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The gold market as a safe haven when stock markets exhibit pronounced levels of risk: evidence during the China crisis and the COVID-19 pandemic

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Abstract

This paper aims to analyze whether the gold market represents a safe haven when major financial markets suffer significant falls. An analysis was carried out to the integration and the co-movements in the stock markets of France (CAC 40), Germany (DAX 30), USA (Dow Jones), UK (FTSE 100), Italy (FTSE MIB), Hong Kong (Hang Seng), and the gold market (XAU), between May 2015 and May 2020, which comprises two complex sub-periods: the crash in China (2015/2016) and the beginning of the COVID-19 pandemic in 2020. The integration analysis used the methodology of Gregory and Hansen (1996). The methodology of impulse-response functions (IRF) with Monte Carlo simulations was used to evaluate the shocks (co-movements) between markets. The results show that the stock markets of France, Germany, and the USA evidence the highest levels of integration, not integrating, however, with the gold market. Regarding this market, no integration was observed with any of the stock markets under analysis, demonstrating that when they show high levels of risk, the XAU index may represent a safe haven for portfolio diversification and mitigation of such risk. This conclusion is reinforced with the analysis of the relationship between the stock and gold markets, in the short term, through the impulse-response functions, where evidence shows positive/negative co-movements, with statistical significance, between all markets except the gold market.

Keywords: Financial integration. Safe haven. Portfolio diversification.

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O mercado do ouro como porto seguro quando os mercados de ações apresentam níveis de risco acentuado: evidência nas crises da China e da pandemia da COVID-19

Resumo

Este artigo tem como objetivo analisar se o mercado do ouro representa um porto seguro quando os principais mercados financeiros sofrem quebras significativas. Para tal, é efetuada uma análise sobre a integração e os comovimentos nos mercados de ações de França (CAC 40), Alemanha (DAX 30), Estados Unidos (Dow Jones), Reino Unido (FTSE 100), Itália (FTSE MIB), Hong Kong (Hang Seng), além do mercado do ouro (XAU), no período entre maio de 2015 e maio de 2020, o qual compreende dois subperíodos complexos: o *crash* na China (2015/2016) e o início da pandemia da COVID-19, em 2020. Na análise de integração, utilizou-se a metodologia de Gregory e Hansen (1996), e, para avaliar os choques (comovimentos) entre mercados, a de funções impulso-resposta (IRF), com simulações de Monte Carlo. Os resultados evidenciam que os mercados de ações de França, Alemanha e Estados Unidos mostram os níveis mais elevados de integração, não integrando, contudo, com o mercado do ouro. Relativamente a este, não se observou uma integração com nenhum dos mercados de ações em análise, demonstrando que, quando estes apresentam níveis elevados de risco, o índice XAU poderá representar um porto seguro para a diversificação de carteiras e mitigação desse risco. Tal conclusão é reforçada pela análise da relação entre os mercados de ações e do ouro em curto prazo, por meio das funções de impulso-resposta, e onde se obtém evidência de comovimentos positivos/negativos, com significância estatística, entre todos os mercados, com exceção do ouro.

Palavras-chave: Integração financeira. Porto seguro. Diversificação de carteiras.

El mercado del oro como refugio cuando los mercados de acciones presentan niveles de riesgo elevados: evidencia de las crisis de China y de la pandemia de COVID-19

Resumen

El objetivo de este artículo es analizar si el mercado del oro representa un refugio seguro cuando los principales mercados financieros sufren caídas importantes. Para ello, se realiza un análisis de integración y de choques (comovimientos) de los mercados de acciones de Francia (CAC 40), Alemania (DAX 30), EE.UU. (Dow Jones), Reino Unido (FTSE 100), Italia (FTSE MIB), Hong Kong (Hang Seng) y el mercado del oro (XAU) en el periodo de mayo de 2015 a mayo de 2020, que comprende dos subperiodos complejos: el *crash* de China (2015/2016) y el inicio de la pandemia de COVID-19, en 2020. En el análisis de integración, se utilizó la metodología de Gregory y Hansen (1996) y para evaluar los choques de los mercados, la metodología de las funciones de impulso-respuesta (IRF) con simulaciones de Monte Carlo. Los resultados muestran que los mercados de acciones de Francia, Alemania y EE.UU. presentan los mayores niveles de integración, no integrándose, sin embargo, con el mercado del oro. En cuanto a este mercado, no se observó integración con ninguno de los mercados de acciones analizados, lo que demuestra que cuando estos presentan niveles de riesgo elevados, el índice XAU puede representar un refugio seguro para la diversificación de carteras y la mitigación de ese riesgo. Esta conclusión se refuerza con el análisis de la relación entre los mercados de acciones y del oro, a corto plazo, a través de las funciones de impulso-respuesta, y donde se obtienen evidencias de choques positivos/negativos, con significación estadística, entre todos los mercados excepto el del oro.

Palabras clave: Integración financiera. Refugio seguro. Diversificación de carteras.

INTRODUCTION

Globalization has accentuated the synchronizations between international financial markets, demonstrating that their correlation has increased, especially in periods of extreme volatility. If a particular stock market is strongly linked to one from another country, the former's financial stability depends, in part, on that of the latter. Therefore, a close or strong link between markets increases vulnerability to external shocks, influencing the countries' economic conditions, welfare levels, and market efficiency (DURUSU-CIFTCI, ISPIR and KOK, 2019; MALAFEYEV et al., 2019; DIAS et al., 2020; PARDAL et al., 2020; DIAS and CARVALHO, 2021; VASCO, PARDAL and DIAS, 2021).

Against this backdrop, this research analyzes whether gold represents a safe haven when stock markets show sharp drops. The study examines 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), and Hong Kong (Hang Seng) in addition to the gold market (XAU). The analyzed period is May 2015 to May 2020, encompassing two sub-periods of turmoil in stock markets: the crash in China's leading markets (between 2015 and 2016) and the beginning of the COVID-19 pandemic in 2020.

The Chinese financial market expanded exponentially in the 1990s after the creation of the Shanghai and Shenzhen stock exchanges. At the end of 2014, according to the Annual Report of the China Security Regulatory Commission, the capitalization of the two exchanges was equivalent to 58.53% of the country's Gross Domestic Product (GDP). The Chinese government introduced two categories of shares (A and B) to liberalize local markets. The dual-listed nature of the Chinese stock market has resulted in a partially segmented financial market, although the government has taken several steps to liberalize financial operations.

Despite these positive developments, the Chinese stock market suffered the most severe crash since the 2008 financial crisis in 2015. The stock market turmoil began in June, after a sharp slowdown in Chinese economic growth, and ended in late January 2016. Among the factors that may have contributed to the crash are the unexpected devaluation of the Chinese currency (RMB) and the less positive expectations regarding the Chinese GDP growth.

After weeks of volatility and fluctuations in stock prices, the Shanghai composite index lost around 25% of its value in one month. Particularly on January 4 and 7, 2016, the trading on the stock market was halted after a 7% drop. The financial turmoil affected regional stock markets, currencies, and commodities (DIAS et al., 2020).

On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic. According to the WHO, by March 30, 2021, worldwide cases had exceeded 129 million, resulting in 2.79 million deaths. The pandemic has negatively affected the economy and social and cultural life globally. Rating agencies such as Moody's and Standard & Poors have restricted China's growth forecast for 2020. In line with these negative effects, a significant impact on economic growth and financial markets seemed inevitable (LIU et al., 2020).

This research adds two main contributions to the literature. The first is the study of risk diversification in specific international stock and gold markets. Most previous studies have focused on the average correlations or dependencies between gold and movements in financial markets and between gold and currency depreciation. This article brings together some of the most

relevant stock markets in the world, testing whether the gold market is a safe haven when there are structural breaks, especially during the crash in China and at the beginning of the COVID-19 pandemic.

In addition, recent studies have analyzed risk diversification crossing the stock and gold markets, such as Batten et al. (2017), Tursoy and Faisal (2018), Ma et al. (2020), and Yamaka and Maneejuk (2020). However, the approach was quite different from the one followed in this article.

The second contribution is econometric. The study compares results obtained through econometric methods and mathematical models able to evaluate long-term correlations in a non-stationarity context, such as the test developed by Gregory and Hansen (1996) that demonstrates the integration between stock markets and structural breaks. In addition, the use of the VAR-IRF model makes it possible to verify the connections of these markets in the short term and assess whether the gold market is a credible option for portfolio diversification.

The results suggest no integration between the analyzed stock markets and the gold market, which shows opportunities for diversifying efficient portfolios. Corroborating the results, the analysis of the relationship between the markets in the short term, through the impulse-response functions (10 days), shows positive/negative movements, with statistical significance between the various stock markets. However, when we analyze the synchronizations with the gold market (XAU), the co-movements are not significant. Thus, concerning the stock markets and the analyzed time horizon, this index shows that the gold market is a safe haven for international investors willing to diversify their portfolios.

This article is organized into five sections, including this introduction. The next presents a literature review on integration in financial markets, followed by a section describing the data and methodology used. The fourth section presents the results, and the fifth is the conclusion.

LITERATURE REVIEW

Studies on integration in financial markets have been more frequent in recent years, emphasizing the integration in emergent markets and particularly examining the hypothesis of portfolio diversification in a global context. For example, Jiang, Zhou, Sornette et al. (2010) showed the results obtained by Chinese investors, who added assets from Asian emerging stock markets to their portfolios through consistent strategies based on regional diversification.

According to Hearn and Piesse (2013), Hearn (2014), Lehkonen (2015), Boamah, Watts and Loudon (2017), the integration of financial markets is partially driven by financial openness, regulatory quality, and market structure. For example, a market correctly regulated and offering transparent information can promote market liquidity and the financial flows of international investors, leading to an increase in financial integration between markets.

Balcilar, Hammoudeh and Asaba (2015), Zhang, Dufour and Galbraith (2016), Batten et al. (2017), and Laily et al. (2017) examined gold indices to validate that they have characteristics of a safe haven. Balcilar, Hammoudeh and Asaba (2015) demonstrated that silver and oil are the most volatile variables, whereas gold is the least volatile, suggesting the use of gold as a safe

haven asset. Zhang, Dufour and Galbraith (2016) examined causal relationships between three commodities (crude oil, gold, and copper) and four countries (Canada, Australia, Norway, and Chile).

The authors found causalities between commodities prices and exchange rates at various time scales in both directions. Batten et al. (2017) found that there are no causal relationships between the price of gold and the stocks used in the sample. Laily et al. (2017) showed a positive relationship between crude oil and gold prices and a negative relationship between GDP and inflation, interest, and exchange rates.

Siddiqui and Roy (2019) tested gold as a hedging asset against oil and Indian stock markets indexes, showing that gold was a more effective hedging commodity for stock investors than crude oil. In the same line of research, Singhal, Choudhary and Biswal (2019) observed that international gold prices positively affect the price of shares in Mexico, unlike the price of oil, which demonstrates a negative effect. Additionally, the authors show that international oil price negatively influences the exchange rate in the long term. In contrast, the price of gold does not influence the exchange markets analyzed.

Ma et al. (2020) and Yamaka and Maneejuk (2020) examined synchronizations between gold, oil, foreign exchange, and equity markets. The case study by Ma et al. (2020) demonstrated negative shocks between gold and equity markets and between gold and US dollar exchange markets. Such results indicated that gold could be considered a safe haven when stock markets and exchange rates are in turmoil.

Yamaka and Maneejuk (2020) found significant causality between gold and Asian stock markets. The authors observed strong correlations between the gold market and the South Korean and Indian stock markets during the 2008 financial crisis.

This article is based on previous studies and offers information to investors and regulators operating in international stock markets where individual and institutional investors seek diversification benefits. In addition, the study helps promote the implementation of policies that contribute to the markets' efficiency. The research examines long-term financial integration and short-term shocks between selected stock markets and the gold index to assess the efficiency of acquiring gold-related assets during troubled times that generate significant structural breaks, such as the crash in the Chinese market and the COVID-19 pandemic.

DATA AND METHODOLOGY

The price index data of 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), were obtained from the Thomson Reuters platform. The trade rates were collected per day, from May 20, 2015, to May 19, 2020, encompassing the sub-periods related to the crash in China and the first phase of the COVID-19 pandemic. Prices were kept in local currency to mitigate distortions related to exchange rates.

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BOX 1

Countries and indices analyzed

Country	Index
France	CAC 40
Germany	DAX 30
The United States	Dow Jones
The United Kingdom	FTSE 100
Italy	FTSE MIB
Gold	XAU
Hong Kong	Hang Seng

Source: Elaborated by the authors.

The study was developed over several stages. The sample was characterized through descriptive statistics and the Jarque and Bera (1980) adherence test. The following tests were used to assess the time series stationarity: ADF (DICKEY and FULLER, 1981); PP (PERRON and PHILLIPS, 1988); and KPSS (KWIATKOWSKI et al., 1992).

Gregory and Hansen's (1996) methodology was used to assess the integration of the six stock markets with that of gold. In this study, standard cointegration tests, such as Engle and Granger (1987) and Johansen (1988), were not used, as they are not appropriate for testing cointegration with regime-switching.

The methodology of impulse-response functions (IRF) was applied with Monte Carlo simulations (1000 iterations) to measure and evaluate the shocks (co-movements) between markets in the short term. This procedure offers a dynamic analysis (variable with time) generated by the VAR model estimates, making it possible to study the causal relationships established, even when causal relationships in the "Grangerian" sense were not previously detected between the variables (LÜTKEPHL and SAIKKONEN, 1997).

IRF shows how a given variable responds over time to an unexpected increase in that variable (stimulus or innovation) or another included in the VAR model. Thus, an innovation in a given variable produces a chain reaction, over time, in the remaining VAR variables, allowing for more efficient monitoring and interpretation of short-term movements between markets through IRF.

For Lütkepohl and Saikkonen (1997) and Aziakpono (2006), if a process is white noise – with a null mean and constant variance – the evaluated VAR can be transformed into a moving average representation, whose coefficients are the responses to the impulses on forecast errors. Thus, the moving average is expressed as follows:

$$Y_t = C + \sum_{s=0}^{k} B_s \mathcal{E}_{t-s} \qquad (1).$$

We used generalized IRF, introduced by Koop, Pesaran and Potter (1996) and Pesaran and Shin (1998), choosing the Monte Carlo simulation procedure with 1000 iterations. This analysis

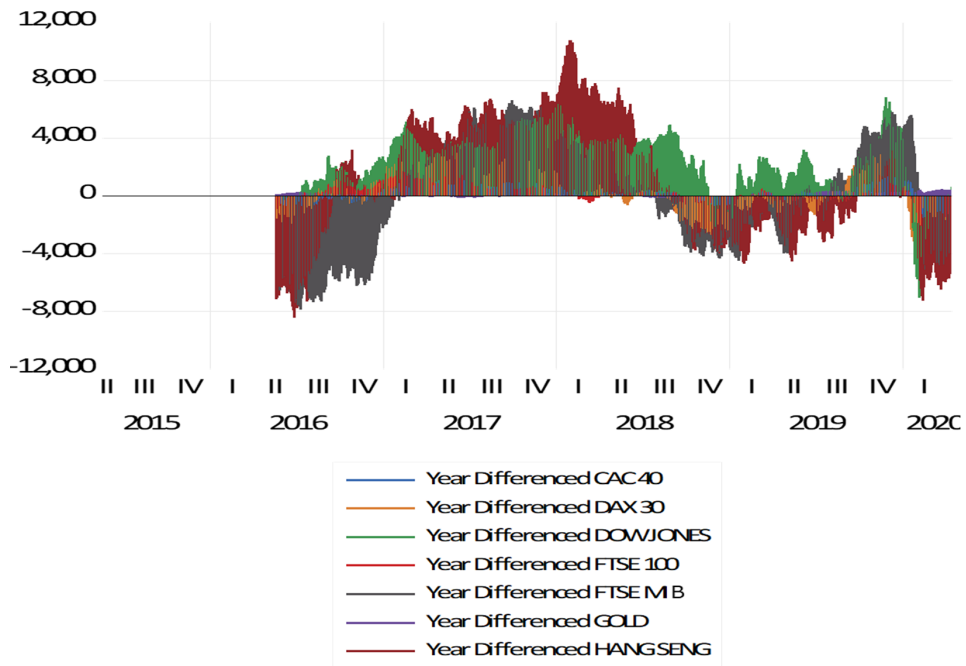
differs from the traditional orthogonalized impulse-response analysis as it does not depend on the ordering of variables in the VAR model. The traditional approach, such as the one based on Cholesky factorization, for the orthogonalization of VAR innovations, leads to different results depending on the ordering of variables.

RESULTS

Figure 1 shows the evolution of the stock and gold markets in the first annual differences. The sample comprises the period from May 20, 2015, to May 19, 2020, which encompasses troubled times such as the economic crash in China and the COVID-19 pandemic. The returns reveal the instability experienced in these markets for 2015-2016, 2018-2019, and 2020. However, there was a rebalancing of the markets between 2017 and the third quarter of 2018.

FIGURE 1

Evolution and first-year differences of the seven financial markets examined from May 20, 2015, to May 19, 2020



Source: Elaborated by the authors.

Table 1 shows the main descriptive statistics of the financial markets under analysis and the Jarque-Bera adherence test. The descriptive statistics analysis allows us to verify that most returns present negative daily averages, except for the US and gold markets. Italy is the market with the most significant standard deviation (risk), with gold showing the least volatility. Most markets show negative asymmetries, except gold and Hong Kong. On the other hand, all the series of returns showed signs of deviation from the normality hypothesis, given the asymmetry and kurtosis coefficients.

In the case of a normal distribution, the skewness coefficient is zero, and the kurtosis is three. The analyzed series are leptokurtic and present asymmetric flaps. In addition, all returns showed

signs of deviation from the hypothesis of normality since the Jarque-Bera test allows rejecting the null hypothesis of normality (H_0) in favor of the alternative (H_1), non-normality, for the level of 1% significance.

TABLE 1

Descriptive statistics (in returns) of the seven financial markets, from May 20, 2015, to May 19, 2020

	CAC 40	DAX 30	DJ	FTSE 100	FTSE MIB	XAU	HS
Average	-0.000110	-5.05E-05	0.000286	-7.64E-05	-0.000261	0.000295	-0.000115
Standard deviation (SD)	0.012765	0.013184	0.012449	0.010927	0.015707	0.008164	0.012449
Skewness	-1.379684	-0.848150	-1.085460	-1.127822	-2.047773	0.129925	0.791455
Kurtosis	17.53914	16.40056	29.63864	19.36472	25.60797	6.148618	17.31572
Jarque-Bera	11661.79***	9715.589***	38038.06***	14531.49***	28110.36***	531.5053***	11046.47***
Sum	-0.141013	-0.064521	0.365750	-0.097686	-0.333291	0.377199	-0.146340
Sum SD	0.208081	0.221955	0.197911	0.152486	0.315036	0.085122	0.197908
Observations	1278	1278	1278	1278	1278	1278	1278

Note: *** represents a significance level of 1%.
Source: Elaborated by the authors.

The results of the ADF (DICKEY and FULLER, 1981), PP (PERRON and PHILLIPS, 1988), and KPSS (KWIATKOWSKI et al., 1992) tests show that the time series are stationary in first differences, a fundamental assumption to estimate VAR-IRF models, with Monte Carlo simulations (1000 iterations).

Regarding the analysis of market integration, Table 2 shows the results of the test by Gregory and Hansen (1996), in which 22 pairs of integrated markets were found (out of 42 possible pairs). Such markets are partially integrated, promoting efficient portfolio diversification strategies.

The stock markets of France (CAC 40), Germany (DAX 30), and the United States (Dow Jones) show five integrations (out of six possible). They integrate with the other markets except for gold. On the other hand, the UK market integrates with four markets, but not with gold and Hong Kong. Italy integrates with two markets, but not with those of the United States (Dow Jones), the United Kingdom (FTSE 100), Hong Kong (Hang Seng), and gold (XAU). The gold market does not integrate with any of the analyzed ones, which shows that it is a safe haven when such stock markets present high levels of risk. The Hong Kong market presents a unique integration with the French stock market, showing opportunities for diversification and being a reference among those analyzed. In addition, we verified that the structural breaks are mostly located in the years 2016, 2017, 2018, and 2019.

These results are in line with the studies by Tursoy and Faisal (2018) gold prices and crude oil prices by applying monthly data from Turkey for the period between January 1986 and November 2016. This study uses the autoregressive distributed lag (ARDL and Siddiqui and Roy (2019), which confirm a negative relationship between the gold and stock markets, showing that gold can be an effective safe haven against extreme movements in stock prices. Such evidence has important implications for individual and international investors, portfolio managers, and policymakers.

TABLE 2

Gregory-Hansen integration tests from May 20, 2015, to May 19, 2020

Markets	t-statistic	Method	Lags	Date of structural breaks (DD/MM/YYYY)	Results
CAC 40 / DAX 30	-5.85***	Regime	2	13/8/2018	Integrated
CAC 40 / Dow Jones	-5.25**	Regime	3	14/8/2019	Integrated
CAC 40 / FTSE 100	-6.55***	Regime	4	2/8/2019	Integrated
CAC 40 / FTSE MIB	-6.53***	Regime	3	28/6/2016	Integrated
CAC 40 / Gold	**-4.34**	**Regime**	**2**	**-----**	**Segmented**
CAC 40 / Hang Seng	-6.92***	Regime	5	29/7/2019	Integrated
DAX 30 / CAC 40	-6.49***	Trend	2	20/6/2016	Integrated
DAX 30 / Dow Jones	-7.18***	Trend	3	19/12/2017	Integrated
DAX 30 / FTSE 100	-6.17***	Trend	5	14/8/2019	Integrated
DAX 30 / FTSE MIB	-6.28***	Trend	3	28/6/2016	Integrated
DAX 30 / Gold	**-4.35**	**Trend**	**0**	**-----**	**Segmented**
DAX 30 / Hang Seng	-5.36**	Trend	3	9/1/2018	Integrated
Dow Jones / CAC 40	-5.14**	Regime	4	1/12/2017	Integrated
Dow Jones / DAX 30	-6.06***	Regime	3	19/12/2017	Integrated
Dow Jones / FTSE 100	-45.58*	Regime	1	20/11/2017	Integrated
Dow Jones / FTSE MIB	-5.51***	Trend	3	23/2/2016	Integrated
Dow Jones / Gold	**-4.05**	**Trend**	**5**	**-----**	**Segmented**
Dow Jones / Hang Seng	-50.68**	Trend	4	12/7/2018	Integrated
FTSE 100 / CAC 40	-8.76***	Trend	0	20/6/2016	Integrated
FTSE 100 / DAX 30	-6.27***	Trend	5	14/8/2019	Integrated

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Markets	t-statistic	Method	Lags	Date of structural breaks (DD/MM/YYYY)	Results
FTSE 100 / Dow Jones	-7.05***	Trend	0	12/7/2016	Integrated
FTSE 100 / FTSE MIB	-5.67***	Trend	2	30/6/2016	Integrated
FTSE 100 / Gold	**-4.04**	**Regime**	**5**	**-----**	**Segmented**
FTSE 100 / Hang Seng	**-4.68**	**Trend**	**0**	**-----**	**Segmented**
FTSE MIB / CAC 40	-6.86***	Regime	3	22/2/2016	Integrated
FTSE MIB / DAX 30	-5.59***	Regime	3	19/2/2016	Integrated
FTSE MIB / Dow Jones	**-3.20**	**Regime**	3	-----	Segmented
FTSE MIB / FTSE 100	-3.63	Regime	4	-----	Segmented
FTSE MIB / GOLD	-3.72	Regime	0	-----	Segmented
FTSE MIB / Hang Seng	-4.30	Trend	1	-----	Segmented
Gold / CAC 40	-4.02	Regime	2	-----	Segmented
Gold / DAX 30	-3.66	Regime	2	-----	Segmented
Gold / Dow Jones	-3.48	Regime	2	-----	Segmented
Gold / FTSE 100	**-3.61**	**Regime**	**3**	**-----**	**Segmented**
Gold / FTSE MIB	**-3.81**	**Regime**	**2**	**-----**	**Segmented**
Gold / Hang Seng	**-3.71**	**Regime**	**3**	**-----**	**Segmented**
Hang Seng / CAC 40	-4.96**	Regime	5	19/6/2019	Integrated
Hang Seng / DAX 30	**-4.10**	**Regime**	**3**	**-----**	**Segmented**
Hang Seng / Dow Jones	**-4.03**	**Regime**	**3**	**-----**	**Segmented**
Hang Seng / FTSE 100	**-4.28**	**Regime**	**3**	**-----**	Segmented
Hang Seng / FTSE MIB	-4.36	Regime	5	-----	Segmented
Hang Seng / Gold	-3.79	Regime	3	-----	Segmented

Notes: Data developed by the authors using Stata software. Critical values for the ADF and Tzu parameters are: -5.45 (1%); -4.99 (5%); -4.72 (10%). For the parameter Za, the critical values are: -57.28 (1%); -47.96 (5%); -43.22 (10%). Trend and Regime displacement methods (see GREGORY and HANSEN, 1996).
***, **, and * indicate statistical significance at 1%, 5%, and 10%, respectively.
Source: Elaborated by the authors.

The VAR Granger Causality/Block Exogeneity Wald tests were applied to analyze the significance of the causal relationships between the seven financial markets. Also, the Akaike information criterion (AIC) was adopted to determine the number of lags to be included in the causality tests, resulting in fifteen lags. A smaller number of lags increases degrees of freedom, while a larger number decreases autocorrelation problems (Table 3).

TABLE 3

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
15	28179.47	131.9112	2.69e-28*	-43.62079*	-40.59069	-42.48203

Source: Elaborated by the authors.

The null hypothesis was not rejected when using the VAR model with fifteen lags and, subsequently, the VAR Residual Serial Correlation LM tests with sixteen lags confirm that the model presents a robust estimation (Table 4).

TABLE 4

VAR Residual Serial Correlation LM tests

Lag	LRE* stat	Df	Prob.	Rao F-stat	Df	Prob.
16	44.61427	49	0.6514	0.910304	(49. 5812.3)	0.6514

Source: Elaborated by the authors

The IRF methodology, with Monte Carlo simulations (Figure 2), tested the degree of response of the variables in the stock markets (indices) (CAC 30, DAX 30, Dow Jones, FTSE 100, FTSE MIB, Hang Seng) and the gold market (XAU) to changes (impulses) of one standard deviation of each of the variables mentioned above. These results show the prompt response to market shocks, with an impact on the following day, but also the speed of the markets in processing information. In all cases, own innovations and innovations from peers can generate, on the following day, positive/negative responses that are statistically significant at the 5% significance level, except for the gold market.

Considering the one-day timeframe, each market's response to its own shocks exceeds the dimension of the response to shocks in others, almost in all cases. The situations in which this phenomenon was not observed were quite reduced. It was possible to see that the stock markets initiated shocks, mostly without affecting the gold market, which is in line with previous tests and contributes to validating the robustness of the results achieved, suggesting that, in this context, the index of gold (XAU) has the properties of a safe haven for efficient portfolio diversification.

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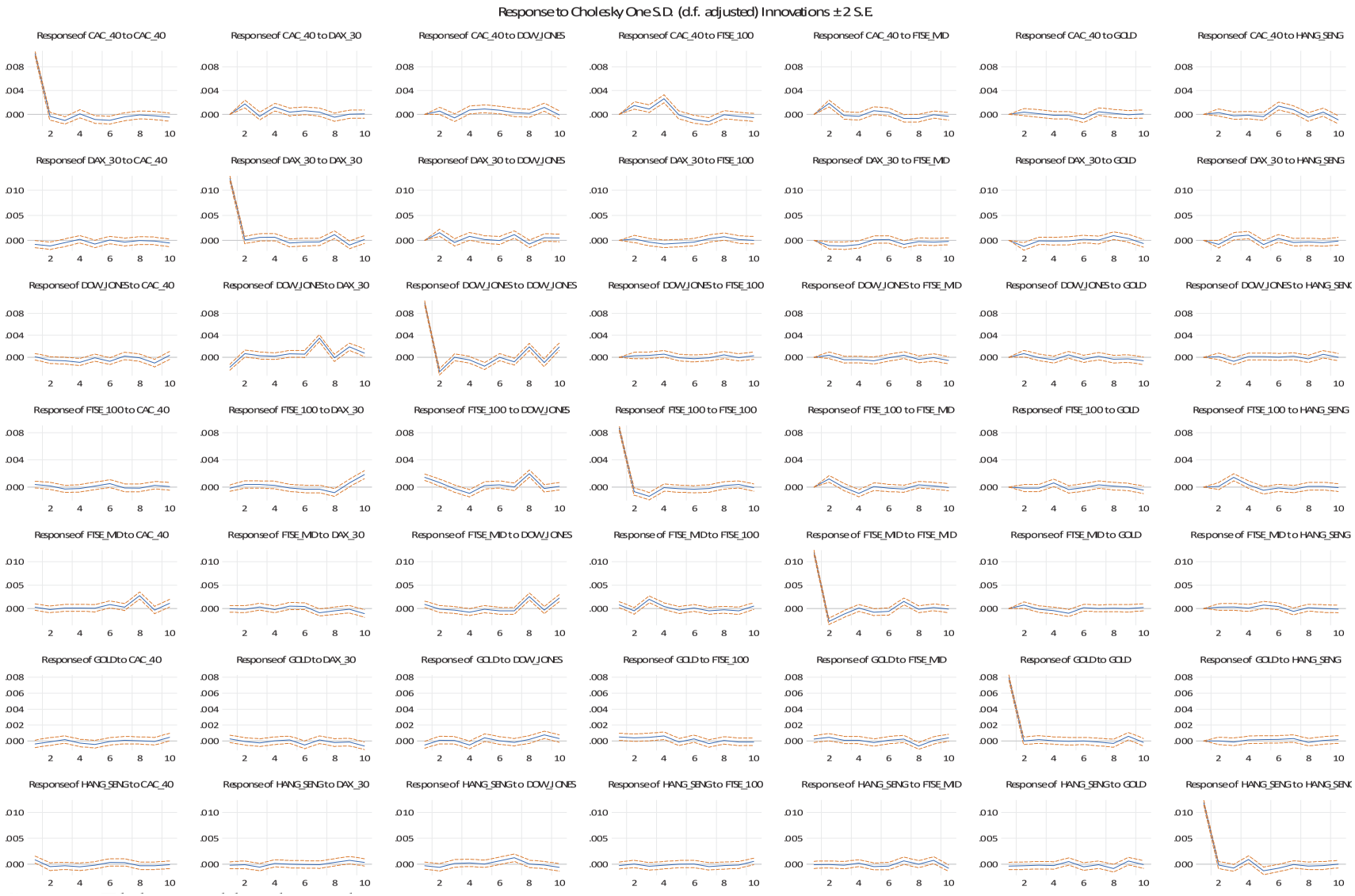
FIGURE 2

IRF charts, with Monte Carlo simulations, from May 20, 2015, to May 19, 2020



Source: Elaborated by the authors.

CONCLUSION

This article analyzed the diversification of portfolios 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), in the period from May 20, 2015, to May 19, 2020. The study particularly analyzed whether the gold market can be a safe haven when the main financial markets crash.

Two econometric models were used. The first estimated whether the markets have significant levels of financial integration – whether they have long-term relationships. The second assessed whether the price indices exhibit co-movements (short-term relationships), evidencing the possibility of gains above the market average.

In the model by Gregory and Hansen (1996), 22 pairs of integrated markets were found (out of 42 possible pairs). In other words, these markets are partially integrated, opening the possibility of portfolio diversification. The stock markets (indices) of France, Germany, and the United States show the highest number of integrations (five out of six possible) – they integrate with their peers, except gold. Analyzing this particular market, it appears that it does not integrate with any of the stock markets under analysis, which shows that it can be a safe haven for investment when these markets present high levels of risk. In addition, we verified that the structural breaks primarily occurred in the years 2016, 2017, 2018, and 2019.

The second test showed the prompt response to market shocks, with an impact on the following day, but also the speed of the markets in processing information. In all cases, own innovations and innovations from peers generate, on the following day, statistically significant positive/negative responses, at a significance level of 5%, except for the gold market, which reinforces the results obtained by the Gregory-Hansen test.

Overall, the results obtained through tests with econometric models show that the gold market has hedging characteristics related to stock market investments. Also, when the stock markets severely drop, gold can act as a safe haven to the detriment of stock papers, both for national and international investors. Such evidence contributes to regulators and investors and can influence policies and portfolio diversification strategies in international financial markets.

This study is limited in its scope of application to the analyzed markets and the first period of the COVID-19 pandemic. In terms of robustness, it was not possible to use intraday data (five minutes) to obtain more significant evidence of movements between the analyzed markets.

For future research, in addition to expanding the sample, we suggest analyzing the effect of markets' behavior on macroeconomic variables, such as GDP, unemployment rate, and inflation rate. Likewise, the relationship between movements in stock markets with commodities – for example, crude oil or silver – and exchange rates can be explored.

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