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Portfolio rebalancing in times of stress: Capital markets vs. Commodities

Rui Manuel Teixeira Dias [a, b], Nicole Rebolo Horta [a], Mariana Chambino [a, *]

[a] *School of Business and Administration, Polytechnic Institute of Setúbal, Setúbal, Portugal*

[b] *Center for Studies and Advanced Training in Management and Economics (CEFAGE), University of Évora, Évora, Portugal*

ABSTRACT

In light of the events of 2020 and 2022, this study aims to examine the co-movements between the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), the United Kingdom (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT) from January 1, 2018 to December 31, 2022. The purpose of this analysis is to answer the following research question: (i) Did the events of 2020 and 2022 increase the shocks between stock markets and WTI, XAG, XAU, and XPT prices? The findings indicate that time series do not follow a normal distribution and are stationary. In response to the question of investigation, we found that during the Tranquil period, it was possible to verify the existence of 28 causal relationships (out of 110 possibilities). During the stress period, there was a very significant increase in the number of causal relationships between the market pairs under analysis (62 causal relationships out of 110 possibilities), including a relative increase in the influence of commodities on capital markets and capital markets on commodities. These findings show that during the events of 2020 and 2022, capital markets and commodities significantly accentuated their co-movements among themselves, indicating that alternative markets such as WTI, XAG, XAU, and XPT do not provide safe-haven properties. These results have implications for portfolio diversification during times of global economic uncertainty.

KEYWORDS

2020 and 2022 Events; Capital markets; Commodities; Rebalancing of portfolios; Safe haven assets

* Corresponding author: Mariana Chambino
E-mail address: mariana.chambino@gmail.com

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1. Introduction

The process of adjusting the allocation of assets in a portfolio to match the investor's investment objectives and risk tolerance, known as portfolio rebalancing, is especially crucial during times of global economic instability since it helps investors manage risk. Rebalancing involves selling assets and reallocating revenues to underperforming assets to align portfolio with goal allocation. This reduces the risk of the portfolio being overly concentrated in a single asset class, sector, or geographical location (Dias et al., 2019, 2020, 2021; Silva et al., 2020; Dias and Carvalho, 2021; Pardal et al., 2021).

The economy and population of a nation may be greatly impacted by financial insecurity. In the case of a financial crisis or stock market fall, lending availability, consumer confidence, and expenditure may suffer. Furthermore, the effects of a financial crisis can spread beyond the financial sector, impacting other areas of the economy such as the real estate market, enterprises, and families. As a result, governments and financial institutions must take steps to limit the risk of financial instability and mitigate its consequences when it happens (Dias, Pardal, et al., 2022; Dias, Pereira, et al., 2022; Teixeira, Dias, and Pardal, 2022; Teixeira, Dias, Pardal, et al., 2022).

Various authors have focused on the research of portfolio diversification to identify potential assets with safe haven characteristics. The authors Yamaka and Maneejuk (2020) investigated the correlations between gold and Asia's emerging markets during the pandemic and provided evidence of shocks between gold and the capital markets under study, refuting the notion that gold had safe-haven qualities. Dias and Carvalho (2020) also examined the stock markets of Mexico (IPC), Chile (S&P/CLX IGPA), Peru (S&P/BVL General IGBL), Brazil (Ibovespa), Argentina (S&P Merval), Chile (S&P/CLX IGPA), the United States (Dow Jones), and the gold and silver markets (Gold Bullion: Zurich and Silver Paris Spot E/KG). According to the authors, who also show that markets have exceptionally significant integrations and causalities, gold and silver do not serve as safe haven assets for portfolio diversification in the capital markets of Latin America and Caribbean (LAC) regional capital markets.

In more recent studies, Teixeira et al. (2022) examined whether the gold market acts as a safe haven asset when the major financial markets of France (CAC 40), Germany (DAX 30), the United States (Dow Jones), the United Kingdom (FTSE 100), Italy (FTSE MIB), and Hong Kong (Hang Seng) crash as a result of the Chinese financial crisis (2015–2016) and the COVID-19 pandemic (2020). The authors show that gold has safe-haven qualities. During the events of 2020 and 2022, the authors Teixeira, Dias, Pardal, et al. (2022) looked at financial integration and movements in the capital markets of Germany (DAX), the United States (Dow Jones), France (CAC 40), the United Kingdom (FTSE 100), Italy (FTSE MIB), Russia (MOEX), Japan (NIKKEI 225), Canada (S&P TSX), China (SHANGHAI and SHENZHEN), as well as the crude oil markets of the United States (AMERICAS-DS OIL), Asia (ASIA-DS OIL), Canada (CANADA-DS OIL), the United Arab Emirates (EMU-DS OIL), China (CHINA-DS OIL), Nigeria (NIGERIA-DS OIL), and United Kingdom (UK-DS OIL). The authors suggest that these commodities have safe haven qualities by showing that the long-term connections between the capital markets and the crude oil markets under study do not explain their short-term movements.

This paper will examine the co-movements of the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), the United Kingdom (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and the spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT) from January 1, 2018, to December 31, 2022. The purpose of this study is to determine if the spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT) display safe-haven characteristics.

According to our knowledge and the studies previously mentioned, this will be the first study to examine the safe haven characteristics of the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), the United Kingdom (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and the spot prices of crude oil (WTI), (XAG), gold (XAU), and platinum (XPT) during the 2020 pandemic and the Russian invasion of Ukraine in 2022.

The findings of this paper suggest a significant rise in co-movements between the events in 2020 and 2022. We also discovered that commodities, particularly WTI, XAG, XAU, and XPT, lack safe-haven qualities.

This study contributes to the existing body of knowledge. The most important contribution is a study of the movements in the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), the United Kingdom (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT) among 2020 and 2022 events. Investors, politicians, and regulators can foresee probable side effects during stressful times and prepare for them by understanding the connections between the capital and commodities markets. Financial institutions can better control the risks associated with their portfolios and choose wise investments by examining the linkages between capital markets and commodities. In general, analyzing the shocks between capital markets and commodities during periods of pressure on the global economy is essential to improving our understanding of the financial system, enabling better decision-making, and reducing the risk of financial instability.

The organization of this article is split into five sections. An overview of the literature on the stock market and commodity price movements is presented in Section 2. Section 3 describes the data and the methodology. Section 4 presents the findings, while Section 5 presents the key conclusions.

2. Literature Review

In a variety of ways, including in terms of portfolio diversification, investors, fund managers, and researchers must understand how global financial markets interact under pressure. Investors can spot market synchronism and decide how to diversify their portfolios with knowledge of the relationships across financial markets. Possibilities for study: Understanding the connections between international financial markets may provide researchers with information on how the global financial system works (Dias et al., 2021; Horta et al., 2022; Pardal et al., 2021; Teixeira, Dias, and Pardal, 2022).

Cong et al. (2008) used a multivariate autoregressive model to investigate the relationship between crude oil price shocks and the Chinese stock market. According to the research, crude oil price shocks had minimal effect on Chinese stock market returns.

Later, El Hedi Arouri et al. (2015) used the VAR-GARCH model to analyze the shocks between the Chinese stock market and world gold prices from March 22, 2004, to March 31, 2011. The authors show that including gold in a portfolio of Chinese stocks enhances its risk-adjusted return and effectively protects against risk exposure over time. Finally, it was realized that gold acted as a safe haven for stocks on Chinese stock markets during the global financial crisis of 2008. Naeem et al. (2020) studied if the global financial crisis exacerbated shocks between the stock markets of the BRICs1 nations and two critical commodities (crude oil and gold). The authors show that during the 2008 financial crisis, the movements increased, putting into doubt the possibility of efficient portfolio diversification.

Hussain Shahzad et al. (2020) assessed the shocks between the G7 capital markets, gold, and the cryptocurrency Bitcoin. For several G7 stock indexes, gold is arguably a safe haven and a hedge, whereas Bitcoin serves these two purposes in Canada. The authors show that gold delivers much greater and more predictable diversification advantages for stock investments in the G7 markets than Bitcoin does.

Dias and Carvalho (2020) investigated whether gold (Gold Bullion: Zurich) and silver (Silver Paris Spot E/KG) exhibit safe-haven characteristics when the capital markets of Argentina (S&P Merval), Brazil (Ibovespa), Chile (S&P/CLX IGPA), Peru (S&P/BVL General IGBL), Mexico (IPC), and the United States (Dow Jones) experience structural breakdowns. The findings reveal that the markets have very significant integrations and causalities,

[1] BRICs is an acronym for five leading emerging economies: Brazil, Russia, India, China, and South Africa.

implying that gold and silver do not act as safe-havens for portfolio diversification in Latin American stock markets.

Umar et al. (2021) examined the link between crude oil shocks and the capital markets of the GCC1 and BRIC, from January 6, 2005, to July 17, 2020. Empirical data show an average relationship between the investigated stock markets and crude oil shocks in terms of returns and volatility, but at an unprecedented level during the most recent COVID-19 crisis. Furthermore, Gharib et al. (2021) analyzed the causal relationship between crude oil and gold spot prices in order to determine how the financial effect of the 2020 pandemic affected both. The authors examined WTI and gold prices from January 4, 2010, through May 4, 2020, and found significant bilateral shocks. This implies that gold cannot act as a safe-haven.

Recently, Teixeira, Dias, and Pardal (2022) investigated if the gold market serves as a safe haven when the major financial markets experience severe falls. They examined integration and co-movements in the stock markets of France (CAC 40), Germany (DAX 30), the United States (Dow Jones), the United Kingdom (FTSE 100), Italy (FTSE MIB), Hong Kong (Hang Seng), and the gold market (XAU) between May 2015 and May 2020. According to the findings, the stock markets of France, Germany, and the United States have the highest degrees of integration, but they do not integrate with the gold market. In this regard, there was no integration with any of the stock markets under consideration, suggesting that when they present significant levels of risk, the XAU index may serve as a safe haven for portfolio diversification and risk mitigation. This result is supported by an examination of the short-term link between the stock and gold markets using impulse-response functions, which reveals evidence of positive/negative co-movements with statistical significance in all markets except for the gold market.

Chkili (2022) explored the relationships between gold, crude oil, and the Islamic stock market from 1996 through 2020, which included the recent 2020 crisis. The empirical findings are summarized as follows: (i) The markets under consideration have some significant linkages. (ii) The signal of the linkages changes greatly depending on markets and regimes. (iii) There is a considerable and beneficial relationship between crude oil and Islamic stock markets, especially during volatile moments. (iv) The lack of positive or negative relationships between the gold market and the Islamic and crude oil stock markets suggests that gold can operate as a hedge and safe haven under severe market conditions.

As a result, this work aims to contribute to the dissemination of information to investors and capital market regulators, where individual and institutional investors seek to effectively diversify their portfolios through commodities that may offer coverage and a safe haven, during times of global economic uncertainty like the events of 2020 and 2022.

3. Data and Methodology

3.1. Data

The daily price indexes of the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), the United Kingdom (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT) from January 1, 2018, to December 31, 2022, were used to prepare the article. The sample was divided into two subperiods: the first from January 2018 to December 2019 (Tranquil subperiod), and the second from January 2020 to December 2022 (Stress subperiod). To reduce exchange rate distortions, the Thomson Reuters platform with local currency quotations was used as the source of information.

3.2. Methodology

The study went through several stages. In the first part, we will create graphs of levels and returns to show

Table 1. The name of countries and their indexes used in this paper.

Index	Country
AEX	Netherlands
CAC 40	France
DAX 30	Germany
FTSE 100	United Kingdom
FTSE MIB	Italy
IBEX 35	Spain
IMOEX	Russia
WTI	USA
XAG	USA
XAU	USA
XPT	USA

Source: Own Elaboration.

how financial markets fluctuate. Descriptive statistics, the Jarque and Bera (1980) adherence test, and stability tests on residues from the data series will be used to characterize the sample.

We will use the VAR Granger Causality/Block Exogeneity Wald Tests model to examine the significance of causal relationships between capital markets and spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT).

This model employs Wald statistics to test whether the endogenous variable "cause", in the Grangerian sense, the dependent variable. However, it should be emphasized that the outcome of this test is sensitive to the number of lags incorporated in the model, so it is important to estimate this value accurately.(Gujarati, 2004). So, to determine the number of lags, we used the following information criteria: LR: sequential modified. LR test statistic (each test at 5% level). LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion. Additionally, to validate and give robustness to the model, we apply the VAR Residual Serial Correlation LM Tests.

4. Results

4.1. Descriptive Statistics

Figure 1 illustrates the evolution, in levels, of the capital markets in the Netherlands (AEX), France (CAC 40), Germany (DAX 30), the United Kingdom (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT) from January 1, 2018, to December 31, 2022.

The disclosure of the COVID-19 pandemic, which instilled a general sense of apprehension and pessimism among investors, may explain the extremely significant structural breakdowns in all markets during the first and second quarters of 2020.

Also, the markets heavily impacted by the effects of the COVID-19 pandemic crisis recovered in 2021, showing high levels of growth, and in some cases, not only recovered the pre-pandemic levels, but also closed the year at a much higher level than pre-pandemic levels. However, Russia begins a series of military exercises along the entire Ukrainian border in mid-December 2021, effectively invading Ukrainian territory on February 24, 2022, and sparking a conflict. Significant structural failures also occur during this announcement, although they're not as bad as they were in 2020. Sun et al. (2022), Pardal, Dias,, Teixeira, Horta (2022), and Dias, Pardal, et al. (2022) studies reinforce these results, demonstrating that the events of 2020 and 2022 produced considerable levels of volatility in global financial markets.

Figure 2 shows the evolution of returns for the capital markets in the Netherlands (AEX), France (CAC 40), Germany (DAX 30), Canada (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and for the spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT) from January 1, 2018, to December 31, 2022. From

these returns, it is possible to infer the relative dispersion of time series distributions. Important to note: The first and second quarters of 2020 and 2022 saw exceptionally high volatility in WTI spot prices. Furthermore, the beginning of 2022 saw turbulence on the Russian stock market.

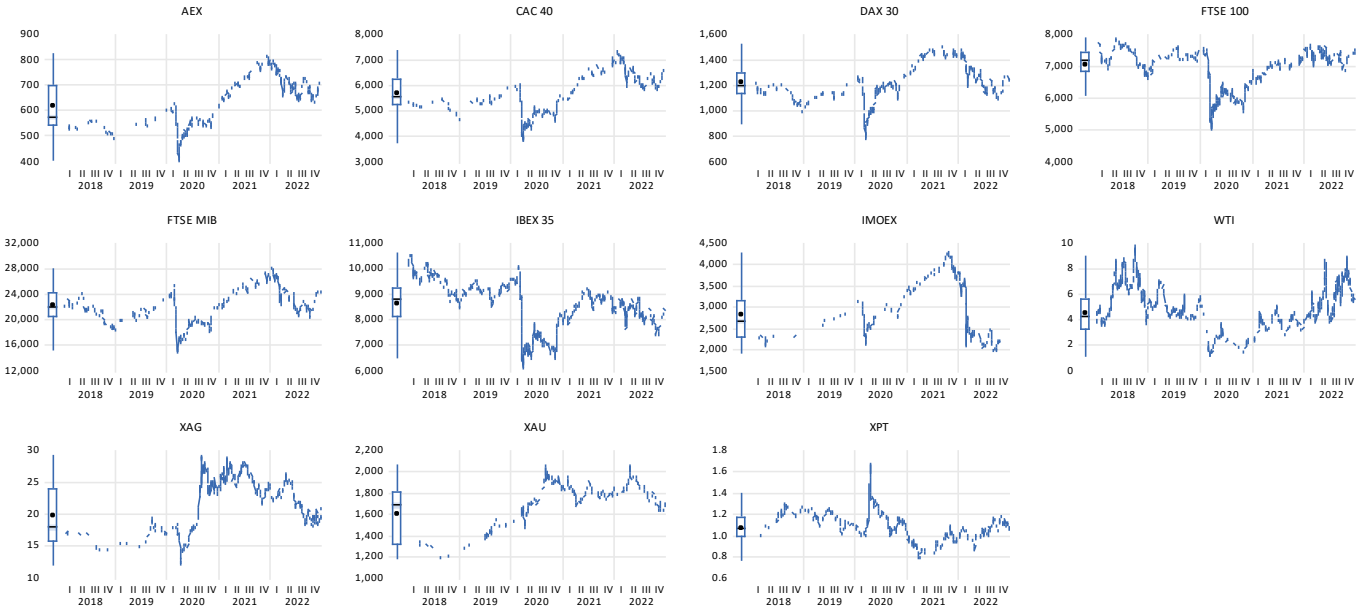

Figure 1. Evolution, in levels, of the 11 financial markets, during the period from January 1st, 2018 to November 31st, 2022.

Source: Own Elaboration.

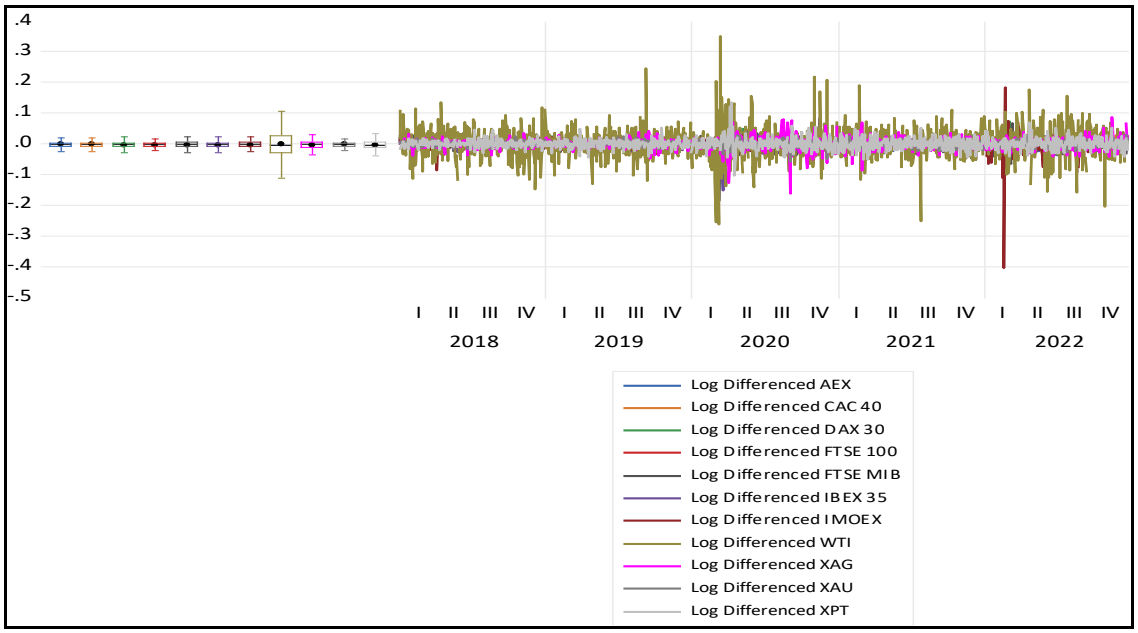

Figure 2. Evolution, in returns, of the 11 financial markets under analysis, during the period from January 1st, 2018 to November 31st, 2022.

Source: Own Elaboration.

The main descriptive statistics for the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), Canada (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and the spot prices of crude oil (WTI), gold (XAU), and platinum (XPT) for the period of January 1, 2018, to December 31, 2022, are presented in

table 2 and 3. The crude oil market (WTI) had the highest average daily return (0.000334), while platinum (XPT) had the lowest (-0.00000692). The markets under examination had positive daily average returns, but they were all near zero, with the exception of the UK (FTSE 100), Spain (IBEX 35), and platinum (XPT) price indexes. The least risky market is gold (XAU), which has the lowest standard deviation (0.008783), while the riskiest market is the Russian market (IMOEX), which has the highest standard deviation (0.018957).

The time series under discussion are thought to exhibit disparities in light of the normalcy hypothesis because the asymmetry and kurtosis coefficients significantly deviate from the reference values for a normal distribution. The results of the Jarque and Bera (1980) test, which demonstrate that the null hypothesis is rejected (at a 1% significance level), support this conclusion.

Table 2. Descriptive statistics, in returns, of the 11 financial markets under analysis, during the period from January 1st, 2018 to December 3st, 2022.

	AEX	CAC 40	DAX 30	FTSE 100	FTSE MIB	IBEX 35	IMOEX
Mean	0.000233	0.000192	1.53E-05	-2.06E-05	6.40E-05	-0.000151	2.90E-05
Std. Dev.	0.011955	0.013016	0.013053	0.011285	0.014682	0.013119	0.018957
Skewness	-0.889384	-1.013273	-0.822243	-1.089376	-2.105654	-1.344574	-7.556943
Kurtosis	14.03806	16.58722	16.05098	17.59219	28.30665	21.84808	175.9746
Jarque-Bera	6578.272	9931.367	9105.825	11455.35	34635.76	19075.60	1586572.
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Observations	1263	1263	1263	1263	1263	1263	1263

Source: Own Elaboration.

Table 3. Descriptive statistics, in returns, of the 11 financial markets under analysis, during the period from January 1st, 2018 to December 3st, 2022.

	WTI	XAG	XAU	XPT
Mean	0.000334	0.000172	0.000207	-6.92E-06
Std. Dev.	0.050654	0.017997	0.008783	0.017331
Skewness	0.175938	-0.667741	-0.533371	0.668327
Kurtosis	7.642354	13.14812	6.790340	9.291742
Jarque-Bera	1140.661	5513.412	815.9306	2177.236
Probability	0.000000	0.000000	0.000000	0.000000
Observations	1263	1263	1263	1263

Source: Own Elaboration.

Since the distribution of the data does not perfectly overlap across the 45-degree line in Figure 3, Q-Q graphs are used to show that the time series returns' distribution is leptokurtic and asymmetric or skewed (normal distribution). The Central Limit Theorem, however, can be used to infer an approximately normal distribution because the data series had a significant number of observations.

4.2. Stationarity Time Series Analysis

When statistical characteristics, such as mean, variance, and so on remain constant across time, the time series is said to be stationary. In a stationary series, the data points would consistently revert to the long-run mean with a constant variance. The majority of forecasting methods presume that a distribution is stationary. In the absence of stationarity, unexpected or unusual behaviors might occur. Unit root tests such as Levin et al. (2002) and Im et al. (2003) as well as Dickey and Fuller (1981), Perron and Phillips (1988) with Fisher's transformation, were employed to assess the stationarity of the time series under consideration. The results lead us to infer that time series are stationary in first differences (see Table 4).

Table 4. Unit Root Tests, applied to the 11 financial markets under analysis, during the period from January 1st, 2018 to December 31st, 2022.

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-141.101	0.0000	11	13869
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-123.221	0.0000	11	13869
ADF - Fisher Chi-square	1316.11	0.0000	11	13869
PP - Fisher Chi-square	1122.47	0.0000	11	13871

*Source: Own Elaboration. Note: ** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.*

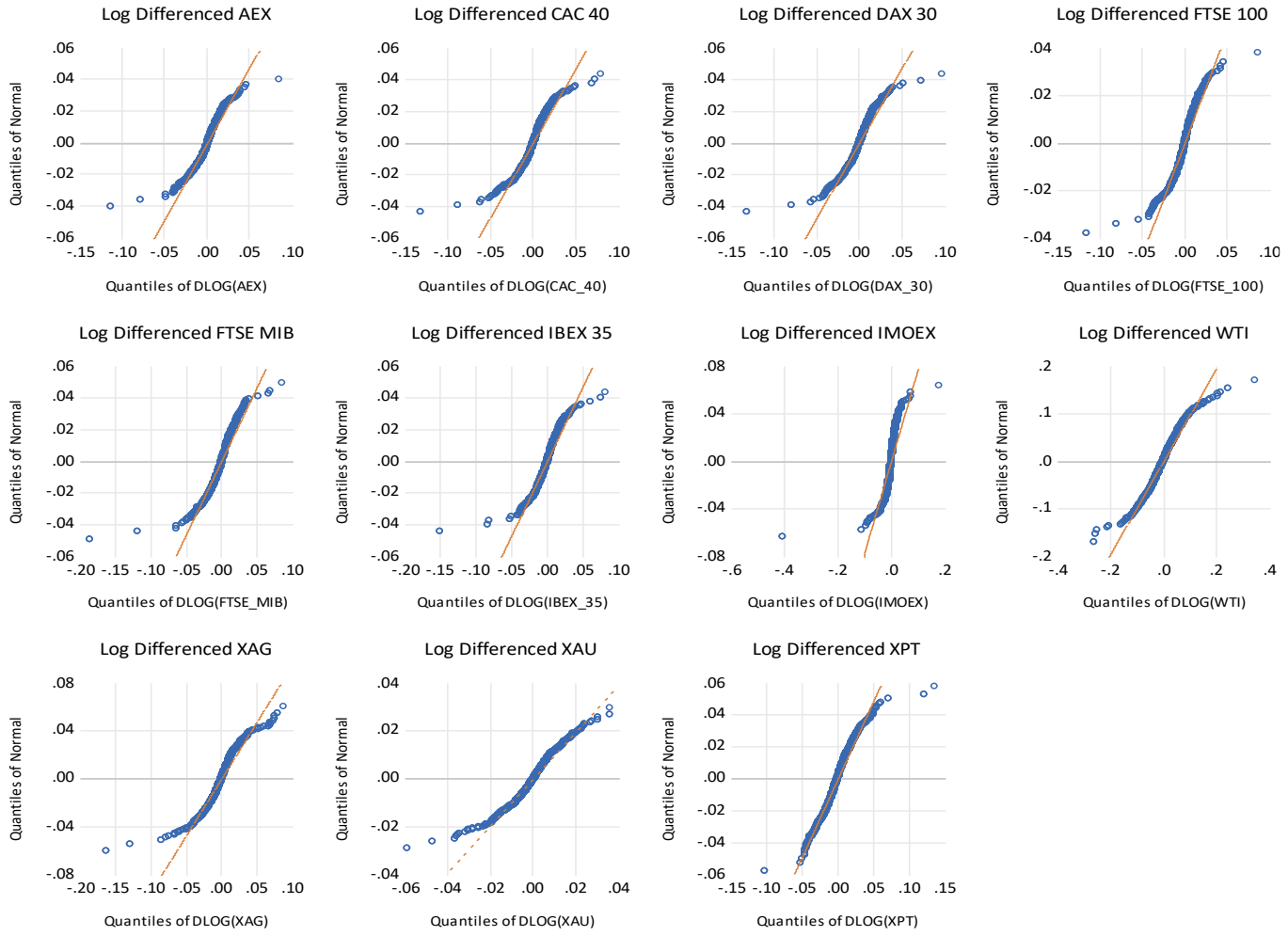

Figure 3. Q-Q Plots, in returns, of the 11 financial markets, for the period from January 1st, 2018 to November 31st, 2022.

Source: Own Elaboration.

4.3. Granger Causality Test Results

The Granger Causality Test was used to examine the structures of the causal relationships in the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), the United Kingdom (FTSE 100), Italy (FTSE MIB),

Spain (IBEX 35), Russia (IMOEX), and the spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT), during the period from January 1, 2018, to December 31, 2022.

The Granger Test identified whether markets have predictive ability over the future prices of their peers by calculating an autoregressive vector. The time period under research was separated into two subperiods in order to better understand the effects of the 2020 (COVID-19 pandemic) and 2022 (armed conflict between Russia and Ukraine) events on market relationships.

The first step in order to estimate the VAR Granger Causality/Block Exogeneity Wald Tests is to rule out the possibility of serial residual autocorrelation. In this respect, using the information criterion shown in Table 5, we can establish that during the Tranquil period, if the model to be estimated considers a number of lags equal to 6, there is enough information to ensure that this hypothesis is to be rejected. This observation is supported by Table 6 because the LM Test resulted in the non-rejection of the null hypothesis, indicating that the residues of the time series under analysis are not autocorrelated. The best number of lags for the stress phase was found to be 10, based on the results of the information criterion in Table 7. This evidence is demonstrated by refuting the premise of serial residual autocorrelation (see Table 8).

Table 5. VAR Lag Order Selection Criteria for the Tranquil period.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	18091.23	NA	6.04e-46	-72.90417	-72.81088*	-72.86755
1	18319.70	445.8750	3.92e-46	-73.33750	-72.21801	-72.89806*
2	18464.02	275.2548	3.57e-46	-73.43153	-71.28584	-72.58928
3	18596.58	246.9492	3.41e-46*	-73.47815*	-70.30626	-72.23308
4	18695.43	179.7645	3.74e-46	-73.38884	-69.19074	-71.74095
5	18763.21	120.2482	4.66e-46	-73.17423	-67.94993	-71.12352
6	18855.17	159.0798*	5.28e-46	-73.05714	-66.80664	-70.60361
7	18937.12	138.1266	6.24e-46	-72.89968	-65.62298	-70.04334
8	19011.03	121.2880	7.66e-46	-72.70978	-64.40688	-69.45062
9	19085.76	119.3331	9.40e-46	-72.52323	-63.19413	-68.86125
10	19165.27	123.4267	1.14e-45	-72.35591	-62.00061	-68.29112

*Source: Own Elaboration. Note: * Indicates lag order selected by the criterion. LR: sequential modified. LR test statistic (each test at 5% level). LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.*

Table 6. VAR Residual Serial Correlation LM Tests for the estimated model corresponding to the Tranquil period.

Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	129.6513	121	0.2789	1.073116	(121, 3253.0)	0.2792
2	128.0239	121	0.3136	1.059384	(121, 3253.0)	0.3139
3	124.1781	121	0.4031	1.026960	(121, 3253.0)	0.4034
4	112.8619	121	0.6887	0.931772	(121, 3253.0)	0.6890
5	137.0031	121	0.1517	1.135233	(121, 3253.0)	0.1520
6	156.8199	121	0.0158	1.303361	(121, 3253.0)	0.0158
7	134.4507	121	0.1902	1.113652	(121, 3253.0)	0.1905

Source: Own Elaboration.

The Granger Causality Test was conducted on the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), Spain (IBEX 35), Russia (IMOEX), Italy (FTSE MIB), and the United Kingdom (FTSE 100). The results are shown in Table 9 for the Tranquil subperiod and Table 10 for the Stress subperiod.

5. Discussion

Based on the findings and their summary in Table 11, we found that there were 44 market shocks during the

Table 7. VAR Lag Order Selection Criteria for the Stress period.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	22661.76	NA	1.27e-40	-60.64461	-60.57664*	-60.61841
1	22784.93	242.3842	1.27e-40	-60.65042	-59.83473	-60.33606
2	23127.71	664.4421	7.00e-41	-61.24420	-59.68079	-60.64167
3	23226.07	187.7687	7.44e-41	-61.18359	-58.87246	-60.29289
4	23704.75	899.6822	2.86e-41	-62.14122	-59.08238	-60.96236*
5	23924.31	406.2087	2.20e-41	-62.40512	-58.59856	-60.93809
6	24129.08	372.8099	1.76e-41	-62.62940	-58.07513	-60.87422
7	24224.61	171.1063	1.89e-41	-62.56120	-57.25922	-60.51785
8	24471.49	434.9305	1.35e-41*	-62.89823*	-56.84853	-60.56671
9	24569.63	170.0141	1.45e-41	-62.83704	-56.03962	-60.21736
10	24668.70	168.6885*	1.55e-41	-62.77831	-55.23318	-59.87047

*Source: Own Elaboration. Note: * Indicates lag order selected by the criterion. LR: sequential modified. LR test statistic (each test at 5% level). LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion.*

Table 8. VAR Residual Serial Correlation LM Tests for the estimated model corresponding to the Stress period.

Null hypothesis: No serial correlation at lag h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	197.5751	121	0.0000	1.645965	(121, 4848.3)	0.0000
2	180.9452	121	0.0003	1.504856	(121, 4848.3)	0.0003
3	217.4825	121	0.0000	1.815514	(121, 4848.3)	0.0000
4	168.6838	121	0.0027	1.401120	(121, 4848.3)	0.0027
5	223.3665	121	0.0000	1.865760	(121, 4848.3)	0.0000
6	222.4251	121	0.0000	1.857717	(121, 4848.3)	0.0000
7	179.6831	121	0.0004	1.494166	(121, 4848.3)	0.0004
8	140.1637	121	0.1123	1.160831	(121, 4848.3)	0.1123
9	183.4279	121	0.0002	1.525892	(121, 4848.3)	0.0002
10	153.6759	121	0.0239	1.274502	(121, 4848.3)	0.0240
11	166.9120	121	0.3612	1.386152	(121, 4848.3)	0.3612

Source: Own Elaboration.

Tranquil subperiod (out of 110 possible). Since they caused 7 out of 10 market possibilities, the crude oil market (WTI) and the Russian capital market (IMOEX) were the main market drivers. The capital markets of France (CAC 40), the Netherlands (AEX), Spain (IBEX 35), and the silver and platinum markets only caused 2 markets (out of 10 possibilities). On the other hand, the markets that experience the largest shocks—those that are most affected by their peers—are the French market (6 shocks) and the Dutch market (5 shocks). The two markets that experience the fewest shocks are the Russian capital market (IMOEX) and WTI (2 shocks out of 10 possible). The precious metals (XAG, XAU, and XPT) under investigation (CAG, XAU, and XPT) only caused themselves, except for the gold market (XAU), which caused the French capital market (CAC 40). Precious metals are also caused by the capital market (XAU), which caused the French capital market (CAC 40). Precious metals are also caused by the capital markets under analysis. The gold (XAU) and platinum (XPT) markets are caused by the capital markets of France (CAC 40), the Netherlands (AEX), and Spain (IBEX 35). The silver (XAG) market is caused by the UK capital market (FTSE 100).

During the Stress subperiod, we observe 62 shocks out of 110 possibilities (see Table 11). The markets that caused their peers the most are the DAX 30 with nine shocks, the FTSE 100, and the FTSE MIB with eight shocks each. Regarding commodities, the crude oil market (WTI) has had seven shocks from its peers; in contrast, the XAG, XAU, and XPT precious metals have only experienced shocks from other precious metals. Also, we discovered that XAG (8 shocks), WTI (7 shocks), and the FTSE MIB (7 shocks) are the markets that experience the most shocks from their peers. We also discovered that during the Stress subperiod, shocks from the capital markets significantly increased for WTI and for precious metals (silver, gold, and platinum). These findings suggest that these commodities won't have safe haven qualities since they are affected by the capital markets under study.

Table 9. Granger causality/Block Exogeneity Wald Tests, of the financial markets under analysis, in the Tranquil subperiod.

XPT	XAU	XAG	WTI	IMOEX	IBEX 35	FTSE MIB	FTSE 100	DAX 30	AEX	CAC 40	
2,45220**	**2,33194****	0,64472	1,18213	1,47260	0,57312	0,54023	0,98648	0,51668	1,16125		**CAC 40**
2,66888**	**3,13829*****	1,32876	0,96435	1,69719	0,42058	0,55831	0,75329	1,08763		1,54712	**AEX**
0,52426	0,94561	0,94927	1,70115	**5,04750*****	**13,9124*****	**38,9529*****	**9,62621*****		**16,3483*****	**14,6422*****	**DAX 30**
1,10169	1,09830	**2,17783****	0,55593	1,25351	**13,8475*****	**6,93442*****		**2,89944*****	**24,5674*****	**23,1700*****	**FTSE 100**
0,68063	0,87669	0,43999	**2,35017****	1,26686	**14,6104*****		**4,24148*****	0,53317	**15,5983*****	**11,8152*****	**FTSE MIB**
2,75997**	**3,09896*****	0,93664	0,86103	1,31783		0,81493	0,64766	1,09117	0,98982	0,50213	**IBEX 35**
0,42109	0,53534	0,86516	**2,38014****		**5,98439*****	**3,17060*****	**5,09660*****	**1,91243***	**7,82492*****	**6,91621*****	**IMOEX**
0,56246	0,62538	1,45879		**3,03923*****	**3,51433*****	**4,19679*****	**4,04311*****	**6,12357*****	**4,63125*****	**4,34046*****	**WTI**
14,2530***	**2,17522****		0,86596	0,78498	0,38122	0,66768	0,77980	0,73269	0,51108	0,81636	**XAG**
6,05424***		**14,0011*****	0,50341	0,80281	1,25780	0,72523	0,37329	0,27745	1,29427	**1,96955***	**XAU**
	2,31025**	**2,75612****	0,30367	0,26473	1,20038	0,43268	0,96053	1,04740	0,43742	0,31064	**XPT**

Source: Own elaboration. ***Note:*** *Markets in column "cause" markets in row. The asterisks ***, **, * indicate the significance of the statistics at 1%, 5% and 10%, respectively*

Table10. Granger causality/Block Exogeneity Wald Tests, of the financial markets under analysis, in the Stress subperiod.

XPT	XAU	XAG	WTI	IMOEX	IBEX 35	FTSE MIB	FTSE 100	DAX 30	AEX	CAC 40	
2,78540***	**3,20434*****	**2,87358*****	**3,18468*****	0,79817	1,35309	**2,53368*****	0,73483	1,49722	1,23612		**CAC 40**
2,09798**	**2,03661****	**1,98834****	**2,58527*****	0,74804	1,02815	**3,25799*****	0,51889	1,38740		1,02082	**AEX**
0,89690	**2,12706****	**2,07389****	**2,81777*****	**1,58442***	**16,4555*****	**37,6425*****	**30,4237*****		**17,9797*****	**16,0331*****	**DAX 30**
2,13105**	1,23096	**1,77418***	**1,94771****	0,81326	**18,3664*****		**1,74459***	**2,36326*****	**17,3399*****	**15,0507*****	**FTSE 100**
1,23390	**2,17854****	**1,79014***	**1,90629****	0,96488		**64,9190*****	**20,3224*****	**3,12860*****	**57,6152*****	**38,0581*****	**FTSE MIB**
2,63759***	**2,16858****	**2,08792****	**2,65759*****	1,14579		**1,93044****	0,94381	1,24358	**14,9135*****	**12,2940*****	**IBEX 35**
0,54057	0,54241	0,33341	**2,24952****		**2,96300*****	**6,75157*****	**7,11081*****	**3,65032*****	**2,71180*****	**3,13704*****	**IMOEX**
1,33413	1,42040	0,77938		**1,90632****	**5,11458*****	**5,35766*****	**8,40333*****	**3,29131*****	**4,56972*****	**3,97078*****	**WTI**
51,6324***	1,30577		0,69444	1,23369	1,51093	0,95633	0,85731	0,73948	0,88740	0,69371	**XAG**
36,5945***		**2,05579****	1,34899	1,39737	1,04719	1,07046	1,35118	0,63093	1,27290	1,47502	**XAU**
	3,05246***	**1,84855****	0,79503	1,11802	0,79806	0,99787	0,84214	**1,92143****	0,68441	0,91621	**XPT**

Source: Own elaboration. ***Note:*** *Markets in column "cause" markets in row. The asterisks ***, **, * indicate the significance of the statistics at 1%, 5% and 10%, respectively.*

This evidence supports Dias and Carvalho's (2020) investigation, which found that neither gold nor silver exhibit safe haven properties. Contrarily, gold is undoubtedly a safe haven and a hedge for Hussain Shahzad et al. (2020) and, Teixeira, Dias, and Pardal (2022). The authors, however, produced their analysis using a different time period and other financial markets than we did.

Table 11. Summary of the Results.

	Market X "cause in grangerian sense" their peers			Market X is "caused in grangerian sense" by the peers		
Index	Tranquil Subperiod	Stress Subperiod	Evolution	Tranquil Subperiod	Stress Subperiod	Evolution
CAC 40	2 shocks	5 shocks	↑	6 shocks	6 shocks	=
AEX	2 shocks	5 shocks	↑	5 shocks	6 shocks	↑
DAX 30	6 shocks	9 shocks	↑	3 shocks	5 shocks	↑
FTSE 100	6 shocks	8 shocks	↓	4 shocks	5 shocks	↓
FTSE MIB	5 shocks	8 shocks	↑	4 shocks	7 shocks	↑
IBEX 35	2 shocks	7 shocks	↑	5 shocks	4 shocks	↓
IMOEX	7 shocks	7 shocks	=	2 shocks	2 shocks	=
WTI	7 shocks	7 shocks	=	2 shocks	7 shocks	↑
XAG	2 shocks	1 shock	↓	3 shocks	8 shocks	↑
XAU	3 shocks	2 shocks	↓	5 shocks	6 shocks	↑
XPT	2 shocks	3 shocks	↑	5 shocks	6 shocks	↑

Source: Own Elaboration.

6. Conclusions

This study examined the movements in the capital markets of the Netherlands (AEX), France (CAC 40), Germany (DAX 30), the United Kingdom (FTSE 100), Italy (FTSE MIB), Spain (IBEX 35), Russia (IMOEX), and the spot prices of crude oil (WTI), silver (XAG), gold (XAU), and platinum (XPT) from January 1, 2018 to December 31, 2022. The purpose of this analysis is to answer the following research question: Is it possible that the events of 2020 and 2022 heightened shocks between stock markets and WTI, XAG, XAU, and XPT prices?

The results show that time series do not have a normal distribution and are stationary in terms of returns. In response to the investigation question, we observed that throughout the Tranquil period, we were able to find 44 causal relationships out of 110 possibilities. During the Stress period, the number of linkages between market pairs under examination increased significantly, including a relative rise in the effect of commodities on capital markets and capital markets on commodities, with 62 causal relationships out of 110 possibilities.

These findings show that during the events of 2020 and 2022, capital markets and commodities significantly accentuated their co-movements among themselves, indicating that alternative markets such as WTI, XAG, XAU, and XPT do not provide safe haven properties. These findings have implications for portfolio diversification during times of global economic uncertainty.

Overall, we can show that assets without "safe haven" characteristics are not seen as a suitable place to keep funds during times of global economic turbulence. The lack of safe haven properties has significant implications for investment strategies, as investors may need to review their portfolio composition and look for other assets to provide stability during times of uncertainty.

In the opinion of the authors, the findings of this study will be beneficial to regulators, institutional investors, and both individual and institutional investors. We also suggest that investors exercise caution when making investments in commodities, particularly those that are susceptible to price volatility and geopolitical risk. Before making any investment decisions, it is crucial to thoroughly consider your objectives, risk tolerance, and investment horizon. Diversification among various asset classes and sectors can reduce portfolio risk and increase the return

in the long run.

The frontier and emerging markets may be included in future studies on the safe-haven qualities of commodities (crude oil and precious metals like silver, gold, and platinum), given their unstable but fast-growing economies and their reputation as potential locations for foreign investment. Future studies may also examine how effectively diversification across different asset classes and industry sectors reduces portfolio risk during times of economic turmoil.

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Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

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