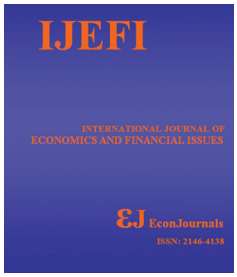

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Analysing Financial Market Integration between Stock and Precious Metals Indices

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ABSTRACT

Given the global pandemic in 2020 and the Russian invasion of Ukraine in 2022, there is renewed interest in understanding the integration between the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, in the period from 1 January 2018 to 23 November 2023. The study aims to address two key questions: (i) Have the events of 2020 and 2022 influenced the integration between the capital markets of MENA countries and precious metals? (ii) In the case of a significant increase in integration, will this imply a trend towards efficiency or inefficiency in the markets analysed? The results of the cointegration tests show an increase in integrations between the Tranquil and Stress subperiods; for example, platinum rose from zero integrations to 4, being the market most affected by the events of 2020 and 2022, the MOEX increased from 3 to 6 integrations, the Dow Jones index rose from 1 to 3 integrations, the Amman SE General from 1 to 2 integrations. On the other hand, the ISRAEL TA 125 index decreased from 5 integrations in the Calm period to 1 integration during the Stress period. The EGX also decreased from 2 integrations to one integration, the MASI from three to zero integrations, and gold from 1 integration to zero. The BLSI stock index maintained its 1-1 level of integrations, while silver also followed the same 2-2 trend. These results do not allow acceptance of the first research question since it was found that there were increases/decreases in integrations during the 2020 and 2022 events. The DFA slopes were estimated to answer the second research question since most markets showed significant persistence. However, it was found that this persistence did not coincide with an increase/decrease in the level of integration between the markets analysed. Given these results, the second research question was also partially rejected. In conclusion, the results of this study have significant implications for international investors operating in the financial markets of MENA countries.

Keywords: Middle East and North Africa Markets, Precious Metals, Financial Integration, Efficiency, Weak Form, Portfolio Rebalancing
JEL Classification: C01, C32, C38, G10, G11, G14, Q42

1. INTRODUCTION

According to the theoretical framework proposed by Markowitz (1952), it is possible to reduce unsystematic risk through diversification. Thus, for international investors, building investment portfolios that include assets from different countries can help mitigate risk. Markowitz argued that by diversifying, i.e., investing in various asset classes with different characteristics, investors can offset any losses in certain market segments with gains in others. The authors agree that investing in similar and correlated assets may not be prudent since if one set of assets loses value, it can lead to the loss of the other assets that comprise the investment portfolio. Similarly, Grinblatt and Titman (2002) argue that diversification allows portfolio managers or individual investors to balance their investments between various securities, thus minimising the overall risk inherent in their portfolios.

Considering the abovementioned, and according to the authors Tahai et al. (2004) and Khan (2011), understanding the degree of links and correlations between assets or markets and assessing the degree of financial integration can help investors diversify their portfolios of assets. Thus, reducing their risk exposure and leveraging their gains since diagnosing the degree of integration will make it possible to identify whether assets have similar returns, if they belong to integrated markets, or if, due to their exposure to different sources of risk, they have different returns and therefore constitute assets that belong to segmented markets.

Within this context, international financial markets have recently become more integrated, driven by the liberalisation of capital flows and technological advances. This combination has generated new opportunities for both investment and financing. However, while financial integration can promote more robust economic growth, markets become more vulnerable to external shocks as they unite. A crisis in one geographical region can spread more easily to other financial markets, given the increasing interconnectivity that has taken place in recent decades (Dias et al., 2019).

Stock market integration refers to how share prices in different countries are interconnected and influenced by common factors such as global economic conditions and events. Technological advances, increased cross-border investment, and the liberalisation of financial markets have facilitated the growing integration of stock markets. However, despite growing integration, stock exchanges still display some level of country-specific influence and divergence due to differences in regulation, economic structure, and political stability (Dias and Carvalho, 2021; Pardal et al., 2021).

In recent years, the international financial markets have suffered major setbacks due to the COVID-19 pandemic, followed by a series of collapses, and in 2022, the Russian invasion of Ukraine, which led to global investor uncertainty. Studying the predictability of returns in capital markets is vital because it provides information on the degree to which future returns can be estimated based on past information. This information can be used to validate investment decisions and improve risk management. In addition, understanding the predictability of returns can help identify market inefficiencies and potential valuation errors, which can promote investment strategies aimed at capturing returns above the market average. In that way, it can help regulators and policymakers design policies that promote financial stability, reducing systemic risk and ensuring fair and transparent markets (Pardal, Dias et al., 2022; Dias et al., 2022; Dias et al., 2022; Teixeira et al., 2022).

Given this background, the research aims, firstly, to analyse whether precious metals such as Gold Bullion LBM, Silver, Handy and Harman, London Platinum, tend towards financial integration with the Dow Jones stock indices (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia), during the period marked by the Covid-19 pandemic and the geopolitical conflict between Russia and Ukraine in 2022. Secondly, the aim is to infer the presence of persistence in the returns of these markets, i.e. to try to understand whether increased integration leads to inefficient markets.

For this study, three precious metals were selected: Gold (Gold Bullion LBM), silver (Silver, Handy and Harman), and Platinum (London Platinum), which have established their position as hedging assets or safe havens. Precious metals, especially gold, have been recognised as a reserve of value for centuries. They are tangible assets that are not subject to the same risks as paper currencies, and they can be affected by inflation, political instability, and economic crises. Investors often look for safe-haven assets during geopolitical uncertainty, economic crises, or financial market volatility. Gold is often seen as a safe haven asset because it tends to retain its value when other assets, such as shares or currencies, suffer significant fluctuations. Including precious metals in an investment portfolio can provide diversification benefits. Diversification involves spreading investments across different asset classes to reduce risk. Since precious metals often have a low correlation with traditional financial assets such as stocks and bonds, they can help mitigate the overall risk of the portfolio (Kumaraswamy et al., 2023; Mensi et al., 2023; Sharma and Karmakar, 2023; Yousaf et al., 2023).

In addition to precious metals, seven capital markets were also selected, namely the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices. The Dow Jones Industrial Average (DJIA), also known as the Dow Jones, is one of the main indicators of the U.S. stock market and is of significant importance to the global economy. This index is comprised of 30 major American companies from various sectors. Objectively speaking, the Dow Jones reflects the health and general direction of the U.S. economy, one of the largest economies in the world. Its widespread acceptance as a reliable indicator means that it is used as a barometer to measure the performance of the U.S. stock market and, consequently, global economies. Many investors, asset managers and investment funds follow the Dow Jones closely, using its fluctuations as a benchmark for making investment decisions. In addition, the performance of the Dow Jones can affect the prices of other financial assets, such as commodities, currencies, and international markets (Tenreiro Machado, 2020; Wang et al., 2020).

The capital markets of the Middle East and North Africa (MENA) countries are globally important for several reasons. Firstly, many of these countries have significant oil and gas reserves, giving them substantial financial resources for investment in local and international markets. In addition, the demand from local investors to diversify their economies beyond natural resources has been a growing constant, namely in sectors such as tourism, technology and finance, which attracts foreign investment and strengthens local capital markets. In addition, opening up these markets to foreign direct investors also contributes to global economic integration. The integration of the MENA region's capital markets with global markets facilitates international trade, promotes regional cooperation, and increases global financial stability, but it makes it difficult to diversify portfolios, which could be an obstacle for international investors.

For this study, it was considered essential to determine the degree of integration between precious metals and other asset classes,

namely stock markets (stock indices), to understand the potential for diversification in periods of uncertainty in the global economy.

According to what is known, some researchers have already analysed the degree of connection between precious metals and clean energies (Elie et al., 2019), with Oil (Mokni et al., 2020), with digital currencies (Saijai et al., 2022), with the capital markets of ASEAN (Robiyanto et al., 2020), BRIC countries (Chen et al., 2022) and even with the stock indices of MENA countries (Mensi et al., 2023), but the time frame, methodology used and research questions were different from those presented in this study. Furthermore, and based on the literature consulted, the authors did not provide concrete evidence on the level of integration between the precise metals and the capital markets of the MENA countries, nor whether such integration would jeopardise the market efficiency hypothesis in its weak form.

Furthermore, the markets analysed and the period of the sample is different from the studies already developed, as it was not possible to identify any research that presented evidence on data corresponding to the period from January 2018 to 23 November 2023, i.e. during the events of the 2020 pandemic and the Russian invasion of Ukraine in 2022.

The study aims to make two contributions. The first is theoretical, as it aims to add evidence to the literature to help investors in their portfolio diversification strategy. The second is econometric, as it compares results estimated using econometric methods and econophysics models that can assess long-term correlations in a context of non-stationarity. In particular, the Gregory and Hansen (1996) test, which allows inferences to be drawn about the integration or segmentation between the precious metals and capital markets of the MENA countries, as well as identifying the presence of structural breaks and the Detrended Fluctuation Analysis (DFA) econophysics model. DFA is an analysis method that examines time dependence in non-stationary data series. By assuming that the time series are non-stationary, this technique avoids spurious results when analysing the long-term relationships of the data series. DFA has the following interpretation: $0 < \alpha < 0.5$: Anti-persistent series; $\alpha = 0.5$ series shows random walk; $0.5 < \alpha < 1$ persistent series.

The study is divided into four chapters. In addition to this introduction, the first chapter contains a literature review, which first introduces the concept of comovement versus financial integration and then reviews empirical evidence on the degree of integration between the stock and precious metals markets in periods of extreme volatility. The second chapter describes the sample data and the methodology used to carry out the research. The third chapter contains the results and their discussion. The fourth and final chapter contains the main conclusions and a line of future research considered pertinent to continue studying the theme developed in this study.

2. LITERATURE REVIEW

The terms "comovement" and "integration" in financial markets, although related to synchronisation between two or more markets, are treated as distinct concepts in the literature (Gaio et al., 2014).

In practical terms, "comovement" refers to joint movement in the same direction, indicating a correlation between time series. If time series are negatively correlated, they move in opposite directions, while a positive correlation indicates joint movement over time (Bhattacharyya, 2019; Kotu and Deshpande, 2019).

Several authors, such as Dias and Pereira (2021) and Dias et al. (2021), have associated high comovements with a high degree of market integration. However, this theory should be interpreted cautiously, as correlated markets do not necessarily indicate integration and vice versa. Conceptually, markets are considered financially integrated when assets of similar risk are linked to similar returns, even from different markets. Empirically, integration can be defined as the condition in which non-stationary time series become stationary when combined linearly. When assessing the degree of integration between two markets, it is common to estimate the differences between the mean prices of the series and check whether this difference remains constant over the long term. If financial markets tend towards integration, prices will eventually return to equilibrium (Chambino et al., 2022).

2.1. Empirical Evidence on Financial Market Integration: Evidence from the Stock Markets

Since the 1990s, the study of segmentation versus international integration of financial markets has been a significant area of interest for academics, financial industry professionals and policymakers. This topic examines whether global financial markets are becoming more integrated or remain segmented in different regions of the world. Financial market segmentation refers to the idea that different markets operate relatively independently of each other, with significant barriers limiting the flow of capital between them. On the other hand, financial market integration implies that capital can flow freely between different markets, allowing asset prices to adjust quickly to market information and conditions. This reduces price disparities between different markets and increases efficiency in allocating global capital (Kendo and Tchakounte, 2022; Iheanacho et al., 2023).

Understanding the international linkages between stock markets is important for investigating the occurrence of financial integration phenomena, especially in the context of stock market crashes. High levels of volatility and uncertainty often accompany stock market crashes, and understanding the interconnections between markets can help provide insight into the causes of such events and the potential consequences for investors. By examining the relationships between stock markets, researchers can assess the extent to which global factors such as economic conditions, political events and monetary policy affect stock prices and market behaviour. In addition, the study of international links between stock exchanges can also provide insight into the phenomenon of financial integration, including the convergence of stock prices, the transfer of information and capital across borders, and the emergence of common market trends. Studying international linkages and financial integration is crucial to improving understanding of stock markets and informing investment

decisions (Dias et al., 2019, 2020; Dias and Carvalho, 2021; Silva et al., 2020).

2.2. Related Studies on Capital Market Integration

Phuan et al. (2009) and Huyghebaert and Wang (2010) assessed the level of integration between the capital markets of ASEAN countries. Phuan et al. (2009) examined the relationship between financial liberalisation and stock market integration in Indonesia, Malaysia, the Philippines, Singapore and Thailand. The authors show that there are high levels of integration, which could jeopardise the hypothesis of portfolio diversification. Complementing this, Huyghebaert and Wang (2010) examined integration and causality between the seven main East Asian stock exchanges and the US before, during and after the 1997-1998 Asian financial crisis. The authors show that the relationships between East Asian stock markets vary over time, although stock market interactions were limited before the Asian financial crisis. However, during the Asian crisis, the Hong Kong and Singapore markets receive significant shocks from the other East Asian markets, including Shanghai and Shenzhen. After the crisis, the shocks in Hong Kong and Singapore largely affected the other East Asian stock markets, except those in Mainland China. In conclusion, the authors show that the US strongly influences stock returns in East Asia, except for Mainland China, in all periods, but note that these Asian markets do not cause any shocks to the US market.

In a complementary way, the authors Graham et al. (2013), Maghyereh et al. (2015) highlight the dynamics of the relationship between the MENA and US stock markets. Graham et al. (2013) suggest that the potential for diversification may be more significant at higher frequencies, but caution is advised during market crises. On the other hand, the authors Maghyereh et al. (2015) indicate that the relationship strengthened after the global financial crisis but has shown signs of returning to pre-crisis levels, emphasising the importance of considering the evolving nature of market linkages for investors.

In 2020, Pardal et al. (2020) examined the financial integration in the capital markets of Austria (ATX), Slovenia (SBITOP), Hungary (BUDAPEST SE), Lithuania (OMX VILNIUS), Poland (WIG), the Czech Republic (PX PRAGUE), Russia (MOEX) and Serbia (BELEX 15) during the 2020 pandemic. The results suggest very significant levels of integration, which reduces the chances of long-term portfolio diversification. The evidence shows 47 integrated stock index pairs (out of 56 possible). The ATX, BUDAPEST SE, and BELEX 15 stock indices show financial integration with all the other indices. In contrast, the OMX VILNIUS index shows only 3 integrations. Heliodoro et al. (2020) analysed financial integration in the markets of Brazil, China, India and Russia (BRICs) from July 2015 to June 2020, with the sample divided into pre- and during the global pandemic (Covid-19). The results suggest very significant levels of integration, and in the Covid period, this evidence reduces the chances of long-term portfolio diversification.

Nardo et al. (2022) analysed financial integration between Europe's capital markets. The authors show that financial integration increases during the sovereign debt crisis and is mainly driven by macroeconomic variables, market capitalisation, political uncertainty and technological developments. Meanwhile, Teixeira et al. (2022) tested financial integration between the capital markets of Germany (DAX), the US (Dow Jones), France (CAC 40), the UK (FTSE 100), Italy (FTSE MIB), Russia (MOEX), Japan (NIKKEI 225), and Canada (S&P TSX), China (SHANGHAI and SHENZHEN), and the oil markets. The results suggest that long-term relationships between capital and oil markets do not help explain short-term movements, that is, financial integration is not related to shocks between markets. The authors believe that the findings are of interest to investors looking for opportunities in these financial markets, and also to policymakers to undertake institutional reforms to increase market efficiency and promote sustainable growth in the financial markets.

In more recent studies, the authors Ben Amar et al. (2023) analysed the dependence and repercussions of volatility between two strategic commodities (crude Oil and gold) and a set of regional Islamic and conventional stock market indices. The results show a strong integration between the financial markets studied, specifically during the COVID-19 crisis period. Furthermore, the authors Santana et al. (2023) analysed the synchronisations between the main source of energy (crude Oil, WTI and Brent) and precious metals such as gold and silver (which are a safe haven for investment). The authors show that the 2020 pandemic did not influence the contagion effect between crude Oil, WTI, and Brent since they were already highly interdependent. On the other hand, the COVID-19 outbreak significantly influenced the crude oil and precious metals sectors, which was evident in the identification of an increase in financial integration.

Yousaf et al. (2023) examined the hedging, diversification and safe haven properties of FAANA shares relative to four alternative assets: Gold, US Treasury bonds, Bitcoin and US dollar/CHF. The authors show that most FAANA stocks serve as weak safe havens against gold, Treasury bonds, Bitcoin, and USD/CHF due to the verified level of financial integration. Complementing this, the author Ustaoglu (2023) assessed the integration between gold and Bitcoin, the main commodities Russia exports (crude oil, natural gas, wheat) and the market indices of the G7, Russia, China and Europe during the Russia-Ukraine war. The results show that gold was only a diversifier during the war. Bitcoin is a strong hedge against wheat but a weak hedge against natural gas. In general terms, the authors point to high levels of financial integration that jeopardise diversification and portfolio rebalancing.

Studying financial integration between the stock and precious metals markets is vital for diversifying and rebalancing investment portfolios. Integration allows investors to reduce risk by diversifying into assets with low correlation, such as gold and silver, which often act as hedging assets during economic instability. Furthermore, investing in precious metals can offer protection against inflation in periods of uncertainty in the global economy, maintaining capital over the long term. In this situation, analysing integration levels enables investors to adjust their assets according to market conditions, maintaining an appropriate portfolio balance and maximising returns.

3. METHODS

3.1. Data

The analysis of the integration degree will be based on the daily quotations of the stock indices as per Table 1, Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia), and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, from 1 January 2018 to 23 November 2023. The sample was divided into two sub-periods to ensure robustness: From January 2018 to December 2019, the so-called Tranquil period, and the second sub-period from January 2020 to November 2023, called the stress period. It was decided to extract the time series data from the Thomson Reuters platform (DataStream) to have reliable data for the research.

3.2. Methodology

This section presents the methodology and the tests used to answer the two research questions. The methodological process of this study was developed in several stages.

In the first stage, the sample was characterised using a set of descriptive statistics methods. In addition, the Jarque and Bera (1980) adherence test was applied to analyse the data distribution of the 10 time series and test the assumption of normality, and the quantile graphs were analysed to check the residuals of the time series.

In the second stage, the panel unit root tests of Breitung (2000), Levin et al. (2002), and Im et al. (2003) were applied to validate the stationarity of the time series. The Dickey and Fuller (1981) and Phillips and Perron (1988) tests, with Fisher's transformation, were used to validate the results. The Gregory and Hansen (1996) econometric model was used to answer the first research question, i.e. to verify integration or segmentation between the capital markets and the precious metals under analysis, bearing in mind that a period of some disturbance in the financial markets will be analysed.

Finally, the Detrended Fluctuation Analysis (DFA) econophysics model was chosen to answer the second research question. DFA is an analysis method that examines time dependence in non-stationary data series. By assuming that the time series are non-stationary, this technique avoids spurious results when analysing the long-term relationships of the data series. DFA has the following interpretation: $0 < \alpha < 0.5$: Anti-persistent series; $\alpha = 0.5$ series shows random walk; $0.5 < \alpha < 1$ persistent series.

Table 1: Countries and respective indices

Country	Indice
United States	Dow Jones
Jordan	Amman SE General
Lebanon	BLSI
Egypt	EGX 30
Israel	ISRAEL TA 125
Marroco	MASI
Russia	MOEX
United Kingdom	Gold Bullion LBM
United Kingdom	Silver, Handy and Harman
United Kingdom	London Platinum

Source: Own elaboration

4. RESULTS AND DISCUSSION

Figure 1 graphically shows the evolution, in levels, of the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum. The sample covers the period from 1 January 2018 to 23 November 2023, thus making it possible to observe the tranquil and highly complex periods marked by the 2020 pandemic crisis and the Russian invasion of Ukraine in 2022.

International markets enjoyed a period of relative calm between 2018 and 2019. The Dow Jones index, the benchmark for the American market, was on the rise, while Jordan's Amman SE General and Egypt's EGX 30 were also growing. In the same period, precious metals such as gold and silver were on an upward trajectory, while platinum remained stable. An unexpected event marked the beginning of 2020: The Covid-19 pandemic. This event shook the international markets, leading to a sharp drop in all the indices analysed. The Dow Jones, for example, fell by 33%, while Jordan's Amman SE General and Lebanon's BLSI suffered even sharper falls of 38% and 42%, respectively. Russia's MOEX index, meanwhile, fell by 50%.

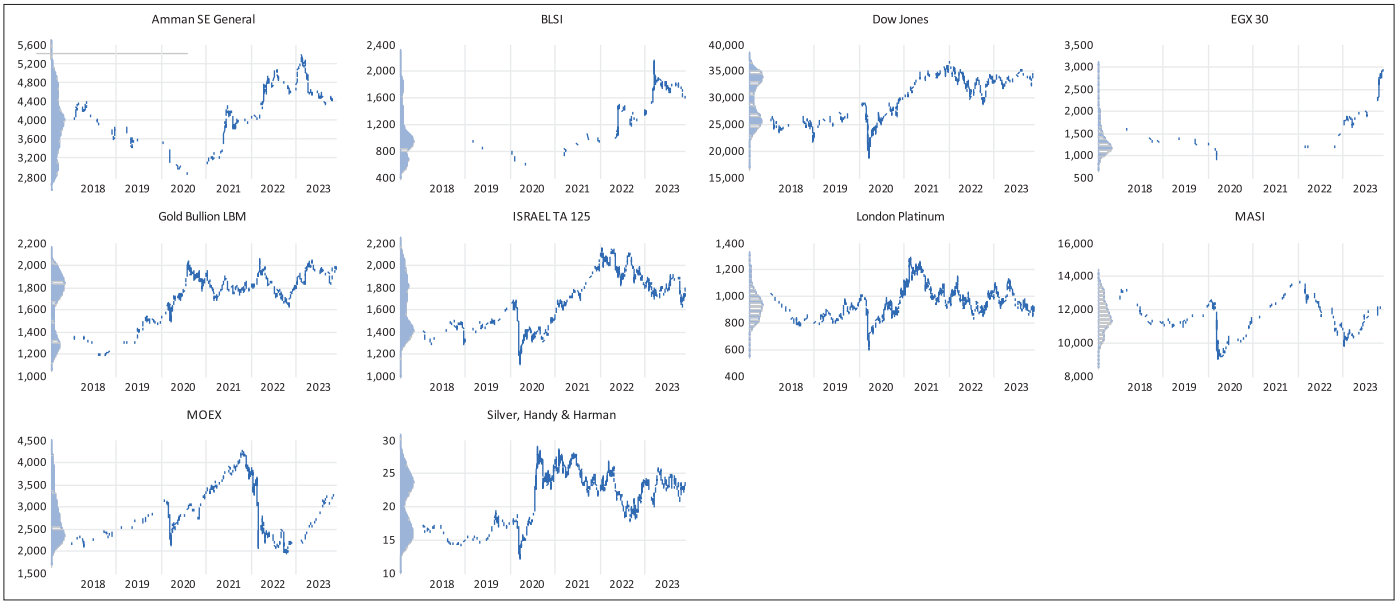
On the other hand, precious metals stood out as safe-haven assets, with gold rising 12% and silver 15%. As the months passed, the markets began a process of gradual recovery. In 2021, the indices began to rise again, albeit with some volatility. Gold and silver consolidated their gains, while platinum remained relatively stable. At the beginning of 2022, a new geopolitical event of great magnitude shook the world: The invasion of Ukraine by Russia. Once again, international markets suffered significant falls. Russia's MOEX, directly impacted by the conflict, fell 60%, while Egypt's EGX 30 (−35%) and Morocco's MASI (−30%) also recorded considerable losses. The Dow Jones, on the other hand, weathered the storm and remained positive.

Figure 2 illustrates the evolution of the returns of the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, over the period from 1 January 2018 to 23 November 2023. Overall, it is possible to observe synchrony between all the series and a generalised dispersion around the mean. However, comparatively, the stock markets show greater dispersion in relation to the mean. On the other hand, there is high volatility, especially in the first few months of 2020. In addition, the Kernel density shows that the stock markets are more volatile when compared to precious metals.

Table 2 summarises the main descriptive statistics for the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel) stock indices from 1 January 2018 to 23 November 2023.

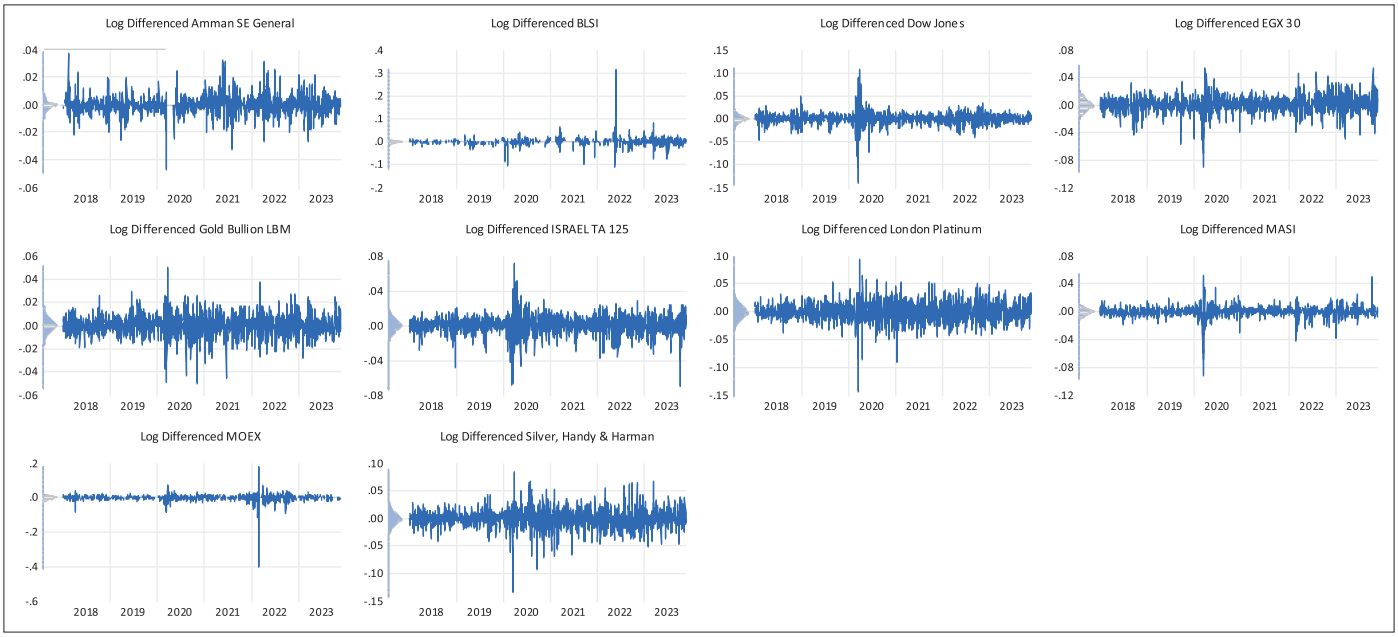
Analysing the descriptive statistics in the table reveals that the mean returns are positive, while in relation to the BLSI stock index (0.01428), we see that it has the greatest dispersion in relation to the mean, making it clear that it is a more volatile market

Figure 1: Evolution, in levels, of the financial markets analysed from 1 January 2018 to 23 November 2023



Source: Data processed by the authors (software: Eviews12)

Figure 2: Evolution, in returns, of the financial markets analysed from 1 January 2018 to 23 November 2023



Source: Data processed by the authors (software: Eviews12)

and adds increased risk when compared to its peers. In addition, stock indices have asymmetry values different from zero, with the BLSI stock index (6.175), while the same index also has the most pronounced kurtosis, the BLSI (165.447), i.e. values different from 3. These results suggest that these are non-Gaussian distributions, and this evidence can be validated with the Jarque-Bera test, which rejects the null hypothesis at a significance level of 1%.

Table 3 summarises the main descriptive statistics for the stock indices MASI (Morocco), MOEX (Russia), and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, over the period from 1 January 2018 to 23 November 2023. Based on the results, the mean returns are positive, except for the MASI index (−2.074e−05) and platinum (−2.10e−05). Regarding the standard deviation, platinum (0.0170) has the highest dispersion and, therefore, the highest risk. As far as skewness and kurtosis are concerned, both indicators are different from 0 and 3. The MOEX stock index (−7.915, 199.234) has the highest values, showing that it is likelier to lose than its peers and does not follow a Gaussian distribution. The Jarque and Bera adherence test validates the evidence and rejects the null hypothesis at a significance level of 1%.

It was necessary to analyse the stationarity of the time series in order to apply econometric methods that will allow answering the research questions. To this end, the Breitung (2000), Levin et al.

(2002), and Im et al. (2003) panel unit root tests were conducted. The Dickey and Fuller (1981) and Phillips and Perron (1988) tests, with Fisher's transformation, were used to validate the results. The Fisher transformation is used to improve the properties of the tests and reduce the dependence on the distribution of the residuals. This transformation is applied to stabilise the variance and reduce the heteroscedasticity of the residuals.

Table 4 shows the summary table of the stationarity tests applied to the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, for the period from January 2018 to November 2023. Based on the results, the presence of unit roots in the residuals was verified, and to achieve stationarity, the price series were transformed into logarithmic first differences, and it was verified that the series are homoscedastic with a significance level of 1%.

4.1. Cointegration Tests: Gregory and Hansen

In this section, the Gregory and Hansen (1996) test was applied due to the presence of breaks in the time series structure analysed. Firstly, given that the date on which the structural break occurred is unknown, a calculation of the structural break and its date will be carried out; secondly, the values obtained from the three statistical tests, DFA, Z_t and Z_a, designed to test the null hypothesis, postulating non-integration against the alternative postulating integration (long-term relations between financial markets) will be evaluated.

This test will analyse the behaviour of the stock indices Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia), and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, as well as their degree of integration. The sample was divided into two periods ("Tranquil" and "Stress"). The period defined as Tranquil comprises the years from 1 January 2018 to 31 December 2019, while the Stress period includes the years from 1 January 2020 to 23 November 2023.

4.2. Gregory and Hansen Test: Dow Jones

Table 5 shows the results of the Gregory and Hansen test applied to the Dow Jones stock index, revealing significant integration with

Table 2: Summary table of the descriptive statistics, in returns, of the financial markets analysed from 1 January 2018 to 23 November 2023

Descriptive statistics	Amman SE General	BLSI	Dow jones	EGX 30	ISRAEL TA 125
Mean	5.38e−05	0.000228	0.000231	0.000478	0.000176
SD	0.00661	0.01428	0.01278	0.01228	0.01093
Skewness	0.177	6.175	−0.950	−0.599	−0.756
Kurtosis	8.760	165.447	23.266	8.512	9.641
Jarque-Bera	2135.166***	1701981.57***	26569.018***	2040.277***	2974.887***
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	1539	1539	1539	1539	1539

Data processed by the authors (software: Eviews12). The asterisks *** represent the rejection of the null hypothesis at a significance level of 1%
Source: Own elaboration

Table 3: Summary table of the descriptive statistics, in returns, of the financial markets studied from 1 January 2018 to 23 November 2023

Descriptive statistics	Gold	Platinum	MASI	MOEX	Silver
Mean	0.00027	−2.10e−05	−2.074e−05	0.00027	0.00021
SD	0.0086	0.0170	0.0075	0.0175	0.0167
Skewness	−0.346	−0.445	−1.877	−7.915	−0.454
Kurtosis	7.149	8.406	30.171	199.234	9.0143
Jarque-Bera	1134.367***	1924.019***	48215.885***	2483779.882***	2370.897***
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	1539	1539	1539	1539	1539

Data processed by the authors (software: Eviews12). *** represents the rejection of the null hypothesis at a significance level of 1%

Table 4: Summary table of the unit root tests in returns for the financial markets analysed from 1 January 2018 to 23 November 2023

Group unit root test: Summary				
Method	**Statistic**	**Prob.****	**Cross-sections**	**Obs**
Null: Unit root (assumes common unit root process)				
Levin, Lin and Chu t*	−188.38	0	10	15358
Breitung t-stat	−92.43	0	10	15348
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	−121.66	0	10	15358
DFA - Fisher Chi-square	2490.11	0	10	15358
PP - Fisher Chi-square	2633.91	0	10	15370

Data processed by the authors (software: Eviews12). ** Probability is assumed to be asymptotically normal
Source: Own elaboration

the MOEX index (November 23, 2018) in the subperiod known as Tranquil. These results show that the North American index can be considered a diversifying asset in periods of tranquillity for the stock markets of the MENA countries, as well as for the precious metals in question. On the other hand, during the Stress period, there was a partial loss of diversification characteristics due to its integration with the BLSI (May 25, 2022), MOEX (May 25, 2022) and platinum (June 22, 2021). However, it remains a diversification option for the Amman SE General (Jordan), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco) stock indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman.

4.3. Gregory and Hansen Test: Amman SE General

Table 6 shows the results of the Gregory and Hansen test applied to the Amman SE General stock index (Jordan). During the tranquil period, it was found to be integrated with the EGX 30 stock index (Egypt), which had a crash on 3 April 2019, showing that it has the properties of a diversifying asset for the Dow Jones

Table 5: Gregory-Hansen tests for the Dow Jones stock index in the Tranquil and Stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
Dow Jones - Amman SE general	Zt	−3.65	Regime	0	***	Segmented
Dow Jones - EGX 30	Zt	−4.29	Trend	3	***	Segmented
Dow Jones - ISRAEL TA 125	Zt	−4.32	Regime	3	***	Segmented
Dow Jones - BLSI	DFA	−4.39	Trend	3	***	Segmented
Dow Jones - MOEX	DFA	−4.73*	Trend	0	November 23, 2018	Integration
Dow Jones - MASI	Zt	−4.22	Trend	3	***	Segmented
Dow Jones - Gold Bullion LBM	Zt	−4.04	Trend	1	***	Segmented
Dow Jones - Silver, Handy and Harman	Zt	−3.85	Regime	3	***	Segmented
Dow Jones - London Platinum	Zt	−4.52	Trend	3	***	Segmented
Total						1/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
Dow Jones - Amman SE general	DFA	−3.96	Regime	5	***	Segmented
Dow Jones - EGX 30	DFA	−4.48	Trend	5	***	Segmented
Dow Jones - ISRAEL TA 125	Zt	−4.33	Trend	2	***	Segmented
Dow Jones - BLSI	Zt	−5.18**	Regime	0	May 25, 2022	Integration
Dow Jones - MOEX	Zt	−6.41***	Regime	5	February 25, 2022	Integration
Dow Jones - MASI	Zt	−4.35	Regime	0	***	Segmented
Dow Jones - Gold Bullion LBM	Zt	−3.88	Regime	5	***	Segmented
Dow Jones - Silver, Handy and Harman	Zt	−4.40	Regime	2	***	Segmented
Dow Jones - London Platinum	Za	−44.97	Regime	1	June 22, 2021	Integration
Total						3/9

Source: Own elaboration

Table 6: Gregory-Hansen tests for the Amman SE General stock index in the Tranquil and stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
Amman SE General - Dow Jones	Zt	−3.82	Regime	2	***	Segmented
Amman SE General - EGX 30	Zt	−4.90*	Trend	1	April 03, 2019	Integration
Amman SE General - ISRAEL TA 125	DFA	−4.42	Trend	2	***	Segmented
Amman SE General - BLSI	Zt	−4.66	Regime	1	***	Segmented
Amman SE General - MOEX	Zt	−3.99	Trend	4	***	Segmented
Amman SE General - MASI	Zt	−4.45	Trend	2	***	Segmented
Amman SE General - Gold Bullion LBM	Zt	−4.27	Trend	3	***	Segmented
Amman SE General - Silver, Handy and Harman	Zt	−4.32	Trend	2	***	Segmented
Amman SE General - London Platinum	Zt	−4.05	Trend	2	***	Segmented
Total						1/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
Amman SE General - Dow Jones	Zt	−4.28	Regime	1	***	Segmented
Amman SE General - EGX 30	Zt	−3.90	Trend	3	***	Segmented
Amman SE General - ISRAEL TA 125	Zt	−3.68	Trend	1	***	Segmented
Amman SE General - BLSI	Zt	−5.19**	Regime	5	March 16, 2023	Integration
Amman SE General - MOEX	DFA	−5.20**	Regime	5	March 03, 2022	Integration
Amman SE General - MASI	Zt	−3.95	Regime	2	***	Segmented
Amman SE General - Gold Bullion LBM	Zt	−3.31	Regime	1	***	Segmented
Amman SE General - Silver, Handy and Harman	Zt	−3.41	Regime	1	***	Segmented
Amman SE General - London Platinum	Zt	−3.48	Regime	4	***	Segmented
Total						2/9

Source: Own elaboration

(United States), BLSI (Lebanon), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock markets, and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum. In addition, during the stress period in the international financial markets resulting from the 2020 pandemic and the Russian invasion of Ukraine in 2022, the Jordanian stock index is integrated with the BLSI (March 16, 2023) and MOEX (March 03, 2022) indices and is therefore considered a diversifying asset for the other markets analysed.

4.4. Teste de Gregory and Hansen: EGX 30

Table 7 shows the results obtained for the Gregory and Hansen test applied to the EGX 30 stock index (Egypt). In the Tranquil period, there were two integrations (out of 9 possible), with the Dow Jones index (October 12, 2018) and with ISRAEL TA 125 (September 24, 2018), being considered a diversifying asset for the stock indices Amman SE General (Jordan), BLSI (Lebanon), MASI (Morocco), MOEX (Russia), and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum. During the stress period, it emerged that the EGX 30 only integrated with the Lebanese index (BLSI - February 24, 2023), thus presenting the properties of a diversifying asset for the other markets analysed.

4.5. Gregory and Hansen Test: ISRAEL TA 125

Table 8 shows the results obtained for the Gregory and Hansen test applied to the ISRAEL TA 125 stock index (Israel). During the Tranquil period, there were 5 integrations (out of a possible 9). The Israeli index integrates with the U.S. market (Dow Jones: December 28, 2018), with Egypt (EGX 30: November 28, 2018), with Russia (MOEX: December 11, 2018), with silver (August 14, 2019), and with platinum (December 11, 2018), making it a diversifying asset for the Amman SE General (Jordan), BLSI (Lebanon), MASI (Morocco) and Gold Bullion LBM stock indices. On the other hand, in a period of uncertainty in the global economy, the Israeli index only integrates with the Lebanese index (BLSI: May 25, 2022), thus exhibiting the characteristics of a diversifying asset for the other markets in analysis.

4.6. Gregory and Hansen Test: BLSI

Table 9 shows the results obtained for the Gregory and Hansen test applied to the BLSI stock index (Lebanon). During the Tranquil period, there was a single integration (out of 9 possible) with the MASI index (April 29, 2019), thus proving to be a diversifying asset for the other markets. During the Stress period in the financial markets, this stock market also integrated only once with the Jordanian market (Amman SE General: March 22, 2023). Given these results, the Lebanese market appears to be a significant diversifying asset for the Dow Jones (United States), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), and MOEX (Russia) stock indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman, and London Platinum, during the 2020 and 2022 events.

4.7. Gregory and Hansen Test: MOEX

Table 10 shows the results obtained for the Gregory and Hansen test applied to the Russian stock market index (MOEX). During the Tranquil period integrates with 3 markets (out of 9 possible), these being the Dow Jones (May 25, 2018), the ISRAEL TA 125 (December 11, 2018), and the MASI (February 12, 2019) Thus, making it a diversifying asset for the Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt) indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum. In the Stress period, the level of integration increased significantly 6 out of a possible 9, with the integrated markets being Dow Jones (February 25, 2022), BLSI (March 03, 2022), MASI (February 14, 2022), Gold Bullion LBM (March 03, 2022), Silver, Handy and Harman (March 03, 2022), London Platinum (March 03, 2022).

Table 7: Gregory-Hansen tests for the EGX 30 stock index in the Tranquil and Stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
EGX 30 - Dow Jones	Zt	−4.88*	Regime	3	October 12, 2018	Integration
EGX 30 - Amman SE General	Zt	−4.52	Trend	2	***	Segmented
EGX 30 - ISRAEL TA 125	Zt	−4.78*	Trend	2	September 24, 2018	Integration
EGX 30 - BLSI	Zt	−4.44	Trend	4	***	Segmented
EGX 30 - MOEX	Zt	−4.08	Trend	4	***	Segmented
EGX 30 - MASI	Zt	−3.87	Trend	3	***	Segmented
EGX 30 - Gold Bullion LBM	Zt	−3.98	Trend	3	***	Segmented
EGX 30 - Silver, Handy and Harman	DFA	−3.73	Trend	3	***	Segmented
EGX 30 - London Platinum	Zt	−3.99	Trend	3	***	Segmented
Total						2/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
EGX 30 - Dow Jones	Zt	−3.31	Regime	0	***	Segmented
EGX 30 - Amman SE General	Zt	−3.39	Regime	3	***	Segmented
EGX 30 - ISRAEL TA 125	Zt	−2.57	Regime	0	***	Segmented
EGX 30 - BLSI	Za	−45.09*	Regime	0	February 24, 2023	Integration
EGX 30 - MOEX	Zt	−2.17	Regime	3	***	Segmented
EGX 30 - MASI	Zt	−3.74	Regime	3	***	Segmented
EGX 30 - Gold Bullion LBM	Zt	−2.20	Regime	0	***	Segmented
EGX 30 - Silver, Handy and Harman	Zt	−3.05	Regime	3	***	Segmented
EGX 30 - London Platinum	Zt	−3.38	Regime	5	***	Segmented
Total						1/9

Source: Own elaboration

Table 8: Gregory-Hansen tests for the ISRAEL TA 125 stock index in the Tranquil and stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
ISRAEL TA 125 - Dow Jones	Zt	−6.03***	Regime	0	December 28, 2018	Integration
ISRAEL TA 125 - Amman SE General	Zt	−4.66	Trend	2	***	Segmented
ISRAEL TA 125 - EGX 30	Zt	−4.90*	Trend	2	November 28, 2018	Integration
ISRAEL TA 125 - BLSI	Zt	−4.47	Trend	1	***	Segmented
ISRAEL TA 125 - MOEX	Zt	−5.03**	Trend	1	December 11, 2018	Integration
ISRAEL TA 125 - MASI	Zt	−4.68	Trend	1	***	Segmented
ISRAEL TA 125 - Gold Bullion LBM	Zt	−4.65	Trend	1	***	Segmented
ISRAEL TA 125 - Silver, Handy and Harman	Zt	−4.70*	Regime	2	August 14, 2019	Integration
ISRAEL TA 125 - London Platinum	Zt	−4.78*	Trend	0	December 11, 2018	Integration
Total						5/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
ISRAEL TA 125 - Dow Jones	Zt	−3.82	Regime	1	***	Segmented
ISRAEL TA 125 - Amman SE General	Zt	−4.02	Trend	1	***	Segmented
ISRAEL TA 125 - EGX 30	Zt	−4.14	Trend	5	***	Segmented
ISRAEL TA 125 - BLSI	DFA	−5.48***	Regime	5	May 25, 2022	Integration
ISRAEL TA 125 - MOEX	Zt	−4.20	Regime	5	***	Segmented
ISRAEL TA 125 - MASI	Zt	−4.54	Regime	1	***	Segmented
ISRAEL TA 125 - Gold Bullion LBM	Zt	−3.33	Regime	5	***	Segmented
ISRAEL TA 125 - Silver, Handy and Harman	Zt	−3.70	Trend	5	***	Segmented
ISRAEL TA 125 - London Platinum	Zt	−4.07	Trend	0	***	Segmented
Total						1/9

Source: Own elaboration

Table 9: Gregory-Hansen tests for the BLSI stock market index for the Tranquil and Stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
BLSI - Dow Jones	Zt	−3.43	Trend	5	***	Segmented
BLSI - Amman SE General	Zt	−4.06	Trend	2	***	Segmented
BLSI - EGX 30	Zt	−3.50	Trend	5	***	Segmented
BLSI - ISRAEL TA 125	Zt	−4.36	Regime	3	***	Segmented
BLSI - MOEX	Zt	−4.25	Regime	1	***	Segmented
BLSI - MASI	DFA	−5.01**	Regime	5	April 29, 2019	Integration
BLSI - Gold Bullion LBM	Zt	−4.01	Trend	0	***	Segmented
BLSI - Silver, Handy and Harman	Zt	−3.74	Trend	0	***	Segmented
BLSI - London Platinum	Zt	−4.17	Trend	5	c	Segmented
Total						1/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
BLSI - Dow Jones	Zt	−4.38	Regime	0	***	Segmented
BLSI - Amman SE General	DFA	−5.68	Regime	5	March 22, 2023	Integration
BLSI - EGX 30	Zt	−3.40	Regime	3	***	Segmented
BLSI - ISRAEL TA 125	DFA	−4.62	Regime	5	***	Segmented
BLSI - MOEX	Zt	−4.15	Regime	3	***	Segmented
BLSI - MASI	Zt	−3.51	Regime	3	***	Segmented
BLSI - Gold Bullion LBM	Zt	−3.86	Regime	5	***	Segmented
BLSI - Silver, Handy and Harman	Zt	−3.88	Regime	5	***	Segmented
BLSI - London Platinum	Zt	−3.36	Regime	0	***	Segmented
Total						1/9

Source: Own elaboration

However, there is also the presence of segmented markets, i.e. those that are not integrated and can consider MOEX as a diversifying asset, such as the Amman SE General index (Jordan), EGX 30 (Egypt), and ISRAEL TA 125 (Israel).

4.8. Gregory and Hansen Tests: MASI

Table 11 shows the results obtained for the Gregory and Hansen test applied to the MASI stock index (Morocco). In the Tranquil period it shows the presence of 3 integrations (out of 9 possible), the indices that integrate are Israel (December 24, 2018), Lebanon (May 24, 2019), and gold (October 15, 2018), thus proving to be a diversifying asset for the Dow Jones (United States), Amman SE General (Jordan), EGX 30 (Egypt), MASI (Morocco), MOEX (Russia) stock indices, and for the precious metals Silver, Handy and Harman, London Platinum. On the other hand, the Moroccan index during the 2020 pandemic and the Russian invasion of Ukraine has the characteristics of a fully diversifying asset, as it does not integrate with any of the markets analysed.

Table 10: Gregory-Hansen tests for the MOEX stock market index in the Tranquil and Stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
MOEX - Dow Jones	DFA	−5.02**	Trend	0	May 25, 2018	Integration
MOEX - Amman SE General	Zt	−3.90	Trend	5	***	Segmented
MOEX - EGX 30	Zt	−4.40	Trend	5	***	Segmented
MOEX - ISRAEL TA 125	Zt	−5.52***	Regime	1	December 11, 2018	Integration
MOEX - BLSI	Zt	−4.18	Regime	5	***	Segmented
MOEX - MASI	Zt	−5.09**	Regime	5	February 12, 2019	Integration
MOEX - Gold Bullion LBM	Zt	−3.66	Trend	0	***	Segmented
MOEX - Silver, Handy and Harman	Zt	−3.42	Trend	0	***	Segmented
MOEX - London Platinum	Zt	−4.02	Regime	0	***	Segmented
Total						3/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
MOEX - Dow Jones	Za	−41.97*	Regime	1	February 25, 2022	Integration
MOEX - Amman SE general	Zt	−3.96	Regime	2	***	Segmented
MOEX - EGX 30	Zt	−3.98	Regime	5	***	Segmented
MOEX - ISRAEL TA 125	DFA	−4.17	Regime	5	***	Segmented
MOEX - BLSI	DFA	−4.89*	Regime	5	March 03, 2022	Integration
MOEX - MASI	Zt	−6.04***	Trend	5	February 14, 2022	Integration
MOEX - Gold Bullion LBM	DFA	−5.64***	Trend	5	March 03, 2022	Integration
MOEX - Silver, Handy and Harman	DFA	−5.56***	Trend	5	March 03, 2022	Integration
MOEX - London Platinum	Zt	−5.62***	Trend	5	March 03, 2022	Integration
Total						6/9

Source: Own elaboration

Table 11: Gregory-Hansen tests for the MASI stock index in the Tranquil and Stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
MASI - Dow Jones	Zt	−4.12	Regime	5	***	Segmented
MASI - Amman SE General	Zt	−3.73	Trend	5	***	Segmented
MASI - EGX 30	Zt	−3.47	Trend	5	***	Segmented
MASI - ISRAEL TA 125	Zt	−5.18**	Regime	1	December 24, 2018	Integration
MASI - BLSI	DFA	−4.91*	Regime	5	May 24, 2019	Integration
MASI - MOEX	Zt	−4.14	Trend	5	***	Segmented
MASI - Gold Bullion LBM	Za	−42.63	Regime	5	October 15, 2018	Integration
MASI - Silver, Handy and Harman	Zt	−4.49	Regime	5	***	Segmented
MASI - London Platinum	Zt	−4.23	Regime	5	***	Segmented
Total						3/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
MASI - Dow Jones	Zt	−4.28	Regime	0	***	Segmented
MASI - Amman SE General	Zt	−4.02	Regime	2	***	Segmented
MASI - EGX 30	Zt	−4.16	Regime	3	***	Segmented
MASI - ISRAEL TA 125	Zt	−4.41	Trend	1	***	Segmented
MASI - BLSI	Zt	−4.60	Regime	3	***	Segmented
MASI - MOEX	Zt	−4.41	Trend	3	***	Segmented
MASI - Gold Bullion LBM	Zt	−4.45	Trend	3	***	Segmented
MASI - Silver, Handy and Harman	Zt	−3.73	Regime	3	***	Segmented
MASI - London Platinum	Zt	−3.67	Trend	3	***	Segmented
Total						0/9

Source: Own elaboration

4.9. Gregory and Hansen Test: Gold Bullion LBM

Table 12 shows the results obtained for the Gregory and Hansen test applied to the precious metal gold (Gold Bullion LBM). During the Tranquil period, it only integrated with the BLSI (June 26, 2019), thus showing that it is segmented with the other markets and considered a diversifying asset. In addition, the results during the Stress period also show that gold is a fully diversifying asset as it is segmented with its peers, namely the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia), and the precious metals Silver, Handy and Harman, London Platinum.

4.10. Gregory and Hansen Test: Silver, Handy and Harman

Table 13 shows the results obtained for the Gregory and Hansen test applied to silver (Silver, Handy and Harman). During the Tranquil period there were 2 integrations (out of 9 possible), the integrated markets being ISRAEL TA 125 (July 29, 2019),

Table 12: Gregory-Hansen tests for the Gold Bullion LBM in the Tranquil and stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
Gold Bullion LBM - Dow Jones	Zt	−3.41	Regime	2	***	Segmented
Gold Bullion LBM - Amman SE General	Zt	−3.40	Trend	2	***	Segmented
Gold Bullion LBM - EGX 30	Zt	−3.89	Trend	2	***	Segmented
Gold Bullion LBM - ISRAEL TA 125	Zt	−4.07	Trend	2	***	Segmented
Gold Bullion LBM - BLSI	Zt	−4.73*	Trend	2	June 26, 2019	Integration
Gold Bullion LBM - MOEX	Zt	−3.45	Trend	2	***	Segmented
Gold Bullion LBM - MASI	Zt	−4.33	Trend	2	***	Segmented
Gold Bullion LBM - Silver, Handy and Harman	Zt	−3.78	Trend	5	***	Segmented
Gold Bullion LBM - London Platinum	Zt	−3.92	Trend	0	***	Segmented
Total						1/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
Gold Bullion LBM - Dow Jones	Zt	−4.06	Regime	0	***	Segmented
Gold Bullion LBM - Amman SE General	Zt	−3.86	Regime	0	***	Segmented
Gold Bullion LBM - EGX 30	Zt	−3.97	Regime	0	***	Segmented
Gold Bullion LBM - ISRAEL TA 125	Zt	−4.06	Regime	0	***	Segmented
Gold Bullion LBM - BLSI	DFA	−4.11	Regime	0	***	Segmented
Gold Bullion LBM - MOEX	Zt	−3.91	Regime	0	***	Segmented
Gold Bullion LBM - MASI	Zt	−3.88	Regime	0	***	Segmented
Gold Bullion LBM - Silver, Handy and Harman	Zt	−4.07	Regime	0	***	Segmented
Gold Bullion LBM - London Platinum	Zt	−3.59	Regime	0	***	Segmented
Total						9/11

Source: Own elaboration

Table 13: Gregory-Hansen tests for Silver, Handy and Harman in the Tranquil and Stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
Silver, Handy and Harman - Dow Jones	Zt	−3.80	Trend	0	***	Segmented
Silver, Handy and Harman - Amman SE General	Zt	−4.07	Trend	0	***	Segmented
Silver, Handy and Harman - EGX 30	Zt	−4.34	Trend	0	***	Segmented
Silver, Handy and Harman - ISRAEL TA 125	DFA	−5.06**	Regime	2	July 29, 2019	Integration
Silver, Handy and Harman - BLSI	Zt	−4.32	Regime	2	***	Segmented
Silver, Handy and Harman - MOEX	Zt	−3.62	Regime	2	***	Segmented
Silver, Handy and Harman - MASI	DFA	−4.70*	Regime	2	July 29, 2019	Integration
Silver, Handy and Harman - Gold Bullion LBM	Zt	−3.66	Regime	5	***	Segmented
Silver, Handy and Harman - London Platinum	Zt	−3.35	Trend	1	***	Segmented
Total						2/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
Silver, Handy and Harman - Dow Jones	Zt	−3.97	Regime	1	***	Segmented
Silver, Handy and Harman - Amman SE General	Zt	−4.88*	Trend	1	August 07, 2020	Integration
Silver, Handy and Harman - EGX 30	Zt	−5.27**	Trend	0	July 31, 2020	Integration
Silver, Handy and Harman - ISRAEL TA 125	Zt	−4.69	Trend	1	***	Segmented
Silver, Handy and Harman - BLSI	Zt	−4.39	Trend	1	***	Segmented
Silver, Handy and Harman - MOEX	Zt	−4.56	Trend	3	***	Segmented
Silver, Handy and Harman - MASI	Zt	−4.41	Trend	1	***	Segmented
Silver, Handy and Harman - Gold Bullion LBM	Zt	−4.16	Trend	0	***	Segmented
Silver, Handy and Harman - London Platinum	DFA	−3.52	Trend	1	***	Segmented
Total						2/9

Source: Own elaboration

MASI (July 29, 2019), presenting the characteristics of a diversifying asset for the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), MOEX (Russia) stock indices, and the precious metals Gold Bullion LBM, London Platinum. In the Stress period, there were also two integrations, but with other markets, with the Amman SE General index (August 07, 2020) and the EGX (July 31, 2020), thus presenting the characteristics of a diversifier with the other markets in analysis.

4.11. Gregory and Hansen Test: London Platinum

Table 14 shows the results obtained for the Gregory and Hansen test applied to Platinum (London Platinum). In the Tranquil period, there was no integration; the markets are segmented and have the characteristics of diversifying assets with the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman. On the other hand, during the stress

Table 14: Gregory-Hansen tests for London Platinum in the Tranquil and Stress periods

Period: Tranquil (January 01, 2018-December 31, 2019)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
London Platinum - Dow Jones	Zt	−4.26	Regime	0	***	Segmented
London Platinum - Amman SE General	Zt	−3.94	Trend	2	***	Segmented
London Platinum - EGX 30	Zt	−3.21	Regime	4	***	Segmented
London Platinum - ISRAEL TA 125	Zt	−4.27	Regime	2	***	Segmented
London Platinum - BLSI	Zt	−3.91	Regime	1	***	Segmented
London Platinum - MOEX	Zt	−4.01	Regime	1	***	Segmented
London Platinum - MASI	Zt	−4.51	Regime	1	***	Segmented
London Platinum - Gold Bullion LBM	Zt	−3.62	Regime	0	***	Segmented
London Platinum - Silver, Handy and Harman	Zt	−3.99	Regime	0	***	Segmented
Total						0/9
Period: Stress (January 01, 2020-November 23, 2023)						
Markets	**Test**	**t statistic**	**Method**	**Lags**	**Break date**	**Results**
London Platinum - Dow Jones	Zt	−4.80*	Trend	1	June 22, 2021	Integration
London Platinum - Amman SE General	Zt	−4.85*	Trend	2	December 07, 2020	Integration
London Platinum - EGX 30	Zt	−4.74*	Trend	0	December 04, 2020	Integration
London Platinum - ISRAEL TA 125	Zt	−4.77*	Trend	2	December 07, 2020	Integration
London Platinum - BLSI	Zt	−4.51	Trend	1	***	Segmented
London Platinum - MOEX	Zt	−4.35	Trend	1	***	Segmented
London Platinum - MASI	Zt	−4.57	Trend	2	***	Segmented
London Platinum - Gold Bullion LBM	Zt	−3.49	Regime	1	***	Segmented
London Platinum - Silver, Handy and Harman	Zt	−4.15	Trend	1	***	Segmented
Total						4/9

Source: Own elaboration

period, it was found that platinum lost its characteristics as a fully diversifying asset, as it had 4 out of a possible 9 integrations: Dow Jones (June 22, 2021), Amman SE General (December 07, 2020), EGX (December 04, 2020) and ISRAEL TA 125 (December 07, 2020). However, it is still a diversifying asset for the BLSI (Lebanon), MASI (Morocco), MOEX (Russia) indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman.

4.12. Gregory and Hansen Test: Global Analysis

Table 15 shows a summary table of the integrations between the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, during the Tranquil and Stress periods.

Regarding the performance of the Dow Jones stock index, a strong correlation was observed with the MOEX index in the Tranquil period, as recorded on 23 November 2018. These findings indicate that the U.S. index can serve as a diversification asset during periods of stability in the stock markets of MENA countries and in the precious metals analysed. On the other hand, during periods of stress, a partial reduction in its properties as a diversification asset was noted due to its correlation with the BLSI (May 25, 2022), MOEX (May 25, 2022) and platinum (June 22, 2021). However, it remains a diversification option for stock indices such as the Amman SE General (Jordan), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), and also for the precious metals Gold Bullion LBM, Silver, Handy and Harman.

During periods of tranquillity in the international financial markets, the Amman SE General stock index (Jordan) demonstrates integration with the EGX 30 stock index (Egypt), which was

Table 15: Summary of the results obtained in the Gregory and Hansen Tests for the financial markets analysed in the Tranquil and Stress periods

Indices	Tranquil	Stress	Evolution
Dow Jones	1/9 possible	3/9 possible	↑
Amman SE General	1/9 possible	2/9 possible	↑
BLSI	1/9 possible	1/9 possible	=
EGX 30	2/9 possible	1/9 possible	↓
ISRAEL TA 125	5/9 possible	1/9 possible	↓
MASI	3/9 possible	0/9 possible	↓
MOEX	3/9 possible	6/9 possible	↑
Gold Bullion LBM	1/9 possible	0/9 possible	↓
Silver, Handy and Harman	2/9 possible	2/9 possible	=
London Platinum	0/9 possible	4/9 possible	↑

Source: Own elaboration

evident on 3 April 2019. This suggests that Amman SE General has diversification properties towards the Dow Jones (U.S.), BLSI (Lebanon), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock markets and the precious metals Gold Bullion LBM, Silver, Handy and Harman and London Platinum. In periods of uncertainty in the international financial markets, such as during the 2020 pandemic and the Russian invasion of Ukraine in 2022, the Jordanian index is also integrated with the BLSI (March 16, 2023) and MOEX (March 03, 2022) indices, reaffirming its role as a diversifying asset for the other markets analysed.

The EGX 30 stock index (Egypt) shows integration with two indices (out of a possible nine): The Dow Jones (October 12, 2018) and the ISRAEL TA 125 (September 24, 2018), during the Tranquil period. This makes it a diversifying asset for the stock indices Amman SE General (Jordan), BLSI (Lebanon), MASI (Morocco), MOEX (Russia) and the precious metals Gold Bullion LBM, Silver, Handy and Harman and London Platinum.

However, during periods of stress, the EGX 30 only integrates with the Lebanese index (BLSI - February 24, 2023), maintaining its properties as a diversifying asset for the other markets analysed.

The ISRAEL TA 125 stock index (Israel) shows five integrations (out of a possible nine) in the period leading up to the 2020 pandemic and the Russian invasion of Ukraine. It should be noted that the Israeli index integrates with the U.S. market (Dow Jones: December 28, 2018), Egypt (EGX 30: November 28, 2018), Russia (MOEX: December 11, 2018), silver (August 14, 2019) and Platinum (December 11, 2018), acting as a diversifying asset for the Amman SE General (Jordan), BLSI (Lebanon), MASI (Morocco) and Gold Bullion LBM stock indices. However, during periods of uncertainty in the global economy, the Israeli index only integrates with the Lebanese index (BLSI: May 25, 2022), maintaining its characteristics as a diversifying asset for the other markets analysed.

As for the BLSI stock index (Lebanon), during tranquil periods, it only integrates with the MASI index on April 29, 2019, highlighting its role as a diversifying asset for other markets. During periods of uncertainty, the Lebanese stock market also integrates only once, this time with the Jordanian market (Amman SE General: March 22, 2023). Based on these results, the Lebanese market appears to be a significant diversifying asset for the Dow Jones (United States), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, during the events of 2020 and 2022.

Russia's stock market index, the MOEX, has different levels of integration with other markets over time. The MOEX integrates with three markets in tranquil periods: Dow Jones, ISRAEL TA 125 and MASI. During stress periods, the MOEX's integration with other markets increases significantly. The index integrates with six markets: Dow Jones, BLSI, MASI, Gold Bullion LBM, Silver, Handy and Harman and London Platinum. This stronger integration can be explained by investors' search for safe-haven assets in times of uncertainty.

Regarding the MASI stock market index (Morocco), in the Tranquil period, there were three integrations (out of a possible 9); the indices that integrated were Israel (December 24, 2018), Lebanon (May 24, 2019), and gold (October 15, 2018), thus proving to be a diversifying asset for the Dow Jones (United States), Amman SE General (Jordan), EGX 30 (Egypt), MASI (Morocco), MOEX (Russia) stock indices, and for the precious metals Silver, Handy and Harman, London Platinum. On the other hand, the Moroccan index during the 2020 pandemic and the Russian invasion of Ukraine has the characteristics of a fully diversifying asset, as it does not integrate with any of the markets being analysed.

As for gold (Gold Bullion LBM), during the tranquil period, it only integrated with the BLSI (June 26, 2019), thus proving to be segmented with the other markets and, therefore, considered a diversifying asset. In addition, the results during the Stress period also show that gold is a fully diversifying asset, as it is segmented with its peers, namely the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia), and the precious metals Silver, Handy and Harman, London Platinum.

Regarding silver (Silver, Handy and Harman), during the tranquil period there were 2 integrations (out of a possible 9), the integrated markets being ISRAEL TA 125 (July 29, 2019), MASI (July 29, 2019), presenting the characteristics of a diversifying asset for the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), MOEX (Russia) stock indices, and the precious metals Gold Bullion LBM, London Platinum. In the Stress period, there were also two integrations, but with other markets, with the Amman SE General index (August 07, 2020) and the EGX (July 31, 2020), thus presenting the characteristics of a diversifier with the other markets analysed.

Concerning Platinum (London Platinum) and during the Tranquil period, there were no integrations; the markets are segmented and exhibit the characteristics of diversifying assets with the Dow Jones stock indices (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia), and the precious metals Gold Bullion LBM, Silver, Handy and Harman. On the other hand, during the stress period, platinum lost its characteristics as a fully diversifying asset, as it had 4 out of a possible 9 integrations: Dow Jones (June 22, 2021), Amman SE General (December 07, 2020), EGX (December 04, 2020), and ISRAEL TA 125 (December 07, 2020). However, it still appears to be a diversifying asset for the BLSI (Lebanon), MASI (Morocco), and MOEX (Russia) indices and the precious metals Gold Bullion LBM, Silver, Handy and Harman.

These results partially reject the first research question, i.e. it was not possible to detect a significant increase in integration during the 2020 and 2022 events, as it was found that there were markets that increased their level of integration between the Tranquil and Stress sub-periods, but there were also markets that decreased their level of integration with their peers. These results are relevant for international investors operating in these financial markets in MENA countries, which have unique characteristics.

4.13. Exponent Test Detrended Fluctuation Analysis (DFA): Global Analysis

Table 16 shows the results of the Detrended Fluctuation Analysis (DFA) exponent for the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia) stock indices, and the precious metals Gold Bullion LBM, Silver, Handy and Harman, London Platinum, during the Tranquil and Stress periods. For more robustness, the DFA slopes have been estimated for the Tranquil period (January 1, 2018-December 31, 2019) and the Stress period (January 1, 2020-November 23, 2023).

During the Tranquil period, the stock indices and precious metals are mostly persistent; for example, the Amman SE General index (0.59), EGX 30 (0.54), MASI (0.55), BLSI (0.53), MOEX (0.52) and platinum (0.52). On the other hand, silver (0.48) shows anti-persistence, i.e. short-term memory, while the Dow Jones (0.50),

Table 16: DFA exponent for return. The values of the linear adjustments for *αDFA* always had R^2 >0.99

Indices	*αDFA* (Tranquil)	Results	*αDFA* (stress)	Results
Dow Jones	0.50≅0.0092	Random Walk	0.54** ≅ 0.0012	Persistence
Amman SE general	0.59** ≅ 0.0016	Persistence	0.64** ≅ 0.0051	Persistence
BLSI	0.53** ≅ 0.0054	Persistence	0.58** ≅ 0.0022	Persistence
EGX 30	0.54** ≅ 0.0060	Persistence	0.59** ≅ 0.0049	Persistence
ISRAEL TA 125	0.50≅0.0138	Random Walk	0.55** ≅ 0.0019	Persistence
MASI	0.55** ≅ 0.0050	Persistence	0.62** ≅ 0.0096	Persistence
MOEX	0.52** ≅ 0.0092	Persistence	0.48** ≅ 0.0073	Anti - persistence
Gold Bullion LBM	0.50≅0.0167	Random Walk	0.47** ≅ 0.0041	Anti - persistence
Silver, Handy and Harman	0.48** ≅ 0.0014	Anti - persistence	0.55** ≅ 0.0058	Persistence
London platinum	0.52** ≅ 0.0044	Persistence	0.51** ≅ 0.0081	Persistence

The hypotheses are H_0: $\alpha = 0.5$ and H_1: $\alpha \neq 0.5$.** Confidence interval 95%
Source: Own elaboration

ISRAEL TA 125 (0.50) and gold (0.50) stock indices do not reject the white noise hypothesis.

These results show that most stock index prices do not follow a purely random process, but this does not necessarily imply return predictability. Additionally, the DFA slopes for the stress period were analysed, and it was found that none of the indices and precious metals followed the random walk hypothesis. The stock indices Amman SE General (0.64), MASI (0.62), EGX 30 (0.59), BLSI (0.58), ISRAEL TA 125 (0.55), Dow Jones (0.54), and precious metals such as silver (0.55) and Platinum (0.51) show very significant persistence, i.e. long-term memories. On the other hand, the MOEX stock market (0.48) and gold (0.47) are anti-persistent, i.e. they have short-term memories.

Therefore, the results partially reject the second research question, i.e. it was impossible to detect a causal relationship between integrations and the presence of memories in the markets analysed. Regarding the results of the Gregory-Hansen integration test, it was found that some markets increased their level of integration between the Tranquil and Stress subperiods, but some markets decreased their level of integration. On the other hand, there was a significant increase in the DFA slopes, which showed that none of the markets analysed followed the random walk hypothesis.

5. CONCLUSION

Renewed interest has arisen in understanding how the global pandemic of 2020 and the Russian invasion of Ukraine in 2022 have affected the relationship between major stock indices such as the Dow Jones (United States), Amman SE General (Jordan), BLSI (Lebanon), EGX 30 (Egypt), ISRAEL TA 125 (Israel), MASI (Morocco), MOEX (Russia), and the precious metals, including the Gold Bullion LBM, Silver, Handy and Harman, London Platinum, during the period from 1 January 2018 to 23 November 2023. The study aimed to address two key questions: (i) Have the events of 2020 and 2022 influenced the integration between the capital markets of MENA countries and precious metals? (ii) If there is a significant increase in integration, will this imply a trend towards efficiency or inefficiency in the markets analysed? The results of the cointegration tests carried out between stock indices and precious metals revealed important insights into the integration between financial markets and the impacts of global events, such as the 2020 pandemic and the Russian invasion of Ukraine in 2022, on the Middle East and North Africa (MENA) markets in relation to precious metals.

During periods of stress caused by these events, there was a significant increase in integration in various markets, such as platinum and the MOEX, Dow Jones and Amman SE General stock indices. These results may suggest a search for more stable or hedging assets during times of uncertainty, where investors tend to diversify their portfolios to mitigate risks. However, the ISRAEL TA 125, EGX, and MASI stock indices and gold showed decreases in integration during these turbulent periods. This can be attributed to factors specific to each market, such as domestic politics, regional dynamics or investors' perception of the safety and stability of these assets in times of crisis.

Regarding market efficiency, the results of the DFA slopes indicated a significant persistence in most markets, regardless of the levels of integration. This suggests that increased financial integration did not directly influence market efficiency during the events analysed. Persistence may indicate inefficiencies in the markets, but these inefficiencies were not clearly related to integration between the markets and precious metals.

These conclusions have important practical implications for investors and policymakers. On the one hand, investors may consider diversifying their portfolios to include less correlated assets during periods of market stress. On the other hand, policymakers may need to monitor financial market dynamics more closely and implement appropriate measures to ensure market stability and transparency in times of crisis.

In summary, while global events influence the integration between financial markets and precious metals, the relationship between this integration and market efficiency is complex and multifaceted, requiring careful analysis and a deep understanding of market dynamics and specific regional contexts.

6. FUTURE LINES OF RESEARCH

Regarding suggestions for future research, it was thought that these should include exploring the interaction between MENA countries' stock indices and other financial assets, such as foreign currencies,

commodities, debt securities, interest rates, inflation and local government policies, which could provide a more comprehensive view of the dynamics of the region's financial markets. Applying advanced volatility modelling techniques (ARCH, GARCH and MGARCH) could also help to understand how the stock and precious metals markets behave during periods of extreme volatility resulting from uncertainty in the global economy. This could reveal behaviour patterns and risk characteristics in MENA's financial markets.

REFERENCES

Ben Amar, A., Goutte, S., Hasnaoui, A., Marouane, A., Mzoughi, H. (2023), The Ramadan effect on commodity and stock markets integration. Review of Accounting and Finance, 22(3), 269-293.

Bhattacharyya, R. (2019), The Gains and Pains of Financial Integration and Trade Liberalization. Bingley: Emerald Publishing Limited.

Breitung, J. (2000), The local power of some unit root tests for panel data. In: Advances in Econometrics. Leeds: Emerald Group Publishing Limited.

Chambino, M., Dias, R., Horta, N. (2022), Time-Varying Co-movements between Wti and European Capital Markets: Implications for Portfolio Diversification and Hedging Strategies. In: International Scientific-Business Conference - LIMEN. Vol. 8. p31-49.

Chen, Y., Xu, J., Hu, M. (2022), Asymmetric volatility spillovers and dynamic correlations between crude oil price, exchange rate and gold price in BRICS. Resources Policy, 78, 102857.

Dias, R., da Silva, J.V., Dionísio, A. (2019), Financial markets of the LAC region: Does the crisis influence the financial integration? International Review of Financial Analysis, 63, 160-173.

Dias, R., Heliodoro, P., Alexandre, P., Vasco, C. (2020), Financial Market Integration of Asean-5 with China: An Econophysics Approach. In: 4th EMAN Conference Proceedings (Part of EMAN Conference Collection). p17-23.

Dias, R., Pereira, J.M. (2021), The impact of the COVID-19 pandemic on stock markets. International Journal of Entrepreneurship and Governance in Cognitive Cities, 1(2), 57-70.

Dias, R., Pereira, J.M., Carvalho, L.C. (2022), Are African stock markets efficient? A comparative analysis between six African markets, the UK, Japan and the USA in the period of the pandemic. Naše Gospodarstvo/Our Economy, 68(1), 35-51.

Dias, R., Santos, H., Heliodoro, P., Vasco, C., Alexandre, P. (2021), Wti Oil Shocks in Eastern European Stock Markets: A Var Approach. In: 5th EMAN Conference Proceedings (Part of EMAN Conference Collection). p71-84.

Dias, R.T., Carvalho, L. (2021), The Relationship between Gold and Stock Markets During the Covid-19 Pandemic. United States: IGI Global. p462-475.

Dias, R.T., Pardal, P., Teixeira, N., Horta, N.R. (2022), Tail Risk and Return Predictability for Europe's Capital Markets: An Approach in Periods of the 2020 and 2022 Crises. United States: IGI Global.

Dickey, D.A., Fuller, W.A. (1981), Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica, 49(4), 1057-1072.

Elie, B., Naji, J., Dutta, A., Uddin, G.S. (2019), Gold and crude oil as safe-haven assets for clean energy stock indices: Blended copulas approach. Energy, 178, 544-553.

Gaio, L.E., Ambrozini, M.A., Bonacim, C.A.G., Pimenta Junior, T. (2014), Interdependência entre os mercados mundiais de ações: Uma análise de volatilidades. BASE - Revista de Administração e Contabilidade Da Unisinos, 11(3), 259-274.

Graham, M., Kiviaho, J., Nikkinen, J., Omran, M. (2013), Global and regional co-movement of the MENA stock markets. Journal of Economics and Business, 65, 86-100.

Gregory, A.W., Hansen, B.E. (1996), Residual-based tests for cointegration in models with regime shifts. Journal of Econometrics, 70(1), 99-126.

Grinblatt, M., Titman, S. (2002), Financial Markets and Corporate Strategy. New York: The McGraw-Hill, Irwin. p880.

Heliodoro, P., Dias, R., Alexandre, P., Vasco, C. (2020), Integration in Bric Stock Markets: An Empirical Analysis. 4th EMAN Selected Papers (Part of EMAN Conference Collection).

Huyghebaert, N., Wang, L. (2010), The co-movement of stock markets in East Asia: Did the 1997-1998 Asian financial crisis really strengthen stock market integration? China Economic Review, 21(1), 98-112.

Iheanacho, E., Okere, K.I., Onoh, J.O. (2023), Nexus between financial integration, capital market development and economic performance: Does institutional structure matters? Heliyon, 9(1), e12827.

Im, K.S., Pesaran, M.H., Shin, Y. (2003), Testing for unit roots in heterogeneous panels. Journal of Econometrics, 115, 53-74.

Jarque, C.M., Bera, A.K. (1980), Efficient tests for normality, homoscedasticity and serial independence of regression residuals. Economics Letters, 6(3), 255-259.

Kendo, S., Tchakounte, J. (2022), The drivers of the financial integration of microfinance Institutions: Do financial development, agency costs and microfinance performance matter? Quarterly Review of Economics and Finance, 84, 128-142.

Khan, T.A. (2011), Cointegration of international stock markets: An investigation of diversification opportunities. Undergraduate Economic Review, 8(1), 52.

Kotu, V., Deshpande, B. (2019), Classification. In: Data Science. Vol. 51. Amsterdam: Elsevier. p65-163.

Kumaraswamy, S., Abdulla, Y., Panigrahi, S.K. (2023), Will gold prices persist post pandemic period? An econometric evidence. International Journal of Financial Studies, 11(1), 8.

Levin, A., Lin, C.F., Chu, C.S.J. (2002), Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics, 108, 1-24.

Maghyereh, A.I., Awartani, B., Al Hilu, K. (2015), Dynamic transmissions between the U.S. and equity markets in the MENA countries: New evidence from pre- and post-global financial crisis. Quarterly Review of Economics and Finance, 56, 123-138.

Markowitz, H. (1952), Portfolio selection. The Journal of Finance, 7, 77-91.

Mensi, W., Maitra, D., Selmi, R., Vinh Vo, X. (2023), Extreme dependencies and spillovers between gold and stock markets: Evidence from MENA countries. Financial Innovation, 9(1), 47.

Mokni, K., Hammoudeh, S., Ajmi, A.N., Youssef, M. (2020), Does economic policy uncertainty drive the dynamic connectedness between oil price shocks and gold price? Resources Policy, 69, 101819.

Nardo, M., Ossola, E., Papanagiotou, E. (2022), Financial integration in the EU28 equity markets: Measures and drivers. Journal of Financial Markets, 57, 100633.

Pardal, P., Dias, R., Šuleř, P., Teixeira, N., Krulický, T. (2020), Integration in central European capital markets in the context of the global covid-19 pandemic. Equilibrium Quarterly Journal of Economics and Economic Policy, 15(4), 627-650.

Pardal, P., Dias, R., Teixeira, N., Horta, N. (2022), The Effects of Russia's 2022 Invasion of Ukraine on Global Markets: An Analysis of Particular Capital and Foreign Exchange Markets. United States: IGI Global.

Pardal, P., Dias, R.T., Santos, H., Vasco, C. (2021), Central European banking sector integration and shocks during the global pandemic (COVID-19). United States: IGI Global. p272-288.

Phillips, P.C.B., Perron, P. (1988), Testing for a unit root in time series regression. Biometrika, 75(2), 335-346.

Phuan, S.M., Lim, K.P., Ooi, A.Y. (2009), Financial liberalization and stock markets integration for Asean-5 countries. International Business Research, 2(1), 100-111.

Robiyanto, R., Nugroho, B.A., Handriani, E., Huruta, A.D. (2020), Hedge effectiveness of put replication, gold, and Oil on ASEAN-5 equities. Financial Innovation, 6(1), 53.

Saijai, W., Maneejuk, P., Sriboonchitta, S. (2022), Contagion effects among stock markets, treasury bill, petroleum, gold, and cryptocurrency during the COVID-19 pandemic: A dynamic conditional correlation approach. In: Studies in Computational Intelligence. Cham, Switzerland: Springer International Publishing. p983.

Santana, T.P., Horta, N., Revez, C., Santos Dias, R.M.T., Zebende, G.F. (2023), Effects of interdependence and contagion on crude oil and precious metals according to ρDCCA: A COVID-19 case study. Sustainability, 15, 3945.

Sharma, U., Karmakar, M. (2023), Are gold, USD, and Bitcoin hedge or safe haven against stock? The implication for risk management. Review of Financial Economics, 41(1), 43-64.

Silva, R., Dias, R., Heliodoro, P., Alexandre, P. (2020), Risk Diversification in Asean-5 Financial Markets: An Empirical Analysis in the Context of the Global Pandemic (Covid-19). In: 6th LIMEN Selected Papers (Part of LIMEN Conference Collection). p15-26.

Tahai, A., Rutledge, R.W., Karim, K.E. (2004), An examination of financial integration for the group of seven (G7) industrialised countries using an I (2) cointegration model. Applied Financial Economics, 14(5), 327-335.

Teixeira, N., Dias, R., Pardal, P., Horta, N. (2022), Financial Integration and Comovements between Capital Markets and Oil Markets: An Approach During the Russian. United States: IGI Global.

Tenreiro Machado, J.A. (2020), Fractal and entropy analysis of the dow jones index using multidimensional scaling. Entropy (Basel), 22(10), 1138.

Ustaoglu, E. (2023), Diversification, hedge, and safe-haven properties of gold and bitcoin with portfolio implications during the Russia-Ukraine war. Resources Policy, 84, 103791.

Wang, L., Ma, F., Liu, G. (2020), Forecasting stock volatility in the presence of extreme shocks: Short-term and long-term effects. Journal of Forecasting, 39(5), 2668.

Yousaf, I., Plakandaras, V., Bouri, E., Gupta, R. (2023), Hedge and safe-haven properties of FAANA against gold, U.S. Treasury, bitcoin, and U.S. Dollar/CHF during the pandemic period. North American Journal of Economics and Finance, 64, 101844.