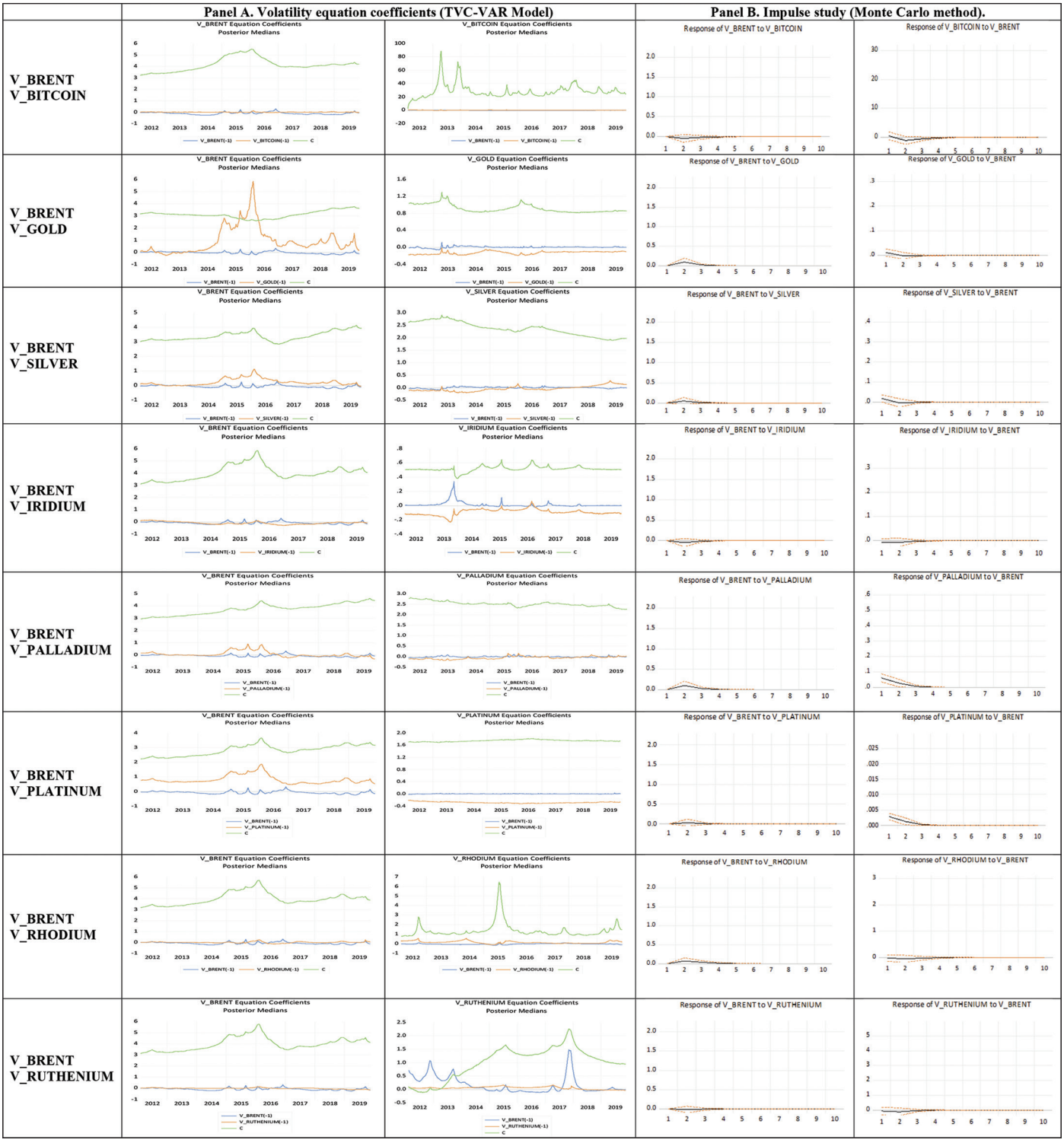
(***), (**), and (*) show significance levels of 1%, 5%, and 10%, respectively

show that Palladium and Rhodium are receivers of volatility spillovers, and that only Rhodium can provide a weak refuge. Furthermore, the stabilizing effect of Gold, toward Brent, began just before the COVID-19 health crisis when the price of Brent dropped and demand for Gold increased. Thus, and in accordance with the results of Ren et al. (2022), the results of this study indicate that Gold has a clear upward trend, which makes Gold a diversifier more than an insurance asset against the volatility of oil returns. Also, the findings of this study demonstrate that investors can diversify their portfolios by investing in the silver and platinum markets.

In order to support these results, we use the analysis of impulse responses via the Monte Carlo method. The results of this estimate reveal that Iridium and Ruthenium are able to constitute safe havens. In addition, and in contrast to the results of Wen et al. (2022) and Pho et al. (2021), Bitcoin may constitute a form of insurance against adverse economic events. Similarly, Rhodium is a low safe haven for investor funds. On the other hand, gold can only play the role of a portfolio diversifier, although its price can rise following the behavior of certain investors in tumultuous economic climates. Regarding silver, platinum and palladium, we note that they cannot be used as insurance funds despite the fact that the impact of oil shocks on these markets does not last long. These results are consistent with those of the TVC-VAR model, showing that posterior sampling draws are efficiently produced by the Monte Carlo method and that its results are robust.

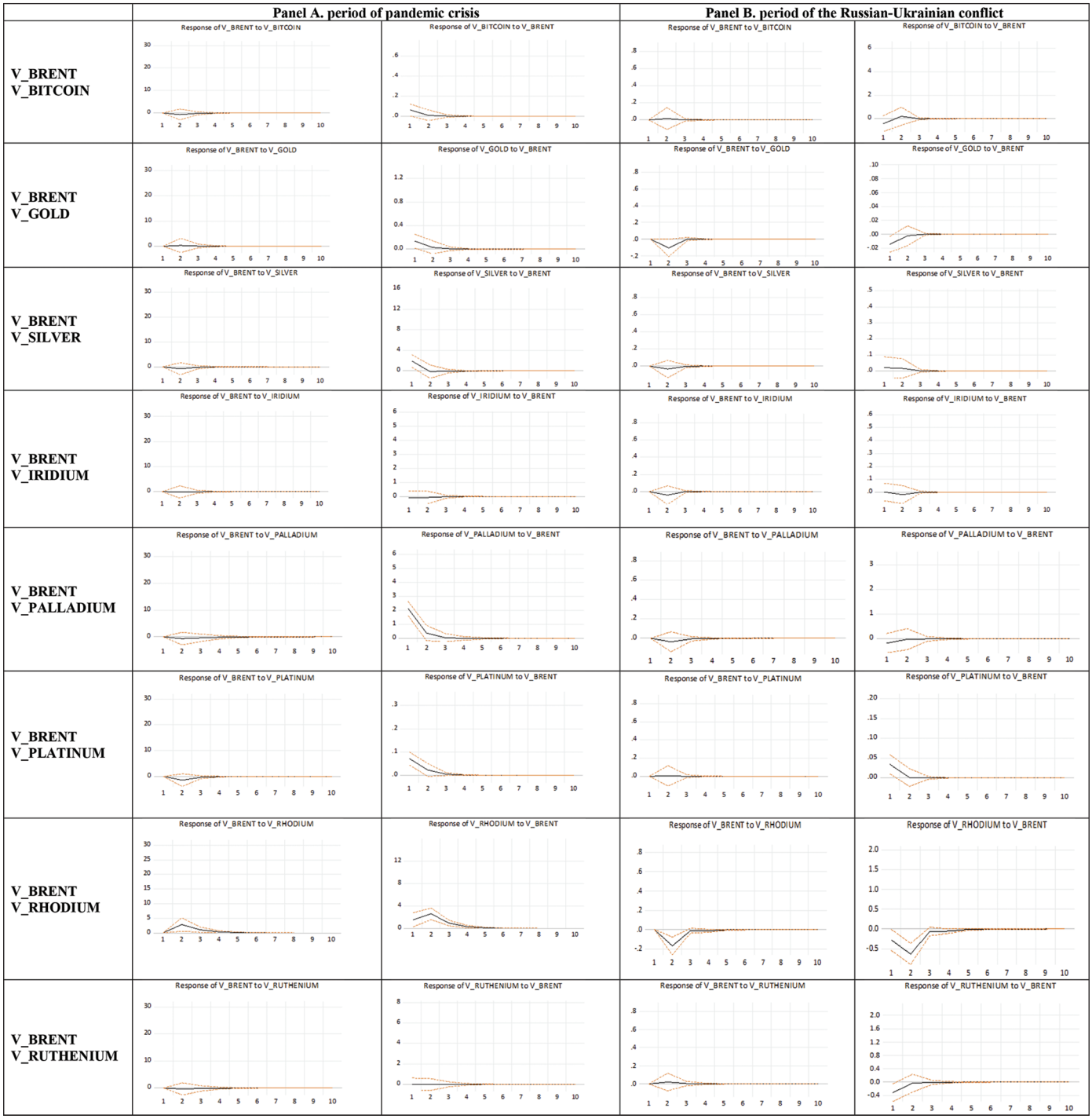
Regarding the health crisis, the empirical findings of the TVC-VAR model demonstrate that iridium and ruthenium maintained their safe-haven characteristics and proved to be the strongest financial hedges accessible to investors despite the increase in volatility spillovers from Brent towards these two metals. In this way, investors will have been able to invest in these two precious metals to preserve their investment funds. Moreover, bitcoin's hedging prospects are of crucial importance to investors. This comes down to the fact that they consider it, like gold, as a main hedge in turbulent circumstances. In this regard,

Figure 1: Coefficients volatility equation and Impulse Study



and in line with the work of Choi and Shin (2021) and Syuhada et al. (2021), we have identified increased bitcoin price volatility during the COVID-19 pandemic which reduced its safe-haven properties. In this regard, Bitcoin went from strong hedge to weak hedge during the pandemic crisis. On the other hand, the results of this study agree with those of Akhtaruzzaman et al. (2021), Conlon and McGee (2020), and Ji et al. (2020), suggesting that gold has held up due to the behaviors of investors who considers it as a store of wealth. However, despite gold having regained its safe haven value, like Bitcoin, it represents a weak hedge. Also, the time-varying impulse response testifies that refuge effects can change depending on the spread of the pandemic and even depending on the behavior of investors worried about waves of infection and mutations of the COVID-19 virus. Similarly, this result was validated during the Russian-Ukrainian war. In this regard, the findings suggest that the dynamic spillover effects that took place after the outbreak of war have remarkably modified the hedging properties of silver and palladium. Both of these

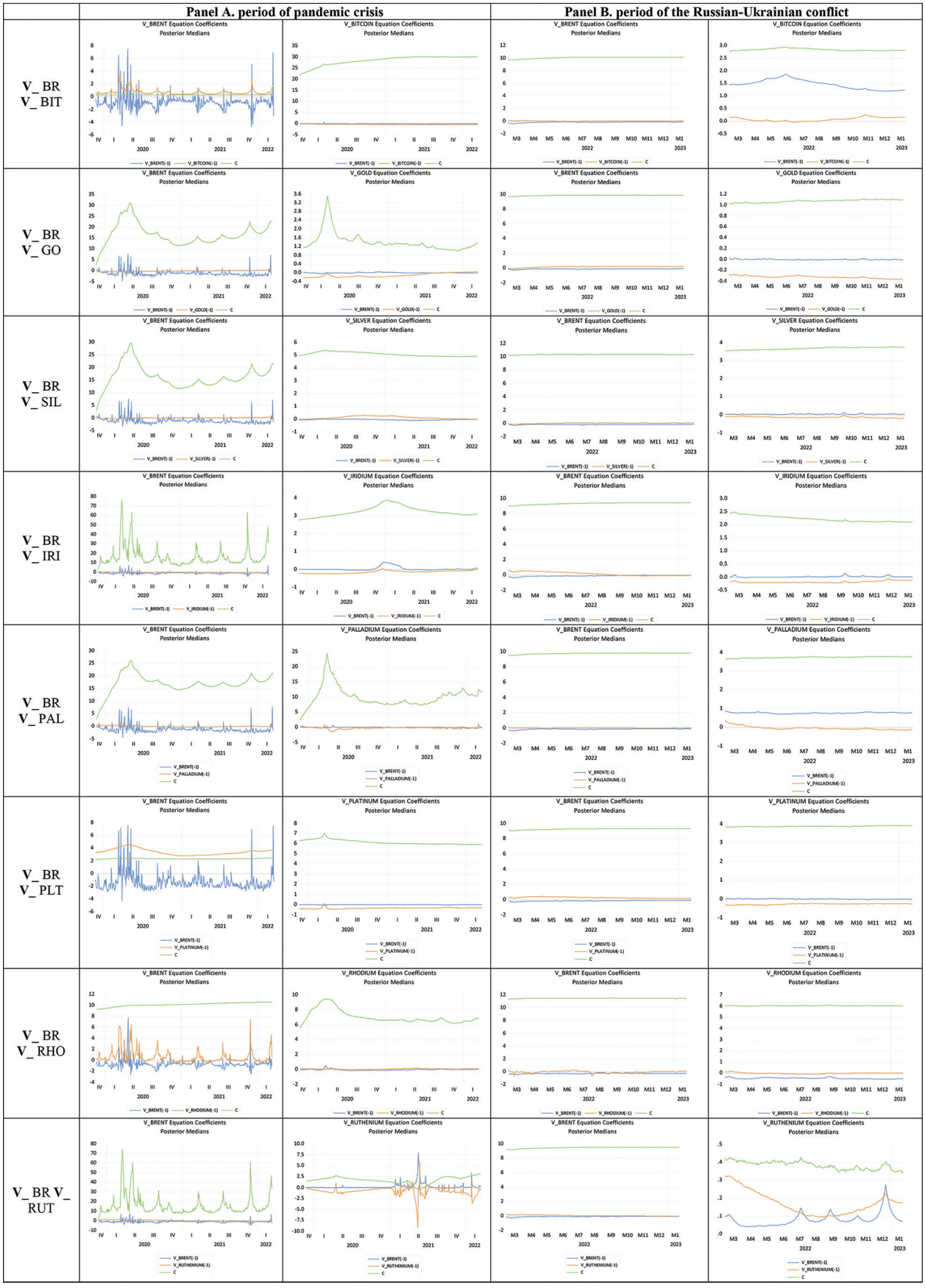
Figure 2: Impulse study via the Monte Carlo method



precious metals have proven to be solid stores of value during this turmoil. This indicates that investors will reduce their oil holdings and look to silver and palladium to hedge against volatility in oil prices and returns.

Also, the results of this study confirm the usefulness of gold in oil portfolios when the price of oil fluctuates extremely. Therefore, investors may again choose gold as a safe haven. Like Gold, Bitcoin retained its property as a safe haven during the war period. Thus, adding Bitcoin to investment portfolios can result in better risk-adjusted returns. On the other hand, the results concerning the yields of ruthenium and iridium are impressive insofar as they are uncorrelated or negatively correlated with the yields of Brent. In this regard, they constitute excellent stores of value in this period characterized by political tension and economic and financial turbulence. In the same vein, the results of the impulse study, shown in Figure 2, indicate that investors worried about the intensification of war have turned once again to gold and Bitcoin to immunize their portfolios against the harmful effects of war. This was evident from the increase in purchases of these two assets in tandem with the advance of Russian forces and growing political and economic tension. These results are therefore consistent with those of Wen et al. (2022), Shahzad et al. (2019), Dyhrberg (2016b), Poppers (2015) and Rogojanu and Badea (2014) who state that Bitcoin exhibits

Figure 3: Estimation of the coefficients of the volatility equation via the TVC-VAR model



many hedging characteristics similar to gold, such as its apolitical attributes, safe-haven property, and independence from inflation.

In summary, the results of this study, shown in Figure 3, indicate the existence of similarity between gold and bitcoin in hedging

Table 4: DCC (1,1) Model with univariate GARCH

Variable	Parameters	Coefficient	Std, Error	z-Statistic	Prob,
BIT	α	0,0040	0,0032	1,2642	0,2062
	β	0,9855	0,0173	56,9126	0,0000***
	γ	0,0391	0,0212	1,8492	0,0644*
GO	α	0,0238	0,0127	1,8754	0,0607*
	β	0,8762	0,0936	9,3563	0,0000***
	γ	0,0731	0,0220	3,3193	0,0009***
SIL	α	0,0042	0,0051	0,8160	0,4145
	β	0,9857	0,0241	40,8531	0,0000***
	γ	0,1203	0,0209	5,7635	0,0000***
IRI	α	0,0075	0,0110	0,6787	0,4973
	β	0,8470	0,2321	3,6487	0,0003***
	γ	-0,0111	0,0220	-0,5044	0,6140
PAL	α	0,0076	0,0036	2,1443	0,0320**
	β	0,9792	0,0093	105,7013	0,0000***
	γ	0,1368	0,0218	6,2730	0,0000***
PLT	α	-0,0021	0,0094	-0,2223	0,8241
	β	0,8356	0,3348	2,4959	0,0126**
	γ	0,1427	0,0216	6,6178	0,0000***
RHO	α	0,0023	0,0022	1,0484	0,2944
	β	0,9901	0,0097	102,1693	0,0000***
	γ	0,0136	0,0206	0,6586	0,5101
RUT	α	-0,0040	0,0015	-2,6035	0,0092***
	β	0,8359	0,2434	3,4339	0,0006***
	γ	-0,0093	0,0183	-0,5062	0,6127

capabilities. In fact, both have been weak havens during the COVID-19 health crisis and strong havens during the Russian-Ukrainian war period. On the other hand, the results suggest that ruthenium and iridium yields are uncorrelated or negatively correlated with Brent yields. In this respect, they constitute a solid store of value in this period characterized by political tension and economic and financial turbulence. This indicates that investors will have had to invest in these two assets during the COVID-19 period and must keep their funds in the forms of iridium and ruthenium during this period of war.

5. CONCLUSION

The objective of this paper is to empirically analyze the safe haven property of Bitcoin and precious metals in a state of crisis. This study focuses mainly on two critical periods, namely the COVID-19 health crisis and the Russian-Ukraine conflict. To answer this question, we used the DCC-GARCH model to study the dynamic correlation between Brent and Bitcoin and precious metals. Then, we used the TVC-VAR model to empirically analyze the safe haven property of these assets. The results of this study suggest that before the COVID-19 pandemic, Iridium and Ruthenium admit neutral positions with respect to the volatility of Brent returns. This indicates that these two markets can be safe havens. In addition, Bitcoin is an excellent hedging tool for oil. On the other hand, Palladium and Rhodium are receivers of volatility spillovers, and only Rhodium can provide a weak refuge. Moreover, Gold's stabilizing relationship began just before the covid-19 health crisis, when the price of Brent crude fell and demand for Gold increased. This therefore indicates that Gold can be a diversifier more than an insurance asset against the volatility of oil returns.

Regarding the health crisis, the empirical results of this study show that despite the increase in volatility spillovers from Brent to iridium and ruthenium, these two metals have maintained their property of refuge and proved to be the strongest financial hedges available to investors. In this way, investors will have been able to invest in these two precious metals to preserve their investment funds. However, we found that the COVID-19 epidemic caused an increase in price volatility for bitcoin, which reduced its safe-haven properties. In this regard, Bitcoin went from strong to weak coverage during the pandemic crisis. Also, although gold has recovered its safe-haven value, like Bitcoin it represents a weak hedge. In the same vein, the dynamic entrainment effects, occurring after the outbreak of war, have significantly modified the hedging properties of silver and palladium. Both of these precious metals proved to be solid stores of value during this turmoil. This indicates that investors will reduce their oil holdings and turn to silver and palladium to hedge against volatility in oil prices and returns. Also, the results of this study confirm the usefulness of gold in oil portfolios when the price of oil fluctuates extremely. Therefore, investors may again choose gold as a safe haven. Like Gold, Bitcoin retained its safe-haven status during the war. Thus, adding Bitcoin to investment portfolios can result in better risk-adjusted returns. On the other hand, the results concerning the yields of ruthenium and iridium are impressive insofar as they are uncorrelated or negatively correlated with the yields of Brent. In this respect, they represent a solid store of value in this period characterized by political tension and economic and financial turbulence. To support these results and check their robustness, we used Monte Carlo analysis of impulse responses. The results of this study are consistent with those of the TVC-VAR and provide evidence that haven effects may change with the spread of the pandemic, depending on the behavior of investors worried about waves of infection and mutations of the COVID-19 virus, and depending on the escalation of the war.

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