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The 2020 Oil Price War Has Increased Integration Between G7 Stock Markets and Crude Oil WTI

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Abstract: *This paper aims to examine whether the oil price war between Saudi Arabia and Russia has increased integration between the Crude Oil WTI Spot oil index and the G7 stock markets, namely France (CAC 40), Germany (DAX 30), USA (DOW JONES), UK (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225), Canada (S&P TSX), from January 2018 to January 2021. The results show that in the period before the oil price war, the G7 stock markets and the WTI index had 29 integrations (out of 56 possible). The WTI index is integrated with the UK stock markets (FTSE 100), and Japan (NIKKEI 225), and is integrated into the Japanese market. In the period of the oil price war, the G7's stock markets and the Crude Oil WTI Spot index had 43 integrations (out of 56 possible), namely the WTI, Dow Jones, and Nikkei 225 indexes, with all their peers (7 out of 7 possible). When comparing the period before and during the 2020 oil crash, we found that integrations increased significantly from 29 to 43 (out of 56 possible); we also found that the Crude Oil WTI Spot index is no longer a safe haven for portfolio diversification in G7 stock markets. These findings validate our research issue, i.e., the oil price war between Saudi Arabia and Russia had increased integrations, and this evidence could question portfolio diversification.*

1. INTRODUCTION

The determination of the price of oil as a commodity is characterized by fluctuations based on the market supply and demand. However, variations in the price of oil are extremely sensitive to factors outside the market, such as strategic movements by major global producers, political events, and speculations to cause imbalances in markets (Kaufmann and Connelly, 2020).

In March 2020, in Saudi Arabia, OPEC's main producing member was involved in a trade war with Russia over the value of the oil barrel. This "war" over the price of oil originated from the worsening global pandemic (COVID-19) and as a consequence - social isolation, which led to a decrease in demand for this fossil fuel, with values much lower than those presented in the past in relevant historical crises such as the great depression of 1929 and the global financial crisis of 2008 (Hanieh, 2020). In order to stabilize the price and control the levels of this commodity in the market, Saudi Arabia decided to lower production levels by reducing global supply. In turn,

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Russia did not accept this measure and the lack of agreement between the world's largest oil producers caused Saudi Arabia to increase production by generating more supply, which led to international price drops hurting several markets, including the Russian market (Ajami, 2020).

In recent decades, the phenomenon of globalization has shown that the correlation between international financial markets has increased, particularly among developed markets. Links between international stock markets can be strong during quiet periods, as well as in times of crisis, which may hinder portfolio diversification. The integration of global stock markets has been a highly analyzed topic in recent decades, especially after the events on the stock markets during the global financial crisis. Investors buying stocks in domestic and foreign markets seek to reduce risk through international diversification. Risk reduction occurs if the various markets are not perfectly correlated. The growing correlation between markets during and after crises has restricted the possibilities for international diversification. From the investor's point of view, knowledge of the form and intensity of interdependence between the different financial markets is vital for making efficient hedging decisions, to minimize the adverse effect of uncertainty on the expected profitability of investments. Likewise, understanding the interdependence relations between international stock markets facilitates the identification of opportunities for diversification. The extinction of barriers to investment in recent years has led many countries to go through the process of integration, both financially and economically. This leads to the benefits of international diversification, brought into question mainly due to the various financial crises that have devastated financial markets around the world (Alexandre, Dias, and Heliodoro, 2020a, 2020b; Alexandre, Heliodoro, and Dias, 2019; Dias et al., 2020; Dias and Carvalho, 2020; Dias, da Silva, and Dionísio, 2019; Dias, Heliodoro, and Alexandre, 2020, 2019; Dias, Heliodoro, Alexandre, Santos, and Farinha, 2021; Dias, Heliodoro, Alexandre, and Vasco, 2020; Dias, Heliodoro, Teixeira, and Godinho, 2020; Dias, Pardal, Teixeira, and Machová, 2020; Dias and Pereira, 2021; Heliodoro, P., Dias, R., Alexandre, P., and Vasco, 2020; Heliodoro, P., Dias, R. and Alexandre, 2020; Heliodoro, Dias, and Alexandre, 2020; Pardal, P., Dias, R., Šuleř, P., Teixeira, N., and Krulický, 2020; Santos and Dias, 2020).

This paper aims to analyze the synchronizations between the stock indexes of France (CAC 40), Germany (DAX 30), USA (DOW JONES), UK (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225) and Canada (TSX 300), and the WTI index, from January 1, 2018, to January 11, 2021. The sample was partitioned into two subperiods: the first subperiod comprises the days of January 1, 2018 to September 30, 2019, which corresponds to the period before the oil price war; while the second comprises the period from October 1, 2019 to January 11, 2021, which incorporates the oil price war between Saudi Arabia and Russia. The results show that in the period before the oil price war, the G7 stock markets and the WTI index had 29 integrations (out of 56 possible). In the period of the oil price war, the G7 stock markets and the Crude Oil WTI Spot index had 43 integrations. When we compared the period before and during the 2020 oil crash, we found that integrations increased significantly from 29 to 43. In conclusion, we found that the Crude Oil WTI Spot index is no longer a safe haven for portfolio diversification in the G7 stock markets.

This research adds two main contributions to the literature. Given the importance of these markets (G7), in the global competitive context, as well as the need to develop further empirical studies, especially confirmatory on the financial dynamics in these markets, it was considered extremely relevant to study the stock markets of the seven most advanced economies in the context of the oil price war in March 2020, this being the first contribution. The second contribution is econometric, due to the comparative results between econometric methods and mathematical models that have the possibility of evaluating correlations in a context of non-stationarity.

In terms of structure, this paper is organized into 5 sections. In addition to the current introduction, section 2 presents an analysis of the State of the Art with articles related to the integration of international financial markets, in section 3 the methodology is described, and section 4 contains the data and results. Section 5 presents the general conclusions of the work.

2. LITERATURE REVIEW

Since the mid-2000s, international financial markets have been subject to many significant financial crises, notably the subprime crisis in the US in 2008, and the sovereign debt crisis in Europe in 2010, which originated in developed economies. These events significantly infected developed economies; however, this significance was not dense in emerging economies (Wong and Li, 2010).

The assessment of the current state of financial integration and market shocks is also relevant from a cost versus benefit analysis point of view. The literature commonly agrees that financial integration brings benefits in good times. However, in times of crisis, high financial integration increases the likelihood of contagion due to the close interrelationship between financial markets through the proximity of markets. Overall, in the long run, the benefits of financial integration are expected to outweigh costs (Babecký, Komarek, and Komárková, 2017)

Gulzar et al. (2019) , Moagar-Poladian, Clichici, and Stanciu (2019), Jawadi, Chlibi, and Cheffou (2019), Salisu, Ndako, Adediran, and Swaray (2020) analyzed the integration into the financial markets and tested the hypothesis of portfolio diversification. Gulzar et al. (2019) examined the financial markets of India, China, Pakistan, Malaysia, Russia, South Korea, and the US, and highlighted the long-term integration between the US market and emerging stock markets in the post CFG. Moagar-Poladian, Clichici, and Stanciu (2019) show that central and eastern European markets show a significant level of integration during the European financial crisis. However, the authors Jawadi, Chlibi, and Cheffou (2019) show that the MENA and BRIC's markets are segmented with the North American market, while the G6 markets show integration. Salisu, Ndako, Adediran, and Swaray (2020) analyzed integration into Islamic markets, and show that markets are integrated and that this behavior can be influenced by global economic conditions.

Tiwari, Trabelsi, Alqahtani, and Raheem (2020), Hussain Shahzad, Bouri, Roubaud and Kristoufek (2020), Bhatia, Das, and Kumar (2020), examined whether commodity markets are a safe haven, to the detriment of investments in the G7 stock markets. Tiwari et al. (2020) suggest that the crude oil market may be a diversified asset for investors in the markets of Japan and France, but investors operating in the remaining G7 markets should exercise caution. Hussain Shahzad et al. (2020) found that the benefits of diversification offered by gold to equity investments in the G7 markets are comparatively much higher and more stable than those of Bitcoin. Bhatia et al. (2020) examined the dynamic relationship between precious metals and G7 stock exchanges and emerging markets (BRIC's). The G7 and BRIC's markets exhibit different dynamics with precious metals during the study period (2000 to 2017). The dynamics between precious metals and G7 stock exchanges have similar patterns, which represents an aggregation behavior; however, the same does not apply to BRIC's countries. In contrast to existing literature, this study found that silver offers better coverage capacity than other precious metals, both in the short and long term. To build an ideal portfolio of two precious metals assets and the stock index, silver emerges as the most favorable option for both the short and long term.

3. METHODOLOGY

3.1. Data

The data to be analyzed are the prices index of the stock markets France (CAC 40), Germany (DAX 30), USA (DOW JONES), United Kingdom (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225)), Canada (S&P TSX), and Crude Oil WTI Spot, in the period from January 1, 2018 to January 11, 2021. The sample was partitioned into two subperiods: the first subperiod comprises the days of January 1, 2018 to September 30, 2019, which corresponds to the period before the oil price war; while the second comprises the period from October 1, 2019 to January 11, 2021, which incorporates the oil price war between Saudi Arabia and Russia. The sample took into account the impact of financial market crashes resulting from the oil price war between Saudi Arabia and Russia in March 2020. Quotes are daily and obtained through the *DataStream* platform and are in local currency in order to avoid exchange-related distortions.

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

Country	Index
France	CAC 40
Germany	DAX 30
USA	DOW JONES
United Kingdom	FTSE 100
Italy	FTSE MID
Japan	NIKKEI 225
Canada	S&P TSX
USA	Crude Oil WTI Spot

Source: Own elaboration.

To analyze the behavior of financial markets, Tsay (2005) proposes the use of profitability series to the detriment of the price series, because investors are primarily interested in knowing the profitability of an asset or a portfolio. In addition, the profitability series show statistical characteristics that simplify analytical treatment, namely the characteristic of stationarity, which is not usually present in price series. For the reasons above, the series of price indexes were modified in growth rates or series in the differences of neperian logarithms of current and previous profitability, of logarithmic yields, instantaneous or continuously composed r_t,by the following expression:

$$r_t = \ln P_t - \ln P_{t-1} \tag{1}$$

where r_t is the rate of return, on the day t ,and P_t and P_{t-1} are the closing prices of the series, at the moment t and t-1 respectively.

3.2. Methodology

The methodology used to answer the research questions is structured as follows – in the first phase we performed descriptive statistics (mean, standard deviation, asymmetry and kurtosis); to validate the distributions of the time series we used the Jarque and Bera test (1980). To validate the assumptions of time series stationarity, we used the data panel unit root tests; the Levin, Lin, and Chu (2002) test postulates unitary roots in the null hypothesis, while the Hadri test (2000) presents the stationery in the null hypothesis, the intersection of the tests will give robustness to the estimated models. To answer the research question, we used a Gregory and Hansen model (1996) that considers regime changes. This methodology is robust in very trou-

bled periods in the financial markets as the authors generalize the usual cointegration tests when considering that the cointegration vector changes at an unknown date. The authors analyzed four models of cointegration. The first model incorporates a level change:

$$y_t = \mu_1 + \mu_2 D_t + \beta' x_t + \mu_t \quad t = 1, \ldots, T \tag{2}$$

In which x_t is a vector $I(1)$ of dimension k, μ_t is $I(0)$, μ_1 is the independent term before the change μ_2, is the change in the independent term after the break D_t, and is a dummy variable.

The second model includes a temporal trend (Trend):

$$y_t = \mu_1 + \mu_2 D_t + \alpha t + \beta' x_t \quad t = 1, \ldots, T \tag{3}$$

In this model, the μ_1 is the independent term before the structure change and μ_2 is the change in the independent term after the break. This model, compared to the previous one, introduces a regime change. (4)

$$y_t = \mu_1 + \mu_2 D_t + \alpha_1 t + \beta'_1 x_t + \beta'_2 x_t D_t + \mu_t \quad t = 1, \ldots, T \tag{4}$$

A possible change in structure admits that the slope vector also changes. This allows the balance ratio to move in parallel with the level. The authors call this third model, the regime change model.

Finally, the fourth model is presented, which emerges to complement the previous ones; the authors add the possibility of changing structure in a model with a segmented temporal tendency (Regime and Trend):

$$y_t = \mu_1 + \mu_2 D_t + \alpha_1 t + \alpha_2 t + \beta'_1 x_t + \beta'_2 x_t D_t + \mu_t \quad t = 1, \ldots, T \tag{5}$$

In this case, both the terms μ_1 and μ_2 are already presented in the previous models. The α_1 represents the cointegration of the slope coefficients and α_2 represents the change in the slope of the coefficients.

4. RESULTS

Figure 1 shows the evolution in levels of the Crude Oil WTI Spot index and the G7 stock markets, including the Stock Indexes of France (CAC 40), Germany (DAX 30), the US (DOW JONES), the United Kingdom (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225), Canada (S&P TSX), from January 2018 to January 2021. The charts show that stock markets display significant structural declines in the first quarter of 2020, and this period is coincident with the oil price war between Saudi Arabia and Russia.

Tables 2 and 3 show the main descriptive statistics for the G7 stock markets and the Crude Oil WTI Spot index; through the analysis, we were able to assess that average yields are positive, except for the UK stock market (FTSE 100). The Crude Oil WTI Spot index shows the sharpest standard deviation (0.038871), while the Italian stock market (FTSE MID) presents asymmetry (-2.776471) and the most significant kurtosis (36.09117), which is contrary to the hypothesis that the data follow a normal distribution (asymmetry = 0, kurtosis = 3). To validate the evidence of the distributions, we performed the Jarque-Bera adherence test, which allows us to corroborate that the data series does not follow a normal distribution.

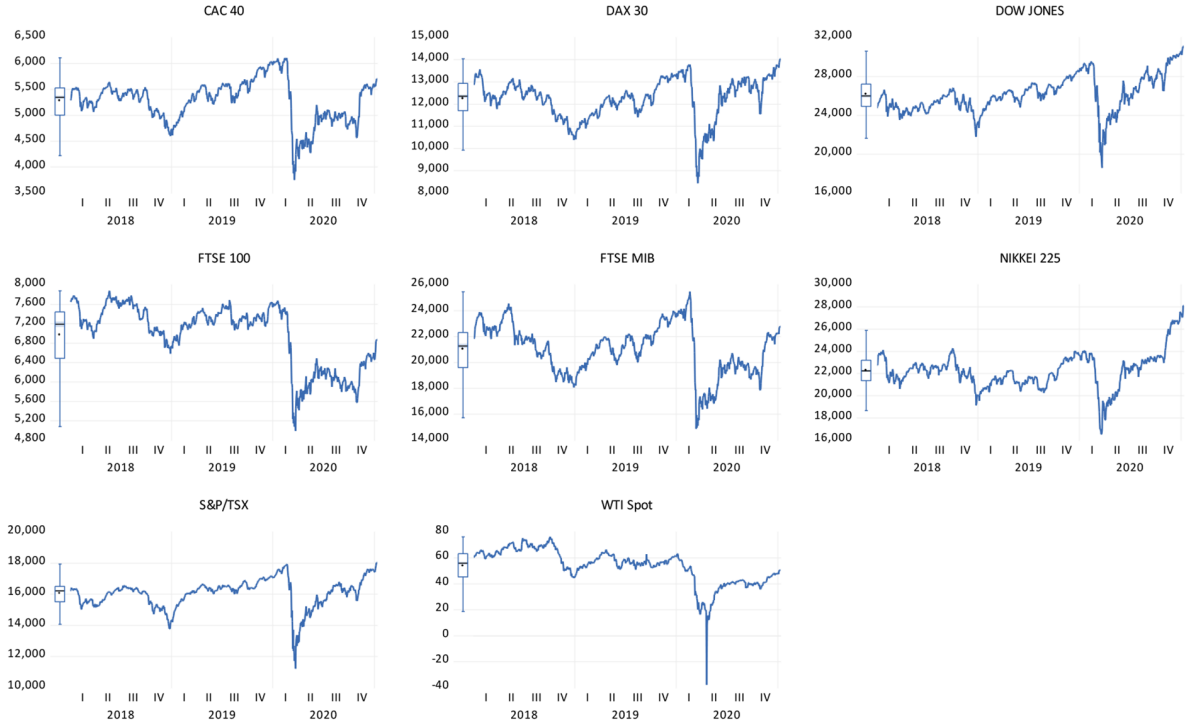

Figure 1. Evolution, in levels, of the G7 stock markets and the WTI index, from January 1, 2018 to January 11, 2021.

Source: Own elaboration.

Note: DataStream: January 1, 2018, 790-point data.

Table 2. Descriptive statistics, return, of the G7 stock markets and the WTI index, from January 1, 2018 to January 11, 2021.

	FTSE MIB	NIKKEI 225	S&P TSX	WTI SPOT
Mean	9.92E-05	0.000309	0.000173	0.000688
Std. Dev.	0.015317	0.012314	0.012689	0.038871
Skewness	-2.776471	-0.125247	-2.026456	-0.292986
Kurtosis	36.09117	8.917285	43.36274	33.32185
Jarque-Bera	37012.67***	1153.157***	54098.33***	30237.05***
Observations	789	789	789	789

Source: Own elaboration.

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

Table 3. Descriptive statistics, return, of the G7 stock markets and the WTI index, from January 1, 2018 to January 11, 2021.

	CAC 40	DAX 30	DOW JONES	FTSE 100
Mean	0.000131	0.000152	0.000357	-0.000110
Std. Dev.	0.013539	0.013946	0.015273	0.012244
Skewness	-1.395302	-0.993695	-1.050123	-1.214132
Kurtosis	20.11454	19.18929	21.70243	19.14127
Jarque-Bera	9885.351***	8746.156***	11644.05***	8759.120***
Observations	789	789	789	789

Source: Own elaboration.

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

As we are estimating time series, we should examine the stationary nature of the Crude Oil WTI Spot index and the G7 stock markets, namely the stock indexes of France (CAC 40), Germany (DAX 30), THE US (DOW JONES), THE UNITED KINGDOM (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225) and Canada (S&P TSX). The Levin, Lin, and Chu (2002) test postulates that the null hypothesis has unitary roots, while the Hadri test (2000) postulates stationarity in the null hypothesis. In tables 4 and 5 we can assess that the time series in both tests are stationarity, which validates an essential assumption to estimate models with time data.

Table 4. Levin, Lin, and Chu 's parking test (2002), applied to the G7 stock markets and the WTI index from January 1, 2018 to January 11, 2021.

Method			Statistic		Prob.***	
Levin, Lin & Chu t*			-31.3116		0.0000	
Series	2nd stage Coefficient	Variance Of Reg	HAC of Dep.	Lag	max Lag	Band-Width	Note
CAC 40	-0.87385	0.0002	8.E-06	7	20	49.0	783
DAX 30	-0.81924	0.0002	8.E-06	8	20	51.0	782
DOW JONES	-0.91077	0.0002	1.E-05	8	20	44.0	782
FTSE 100	-0.95160	0.0001	6.E-06	7	20	47.0	783
FTSE MIB	-0.89432	0.0002	8.E-06	1	20	57.0	789
NIKKEI 225	-0.96573	0.0002	4.E-06	0	20	77.0	790
S&P TSX	-0.76488	0.0001	7.E-06	6	20	43.0	784
WTI SPOT	-0.77187	0.0010	0.0002	9	18	57.0	769
	Coefficient	T-Stat	Reg SE	mu*	sig*		Note
Pooled	-0.90600	-39.063	1.001	-0.500	0.707		6262

Source: Own elaboration.

Notes: * Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. ***. **. *. represent significance at 1%. 5% and 10%, respectively.

Table 5. Hadri panel parking test (2000), applied to the G7 stock markets and the WTI index, from January 1, 2018 to January 11, 2021.

Null Hypothesis: Stationarity				
Method			Statistic	Prob.**
Hadri Z-stat			-1.43136	0.9238
Heteroscedastic Consistent Z-stat			-1.55778	0.9404
Series	Lm	Variance Hac	Bandwidth	Note
CAC 40	0.0565	0.000215	3.0	791
DAX 30	0.0962	0.000210	2.0	791
DOW JONES	0.0600	0.000179	26.0	791
FTSE 100	0.0632	0.000162	9.0	791
FTSE MIB	0.0575	0.000308	9.0	791
NIKKEI 225	0.1824	0.000167	2.0	791
S&P TSX	0.0609	0.000175	10.0	791
SPOT WTI	0.0999	0.001964	10.0	789

Source: Own elaboration.

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

Figure 2 shows the stability tests performed on G7 stock market residues and the Crude Oil WTI Spot index. Through the graphical analysis we were able to perceive the existence of disturbances in variance. Additionally, when examining the graphs and the probability limits of 95% we verified the existence of violation of probability limits; therefore, the time-series evidence an unstable behavior, that is, the existence of structural breaks.

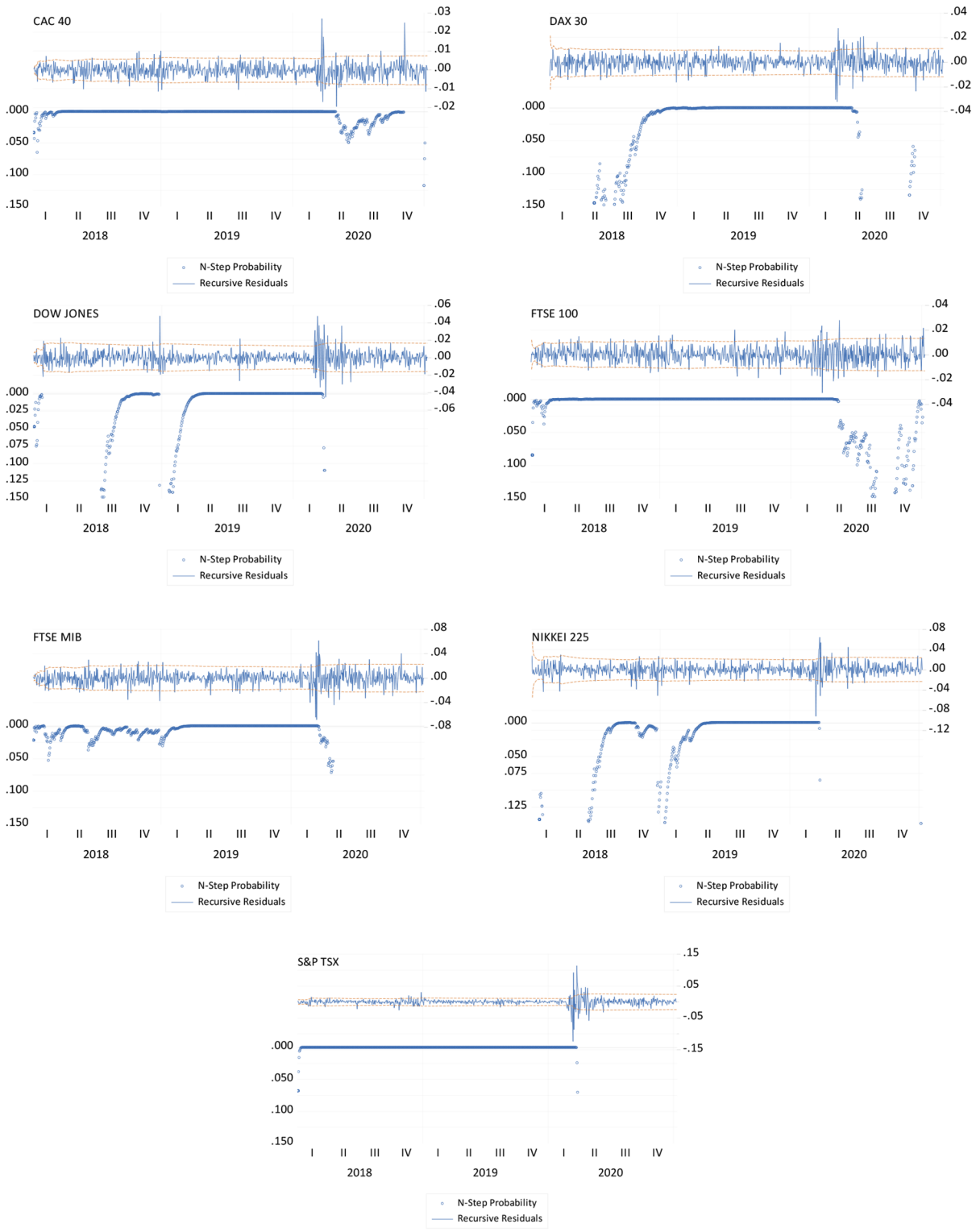

Figure 2. Stability tests carried out on the residues of the G7 stock markets, from January 1, 2018 to January 11, 2021.

Source: Own elaboration.

Table 6 shows the results of the Gregory-Hansen test, related to the stock markets of France (CAC 40), Germany (DAX 30), USA (DOW JONES), United Kingdom (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225)), Canada (S&P TSX), and the US Crude Oil WTI Spot index, in the period from January 1, 2018 to September 30, 2019 which corresponds to the period before the oil price war.

The G7 stock markets and the Crude Oil WTI Spot index had 29 integrations (out of 56 possible), including the Dow Jones, Nikkei 225 indices, that are part of 6 markets (out of 7 possible), while the FTSE 100 and DAX 30 stock indices had 5 integrations with their peers. The French market (CAC 40) integrates with 4 of its peers, while the S&P TSX index had 1 integration, and the FTSE MID does not integrate with any market. The WTI index is integrated with the UK stock markets (FTSE100) and Japan (NIKKEI225), and is integrated by the NIKKEI 225 / Crude Oil WTI pair. These findings show that in this subperiod the U.S. oil index does not show marked synchronizations with the G7 stock markets, showing that it may be a safe haven for portfolio diversification.

Table 6. Gregory-Hansen tests, pre-Crash period (January 1, 2018 to September 30, 2019)

Markets	T-statistic	Method	Lags	Break Date	Results
Crude Oil WTI / FTSE 100	-4.48*	regime	0	14/11/2018	Integration
Crude Oil WTI / NIKKEI 225	-43.67*	Trend	0	05/11/2018	Integration
CAC 40 / FTSE 100	-5.00**	regime	0	28/09/2018	Integration
CAC 40 / DOW JONES	-45.98*	Trend	0	20/08/2018	Integration
CAC 40 / NIKKEI 225	-45.60*	Trend	2	27/08/2018	Integration
CAC 40 / S&P TSX	-5.16**	Trend	1	13/06/2018	Integration
FTSE 100 / CAC 40	-5.70***	regime	1	21/09/2018	Integration
FTSE 100 / FTSE MID	-5.66***	Trend	0	22/05/2018	Integration
FTSE 100 / DAX 30	-5.88***	regime	1	02/05/2018	Integration
FTSE 100 / NIKKEI 225	-5.16**	Trend	1	31/08/2018	Integration
FTSE 100 / S&P TSX	-5.18**	Trend	0	12/04/2018	Integration
DAX 30 / CAC 40	-4.89*	Trend	0	26/04/2019	Integration
DAX 30 / FTSE 100	-5.77***	Trend	1	19/04/2019	Integration
DAX 30 / NIKKEI 225	-5.16**	Trend	0	31/08/2018	Integration
DAX 30 / DOW JONES	-5.21**	Trend	0	20/08/2018	Integration
DAX 30 / S&P TSX	-5.18**	Trend	0	12/04/2018	Integration
DOW JONES / CAC 40	-5.08**	Trend	2	21/08/2018	Integration
DOW JONES / FTSE 100	-5.63***	regime	0	28/08/2018	Integration
DOW JONES / FTSE MID	-4.98**	regime	0	07/08/2018	Integration
DOW JONES / DAX 30	-5.42**	regime	0	28/08/2018	Integration
DOW JONES / NIKKEI 225	-5.70***	Trend	3	16/04/2018	Integration
DOW JONES / S&P TSX	-4.75*	regime	0	21/08/2018	Integration
NIKKEI 225 / Crude Oil WTI	-4.81*	regime	4	31/12/2018	Integration
NIKKEI 225 / CAC 40	-49.49**	Trend	3	27/08/2018	Integration
NIKKEI 225 / FTSE 100	-5.13**	Trend	3	31/08/2018	Integration
NIKKEI 225 / DAX 30	-50.79**	Trend	1	17/08/2018	Integration
NIKKEI 225 / DOW JONES	-5.60***	Trend	5	16/04/2018	Integration
NIKKEI 225 / S&P TSX	-45.03*	Trend	4	05/09/2018	Integration
S&P TSX / CAC 40	-5.07**	Trend	1	31/05/2018	Integration

Source: Own elaboration.

Notes: The AIC information criterion was chosen. The critical values are found in Gregory and Hansen (1996). The critical values for the ADF and Zt parameters are: −5.45 (1%); −4.99 (5%); −4.72 (10%). For the Za parameter, the critical values are: −57.28 (1%); −47.96 (5%); −43.22 (10%). The asterisks ***, **, * indicate statistical significance at 1%, 5% and 10%, respectively.

Gregory-Hansen's integration tests on G7 stock markets and the Crude Oil WTI Spot index can be seen in table 7 - from October 1, 2019, to January 11, 2021, which incorporates the oil price war between Saudi Arabia and Russia. The G7 stock markets and the Crude Oil WTI Spot index had 43 integrations (out of 56 possible), namely the WTI, Dow Jones, and Nikkei 225 indexes that integrate with all their peers (7 out of 7 possible). FTSE 100, DAX 30 stock markets are five-times, while stock indexes CAC 40, FTSE MID, S&P TSX had four integrations with their peers. When

we compared the period before and during the 2020 oil crash, we found that integrations increased significantly from 29 to 43 (out of 56 possible); we also found the U.S. crude oil index (Crude Oil WTI Spot) is no longer a safe haven for portfolio diversification in G7 stock markets. These findings validate our research question, i.e. the oil price war between Saudi Arabia and Russia has led to the need for integration, which calls into question the possibility of implementing efficient portfolios.

Table 7. Gregory-Hansen tests, Crash period (October 1, 2019 to January 11, 2021)

Markets	T-statistic	Method	Lags	Break Date	Results
Crude Oil WTI / CAC 40	-7.44***	Trend	1	14/05/2020	Integration
Crude Oil WTI / FTSE 100	-7.26***	Trend	1	15/06/2020	Integration
Crude Oil WTI / FTSE MID	-7.41***	Trend	1	14/05/2020	Integration
Crude Oil WTI / DAX 30	-8.06***	Trend	1	24/03/2020	Integration
Crude Oil WTI / DOW JONES	-6.97***	Trend	1	11/06/2020	Integration
Crude Oil WTI / NIKKEI 225	-7.47***	Trend	1	15/06/2020	Integration
Crude Oil WTI / S&P TSX	-6.89***	Trend	3	20/01/2020	Integration
CAC 40 / Crude Oil WTI	-6.51***	Trend	0	14/05/2020	Integration
CAC 40 / MID FTSE	-6.81***	Trend	4	30/01/2020	Integration
CAC 40 / DOW JONES	-52.02**	Trend	1	27/07/2020	Integration
CAC 40 / NIKKEI 225	-7.51***	Trend	1	24/12/2019	Integration
FTSE 100 / Crude Oil WTI	-6.50***	regime	1	15/06/2020	Integration
FTSE 100 / FTSE MID	-4.78*	regime	1	28/02/2020	Integration
FTSE 100 / DOW JONES	-5.33**	Trend	1	27/07/2020	Integration
FTSE 100 / NIKKEI 225	-7.55***	Trend	2	23/12/2019	Integration
FTSE 100 / S&P TSX	-4.72*	regime	1	02/03/2020	Integration
FTSE MID / Crude Oil WTI	-5.79***	regime	1	14/05/2020	Integration
MID FTSE / CAC 40	-6.07***	regime	4	30/01/2020	Integration
MID FTSE / DOW JONES	-42.12*	regime	3	08/04/2020	Integration
FTSE MID / NIKKEI 225	-5.62***	regime	2	08/04/2020	Integration
DAX 30 / Crude Oil WTI	-6.92***	Trend	1	07/04/2020	Integration
DAX 30 / FTSE 100	-4.89*	regime	2	28/05/2020	Integration
DAX 30 / DOW JONES	-5.58***	Trend	1	28/05/2020	Integration
DAX 30 / NIKKEI 225	-7.23***	Trend	2	2/10/2020	Integration
DAX 30 / S&P TSX	-5.59***	Trend	5	28/05/2020	Integration
DOW JONES / Crude Oil WTI	-6.70***	Trend	2	28/02/2020	Integration
DOW JONES / CAC 40	-5.00**	Trend	1	27/07/2020	Integration
DOW JONES / FTSE 100	-5.75***	Trend	1	27/07/2020	Integration
DOW JONES / FTSE MID	-53.70**	Trend	3	19/02/2020	Integration
DOW JONES / DAX 30	-6.25***	Trend	3	09/03/2020	Integration
DOW JONES / NIKKEI 225	-6.49***	Trend	3	02/11/2020	Integration
DOW JONES / S&P TSX	-6.46***	Trend	1	19/02/2020	Integration
NIKKEI 225 / Crude Oil WTI	-6.57***	Trend	0	02/11/2020	Integration
NIKKEI 225 / CAC 40	-7.57***	Trend	1	24/12/2019	Integration
NIKKEI 225 / FTSE 100	-7.62***	Trend	2	23/12/2019	Integration
NIKKEI 225 / FTSE MIB	-6.34***	Trend	2	21/01/2020	Integration
NIKKEI 225 / DAX 30	-7.32***	Trend	2	2/10/2020	Integration
NIKKEI 225 / DOW JONES	-6.40***	Trend	1	02/11/2020	Integration
NIKKEI 225 / S&P TSX	-49.14**	Trend	1	02/11/2020	Integration
S&P TSX / Crude Oil WTI	-5.78***	Trend	1	18/05/2020	Integration
S&P TSX / DAX 30	-5.34**	Trend	5	09/03/2020	Integration
S&P TSX / DOW JONES	-5.64***	Trend	1	19/02/2020	Integration
S&P TSX / NIKKEI 225	-49.04**	Trend	5	12/03/2020	Integration

Source: Own elaboration.

Notes: The AIC information criterion was chosen. The critical values are found in Gregory and Hansen (1996). The critical values for the ADF and Zt parameters are: −5.45 (1%); −4.99 (5%); −4.72 (10%). For the Za parameter, the critical values are: −57.28 (1%); −47.96 (5%); −43.22 (10%). The asterisks ***, **, * indicate statistical significance at 1%, 5% and 10%, respectively.

5. CONCLUSION

In this paper, we tested whether the oil price war between Saudi Arabia and Russia increased the integration between the Crude Oil WTI Spot index and the G7 stock markets, the stock indexes of France (CAC 40), Germany (DAX 30), THE US (DOW JONES), the United Kingdom (FTSE 100), Italy (FTSE MID), Japan (Nikkei 225) and Canada (S&P TSX), from January 2018 to January 2021. The results show that integrations increased significantly, between subperiods before and during the oil price war, from 29 to 43 (out of 56 possible), which validates our research question.

The general conclusion sustained in the results obtained, through tests carried out with econometric models, shows that the oil price war has significantly increased the integration between the G7 stock markets and the Crude Oil WTI Spot index; we also found that the WTI index is no longer a safe haven for portfolio diversification in the G7 stock markets. These findings are of interest to investors looking for portfolio diversification opportunities in the G7 stock markets.

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