

SAFE HAVEN, HEDGE AND DIVERSIFICATION FOR STOCK MARKETS: GOLD VERSUS SILVER

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DOI: <https://doi.org/10.31410/ITEMA.S.P.2020.67>

Abstract: *This paper aims to analyse if whether Gold (Gold Bullion: Zurich) and Silver (Silver Paris Spot E/KG) will be a safe haven for portfolio diversification in the financial markets of Germany (DAX 30), USA (DOW JONES), France (CAC 40), Italy (FTSE MID), United Kingdom (FTSE 100), Hong Kong (Hang Seng), China (SHANGHAI SE ASHARE), Japan (NIKKEI 225), in the period between 1 January 2019 to 2 September 2020. In order to perform this analysis where undertaken different approaches to analyse if: (i) the gold and silver market will be a safe haven when financial markets break down? (ii) If so, can market shocks question portfolio diversification? The results suggest 53 pairs of integrated markets (out of 90 possible). Gold and Silver have integrations with each other and with the USA, but the other financial markets integrate with Gold and Silver, namely the US, France, UK, Italy and Hong Kong markets (the latter only with Silver). The China market has a single integration but is integrated by the USA, France, the United Kingdom, Italy, and Germany, which partially rejects the first investigation question. In corroboration, causality tests show 67 causal relationships (out of 90 possible). The Markets of Italy (FTSE MID), the USA (DOW JONES) cause, in the Grangerian sense, all its peers (9 out of 9 possible), while France (CAC 40), the United Kingdom (FTSE 100), Japan (NIKKEI 225), and Germany (DAX 30) cause 8 out of 9. Silver and Gold cause the financial markets 7, and 6 times (out of 9 possible), respectively, while the Hong Kong (Hang Seng) and China (SHANGHAI) markets cause 3 and once, respectively, which validates the second investigation question. Given the high level of integration and shocks between markets, portfolio diversification may be brought into question. These findings also make room for market regulators to take steps to ensure better information among international financial markets.*

Keywords: *Gold, Silver, Hedging, Safe haven, Risk diversification.*

1. INTRODUCTION

The fastest dissemination of the Coronavirus (COVID-19) has caused stress in the financial markets all around the world. The global pandemic of 2020 generated an unprecedented level of risk, causing investors to suffer significant losses, in a short amount of time. The new Coronavirus disease evolved quickly from a provincial health outbreak to a global collapse, affecting the global economy, damaging one-quarter of the global

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wealth in less than a month. (Larry, 2020; Ali, Alam, and Rizvi, 2020; Zhang, Hu, and Ji, 2020).

The growing trend of integration and interdependence in international financial markets has increased the probability of risk transmission between markets. In times of agitation, investors should rebalance their portfolios by closing long positions in markets with significant levels of risk. (Dias, da Silva, and Dionísio, 2019; Mohammadpoor and Rezazadeh, 2019; Morales and Gassie, 2014).

The growing uncertainty of the global economy has been passed on to the global financial market, which causes investors to tend to distribute their portfolios from high-risk markets to low-risk markets. From the perspective of investors, and risk managers, gold is regularly regarded as a hedge or safe haven against stock markets, so understanding the relationship between gold and financial markets has relevant implications. (Ma, Yang, Zou, and Liu, 2020; Yamaka and Maneejuk, 2020).

The goal of this paper is to test if whether Gold (Gold Bullion, Zurich) and Silver (Silver Paris Spot E/KG), will be a safe haven for portfolio diversification in financial markets of Germany (DAX 30), EUA (DOW JONES), France (CAC 40), Italy (FTSE MID), United Kingdom (FTSE 100), Hong Kong (Hang Seng), China (SHANGHAI SE A SHARE), Japan (NIKKEI 225), in the period between 1 January 2020 to 2 September 2020. In order to perform this analysis, different approaches will be undertaken to analyse the two investigation questions: (i) will the gold and silver market be a safe haven when financial markets break down? (ii) If so, can market shocks question portfolio diversification? The results show that the high level of integration and shocks may question portfolio diversification.

This research adds two contributions to the literature. The first refers to the study of risk diversification in international markets, and the Gold Bullion (Zurich) and Silver (Silver Paris Spot E/KG) markets. Most of the previous studies focused on the correlations or average dependencies between gold and financial market movements, and between gold and currency depreciation. The second contribution relates to the combination of some of the most relevant financial markets in global terms and tests whether the gold and silver market will be a safe haven when these stock markets break down from high levels of risk, particularly during the global pandemic (Covid-19). As far as we know, there are recent studies that have looked at risk diversification, crossing the stock and gold markets, namely the authors, Naeem, Hasan, Arif, Balli, and Shahzad (2020), Hussain Shahzad, Bouri, Roubaud, and Kristoufek (2020), Yamaka and Maneejuk (2020); however, the approach was quite different from the one followed in this paper.

In terms of structure, this paper is organized into 5 sections. Section 1 is represented by the current introduction. Section 2 presents a Literature Review on articles about assets that may be safe ports in portfolio diversification. Section 3 describes the data and methodology. Section 4 contains the results. Finally, section 5 presents the general conclusions of the work.

2. LITERATURE REVIEW

Understanding the international connections between financial markets in times of financial crisis is relevant for investors, fund managers, and academics in different respects, particularly on the subject of portfolio diversification. (Kumar, 2017; Sheik and Banu, 2015).

Balcilar, Hammoudeh, and Asaba (2015), Batten, Ciner, Kosedag, and Lucey (2017), Laily et al. (2017) analysed gold synchronism with certain assets and markets. Balcilar, Hammoudeh, and Asaba (2015) show that gold is a less volatile asset when compared to silver and oil, ensuring its use as a "safe haven asset". Batten, Ciner, Kosedag, and Lucey (2017) evidence the lack of causal relationships between the price of gold and the stock markets analysed. On the other hand, Laily et al. (2017) show a positive relationship between crude oil prices, and the price of gold, and a negative synchronization between inflation rate, GDP, interest rates, and exchange rates.

Tursoy and Faisal (2018), Siddiqui and Roy (2019), D. Huang and Kilic (2019) examined the importance of gold as a safe risk hedging asset. Tursoy and Faisal (2018) show a negative relationship between the price of gold and stock prices and a positive relationship between crude oil and stock prices. Siddiqui and Roy (2019) show that gold is a more effective hedging asset than crude oil for institutional investors in India. D. Huang and Kilic (2019) demonstrate that gold prices fall into recessions, although to a smaller extent than platinum prices.

Balcilar, Demirer, Gupta, and Wohar (2020), Kang, Yoon, Bekiros, and Uddin (2020), Bouri, Shahzad, Roubaud, Kristoufek, and Lucey (2020), Corbet, Larkin, and Lucey (2020), Yamaka and Maneejuk (2020) examined several assets to test whether they are an alternative to stock markets. Balcilar, Demirer, Gupta, and Wohar (2020) show that precious metals cause shocks in stock markets in periods of high volatility. However, treasury bonds present negligible risk in periods of stock stress which implies that these assets would serve as more effective hedges (or safe havens) for investors in international stock markets. Kang, Yoon, Bekiros, and Uddin (2020) investigated the dynamic relationship between Bitcoin and U.S. stocks (S&P 500), U.S. dollar, treasury bonds and gold futures, evidencing that Bitcoin can be used as a safe haven for investors. Bouri, Shahzad, Roubaud, Kristoufek, and Lucey (2020) compared bitcoin's safe harbour properties, gold and commodity index with stock markets. The authors show that the degree of co-movement between gold and the profitability of the shares affects the VaR level of the portfolio. Specifically, the benefits of diversification vary in frequency of time, with Bitcoin showing superiority over gold and the commodity index. Corbet, Larkin, and Lucey (2020) evidence significant causalities and shocks between China's major stock markets and Bitcoin during the global pandemic (Covid-19), showing reservations about this new financial product in portfolio diversification. Yamaka and Maneejuk (2020) presented significant causalities between gold and the volatility of Asian stock markets during the global financial crisis (2008).

Naeem, Hasan, Arif, Balli, and Shahzad (2020), Hussain Shahzad, Bouri, Roubaud, and Kristoufek (2020), Yamaka and Maneejuk (2020) examined the synchronization between the stock markets with oil, gold and Bitcoin. Naeem, Hasan, Arif, Balli, and Shahzad (2020) show that the global financial crisis of 2008 accentuated the shocks between BRIC stock markets with oil and gold. Hussain Shahzad, Bouri, Roubaud, and Kristoufek (2020) demonstrate that gold and Bitcoin are safe ports but have distinct hedging characteristics. Gold is an undisputed haven and protection in the G7 stock markets, while Bitcoin takes on these two functions in Canada. They suggest that the diversification benefits offered by gold to capital investments in the G7 markets are comparatively higher and more stable than Bitcoin. Yamaka and Maneejuk (2020) evidence the existence of significant causalities between gold shocks and volatilities in Asian stock markets. The authors show strong correlations between the South Korean stock markets and India, and the gold market, during the global financial crisis when compared to the pre and post-crisis periods. Additionally, there are indications of the existence of contagion effects between the gold market and the stock markets analysed.

In summary, this work aims to contribute to the provision of information to investors and regulators in international stock markets, where individual and institutional investors seek diversification benefits. Therefore, the context of this work is to examine the integration and shocks between the stock markets under analysis and the prices of Gold and Silver, to understand whether these commodities will be a safe haven in the period of the global pandemic (Covid-19).

3. METHODOLOGY

DATA

The data analysed are the index prices from the stock markets of Germany (DAX 30), EUA (DOW JONES), France (CAC 40), Italy (FTSE MID), United Kingdom (FTSE 100), Hong Kong (Hang Seng), China (SHANGHAI SE A SHARE), Japan (NIKKEI 225), and gold prices (Gold Bullion: Zurich) and Silver (Silver Paris Spot E/KG), between the period of 1 January 2019 to 2 de September 2020. The quotations are daily and were obtained from the Thomson Reuters platform. The quotes are in local currency to mitigate distortions in exchange rates.

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

Country	Index
Germany	DAX 30
USA	DOW JONES
France	CAC 40
Italy	FTSE MID
United Kingdom	FTSE 100
Hong Kong	HANG SENG
China	SHANGHAI SE A SHARE
Japan	NIKKEI 225
Gold	Gold Bullion (Zurich) kg (995) CHF
Silver	Silver Paris Spot E/KG

Source: Own elaboration.

METHODOLOGY

The development of the research took place along several stages. The characterization of the sample used was performed through descriptive statistics, the adherence test of Jarque and Bera (1980), and the quantile charts. In order to assess the stationarity of the time series, we will use the ADF tests (Dickey and Fuller, 1981) and PP (Perron and Phillips, 1988). For the verification of integration or segmentation between the financial markets analysed, we'll use the methodology of Gregory and Hansen (1996) because we are looking at a very troubled period in the financial markets. Additionally, the reason why standard cointegration tests such as Engle and Granger (1987) and Johansen (1988), are not appropriate to test the cointegration with regime change that such tests assume that the cointegration vector is invariant in time.

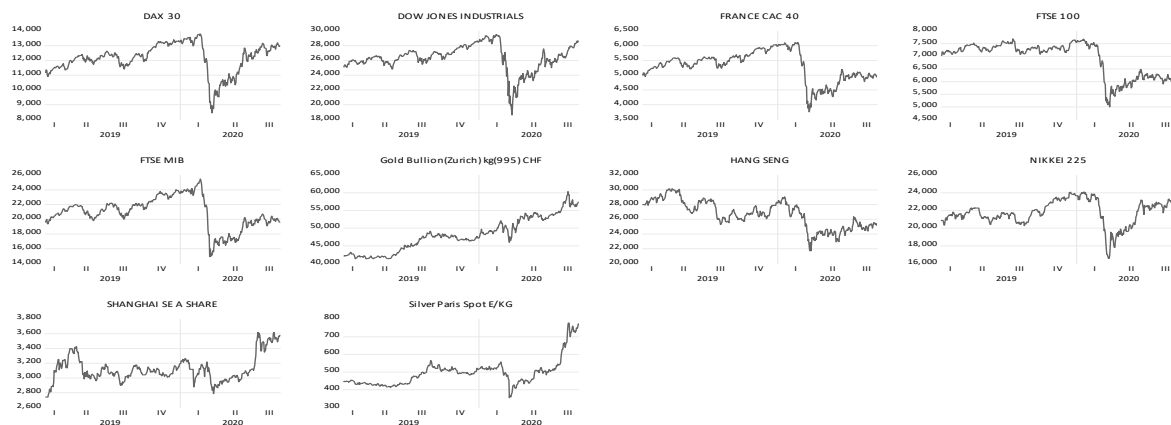
To examine the clashes between markets we will use the *VAR Granger Causality/Block Exogeneity Wald Tests* model, which employs Wald's statistics, which tests whether the null hypothesis that the coefficients of the out-of-date endogenous variables of the variable "cause" are null or not "cause" in the Grangerian sense of the dependent variable. However, the result of this test has a high sensitivity to the number of lags considered in the model, so the first concern is to conveniently estimate this value, in order to reach robust evidence (Gujarati,

2004). To determine the number of lags to include in causality tests, we will use the *Final Prediction Error (FPE)* and *Akaike information criterion (AIC)* criteria to validate the robustness of the model we will estimate the *VAR Residual Serial Correlation LM Tests*.

4. RESULTS

Figure 1 shows the evolution of the financial markets, at levels, between 1 January of 2019 to 2 September 2020, being this a period of great complexity, due to the global pandemic outbreak (Covid-19). Most of the markets reveal structural breakdowns between February and March of 2020.

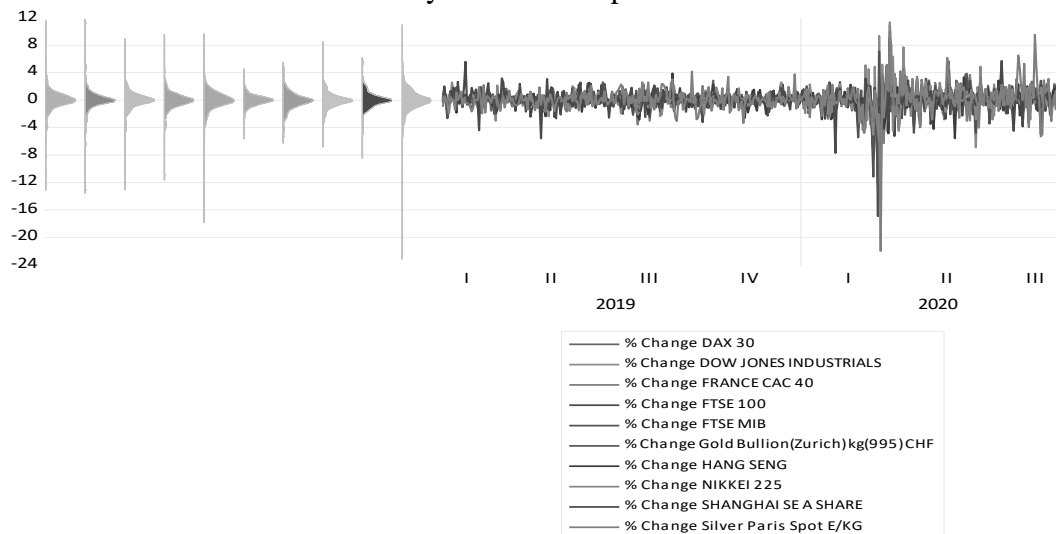
Figure 1: Evolution, in levels, of the ten financial markets, between the period of 1 January 2019 to 2 September 2020



Source: Own elaboration.

Figure 2 shows the evolution, in % of the differences, of the 10 financial markets under analysis. In all series, a relatively high dispersion around the mean is noted, as well as a relatively synchronized behaviour between the data series. Through graphical analysis, high volatility is observed, especially in February, March, and April 2020.

Figure 2. Evolution, in % of the differences, of the 10 financial markets, between the period of 1 January 2019 to 2 September 2020.



Source: Own elaboration.

Tables 2 and 3 show the main descriptive statistics from the financial markets analysed. The profitability of stock indices has positive daily averages, except for the Markets of France (CAC 40), The United Kingdom (FTSE 100), and Hong Kong (HANG SENG). However, all the series showed signs of deviation from the hypothesis of normality, considering the coefficients of skewness and kurtosis. The asymmetry characteristics are negative, especially in silver prices. Additionally, the coefficients of skewness and kurtosis are statistically different from those in a normal distribution, these indices are corroborated by the Jarque-Bera adherence test.

Table 2: Descriptive statistics, in profitability, of the 10 financial markets, between the period of 1 January 2019 to 2 September 2020.

	DAX 30	DOW JONES	CAC40	FTSE 100	FTSE MIB
Mean	0.000359	0.000323	-3.94E-05	-0.000435	2.25E-06
Std. Dev.	0.016387	0.018343	0.016123	0.014549	0.017947
Skewness	-1.160567	-1.060573	-1.728236	-1.407132	-3.292874
Kurtosis	18.42201	19.26823	17.63492	17.46935	35.74753
Jarque-Bera	4195.652***	4642.918***	3900.710***	3748.119***	19247.08***
Sum	0.148781	0.133574	-0.016302	-0.180295	0.000932
Sum Sq. Dev.	0.110904	0.138953	0.107359	0.087423	0.133021
Observations	414	414	414	414	414

Source: Own elaboration.

Notes: ***, **, *. represent significance at 1%, 5% and 10%, respectively.

Table 3. Descriptive statistics, in profitability, of the 10 financial markets, between the period of 1 January 2019 to 2 September 2020.

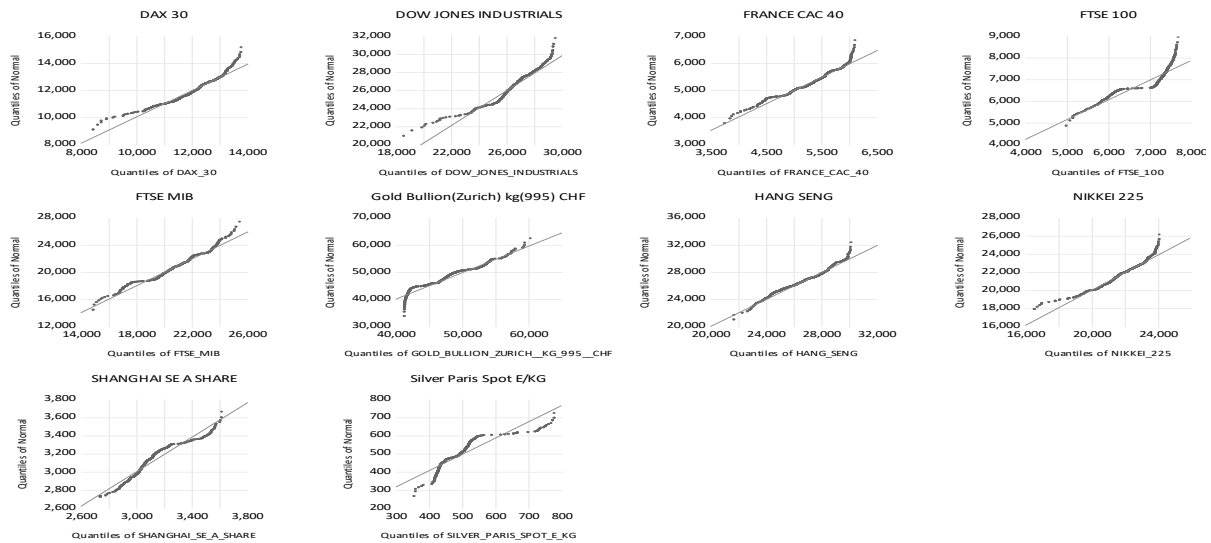
	GOLD	HANG SENG	NIKKEI 225	SHANGHAI	SILVER
Mean	0.000745	-0.000256	0.000270	0.000636	0.001306
Std. Dev.	0.009279	0.012770	0.013390	0.012568	0.020734
Skewness	-0.449500	-0.385542	0.207371	-0.767970	-3.731415
Kurtosis	8.868926	5.879456	9.485668	10.07067	54.52105
Jarque-Bera	608.1056***	153.2807***	728.5692***	903.0985***	46749.44***
Sum	0.308557	-0.106060	0.111788	0.263511	0.540774
Sum Sq. Dev.	0.035560	0.067350	0.074046	0.065233	0.177553
Observations	414	414	414	414	414

Source: Own elaboration.

Notes: ***, **, *. represent significance at 1%, 5% and 10%, respectively.

The quantile charts demonstrate that the distribution of profitability rates is leptokurtic and asymmetric or skewed. The distribution is leptokurtic because the graph is shaped like "S", on the 45° line, and is asymmetric because the "S" is not symmetrical on the line, evidencing the existence of nonlinear relationships (see Figure 3).

The results from the stationarity tests, through the ADF tests (Dickey and Fuller, 1981), and PP (Perron and Phillips, 1988), reveal that the temporal series analysed are stationarity, in profitability, fundamental presupposition for estimating the model *VAR Granger Causality/Block Exogeneity Wald Tests* (attachments A, B e C).

Figure 3. Quantile charts of profitability rates, from the financial markets under analysis, between the period of 1 January 2019 to 2 September 2020

Source: Own elaboration

In Table 4 are the results from the Gregory-Hansen integration test, with structure breakage, and we found 53 pairs of integrated markets (out of 90 possible); we also saw that the structural breakdowns occur, mostly, in March 2020. The UK market (FTSE 100) has 9 integrations (out of 9 possible), while the US (DOW JONES), France (CAC 40), Italy (FTSE MID) markets show 8 integrations. The Hong Kong (HANG SENG), Japan (NIKKEI 225), and Germany markets show 5 integrations, Gold and Silver have 2 integrations. The China market (SHANGHAI) has a single integration with the United Kingdom (FTSE 100). In response to the first investigation question, gold and silver prices have integrations with each other and with the US, but the other financial markets integrate with Gold and Silver, namely the US, France, UK, Italy, and Hong Kong markets (the latter only with Silver). The China market has a single integration, but is integrated by the USA, France, THE UNITED KINGDOM, Italy, and Germany; these findings show that portfolio diversification could be put into question due to the high level of integration between the stock markets and Gold and Silver.

Table 4. Gregory-Hansen tests, between the period of 1 January 2019 to 2 September 2020.

Markets	t-statistic	Method	Lags	Break Date	Results
GOLD / SILVER	-6.75***	Regime	0	17/03/2020	Integration
GOLD / DJ	-4.81*	Regime	0	27/02/2020	Integration
SILVER / GOLD	-5.63***	Regime	3	18/03/2020	Integration
SILVER / DJ	-5.81***	Regime	3	03/06/2020	Integration
DJ / GOLD	-5.21**	Regime	2	12/03/2020	Integration
DJ / SILVER	-53.43**	Trend	2	28/02/2020	Integration
DJ / CAC 40	-53.47**	Regime	4	04/03/2020	Integration
DJ / FTSE MID	-54.38**	Trend	2	10/04/2020	Integration
DJ / HANG SENG	-56.10**	Trend	2	28/02/2020	Integration
DJ / NIKKEI 225	-6.76***	Trend	1	12/03/2020	Integration
DJ / DAX 30	-62.15***	Trend	1	12/03/2020	Integration
DJ / SHANGHAI	-5.48***	Trend	2	28/02/2020	Integration

CAC 40 / GOLD	-6.89***	Trend	1	02/03/2020	Integration
CAC 40 / SILVER	-6.39***	Trend	1	02/03/2020	Integration
CAC 40 / DJ	-6.18***	Trend	1	03/03/2020	Integration
CAC 40 / FTSE MID	-6.52***	Regime	4	30/01/2020	Integration
CAC 40 / HANG SENG	-5.49***	Regime	0	29/07/2019	Integration
CAC 40 / NIKKEI 225	-6.22***	Regime	1	10/03/2020	Integration
CAC 40 / DAX 30	-6.55***	Regime	2	03/03/2020	Integration
CAC 40 / SHANGHAI	-7.69***	Trend	2	02/03/2020	Integration
FTSE 100 / GOLD	-6.63***	Trend	1	02/03/2020	Integration
FTSE 100 / SILVER	-6.59***	Trend	1	02/03/2020	Integration
FTSE 100 / DJ	-5.47***	Trend	0	02/03/2020	Integration
FTSE 100 / CAC 40	-5.09**	Regime	0	02/03/2020	Integration
FTSE 100 / FTSE MID	-5.37**	Regime	0	02/03/2020	Integration
FTSE 100 / HANG SENG	-5.56***	Regime	0	02/03/2020	Integration
FTSE 100 / NIKKEI 225	-6.99***	Regime	0	02/03/2020	Integration
FTSE 100 / DAX 30	-6.82***	Regime	1	02/03/2020	Integration
FTSE 100 / SHANGHAI	-6.46***	Regime	1	02/03/2020	Integration
FTSE MID / GOLD	-5.68***	Trend	0	03/03/2020	Integration
FTSE MID / SILVER	-5.75***	Trend	0	03/03/2020	Integration
FTSE MID / DJ	-5.41**	Trend	4	04/03/2020	Integration
FTSE MID / CAC 40	-6.64***	Trend	4	30/01/2020	Integration
FTSE MID / HANG SENG	-5.53***	Regime	0	30/07/2019	Integration
FTSE MID / NIKKEI 225	-6.24***	Regime	1	10/04/2020	Integration
FTSE MID / DAX 30	-48.20***	Trend	5	04/03/2020	Integration
FTSE MID / SHANGHAI	-6.75***	Trend	3	02/03/2020	Integration
HANG SENG / SILVER	-4.70*	Regime	1	03/03/2020	Integration
HANG SENG / CAC 40	-5.09**	Trend	0	02/03/2020	Integration
HANG SENG / FTSE 100	-4.88*	Trend	0	21/05/2020	Integration
HANG SENG / FTSE MID	-5.66***	Trend	0	02/03/2020	Integration
HANG SENG / DAX 30	-5.08**	Trend	0	19/12/2020	Integration
NIKKEI 225 / DJ	-6.09***	Regime	1	26/05/2020	Integration
NIKKEI 225 / CAC 40	-6.71***	Regime	1	10/03/2020	Integration
NIKKEI 225 / FTSE 100	-50.14**	Trend	1	16/05/2019	Integration
NIKKEI 225 / FTSE MID	-5.84***	Trend	2	10/03/2020	Integration
NIKKEI 225 / DAX 30	-6.23***	Regime	1	17/09/2019	Integration
DAX 30 / DJ	-5.39**	Regime	1	28/05/2020	Integration
DAX 30 / CAC 40	-5.70***	Regime	0	04/03/2020	Integration
DAX 30 / FTSE MID	-4.92*	Regime	0	04/03/2020	Integration
DAX 30 / NIKKEI 225	-6.19***	Trend	1	03/05/2019	Integration
DAX 30 / SHANGHAI	-5.04**	Trend	2	02/03/2020	Integration
SHANGHAI / FTSE 100	-5.02**	Regime	5	05/06/2020	Integration

Source: Own elaboration.

Notes: ***, **, *. represent significance at 1%, 5% and 10%, respectively.

To analyse the significance of causal relationships between financial markets under analysis, we applied the VAR Granger Causality/Block Exogeneity Wald Tests. To determine the number of lags to be included in causality tests, we used the *Final prediction error* (FPE) criteria and AIC (Akaike information criterion) that suggest 4 lags. A smaller number of lags increases the degrees of freedom; a greater number of lags decreases the problems of autocorrelation (see Table 5).

Table 5. VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
4	13686.73	224.7519	1.36e-41*	-65.72639*	-61.66555	-64.11888

Source: Own elaboration.

Note: * indicates lag order selected by the criterion.

In Table 6 is possible to check the results of *VAR Residual Serial Correlation LM* Tests, we estimate a VAR with 4 lags, and verified the existence of autocorrelation in the residues (5 lags). To eliminate the correlation in series we estimated a VAR with 6 lags, and then performed the autocorrelation test to 7 lags, the null hypothesis was not rejected, which corroborates that the present model is a robust estimate.

Table 6. VAR Residual Serial Correlation LM Tests

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
7	93.71510	100	0.6579	0.936181	(100, 2360.2)	0.6582

Source: Own elaboration.

Table 7. Granger Causality Testes / Block Exogeneity Wald Tests, between the period of 1 January 2019 to 2 September 2020.

	GOLD	SILVER	DJ	CAC 40	FTSE 100	FTSE MID	HANG SENG	NIKKEI 225	DAX 30	SHANG HAI
GOLD	***** *	5.51(6) ***	3.66(6) ***	6.54(6) ***	4.67(6) ***	7.85(6) ***	2.23(6) **	2.35(6) **	6.43(6) ***	0.50(6)
SILVER	17.78(6) ***	***** **	9.83(6) ***	10.07(6) ***	10.29(6) ***	17.69(6) ***	1.01(6)	3.06(6) ***	9.16(6) ***	0.94(6)
DJ	4.52(6) ***	4.92(6) ***	***** *	9.86(6) ***	4.28(6) ***	14.73(6) ***	1.40(6)	6.16(6) ***	10.75(6) ***	0.83(6)
CAC 40	2.01(6)*	3.93(6) ***	11.52(6) ***	***** *	3.62(6) ***	7.97(6) ***	1.49(6)	3.86(6) ***	1.08(6)	0.75(6)
FTSE 100	2.26(6) **	5.20(6) ***	7.31(6) ***	5.61(6) ***	***** *	7.03(6) ***	0.51(6)	4.53(6) ***	3.54(6) ***	0.33(6)
FTSE MID	1.43(6)	1.48(6)	8.75(6) ***	1.51(6)	2.21(6) **	***** *	1.60(6)	3.03(6) ***	1.84(6)*	1.09(6)
HANG SENG	2.32(6) **	4.98(6) ***	10.92(6) ***	5.32(6) ***	4.74(6) ***	8.63(6) ***	*****	6.01(6) ***	5.73(6) ***	0.45(6)
NIKKEI 225	2.22(6) **	2.83(6) **	11.16(6) ***	19.87(6) ***	10.99(6) ***	19.94(6) ***	4.51(6) ***	***** *	24.17(6) ***	1.92(6)*
DAX 30	1.46(6)	4.95(6) ***	10.13(6) ***	2.43(6) **	3.46(6) ***	7.24(6) ***	1.18(6)	2.99(6) ***	***** *	0.65(6)
SHANGHAI	0.95(6)	1.78(6)	2.54(6) **	2.82(6) **	1.64(6)	3.51(6) ***	3.52(6) ***	1.03(6)	2.32(6) **	***** *

Source: Own elaboration.

Notes: Column markets “cause” online markets. The lateral values in parentheses refer to lags. ***, **, * represent significance at 1%, 5% and 10%, respectively.

The results of Granger's causality tests for the financial markets under analysis are shown in Table 7. The causality tests show 67 causal relationships (out of 90 possible). The Markets of Italy (FTSE MID), the USA (DOW JONES) cause, in the Grangerian sense, all its peers (9 out

of 9 possible), while France (CAC 40), the United Kingdom (FTSE 100), Japan (NIKKEI 225), and Germany (DAX 30) cause 8 out of 9. Silver and Gold cause the financial markets 7, and 6 times (out of 9 possible), respectively, while the Hong Kong (Hang Seng) and China (SHANGHAI) markets cause for 3 and once, respectively. The caused markets in the Grangerian sense are the stock indices NIKKEI 225 (9), HANG SENG (8), DOW JONES (7) FTSE 100 (7), CAC 40 (6), DAX 30 (6), SHANGHAI (5), FTSE MID (4), while Gold and Silver are caused by 8 and 7, respectively. These results show that the Gold and Silver market are not a safe haven, and they are not an alternative to portfolio diversification in these stock markets. These findings are in line with the evidence presented by the authors Yarovaya and Lau (2016), Diaz, Molero, and Perez de Gracia (2016), Ferreira, Dionísio and Movahed (2017) show significant movements in various financial markets, which calls into question portfolio diversification.

5. CONCLUSION

The general conclusion to be retained and, supported by the results obtained, through the tests carried out with econometric and mathematical models, demonstrate that the global pandemic has a significant impact on the memory properties of the markets analysed. The results indicate that markets have very significant integrations and causalities, i.e. Gold and Silver do not function as safe havens to portfolio diversification in these stock markets. These findings also make room for market regulators to take steps to ensure better information among international financial markets. In conclusion, we consider that investors should diversify their portfolios, and invest in less risky markets, to mitigate risk and improve the efficiency of their portfolios.

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Attachment A:

Null Hypothesis: Unit root (common unit root process)							
Method		Statistic		Prob.**			
Levin, Lin & Chu t*		-36.1140		0.0000			
** Probabilities are computed assuming asymptotic normality							
Intermediate results on UNTITLED							
	2nd Stage	Variance	HAC of		Max	Band-	
Series	Coefficient	of Reg	Dep.	Lag	Lag	width	Obs
DAX 30	-0.86834	0.0003	0.0001	1	17	4.0	412
DOW JONES	-0.91109	0.0003	4.E-05	6	17	16.0	407
CAC 40	-0.86010	0.0003	0.0005	1	17	0.0	412
FTSE 100	-0.95483	0.0002	3.E-05	7	17	11.0	406
FTSE MIB	-0.87840	0.0003	0.0001	1	17	5.0	412
GOLD	-0.97380	9.E-05	2.E-06	0	17	107.0	413
HANG SENG	-1.04163	0.0002	2.E-05	0	17	20.0	413
NIKKEI 225	-0.82111	0.0002	5.E-06	1	17	73.0	412
SHANGHAI	-0.98287	0.0002	9.E-06	0	17	34.0	413
SILVER	-1.01008	0.0004	5.E-05	3	17	16.0	410
	Coefficient	t-Stat	SE Reg	mu*	sig*		Obs
Pooled	-0.94505	-45.506	1.002	-0.500	0.707		4110

Source: Own elaboration.

Attachment B:

Null Hypothesis: Unit root (individual unit root process)				
Method		Statistic		Prob.**
ADF - Fisher Chi-square		1079.53		0.0000
ADF - Choi Z-stat		-31.0917		0.0000
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.				
Intermediate ADF test results UNTITLED				
Series	Prob.	Lag	Max Lag	Obs
DAX 30	0.0000	1	17	412
DOW JONES	0.0000	6	17	407
CAC 40	0.0000	1	17	412
FTSE 100	0.0000	7	17	406
FTSE MIB	0.0000	1	17	412
GOLD	0.0000	0	17	413

HANG SENG	0.0000	0	17	413
NIKKEI 225	0.0000	1	17	412
SHANGHAI	0.0000	0	17	413
SILVER	0.0000	3	17	410

Source: Own elaboration.

Attachment C:

Null Hypothesis: Unit root (individual unit root process)			
Method		Statistic	Prob.**
PP - Fisher Chi-square		1559.15	0.0000
PP - Choi Z-stat		-38.5919	0.0000
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.			
Intermediate Phillips-Perron test results UNTITLED			
Series	Prob.	Bandwidth	Obs
DAX 30	0.0000	9.0	413
DOW JONES	0.0000	5.0	413
CAC 40	0.0000	8.0	413
FTSE 100	0.0000	7.0	413
FTSE MIB	0.0000	10.0	413
GOLD	0.0000	18.0	413
HANG SENG	0.0000	3.0	413
NIKKEI 225	0.0000	1.0	413
SHANGHAI	0.0000	1.0	413
SILVER	0.0000	7.0	413

Source: Own elaboration.