MINISTERUL EDUCAȚIEI NAȚIONALE
ROMÂNIA

UNIVERSITATEA DE MEDICINĂ, FARMACIE, ȘTIINȚE ȘI TEHNOLOGIE „GEORGE EMIL PALADE" DIN TÂRGU MUREȘ

ACTA MARISIENSIS, SERIA OECONOMICA
Online:ISSN 2668-3989, ISSN L 2668-3148
Print:ISSN 2668-3148, ISSN L 2668-3148

EVIDENCE OF FINANCIAL MARKET SYNERGIES. A COMBINED STATISTICAL AND MACHINE LEARNING RESEARCH APPROACH

Tatiana Dănescu[1],
Roxana Maria Stejerean[2*]
Raluca Sandru[3]

[1]Faculty of Economics and Law, Economic Sciences ED1 Department, George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures, Gheorghe Marinescu, 38, Targu Mures, 540139, Romania
[2]"1 Decembrie 1918" University of Alba Iulia, 5 Gabriel Bethlen Street, Alba Iulia, 510009, Romania
[3]Business Faculty,"Babes-Bolyai" University, 7 Horea Street, Cluj-Napoca, 400174, Romania

Rezumat: *Cercetarea prezintă demersuri de investigare a modului în care conflictele geopolitice influențează piețele globale de mărfuri și piețele financiare, pentru a identifica în contextul sinergiilor din piețe financiare efecte asupra indicatorilor economico-financiari ai companiilor din sectorul petrolier. În studiul este implementată o abordare integrată, care combină metode statistice tradiționale cu tehnici avansate de învățare automată. Rezultatele investigațiilor au fost analizate pe două niveluri distincte: (1) cel al evoluției prețurilor principalelor mărfuri la nivel global în perioada conflictelor din Ucraina și Fâșia Gaza, și (2) al performanței financiare a 250 de companii din industria petrolieră, sintetizată în șapte indicatori-cheie. Concluzii elocvente indică faptul că ambele conflicte au generat schimbări semnificative în prețurile mărfurilor, cu reacții puternice ale investitorilor către activele considerate de refugiu, cum ar fi aurul și argintul. În plus, există manifestări clare ale unui comportament ce reflectă temerile privind aprovizionarea, datorită prețurilor resurselor energetice care au înregistrat creșteri considerabile. Din analiza corelațiilor a rezultat legătura semnificativă dintre variațiile în creștere ale prețului petrolului și modificările unor indicatori financiari (precum EBITDA), dar și creșteri ale activelor. Prin integrarea metodelor statistice tradiționale și a tehnicilor avansate de învățare automată, se evidențiază capacitatea modelelor hibride GARCH-ML de a prezice cu precizie volatilitatea indicilor bursieri în contextul tensiunilor geopolitice. Rezultatele cercetării subliniază beneficiile abordării holistice în analiza interconexiunilor complexe dintre piețele de mărfuri, piețele financiare și performanța companiilor.*

Cuvinte cheie: *conflicte geopolitice; interconectivitatea piețelor; modelare predictivă*

Abstract: *The research investigates how geopolitical conflicts influence global commodities and financial markets, aiming to identify effects on oil companies' economic and financial indicators within the context of financial market synergies. An integrated approach is implemented in the study, combining traditional statistical methods with advanced machine learning techniques. The results of the investigation were analyzed at two distinct levels: (1) that of the evolution of global commodity prices during the conflicts in Ukraine and the Gaza Strip, and (2) that of the financial performance of 250 companies in the oil industry, summarized in seven key indicators. Eloquent findings indicate that both conflicts have triggered significant changes in commodity prices, with strong investor reactions to safe haven assets such as gold and silver. In addition, there are clear manifestations of behavior reflecting supply-side concerns, as energy prices have risen considerably. Correlation analysis has shown a significant link between upward oil price movements and changes in some financial indicators (such as EBITDA) as well as asset increases. By integrating traditional statistical methods and advanced machine learning techniques, the ability of GARCH-ML hybrid models to accurately predict stock index volatility in the context of geopolitical tensions is highlighted. The research results highlight the benefits of the holistic approach in analyzing the complex interconnections between commodity markets, financial markets and company performance.*

Keywords: *geopolitical conflicts; market interconnectivity; predictive modeling*

* *Corresponding author: Roxana Stejerean*
e-mail: stejerean.roxana.sdc2021@uab.ro

1. INTRODUCTION

Geopolitical conflicts often have the potential to exert a significant influence on stock market reactions, creating uncertainty and volatility, and dampening investor confidence.
The war in Ukraine has also had a widespread impact on the global economy, as the conflict and the subsequent economic sanctions imposed by several countries on Russia have had a direct effect on Russian equities and the market as a whole. The announced and implemented sanctions have caused a downturn in investment and economic activity, generating negative adjustments in the Russian stock market as well as global markets.

Recent tensions in the Israel-Gaza region in the context of the Russia-Ukraine crisis underline the complexity of global interdependencies for investors. The Middle East plays a significant role in global oil supply, and any instability in this region, such as the Israel-Gaza conflict, may lead to speculative price increases due to the potential threat to global supply. Historically, crises in the Middle East have tended to cause significant increases in oil prices, impacting global inflation and trade balances.

We note the indirect implications of the military conflict on the accounting and financial reporting of entities, on the auditing of financial statements due to the need to apply rigorous professional judgment in identifying and assessing the necessary adjustments, including in the going concern assessment. In order to report adequately on-going concern uncertainties, entities need to estimate the fair value of assets together with other expected losses, such as credit losses. In a context where the literature has few studies on the financial impact of recent conflicts, our approach makes a significant contribution to the literature by analyzing in detail the reactions of global financial markets to two distinct and significant military conflicts, namely the Russian-Ukrainian crisis and the Middle East conflict. With the use of robust analytical methods, the study provides a clear insight into how these events may influence financial markets, thereby contributing to a deeper understanding of the interdependencies between geopolitical events and market volatility. This study makes a significant contribution to the field of finance and risk management, supporting the development of more informed strategies in a financial environment characterized by uncertainty.

A major challenge facing accounting professionals and standard setters is adapting to the influence of human behavior on accounting principles, concepts and characteristics in an ever-changing economic, macroeconomic and global landscape. This challenge is magnified in the context of ongoing military conflicts, which can significantly disrupt the economic environment and create additional uncertainty in accounting and investment decision-making.

As the economic and business environment changes rapidly, it is important that accounting practices adapt to new demands and challenges. This requires a deep understanding of behavioral influences and how they can affect decision making and accounting processes.

Examining in detail the stock market response to various disasters and crises has been done by various researchers over the years – in 2010, a paper written by Gangopadhyay et al. (2010) investigated the reaction and behavior of stock market to the Hurricane Katrina disaster;

ACTA MARISIENSIS, SERIA OECONOMICA
Online:ISSN 2668-3989, ISSN L 2668-3148
Print:ISSN 2668-3148, ISSN L 2668-3148

researchers Becchetti and Ciciretti (2011) examined the 2007 financial crisis response on the stock market. A more recent study analyzed the response of the stock market to mining disasters (Kowalewski & Spiewanowski, 2020).

Wars can influence the third countries` economies, with significant external effects: first, direct effects on third countries, often neighboring nations, which are typically affected by significant migration flows and substantial disruptions in trade relations (Glick, 2010). On the other hand, as per Ianchovichina (2016), indirect external spillovers that influence global markets, according to Rigobon (2005), when one or more conflict- involved countries is important enough in altering the balance of international, financial or commodity markets. (Schneider, 2006).

Literature findings show that political instability has a significant negative effect eighter on stock market returns and the risk profile of financial assets. For example. Berkman et al. in their research gave light over the importance of different countries' political crises in the volatility of stock market returns (2011). Similar results obtained Lehkonen & Heimonen (2015), finding a negative link between political uncertainty and stock market returns in their research over 49 emerging markets.

Many studies focus on recent major political risks events, highlighting the direct influence of the political risk and stock market volatility – Brexit referendum (Smales, 2017), diplomatic disputes between China and Taiwan (He et al, 2017), diplomatic and economic blockades on Quatar (Kapar & Buigut, 2020).

Empirically, the main determinants for oil price fluctuation are financial and market uncertainty (Le, 2021). Until today, oil prices were associated with political stability, economic prospects and policy, but also with regulatory uncertainty, especially in the countries that base their economy on exporting or on intensively using oil resources (Yergin, 2012).

Literature offers diversity when examining the link between oil prices and the stock market, even though most research show that there is positive relationship between a rise in oil prices and stock prices in oil-exporting economies, which can be explained by the higher revenues obtained from oil exportation activities.

We find that in studying the effects of geopolitical conflicts on financial and commodity markets, existing research has predominantly used traditional statistical methods such as parametric and non-parametric tests.

In recent years, the trend has also been to apply advanced artificial intelligence and machine learning techniques to research phenomena in financial markets. Studies such as Jiang et al. (2017) and Chong et al. (2019) have demonstrated the ability of Random Forest and Gradient Boosting models to predict the price movements of financial asset prices and stock market indices.

Moreover, Bao et al. (2017) proposed a combined hybrid model of recirculatory neural networks and additive gradient boosting, which outperformed in predicting the volatility of stock indexes compared to individual models.

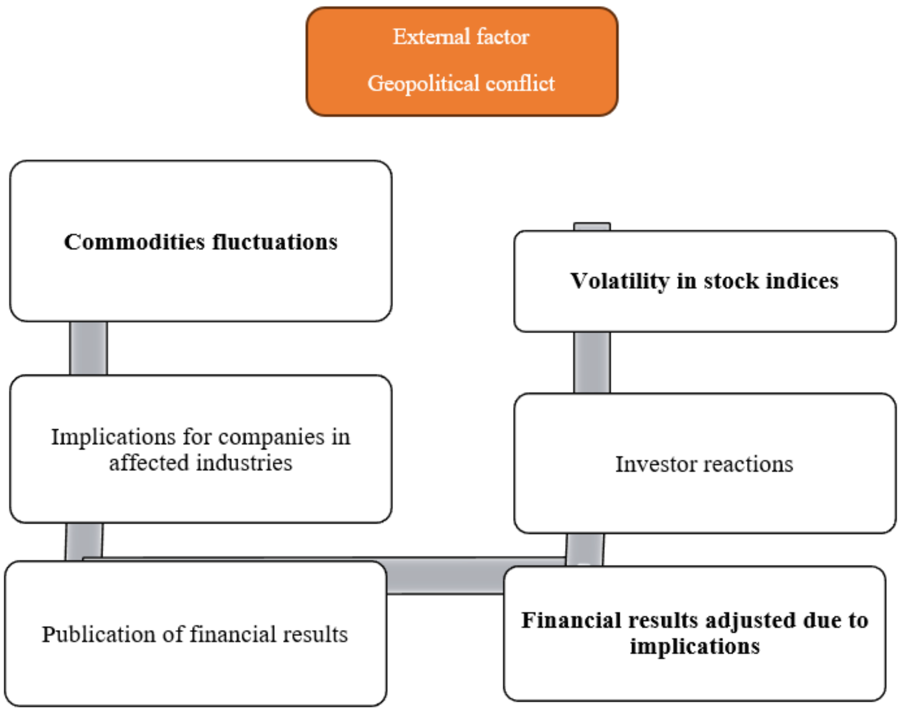
In addition, recent research has explored the potential of convolutional neural networks and LSTM (Long Short-Term Memory) models in financial time series analysis. For example, Selvin et al. (2017) developed an LSTM model for stock price prediction, while Zhang et al. (2020) proposed a hybrid CNN-LSTM architecture for volatility forecasting.

2. DEFINING THE RESEARCH PROBLEM

We focused our attention on investigating two categories of information: (1) the evolution of commodity prices at the global level, and (2) the economic- financial indicators, relevant for companies operating in the oil sector. We considered it appropriate to use a complex methodological framework that includes both traditional statistical analysis methods and advanced artificial intelligence techniques.

Underlying the generation of the research questions is the following interconnectedness observed between Commodities-Financial Markets-Accounting, shown in Figure 1.

Figure no. 1 – Commodities- Financial items – Accounting Synergies



Source: Authors' calculations

To identify effects on the economic-financial indicators of oil companies due to geopolitical conflicts, in the context of the interconnectivity between Commodities-Financial Markets-Accounting we structured the research is structured around three fundamental questions. The last question being mainly centered on the identification of advanced machine learning techniques

ACTA MARISIENSIS, SERIA OECONOMICA
Online:ISSN 2668-3989, ISSN L 2668-3148
Print:ISSN 2668-3148, ISSN L 2668-3148

that can contribute to obtaining the most detailed answers, with an emphasis on filling the gaps in this research area.

Research Question 1: Are there similarities between the global commodity market movements in the two events?

Research Question 2: Do oil fluctuations have an indirect impact on accounting through the relevant economic and financial indicators?

Research Question 3: How accurately can deep learning techniques identify and predict the aggregate volatility between the oil price and the main European index?

2.1 Research sample

In terms of traditional statistical analysis methods, we analyzed how the global financial markets reacted to the most recent military conflicts that took place between 2022 and 2023, namely the Russian invasion in the first part of 2022 and the confrontation in the Gaza Strip that broke out in October 2023. We chose an estimated interval between [-15, 15] days from the outbreak of each conflict. This range allowed us to carefully examine the reactions of financial markets in the immediate aftermath of the outbreaks of conflict and assess the consistency of these reactions over time.

The reference date (t0) selected for each of these events was the day on which the respective military conflicts started: February 24, 2022, for the Russian invasion and October 6, 2023 for the Middle East conflict. This choice of reference dates gave us a clear basis to analyze the impact of these conflicts on financial markets and to identify trends and reaction patterns during these critical periods.

In order to extend the study, data was collected over a longer period of time, starting in November 2012. This temporal extension of the study period was done to include previous military conflicts that took place in the two regions, which at the time of the research were back in the spotlight. Thus, the reference date (t0) in this context was set to November 14, 2012, marking the launch of the military operation called "Pillar of Defense," coordinated by the Israeli Army in the Gaza Strip, as well as on February 20, 2014, when the political and military process related to the Annexation of Crimea began.

Table 1 consists of the list of commodities that are part of the analyzed sample. These commodities are considered in our analysis and are essential elements for the assessment of financial market reactions to the studied events.

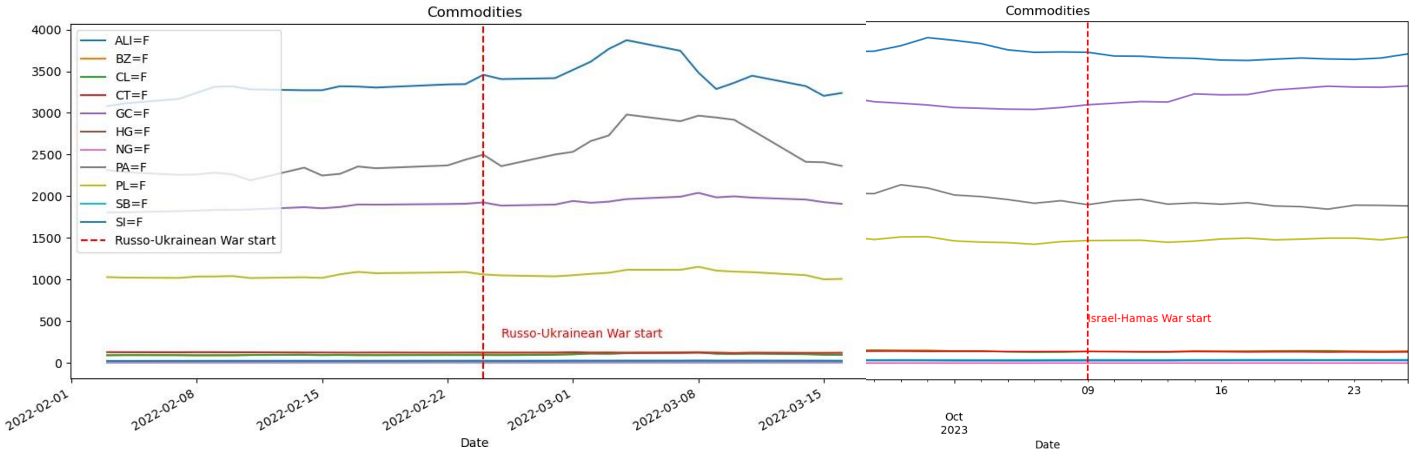
Table no. 1 – Research Sample

Symbol	**ALI=F**	**BZ=F**	**CL=F**	**CT=F**	**GC=F**	**HG=F**	**NG=F**	**PA=F**	**PL=F**	**SB=F**	**SI=F**
Comfort Name	Aluminum Futures	Brent Crude Oil	Crude Oil	Cotton	Gold	Copper	Natural Gas	Palladium	Platinum	Sugar No. 11	Silver Futures

Source: Authors' projection, www.yahoofinance.com

The evolution of all commodities before and after the outbreak of the two military conflicts is shown in Fig.2. The largest fluctuations were found for aluminum (ALI=F), palladium (PA=F) and gold (CG=F), respectively.

Figure no. 2 – Pre and post conflict evolution



Source: authors' projection using Pyton

The data collection process has been structured to facilitate fast and efficient integration of information from various sources using advanced technologies. To ensure relevant and up-to-date financial data, specialized APIs have been implemented that automatically extract information from trusted sources, such as Yahoo Finance, in terms of commodity quotes, European index quotes, and financial information used.

To ensure that the data sets collected are of high quality and suitable for further analysis, we have developed an automated data processing process structured in several steps. We identified and treated values that deviate significantly from the rest of the data, for which purpose we used an algorithm called Isolation Forest, which allows automatic anomaly detection without the need for extensive manual intervention on our part. This process was completed by implementing advanced imputation techniques to handle missing values, thus minimizing the risk of incomplete data affecting the validity of the results. Subsequently, the data were standardized and normalized by applying adaptive scaling methods, which ensure the uniformity of the metrics and the elimination of unwarranted variation between variables, resulting in a consistent and comparable database.

2.2 Selecting the research sample

In order to integrate financial accounting information, i.e. to identify interconnectedness at this level as well, we used a sample of 250 companies operating in the following industries:

- Integrated Oil;
- Oil&Gas Pipelines;
- Oil&Gas Production;

MINISTERUL EDUCAŢIEI NAŢIONALE
ROMÂNIA
UNIVERSITATEA DE MEDICINĂ, FARMACIE, ŞTIINŢE ŞI TEHNOLOGIE „GEORGE EMIL PALADE" DIN TÂRGU MUREŞ

ACTA MARISIENSIS, SERIA OECONOMICA
Online:ISSN 2668-3989, ISSN L 2668-3148
Print:ISSN 2668-3148, ISSN L 2668-3148

- Oil Refining/Marketing;
- Oilfield Services/Equipment.

2.3 Research methods

In deriving scientifically valid conclusions, we have adopted a hybrid methodology that harmoniously blends traditional statistical techniques with advanced machine learning models, thus maximizing the ability to interpret data complexity and formulate robust predictions.

2.3.1 Traditional statistical methods

In exploratory and inferential analysis, we applied established statistical methods to assess the fundamental properties of the data distribution and the relationships between variables. First, to check the homogeneity of variances within the different groups of interest, we used the Levene test, recognized for its robustness to non-normal distributions. In situations where the assumption of equality of variances was disproved, we used the Welch test, a modified method for comparing means between groups that relaxes the assumption of homoscedasticity. We also implemented the Kruskal-Wallis test, a non-parametric method suitable for situations where distributions are highly skewed or contain outliers, to analyze differences between several groups in the absence of strict assumptions about the distribution of the data.

2.3.2 Advanced machine learning model

In addition to classical statistical methods, we have used advanced machine learning techniques to analyze complex relationships in the data and make accurate predictions. In the case of time series, a model based on Long Short-Term Memory (LSTM) neural networks was implemented, which allows capturing long- and short-term temporal dependencies, thus providing a superior capability to model the data dynamics. In parallel, in order to identify determinants and achieve high- accuracy predictions in multidimensional datasets, we used the Extreme Gradient Boosting (XGBoost) algorithm, which efficiently combines the power of boosting algorithms with advanced optimization, guaranteeing high performance and relative interpretability in the modeling process.

This integrated approach, which brings together rigorous statistical analysis and the predictive capabilities of machine learning, has allowed a thorough understanding of the phenomena under study, providing a solid methodological framework for hypothesis testing and extrapolation of results.

2.3.3 Volatility and correlation analysis

For the analysis of volatility and the complex relationships between the variables under study, we have developed an innovative methodological framework that integrates a hybrid GARCH-ML model for modeling volatility and advanced correlation techniques for capturing linear and non- linear relationships. We designed this process to provide a deep and nuanced understanding of the dynamics of financial and economic phenomena.

To capture short- and long-term volatility, we implemented a hybrid model that combines traditional GARCH (Generalized Autoregressive Conditional Heteroskedasticity) approaches with advanced machine learning methods, thus improving the model's ability to capture complex behaviors. In the first stage, the underlying volatility components we modeled using a classical GARCH model, which estimates conditional variances based on autoregressive dynamics with predefined latencies. After adjusting the GARCH model and extracting residuals, we augmented these components by integrating a neural network, aimed at capturing complex patterns and irregularities in the time series, inaccessible by classical techniques.

2.3.4 Interconnectivity between external factors and accounting

Geopolitical conflicts trigger several IFRS accounting considerations affecting both annual and interim financial statements. Thus, the quantification of adjustments in financial reporting, as a result of the implications generated by external factors.

We computed the developments of the financial indicators in Table 2 based on the most recent financial results published by the listed oil companies, i.e. the last previous quarter, to capture the effects of both ongoing military conflicts.

Table no. 2 Methodology hypothesis 3

Standard impacted	Indicator	Calculation formula
	EBITDA (Quarterly QoQ Growth)	(EBITDA (Current Quarter)-EBITDA (Previous Quarter))/EBITDA (Previous Quarter)×100
IFRS 13	Free Cash Flow (Quarterly QoQ Growth)	(Free Cash Flow (Current Quarter)-Free Cash Flow (Previous Quarter))/Free Cash Flow (Previous Quarter)×100
IFRS 15	Revenue (Quarterly QoQ Growth)	(Revenue (Current Quarter)-Revenue (Previous Quarter))/Revenue (Previous Quarter)×100
IAS 36	Total Assets (Quarterly QoQ Growth)	(Total Assets (Current Quarter)-Total Assets (Previous Quarter))/Total Assets (Previous Quarter)×100
IFRS 9	Total Debt (Quarterly QoQ Growth)	(Total Debt (Current Quarter)-Total Debt (Previous Quarter))/Total Debt (Previous Quarter)×100
	Gross Profit (Quarterly QoQ Growth)	(Gross Profit (Current Quarter)-Gross Profit (Previous Quarter))/Gross Profit (Previous Quarter)×100
	Net Income (Quarterly QoQ Growth)	(Net Income (Current Quarter)-Net Income (Previous Quarter))/Net Income (Previous Quarter)×100

Source: authors' projection

To assess and understand the influence of different factors on key financial indicators, we applied multiple regression analysis. This method allowed us to investigate the potential

MINISTERUL EDUCAȚIEI NAȚIONALE
ROMÂNIA
UNIVERSITATEA DE MEDICINĂ, FARMACIE, ȘTIINȚE ȘI TEHNOLOGIE „GEORGE EMIL PALADE" DIN TÂRGU MUREȘ
ACTA MARISIENSIS, SERIA OECONOMICA
Online:ISSN 2668-3989, ISSN L 2668-3148
Print:ISSN 2668-3148, ISSN L 2668-3148

determinants of each individual financial indicator, with a particular focus on identifying the impact of oil price developments on them. Thus, the dependent variable was, in turn, each of the aforementioned indicators, keeping as constant, the oil price evolution corresponding to the last quarter, namely July-September 2023.

3. PRESENTING THE RESEARCH FINDINGS

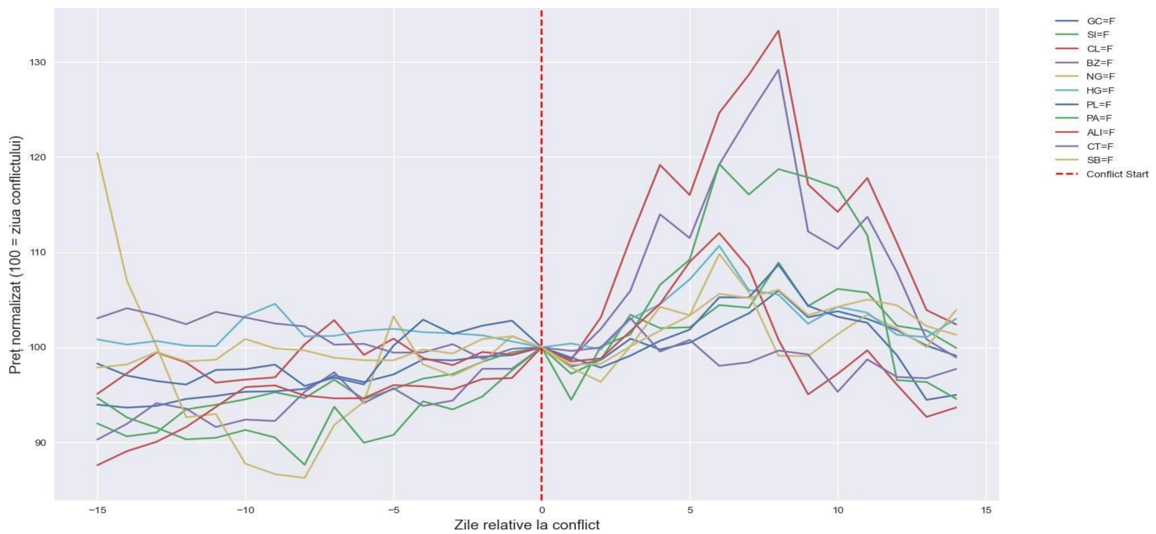
3.1 Research Question 1

The conflict in Ukraine has had a profound and generalized impact on financial and energy markets, generating significant changes in both safe-haven assets and prices of key resources. Gold and silver have seen substantial increases in price averages since the onset of the conflict, indicating a strong reaction of investors to safe assets. The results of statistical tests support these conclusions, showing highly significant differences between the pre- and post-conflict periods in the context of homogeneous variances.

Energy markets reflected a heightened response to geopolitical uncertainties, with crude oil and Brent crude oil prices rising sharply in the post-conflict period, indicating fears about global supply. In the case of natural gas, price increases were less pronounced, but still statistically significant, underlining the greater regional sensitivity of this market.

Industrial and agricultural resources such as aluminum and cotton also showed varied responses. While most industrial indicators recorded significant increases, some markets, such as cotton, recorded declines, possibly reflecting adjustments in aggregate demand according to the specifics of each market.

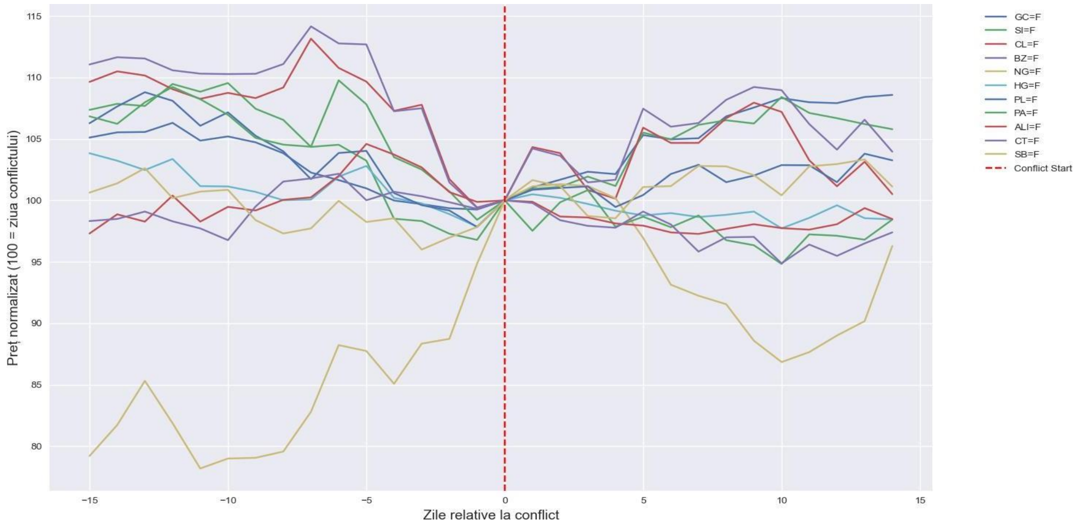
Figure no. 3 Price developments around the conflict in Ukraine



Source: authors' projection using Pyton

In contrast, the conflict in Gaza (Figure 4) had a less widespread impact on global markets. Price changes were more moderate, and some markets showed declines rather than increases, such as crude oil and Brent. However, the rise in gas prices suggests that in some sectors the conflict has influenced regional supply flows. Agricultural and industrial resources also reflected specific responses, with notable declines for aluminum and palladium but moderate increases for sugar.

Figure no. 4 – Price developments around the Gaza conflict



Source: authors' projection using Pyton

Before applying specific statistical tests, we assessed the homogeneity of the variables using the Levene test.

Table no. 3 – Application of the Levene test

	Ukraine		Israel	
Symbol	Levene Statistic	p-value	Levene Statistic	p-value
GC=F	0.105	0.749	1.656	0.210
SI=F	1.080	0.307	3.765	0.064
BZ=F	13.016	0.001	1.032	0.319
CL=F	11.852	0.002	0.180	0.675
HG=F	5.544	0.025	2.004	0.169
PL=F	0.377	0.544	6.366	0.018
PA=F	4.033	0.054	5.867	0.023
SB=F	6.135	0.019	0.000	0.988
CT=F	3.332	0.078	0.056	0.814
NG=F	0.000	0.987	0.002	0.962
ALI=F	9.636	0.004	4.255	0.050

Source: authors' projection

ACTA MARISIENSIS, SERIA OECONOMICA
Online:ISSN 2668-3989, ISSN L 2668-3148
Print:ISSN 2668-3148, ISSN L 2668-3148

Table 3 shows the results after applying the Levene test. For the conflict in Ukraine, the Levene test revealed that the variability of the data in the sample is not homogeneous. This suggests that the data for the selected commodities experienced significantly different variances during the period of the conflict in Ukraine, indicating increased volatility. As for the conflict in Israel, the test indicated that the data in the sample are homogeneous, the prices of the analyzed commodities showed a relatively constant and more uniform variation during the period of this military conflict.

Since the previous statistical test confirmed the homogeneity of the data series, in order to analyze the differences between the pre- and post-outbreak periods of the Middle East conflict, we continued with the Welch test.

Traditionally, the significance level used is 0.05 (5%) to assess statistical significance. Thus, when the p-Value is less than 0.05, this indicates the existence of significant differences between the two identified periods.

Table no. 4 – Welch test results

	GC=F	**SI=F**	**BZ=F**	**CL=F**	**HG=F**	**PL=F**	**PA=F**	**SB=F**	**CT=F**	**NG=F**	**ALI=F**
T-stat	**-4.81**	**-5.70**	**-5.17**	**-4.58**	**-1.96**	**-2.13**	**-5.79**	**-2.83**	**1.65**	**-3.11**	**-4.04**
P-value	0.00	0.00	0.00	0.00	0.07	0.05	0.00	0.01	0.12	0.01	0.00

Source: authors' projection

According to Table 4, we observe that there is sufficient statistical evidence to reject the null hypothesis that there are no significant differences between the data series and to accept the alternative hypothesis for 9 out of the 11 commodities analyzed.

To provide a complete picture of stock market reactions, we also analyzed the direction of the resulting differences. T-Stat is an indicator of the size and direction of the standardized differences between the two periods (before and after the conflict). A positive T-Stat indicates an increase in stock market value after the conflict, while a negative T-Stat indicates a decrease in value.

Thus, we identify significant differences between the two periods, but of a negative order. After the outbreak of the conflict, the prices of commodities show negative evolutions, except for the price of copper (HG=F), which increases with the outbreak of the conflict.

Due to the finding of non-homogeneity by Levene's test, the next step was to use the non-parametric Kruskal-Wallis test to more accurately assess the confirmation or rejection of the null hypothesis.

Table no. 5 – Kruskal-Wallis test results

	ALI=F	**BZ=F**	**CL=F**	**CT=F**	**GC=F**	**HG=F**	**NG=F**	**PA=F**	**PL=F**	**SB=F**	**SI=F**
H statistic	11.9058	4.5544	6.7276	6.7276	4.2785	5.2821	10.9964	12.8074	1.1739	10.7797	0.0528
p-value	0.00056	0.03283	0.00949	0.00949	0.0386	0.02155	0.00091	0.00035	0.2786	0.00103	0.81823

Source: authors' projection

According to the results presented in Table 5, the p-value is less than the chosen significance level (0.05). This finding indicates that there is sufficient evidence to reject the null hypothesis and conclude that there are significant differences between the two periods studied for 9 out of the 11 commodities analyzed.

Table no. 6 – Results obtained

Indicator	Ukraine conflict: Impact	Gaza conflict: Impact	Comments
GC=F	From	From	Significant increases in gold prices for both conflicts, confirming its status as a safe-haven asset.
SI=F	From	No	Silver was only significantly impacted in the context of the conflict in Ukraine, suggesting a limited response to the conflict in Gaza.
CL=F	From	Yes (decrease)	Crude oil has been significantly affected in both conflicts, but the direction of the impact differs: up in Ukraine and down in Gaza.
BZ=F	From	Yes (decrease)	Brent follows a similar dynamic to crude oil, reflecting global geopolitical sensitivities.
NG=F	From	From	Natural gas was impacted, but the response for Ukraine was more modest, while Gaza reflected a notable increase in prices.
HG=F	No	Yes (decrease)	Copper prices have fluctuated insignificantly in Ukraine, but the conflict in Gaza has triggered a significant fall.
PL=F	No	From	Palladium showed a moderate but significant increase only in the case of the Gaza conflict, indicating specific regional sensitivity.
PA=F	From	Yes (decrease)	Aluminum recorded a strong increase for Ukraine and a notable decrease for Gaza, reflecting varied adjustments in supply and demand.
ALI=F	From	Yes (decrease)	Aluminum was affected in both cases, with an increase in Ukraine and a decrease in Gaza, indicating differences in overall market dynamics.
CT=F	Yes (decrease)	Yes (decrease)	Cotton fell significantly in both conflicts, suggesting general effects on global demand for agricultural resources.
SB=F	No	From	Sugar has seen a moderate but significant increase only in the context of the Gaza conflict, suggesting regional factors have influenced the price.

Source: authors' projection

As a result of the corresponding tests, it can be concluded that there are significant differences between the periods before and after the outbreak of the military conflicts in both critical situations.

This indicates that the impact of the conflicts on the commodity market was substantial and generated significant changes in commodity prices.

From the results obtained and analyzed, as shown in Table 6, we can confirm that similar reactions occurred in the global commodity market in the context of the two recent military

MINISTERUL EDUCAȚIEI NAȚIONALE
ROMÂNIA
UNIVERSITATEA DE MEDICINĂ, FARMACIE, ȘTIINȚE ȘI TEHNOLOGIE „GEORGE EMIL PALADE" DIN TÂRGU MUREȘ

ACTA MARISIENSIS, SERIA OECONOMICA
Online:ISSN 2668-3989, ISSN L 2668-3148
Print:ISSN 2668-3148, ISSN L 2668-3148

conflicts. We observed that in both situations, commodity prices experienced significant changes and showed increased volatility before and during the conflicts. These similar responses indicate that the global commodity market is susceptible to the influences and uncertainties generated by military conflicts and that they have a significant impact on commodity prices and volatility.

3.2 Research question 2

According to the results in Table 7, it can be seen that "Average_Pret_Petrol" has a coefficient of -87.0406 and a p-value of 0.033, which suggests that the price of oil (Average_Pret_Petrol) is significantly associated with the indicator "EBITDA (QUARTERLY QOQ GROWTH)". With a significant and negative coefficient, this result suggests that the indicator "EBITDA (QUARTERLY QOQ GROWTH)" is sensitive to changes in the oil price. This correlation can be explained by the impact that the oil price has on the financial operations of a company. For example, an increase in the price of oil may lead to higher costs for raw materials or transportation, thus negatively affecting EBITDA. Conversely, a fall in the oil price can reduce operating costs.

Table no. 7 – OLS regression results

Dependent variable	Coefficient	p-value
EBITDA	-87.0406	0.033
FREE CASH FLOW	-100.4884	0.488
REVENUE	-5.0741	0.757
GROSS PROFIT	109.3073	0.231
NET PROFIT	120.0197	0.706
TOTAL ASSETS	5.0696	0.031
TOTAL DEBT	33.3960	0.205

Source: authors' projection

The OLS regression results indicate for the dependent variable "TOTAL ASSETS (QUARTERLY QOQ GROWTH)", that the independent and constant variable "Average_Pret_Petrol" (average oil price) has a coefficient of 5.0696 and a p-value of 0.031. In this case, the results lead to the conclusion that the oil price has a significant impact on the quarterly growth of total assets, with a positive correlation between these two variables. A significant increase in the oil price may stimulate investment in oil exploration, production and extraction, leading to an increase in the assets of companies in this sector. An increase in the oil price can also increase the attractiveness of investments in renewable energies, which can help diversify a company's portfolio and increase assets.

3.3 Research question 3

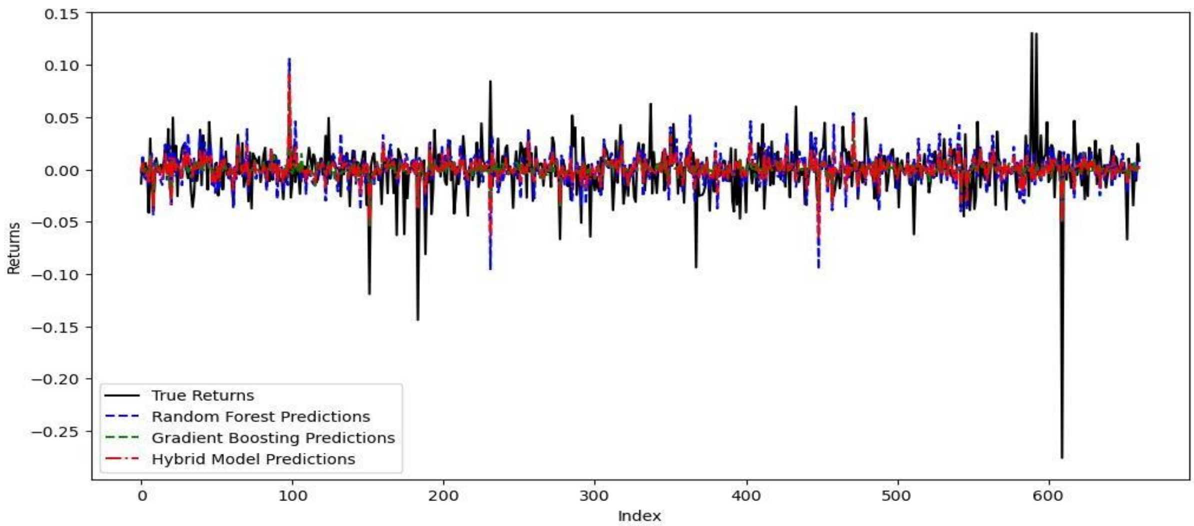
In our research, we evaluated three machine learning models to predict the volatility and correlations between the oil price and the European benchmark index (^N100). The models used include Random Forest, Gradient Boosting, and a combined hybrid model, which integrates both approaches to maximize predictive performance.

The results obtained show a high performance of these techniques, wih extremely low mean squared error (MSE) values, suggesting a high degree of accuracy in predicting oil price variability as a function of European financial market volatility. Thus, the MSE for each of the models analyzed is presented below:

- Random Forest: 2.92×10^(-7)
- Gradient Boosting: 2.24×10^(-7)
- Combined Hybrid Model: 1.31×10^(-7)

These values indicate that the models are capable of correctly capturing complex relationships and market volatilities, having a significant impact on the accuracy of predictions. The combined hybrid model demonstrated superior performance, with a significantly lower MSE than the other two techniques, also demonstrated in the figure below, suggesting that combining the models can provide a considerable advantage in predicting market volatility.

Figure no. 5 – Predictions versus Results



Source: authors' projection

CONCLUSIONS

The analysis of the results confirms that recent military conflicts, such as those in Ukraine and Gaza, have had significant effects on global commodity markets. Using a variety of statistical tests, such as Levene, Welch and Kruskal-Wallis, we identify differences in

ACTA MARISIENSIS, SERIA OECONOMICA
Online:ISSN 2668-3989, ISSN L 2668-3148
Print:ISSN 2668-3148, ISSN L 2668-3148

commodity movements between pre- and post-conflict periods for a range of assets, including gold, silver, oil, natural gas, aluminum and cotton.

The conflict in Ukraine has brought increased volatility and significant shifts in the prices of many commodities to the global commodity market, prompting strong investor reactions to safe-haven assets such as gold and silver. The sharp rise in the prices of key energy resources such as oil and natural gas in the post-conflict period has caused widespread investor concerns about global security of supply.

The conflict in Gaza has had more moderate effects on the global commodity market, with some commodities even showing price declines, such as oil and copper. However, rising natural gas prices in some segments point to disruptions in regional supply flows.

The way in which oil price fluctuations can impact on companies' performance and investment decisions is evidenced by the manifestation of a significant correlation between the oil price and key indicators such as EBITDA on the one hand and total asset growth on the other.

In addition, the machine learning models developed, in particular the combined hybrid approach, have demonstrated a significant ability to accurately predict oil price volatility as a function of the evolution of the European benchmark stock index.

Overall, the findings of this study highlight how military conflicts can generate significant disruptions in global commodity markets, leading to substantial changes in prices and volatility.

Bibliography:

Gangopadhyay, P., Haley, J., & Zhang, L. (2010). An Examination of Share Price Behavior Surrounding the 2005 Hurricanes Katrina and Rita. Journal of Insurance Issues, 33, 132- 151.

Becchetti, L., Ciciretti, R., & Hasan, I. (2015). Corporate social responsibility, stakeholder risk, and idiosyncratic volatility. Journal of Corporate Finance, 35, 297-309.

Kowalewski, O., & Śpiewanowski, P. (2020). Stock market response to potash mine disasters. Journal of Commodity Markets, 20.

Glick, R., & Taylor, A. M. (2010). Collateral damage: Trade disruption and the economic impact of war. The Review of Economics and Statistics, 92(1), 102-127.

Ianchovichina, E., & Ivanic, M. (2016). will the Bali agreement deliver a development round? World Trade Review, 15(1), 43-71.

Rigobon, R., & Sack, B. (2005). Measuring the reaction of monetary policy to the stock market. The Quarterly Journal of Economics, 120(2), 639-669.

Schneider, F., & Troeger, V. War and the world economy: Stock market reactions to international conflicts. Journal of Conflict Resolution, 50(5), 623-645.

Berkman, H., Jacobsen, B., & Lee, J. B. (2011). Time-varying rare disaster risk and stock returns. Journal of Financial Economics, 101(2), 313-332.

Lehkonen, H., & Heimonen, K. (2015). Democracy, political risks and stock market performance. Journal of International Money and Finance, 59, 77-99.

Smales, L. A. (2017)."Brexit": A case study in the relationship between political and financial market uncertainty. International Review of Finance, 17(3), 451-459.

He, Y., Nielsson, U., & Wang, Y. (2017). Hurting without hitting: The economic cost of political tension. Journal of International Financial Markets, Institutions & Money, 51, 106- 124.

Kapar, B., & Buigut, S. (2020). Effect of Qatar diplomatic and economic isolation on Qatar stock market volatility: an event study approach. Applied Economics, 52(55), 6022-6030.

Le, T.-H., Le, A. T., & Le, H.-C. (2021). The historical oil price fluctuation during the Covid-19 pandemic: What are the causes? Research in International Business and Finance, 58, 101489.

Yergin, D. (2012). How is energy remaking the world? Foreign Policy, 194, 60.

Jiang, Ximiao & Abdel-Aty, Mohamed & Hu, Jia & Lee, Jaeyoung. (2015). Investigating macro-level hotzone identification and variable importance using big data: A random forest models approach. Neurocomputing. 181. 10.1016/j.neucom.2015.08.097.

Chong, E., Han, C., & Park, F. C. (2017). Deep learning networks for stock market analysis and prediction: Methodology, data representations, and case studies. Expert Systems with Applications, 83, 187-205.

Bao, W., Yue, J., & Rao, Y. (2017). A deep learning framework for financial time series using stacked autoencoders and long-short term memory. PLoS ONE, 12(7), e0180944.

Selvin, S., Vinayakumar, R., Gopalakrishnan, E. A., Menon, V. K., & Soman, K. P. (2017). Stock price prediction using LSTM, RNN and CNN-sliding window model. 2017 International Conference on Advances in Computing, Communications and Informatics (ICACCI), 1643-1647.

Zhang, Y., Xiong, Y., Zhang, Z., Zhang, Y., Wang, W., & Mao, S. (2020). A hybrid CNN- LSTM model for stock index forecasting. 2020 IEEE Symposium Series on Computational Intelligence (SSCI), 1-7.