

Impact of Russia's Export Commodities on the Europe Stock Market during and before the Russia-Ukraine War

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How to cite this paper: Li, Y. A., Jin, J. C., Lyu, D. L., & Zheng, Q. (2022). Impact of Russia's Export Commodities on the Europe Stock Market during and before the Russia-Ukraine War. *iBusiness*, 14, 213-229.
<https://doi.org/10.4236/ib.2022.144016>

Received: September 6, 2022

Accepted: November 28, 2022

Published: December 1, 2022

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Abstract

The research aim of this paper is to investigate whether futures price fluctuations of major commodities during the Russian-Ukrainian war had an increased impact on the volatility of European stock index prices and whether they better explained stock index price fluctuations compared to pre-war commodity price fluctuations. Based on the results based on empirical research data, we tried to further discuss the correlation between strategic commodities of political significance and other global financial asset prices during special periods such as war. As main research method, regression analysis was used to explore whether the price fluctuation of Russia's main export commodities (natural gas and wheat) better explained Europe's stock market fluctuation (represented by FTSE) during the 2022 Russian invasion of Ukraine compared to the pre-war period. We compare the correlation between the European stock index and each of the two commodities during the war and before the war. The correlation is examined by investigating whether the changes in the indicators representing the increase in explanatory power are statistically significant. Spearman rank correlation coefficient was used as a more robust version to explain the change.

Keywords

Commodities, European, Stock Market Fluctuation, Russian-Ukrainian Conflict, Regression Analysis, Hedging Strategy

1. Introduction

1.1. Research Background

In retrospect history, when there is a war fire outbreak, there might be two types

of traders, the one who long their commodity position and the one who short those positions. For there are two possible moving directions of commodities: Firstly, Countries' financial stress caused by the war urge the country to dump major export in order to release economic stress, further leading to the downfall of the price. Secondly, the supply chain disruption, as well as the fear of the shortage of supply caused by the war, leads to the soaring of the price. Emotions have a very important impact on the market. Before or during the early stages of a war, uncertainty creates great concern in the market and may trigger hoarding of some specific types of commodities, which adds up to market volatility.

The war between Russia and Ukraine has moved global financial markets, with European stocks plunging, Russian stocks and bonds falling across the board, and Brent crude oil surging through the \$100 mark. At the same time, Russia and Ukraine are important global commodity resource countries. Ukraine is an important global grain exporter, and Russia has a pivotal position in the global supply of crude oil and natural gas. The conflict between the two has a huge impact on the global supply of commodities, which also caused significant fluctuations in commodity futures prices.

We specifically choose natural gas and wheat as our representatives for major exporting commodities: Among the different types of commodities exported by Russia and Ukraine, natural gas and wheat are the ones that account for a large share of exports and can be said to be significantly representative; at the same time, Russian and Ukrainian exports of natural gas and wheat also account for a significant share of the total exports of these two commodities worldwide. Russia is the world's largest exporter of wheat and natural gas. Ukraine is a key exporter of wheat, corresponding to about 10% of global wheat export (*The Impact of the War in Ukraine on Commodity Markets*, 2022). Europe imports a substantial share of its energy from Russia, including natural gas (35 percent), crude oil (20 percent), and coal (40 percent) (*The Impact of the War in Ukraine on Commodity Markets*, 2022). For comparison, total natural gas consumption in the EU in 2021 was close to 400 bcm, while imports from Russia were 155 bcm (*The Impact of the War in Ukraine on Commodity Markets*, 2022). In turn, Russia is similarly dependent on the European Union (EU) for its exports, with around 40 percent of its crude oil and natural gas being exported to the EU (*The Impact of the War in Ukraine on Commodity Markets*, 2022). Russia and Ukraine have, in recent years, accounting for about one-quarter of global exports of wheat. More than half of wheat imports in numerous countries in Africa, developing Europe, and the Middle East, come from Russia and Ukraine (*The Impact of the War in Ukraine on Commodity Markets*, 2022).

According to MarketWatch, the top three Europe Market Index are FTSE 100, DAX, and CAC40, which are the stock index representing Britain, Germany, and France stock markets. We decided to use FTSE 100 to represent the Europe market's performance for two main reasons: first, the FTSE 100 includes the performance of the 100 companies listed on the London Stock Exchange with

the highest market capitalization, but DAX and CAC40 only list 40 companies, which we believe that the more companies a stock index contain, the more representative it will be; second, we regress the other two indexes with FTSE 100 and find that these three indexes are highly related before the invasion, as listed in **Table 1**, their alpha is close to 0, their beta is close to 1, and FTSE could explain 75% and 80% of DAX and CAC 40's data. Therefore, the performance of the FTSE 100 is statistically significant in explaining the other two indexes.

Due to the globalization of the world's financial markets today, there is a close correlation between the prices of different financial assets in different regions and categories. The volatility of commodity markets also affects the volatility of stock markets. That is, changes in commodity prices have a certain correlation with changes in stock index prices and have some explanatory power for changes in stock index prices.

Looking at the commodity futures and stock index price market data during the Russia-Ukraine war, we can see that both have increased volatility compared to the pre-war period, and more importantly, we also notice that some of the commodity futures price movements have a clear consistency with stock index price movements during specific time periods. Around the point in time when commodity futures prices reach their peak, they are accompanied by stock index prices reaching their peak levels. Past research has shown that correlations between prices of different types of financial assets can change significantly during special periods and are usually characterized by an increase in asset price correlations when economic conditions deteriorate. The particularities of the period of the Russian-Ukrainian war and the global economic impact due to geopolitical factors are likely to cause changes in financial asset price correlations, such as a significant increase in the correlation between commodity prices and stock index prices. That is, a significant change in the supply of commodities as a result of the war may lead to commodities becoming a more critical asset in financial markets, and their price fluctuations may have a significantly higher impact on other financial assets, for example, the explanatory power of commodity price fluctuations on the movements of stock index prices may increase significantly.

Among the different types of commodities exported by Russia and Ukraine, natural gas and wheat are the ones that account for a large share of exports and can be said to be significantly representative; at the same time, Russian and Ukrainian exports of natural gas and wheat also account for a significant share of the total exports of these two commodities worldwide. Therefore, as key

Table 1. Simple linear regression from 2018-01-03 to 2022-02-04.

	alpha	FTSE_log_return	r-squared
FTSE_log_return	0	1	1
DAX_log_return	0.00009	1.020361	0.743936
CAC 40_log_return	0.000255	1.027077	0.798823

commodities with significant price volatility over the past few months, natural gas and wheat may have a strong influence on stock index price movements.

That is, since Russia and Ukraine account for a significant portion of total global exports of natural gas and wheat, a significant change in the supply of these two commodities from Russia and Ukraine could lead to a relatively large change in total supply, which in turn could cause significant fluctuations in commodity prices and commodity futures prices. Therefore, it may be assumed that the commodities exported by Russia and Ukraine had a greater influence on the global financial markets during the war, and their price fluctuations can significantly affect the price fluctuations of other financial assets and have more significant explanatory power on the stock index price movements, etc.

1.2. Study Purpose and Research Questions

The purpose of our study is to investigate whether the impact of major commodities on other financial assets in global financial markets before and after the Russo-Ukrainian war is more pronounced than before the war through regression analysis. In this paper, we examine whether commodity futures price fluctuations of key commodities during the Russo-Ukrainian War had an increased impact on European stock index price fluctuations and whether they better-explained stock index price movements compared to pre-war commodity price movements. And we would examine whether the before-and-after changes in indicators representing changes in explanatory power are statistically significant. We will try to further discuss the impact of changes in the current international situation on the correlation of financial asset prices in global financial markets during special times such as war.

Further, we will select the commodity with the most explanatory power for stock index prices based on the regression model developed, model the relationship between the price of that asset and the price of the stock index, and attempt to construct a corresponding hedging strategy for stock index futures based on the model developed, and backtest the strategy to see the corresponding returns.

Research Questions:

1) Is the explanatory power of major commodity price changes on stock index price changes during the war period increased compared to the period before the Russo-Ukrainian war? That is, whether stock index price fluctuations were influenced by major commodity price fluctuations to a greater extent during the war compared to the pre-war period.

2) Whether the explanatory power of price changes of commodities with a greater total export volume of Russia and Ukraine on the stock index price changes during the war has increased. That is, the degree to which stock index price fluctuations are influenced by price fluctuations of commodities with greater export volumes is greater.

2. Literature Review

Large selling commodities always have a certain relation with the stock market.

As big exporters, Ukraine and Russia play an important role in certain commodities' selling. According to the impact of the war in Ukraine on commodity markets, Russia provides 40% of the coal, 35% of the gas, and 20% of oil, and Ukraine and Russia provide almost 100% of wheat in countries like Mongolia and Belin ([The Impact of the War in Ukraine on Commodity Markets, 2022](#)). As far as we know, we have gathered eleven papers about the relationship between commodities and the stock market worldwide. These papers can be divided into two categories: 1) the relationship between commodity and stock price; 2) the change in the relationship between commodity and stock price during the war.

Regarding the relationship between commodity and stock price, since we cannot find a paper that directly and thoroughly talks about the relationship between the large selling commodity in Russia and the Europe stock market, we find the paper that talks about the four commodities that we analyze in our paper. Since we also cannot find a paper that talks about the relationship between silver and Europe stock market, we use oil instead. For oil, Miramir Bagirov and Cesario Mateus found out that the oil price will have a positive impact on listed gas and oil firms in Europe ([Bagirov & Mateus, 2019](#)). For natural gas, Ali Acaravci, Ilhan Ozturk, and Serkan Yilmaz Kandir figure out that gas price only has an influence on a few European countries' stock markets ([Acaravci et al., 2012](#)). For wheat, Perry Sadorsky shows in his paper that wheat prices have a negative leverage effect on the stock market ([Sadorsky, 2014](#)). And for Lean hogs, Zaghun Umar, Ariya Gubareva, Muhammad Naeem, and Ayesha Akhter have shown in their paper that lean hogs are the main receiver of the oil price shock ([Umar et al., 2022](#)).

Considering the relationship during the war, most of our papers are found during the 2022 Russia-Ukraine war. As a connection with the first category, Amin Sokhanvar and Elie Bouri show in their paper that the change in the price of oil, wheat, and gas is the driving force of the depreciation of the Euro during the Russo-Ukraine war ([Sokhanvar & Bouri, 2022](#)). Shaker Ahmed, Mostafa M'Hasan, and Ma Rajib Kahal show that Europe has a generally negative AAR and CAR, but there is still a significant country-level variation in the change in the stock price ([Ahmed et al., 2022](#)). Gaye-Del Lo, Issac Marcelin, Theophile Bassene, and Babacar Sene show in their paper that the Ukraine war negatively affects the stock market in every country, and countries with over 20% dependence on Russian commodities will experience a more significant effect ([Lo et al., 2022](#)). These two ideas can somehow illustrate the situation that the German stock market is largely influenced by the Ukraine war compared with the French stock market. According to data on OCE, Russia exported 14.2 billion dollars to German in 2020, which is the fifth biggest export country for Russia ([Russia \(RUS\) and Germany \(DEU\) Trade|OEC, n.d.](#)), and exported 4.93 billion dollars to French, which is the 18th biggest ([Russia \(RUS\) and France \(FRA\) Trade|OEC, n.d.](#)). What's more, 55% of natural gas supply from Russia (only 17% in France) and a half-century occupation by the USSR in the eastern part let German have an unusual relationship with Moscow compared with other western

European countries. The great difference between the export value of Russia to German and France might cause German strongly rely on Russian commodities. On the other hand, Oluwasegun Adekoya, Johnson Oliyide, OlaOluwa Yaya, and Mamdouh Abdulaziz Saleh Al-Faryan show their point that Ukraine's war strength the connectedness between oil and other commodities (Adekoya et al., 2022), and Zaghun Umar, Onur Polat, Sun-Yong Choi, and Tamara Teplova found out that the relationship between different financial assets (like commodities and stocks) changed during the Ukraine war (Umar et al., 2022). In the most recent paper written by Deborah D'Souza on Investopedia, the war between Russia and Ukraine may severely impact commodities like oil and gas. According to the history of the change in the stock market during the war and the variation of the stock market in the first few months, the stock market followed a similar pattern that rebounded after the decline at the start of the war. This pattern will likely occur in a war that starts after a prelude (D'Souza, 2022).

3. Research Design, Data & Empirical Results

3.1. Research Design & Data

For the study design, we first selected two major commodities of strategic importance and two commodities that are less correlated with war and have performed relatively consistently over the time period under study. After standardizing the price data, cleaning the data, and calculating the log returns, we regress the four data sets on the FTSE data samples for the same time period and plot the corresponding graphs. Based on the regression data, we analyze the alpha, beta, and r-squared indicators in turn. In addition to comparing the correlation data between the four commodities and the stock index during the war, we also compare the differences in the correlations before and after the war and investigate whether the changes in the data are statistically significant. Subsequently, we employ a nonparametric measure of rank correlation, the Spearman rank correlation coefficient, to more strongly explain the implications of changes in correlation data before and after the war, making an analysis of p-value changes. Finally as an extension, we made a simple hedging strategy using correlation data for the commodity natural gas, which has been shown to have significant explanatory power changes, with data for the stock index FTSE to examine the investment possibilities represented in the data set.

We test the two hypotheses for a total of 4 of Russia's export commodities and one stock index: wheat, natural gas, lean hogs, silver, and FTSE 100. We choose TTF Natural gas from Investing.com, and we choose FTSE 100 index, Chicago SRW Wheat Futures, Lean Hogs Futures, and Silver Futures from Yahoo Finance. We use the close price for FTSE 100 in Pound sterling, TTF Natural gas future in Euros per contract unit, Chicago SRW Wheat Futures, Lean Hog Futures and Silver Futures in US dollars per contract unit. Our dataset is daily, and **Table 2** shows the head and tail of our raw dataset. To compare the impact of these commodities on the stock market before and during the war, we choose

Table 2. Raw dataset with daily price from 2018-01-02 to 2022-08-01.

	FTSE	DAX	CAC 40	Chicago SRW Wheat Futures	TTF Natural Gas	Lean Hogs Futures	Silver Futures
Date							
2018-01-02	7648.1	12871.39	5288.6	433.5	19.32	70.725	17.121
2018-01-03	7671.1	12978.21	5331.28	436	19.32	71.05	17.185
2018-01-04	7695.9	13167.89	5413.69	434	19.2	71.375	17.189
2018-01-05	7724.2	13319.64	5470.75	430.75	18.91	71.425	17.205
2018-01-06	7696.5	13367.78	5487.42	427.75	19.05	72.975	17.064
...
2022-07-26	7306.3	13096.93	6211.45	803.75	199.92	116.975	18.487
2022-07-27	7348.2	13166.38	6257.94	790.25	205.225	118.6	18.553
2022-07-28	7345.3	13282.11	6339.21	817	198.93	119.125	19.827
2022-07-29	7423.4	13484.05	6448.5	807.75	190.915	120.65	20.156
2022-08-01	7413.4	13479.63	6436.86	800.25	200.795	120.45	20.322

two periods for each: the first period is from 3 January 2018-24 February 2022, and the second period is from 24 February 2022-01 August 2022, since the 2022 Russian Invasion of Ukraine starts at 24 February 2022. We deleted the rows that has N/A value. After cleaning the dataset and calculating the log return of all commodities and stock index, **Table 3** and **Table 4** shows the head and tail of 995 rows of data for the first period and 100 rows of data for the second period.

3.2. Analysis

First, we plot the scatterplots of each of the four commodities on FTSE100. The result shows that the slope of wheat on FTSE and silver on FTSE change from positive to negative during the Invasion, as shown in **Figure 1** and **Figure 2**. The slope of natural gas on FTSE decreases significantly compared to the one before the Invasion, as shown in **Figure 3**. However, the slope of lean hog on FTSE in **Figure 4** does not demonstrate the increase in slope. Before the Invasion, most of the commodities are positively correlated with the Europe stock market index. We think three of four commodities become more negatively correlated with the Europe stock market because the supply chain disruption causes the commodities' price to increase significantly, and the stock market performs worse because of the uncertainty during the Invasion.

Secondly, we regressed the log return of FTSE on each commodity's log return. Assuming there are 252 trade days in a year, the alpha in the following table is annualized. Therefore, instead of daily log returns, you could see those as annual log returns. The alpha and beta are truncated to three decimals, r-squared is turned to one decimal percentage.

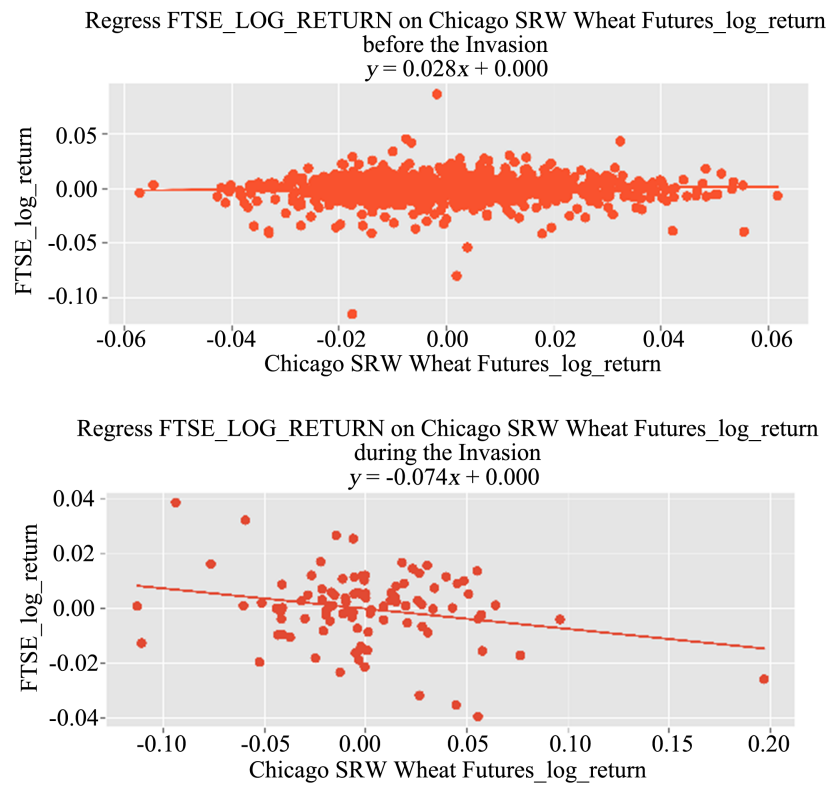


Figure 1. Wheat and FTSE100 scatterplots before and during the invasion.

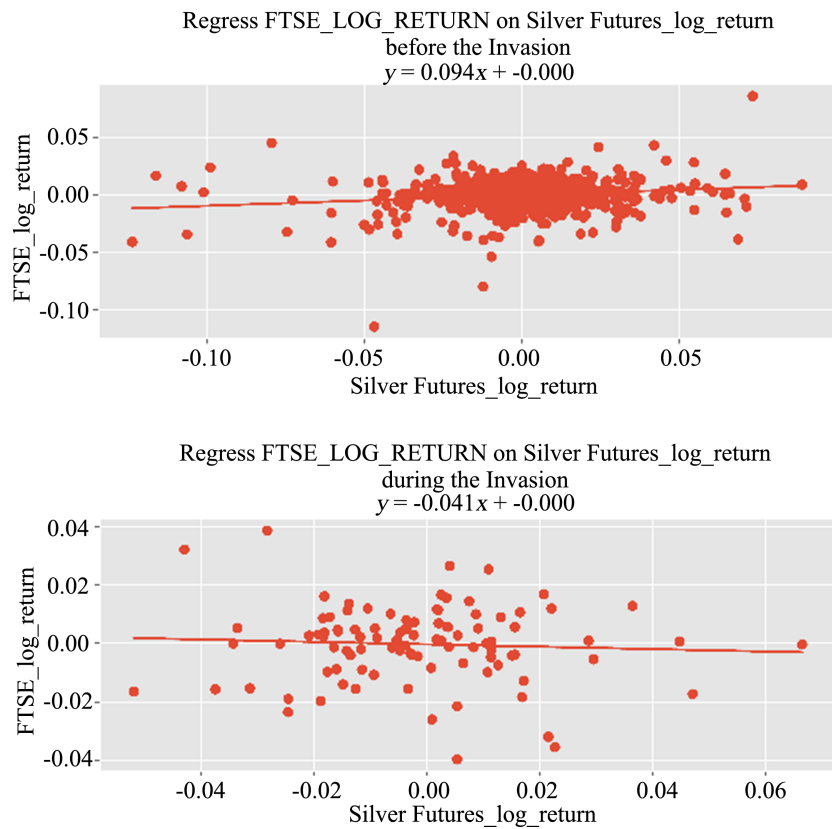


Figure 2. Silver scatterplots before and during the invasion.

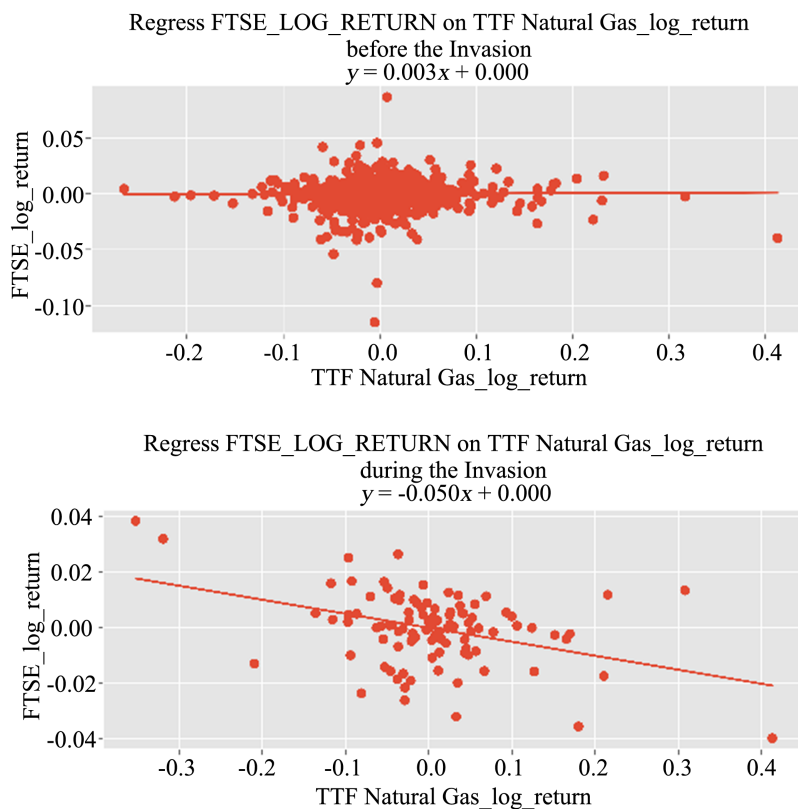


Figure 3. Natural Gas scatterplots before and during the invasion.

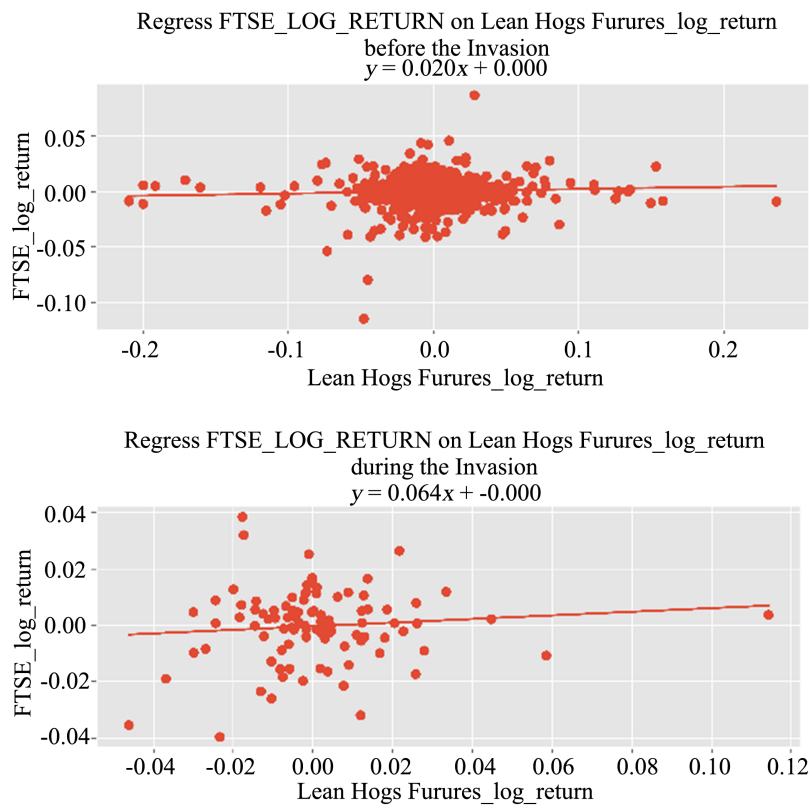


Figure 4. Lean Hog scatterplots before and during the invasion.

Table 3. Dataset with daily log return: before the invasion.

	FTSE_log_return	Chicago SRW Wheat Futures_log_return	TTF Natural Gas_log_return	Lean Hogs Futures_log_return	Silver Futures_log_return
Date					
2018-01-03	0.003003	0.00575	0	0.004585	0.003731
2018-01-04	0.003228	-0.0046	-0.00623	0.004564	0.000233
2018-01-05	0.003671	-0.00752	-0.01522	0.0007	0.00093
2018-01-08	-0.00359	-0.00699	0.007376	0.021469	-0.00823
2018-01-09	0.004473	0.010465	0.020008	0.002737	-0.00753
...
2022-02-14	-0.01704	0.001879	0.042296	0.012354	0.020293
2022-02-17	-0.00877	0.022174	0.070792	0.15814	0.011501
2022-02-18	-0.00316	-0.00125	-0.01554	0.016823	0.004889
2022-02-23	0.000534	0.036917	0.108001	-0.03681	0.009987
2022-02-24	-0.03961	0.055508	0.412788	-0.02342	0.005321

Table 4. Dataset with daily log return: During the invasion.

	FTSE_log_return	Chicago SRW Wheat Futures_log_return	TTF Natural Gas_log_return	Lean Hogs Futures_log_return	Silver Futures_log_return
Date					
2022-02-24	-0.03961	0.055508	0.412788	-0.02342	0.005321
2022-02-25	0.038449	-0.09391	-0.35241	-0.01769	-0.02831
2022-02-28	-0.00418	0.096065	0.043246	-0.00169	0.015055
2022-03-01	-0.01733	0.076472	0.210333	0.025752	0.047027
2022-03-02	0.013469	0.055104	0.30789	0.000941	-0.01384
...
2022-07-26	0	0.042898	0.123945	-0.00214	0.010495
2022-07-27	0.005718	-0.01694	0.02619	0.013796	0.003564
2022-07-28	-0.0004	0.03329	-0.03115	0.004417	0.066413
2022-07-29	0.010577	-0.01139	-0.04113	0.01272	0.016457
2022-08-01	-0.00135	-0.00933	0.050456	-0.00166	0.008202

The **Table 5** shows that the beta of wheat, natural gas, and silver decreased during the Invasion, as we explained in the scatterplots.

R-squared is possibly the most important statistical measurement, which shows how much percentage of the change caused by the independent variable can be explained. Russia's major export commodities: wheat and natural gas'

Table 5. Simple linear regression metrics.

Before Invasion			
	alpha	beta	r-squared
Chicago SRW Wheat Futures_log_return	0.00068	0.028	0.002
TTF Natural Gas_log_return	0.00397	0.003	0
Lean Hogs Futures_log_return	0.00541	0.02	0.003
Silver Futures_log_return	−0.0035	0.094	0.025
During Invasion			
	alpha	beta	r-squared
Chicago SRW Wheat Futures_log_return	−0.06979	−0.074	0.057
TTF Natural Gas_log_return	0.00742	−0.05	0.154
Lean Hogs Futures_log_return	−0.08216	0.064	0.01
Silver Futures_log_return	−0.08651	−0.041	0.004

r-squared increased significantly in the two periods. Before the Invasion, the linear model demonstrates that wheat can only explain 0.2% of the change in FTSE, but it can explain 5.7% of the change during the Invasion. More statistically significant, the r-squared of FTSE regressed on natural gas becomes 15.4%, compared to 0% before the Invasion. For the minor export commodities, lean and hog, there isn't a big change in the r squared.

Alpha for any of the commodities does not show that it's outperforming the market by a lot during the Invasion. The only commodity that shows outperformance during the Invasion is natural gas, and it's only 0.742%. Transfer 0.742% of log return to percentage change, which is about 0.7%, which is much smaller than the risk-free rate, assuming it's 2%. In reality, the true percentage return should probably be smaller than 0.7% due to the large possible draw-down.

Next, we calculate the correlation of each commodities' log return with FTSE's log return before the Invasion and during the Invasion, as shown in **Table 6**.

All commodities, except for silver, have a higher absolute value of correlation coefficient, which means that they are more correlated with the performance of the stock market during the Invasion. In addition, for the major export commodities, the wheat and natural gas correlation coefficient increases 5 and 38 times compared to relatively small changes in the correlation coefficient of the minor export commodities.

In conclusion, the regression and correlation analysis support our hypothesis that, firstly, the explanatory power of major commodity price changes on stock index price changes during the war period increased compared to the period before the 2022 Russian invasion of Ukraine, and, secondly, the explanatory power of price changes of major commodities (with largest export volume) of the countries on the stock index changes during the Invasion has increased.

To make the correlation analysis stronger, we also use a robust version of the standard correlation coefficient, which is Spearman's rank correlation coefficient, to compare the correlation before and during the Invasion. According to Laerd Statistics, Spearman's rank is a nonparametric measure of rank correlation, and it assesses how well the relationship between two variables can be described using a monotonic function. The p -value shows how likely the observed correlation is due to chance.

As results listed in **Table 7**, Natural gas's Spearman's rank correlation coefficient goes from 0.06 to -0.22 , and its p -value decreases from 0.04 to 0.03, which shows that it becomes significantly negatively correlated to FTSE, and the observed coefficient is less likely due to the chance. However, for the other three commodities, there is no significant change in their coefficients and their p -value increase. Therefore, Spearman's rank analysis can only support that one of the major commodities: natural gas, was more correlated with FTSE during the Invasion.

Table 6. Correlation coefficient matrix.

Before invasion		During invasion	
	FTSE_log_return		FTSE_log_return
FTSE_log_return	1	FTSE_log_return	1
Chicago SRW Wheat Futures_log_return	0.04	Chicago SRW Wheat Futures_log_return	-0.24
TTF Natural Gas_log_return	0.01	TTF Natural Gas_log_return	-0.39
Lean Hogs Futures_log_return	0.05	Lean Hogs Futures_log_return	0.1
Silver Futures_log_return	0.16	Silver Futures_log_return	-0.06

Table 7. Spearman's rank correlation coefficient matrix.

Before invasion			During invasion		
	SRC with FTSE	p_value		SRC with FTSE	p_value
FTSE_log_return	1	0	FTSE_log_return	1	0
Chicago SRW Wheat Futures_log_return	0.03	0.3	Chicago SRW Wheat Futures_log_return	-0.06	0.57
TTF Natural Gas_log_return	0.06	0.04	TTF Natural Gas_log_return	-0.22	0.03
Lean Hogs Futures_log_return	0.03	0.41	Lean Hogs Futures_log_return	0.04	0.72
Silver Futures_log_return	0.12	0	Silver Futures_log_return	0	0.98

3.3. Simple Hedging Strategy

To better understand the alpha data of our regression result and also to better explain how our results may affect practical trading strategy, we build a simple strategy based on the beta hedging method.

A high beta corresponds to a high level of speculative risk, which means betting on a volatile bet. Insensitivity to various factors is very valuable, which means that the vast majority of returns are determined through alpha and are independent of various factors. The beta of an asset is the beta of that asset's return fitted to the returns of other assets by a regression model. At the same time, the beta is more of the asset's exposure relative to the risk benchmark, i.e., the regression coefficient obtained from the unitary linear.

Suppose the return of the portfolio can be approximated as $\alpha + \beta X$. If selling the market shortly, the return becomes $\alpha + \beta X - \beta X = \alpha$, which means the portfolio's exposure to the market becomes zero. We calculated the daily log return of natural gas and FTSE, built a regression model based on it and defined our simple strategy as per long share of FTSE. Accordingly, we short beta share of TTF nature gas. We use the data of the period before and during the Invasion to backtest our strategy.

Using the beta hedging strategy, we found that the strategy provides a higher log return during the invasion compared to before the invasion, as in **Figure 5** and **Figure 6**. The higher cumulative log return of our strategy can be seen more clearly in **Figure 7** and **Figure 8**. **Table 8** shows the exact cumulative log return of FTSE 100 and the one of beta hedging strategy for the two periods. Before the invasion, the cumulative log returns of beta hedging strategy is 0.0017 higher than the FTSE 100 cumulative log return. During the invasion, the cumulative log returns of beta hedging strategy is 0.0296 higher than the FTSE 100 cumulative log return, which represents a 1641% increase in the difference of the log return. Therefore, it demonstrates that the natural gas has a higher correlation with the FTSE 100 index during the invasion.

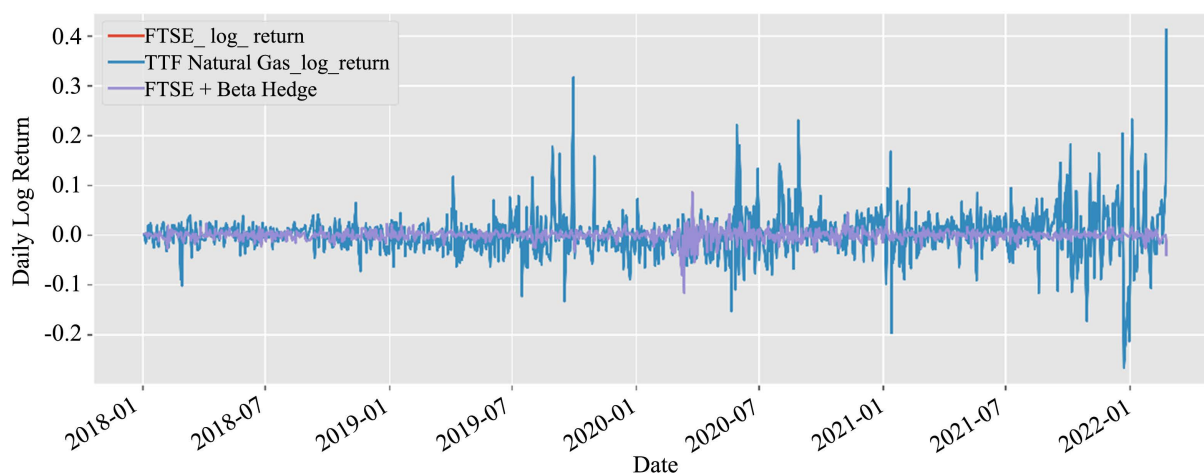


Figure 5. Daily log return graph of strategy compared to FTSE and natural gas before the invasion.

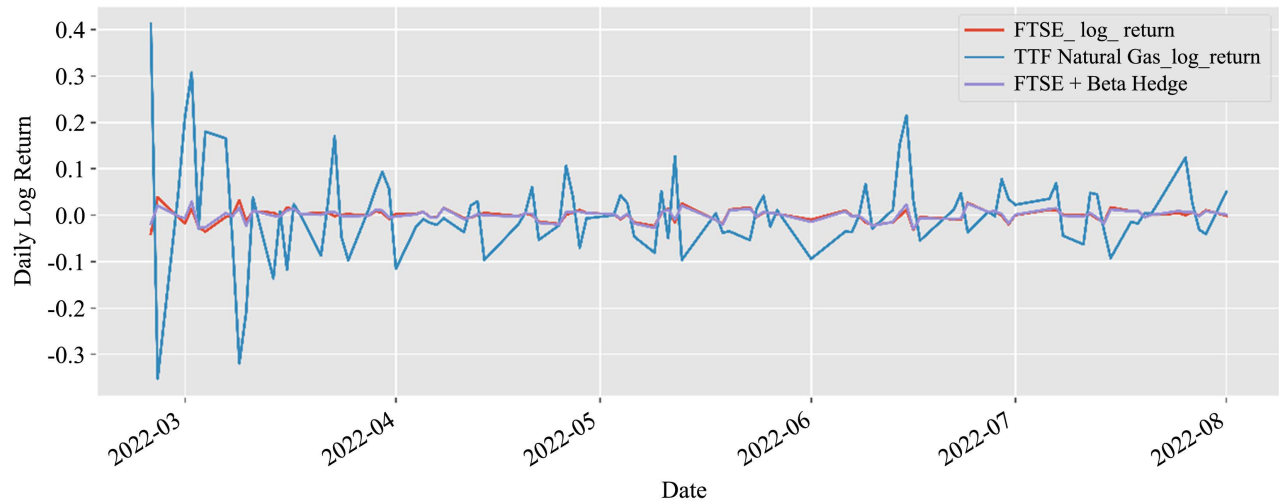


Figure 6. Daily log return graph of strategy compared to FTSE and natural gas during the Invasion.

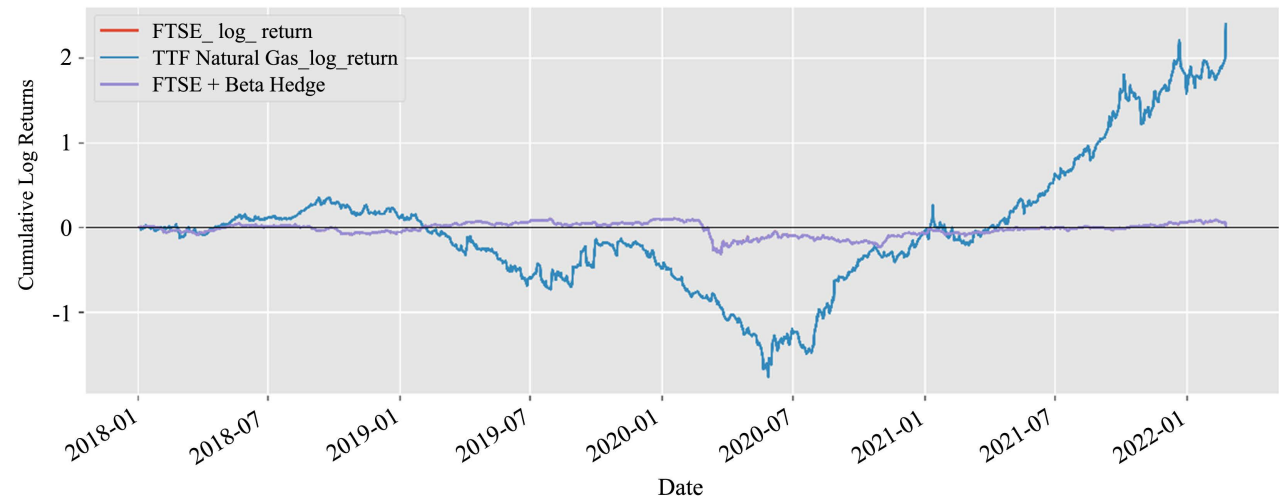


Figure 7. Cumulative log return graph of strategy compared to FTSE and natural gas before the invasion.

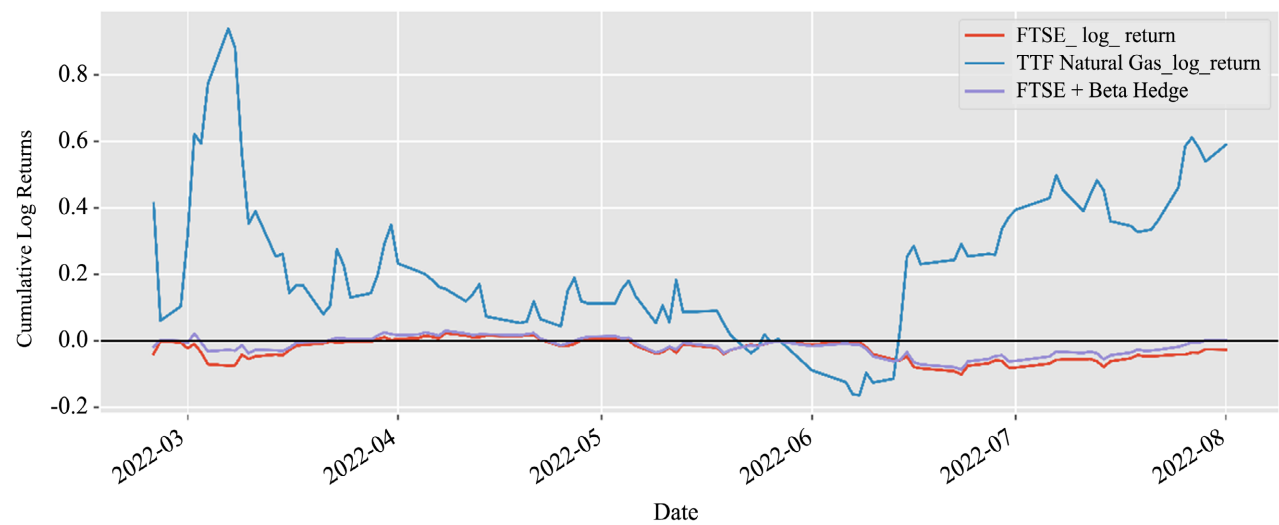


Figure 8. Cumulative log return graph of strategy compared to FTSE and natural gas during the invasion.

Table 8. Cumulative log return for the two periods.

	Before the Invasion	During the Invasion
FTSE_log_return	0.0229	-0.0267
TTF Natural Gas_log_return	2.4019	0.5894
FTSE + Beta Hedge	0.0246	0.0029

4. Conclusion & Limitation

In this paper, we have analyzed data from FTSE, Chicago SRW wheat futures, TTF natural gas, Lean hogs futures, and silver futures in three different ways—scatter plot, regression, and correlation coefficient, to examine our hypothesis on research questions that whether the explanatory power of major commodity price changes on stock index price changes during the war period increased compared to the period before 2022 Russian invasion of Ukraine and whether the explanatory power of price changes of major commodities (with largest export volume) of the countries on fire on the stock index changes during the Invasion has increased. In scatter plot analysis, we plot graphs of each commodity's log return and the FTSE log return, comparing the slope of the best fit line before and during the Invasion. In linear regression analysis, we regressed the log return of FTSE on each commodities' log return, annualized the alpha, and compared the value of r-squared as it indicates how much of the independent variable (stock) is explained by changes in our dependent variables (commodity). In correlation analysis, we use the standard correlation coefficient and Spearman's rank correlation to measure the strength of the relationship between commodities and FTSE. As the result of our analysis, we have proved the correctness of both of our research questions and found out that the major export commodities have a larger impact on the Europe stock market than the minor export commodities during the Invasion.

Before the Invasion, most commodities were positively correlated with the European stock market index; while after the Invasion, the disruption in the supply chain led to a rapid increase in the prices of many commodities, and we find that three of the four commodities became more negatively correlated with the European stock market through regression and correlation analysis. Therefore, we believe that the disruption in the supply chain led to a significant increase in commodity prices, and because the stock market shook sharply to the downside due to the uncertainty of the war, commodity prices and the European stock index showed a significant negative correlation. At the same time, based on the changes in R-squared according to our linear regression of four commodities on FTSE 100, it is clear that the war has made the explanatory power of the changes in the prices of the main export commodities of the war-related countries (Russia and Ukraine) on the overall price movements of the stock market significantly stronger.

According to the performance of the indicators during the Russian-Ukrainian

war, traders should pay more attention to the commodity market when the war comes because, at this time, changes in the main export commodities of the warring countries will significantly affect the dynamics of global financial markets and may have a significant knock-on effect on the prices of other financial assets. And, according to the war countries on the main export commodity policy adjustments, traders should always pay attention to whether they can appropriately short stock indices and long commodities so that they can capture excess returns in the volatile global financial situation. Even though the cumulative return of our beta-hedge strategy is close to zero at the end, it still outperforms FTSE 100 on most of the days during the Invasion.

Also, due to the increased explanatory power of key commodities on stock prices during the war, traders can consider including commodities within their portfolios depending on the international situation while using stock indices or commodities as hedging factors based on the negative correlation between stock indices and commodities. Because negative correlations usually have a very high value in a portfolio, they can be used as a good diversifier in order to make a portfolio with higher yields while having less volatility, i.e., more stability.

The empirical results reported herein should be considered in light of some limitations. For instance, we only show natural gas in Spearman's rank correlation; we use simple linear regression instead of multivariable regression. In our research, we have only chosen four different commodities. Two of them are major export commodities, and the other two are minor export commodities. Our result could be more convincing if we collected data from more commodities. Similarly, since the Invasion only started by six months, we have much more data before the Invasion compared with data during the Invasion, and it will be better if we can do the same analysis after the Invasion. Future research may focus on reverse regression analysis of the impact of stock index prices on the prices of major commodities, cross-sectional comparison of the impact of more categories of commodities on stock index prices in different geographic regions in different periods, etc.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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