IMPACT OF OIL SHOCKS ON THE OIL, AGRICULTURAL AND FOOD INDUSTRY - QUANTILE AND OLS REGRESSION

Sanja Bakić[1]

**Corresponding author E-mail: sanja.bakic991@gmail.com*

ARTICLE INFO

Review Article

Received: *30 December 2023*

Accepted: *24 February 2024*

doi:10.59267/ekoPolj2401293B

UDC 665.61:338.439]:519.233.5

Keywords:

oil, oil industry, agriculture, OLS, quantile regression

***JEL**: Q10, Q41, Q14*

ABSTRACT

This paper determines the impact of Brent oil shocks on the price of shares of companies from the oil, agricultural and food industries that includes the period of the COVID-19 pandemic. For this purpose, they use a quantile regression approach and compare its findings with a standard Ordinary Least Squares (OLS) regression model. Moreover, in this research they use quantile regression, which enables them to analyze different quantiles of share prices of companies from the oil industry, the agricultural industry, and the food industry. They observe three different periods - a period of recession, a normal period and a period of expansion. Finally, empirical evaluations using quantile regression and OLS models show us that shocks from the oil market are more pronounced in companies from the oil industry compared to companies from the agricultural and food industries. The findings of this research provide important information for investors, economic policy makers, and other parties.

Introduction

The price of Brent crude oil is a key economic factor that has a significant impact on the world economy. Brent crude oil price movements have become increasingly complex in recent years, mainly as a result of geopolitical reasons, including the war between Russia and Ukraine (Jahanshahi et al, 2022, Wang et al, 2022). The conflict has caused significant disruptions in oil supplies and has led to increased levels of uncertainty in the oil market, hindering the ability to make accurate predictions. Forecasting Brent crude oil prices is a difficult task. Thus, incorporating the consequences of conflict with the Brent price simulation may prove useful for policy makers, especially in oil-producing countries, as it may help them formulate appropriate fiscal policies (Mati et al, 2023).

Besides the war, the COVID-19 pandemic has had a detrimental effect on the global energy economy. The implementation of response measures, such as a widespread lockdown, has led to disruptions in production and supply chains. This led to a decrease

1 Sanja Bakić, Phd student, Faculty of Economics, University of Novi Sad, Dr Sime Miloševića 16, 21000 Novi Sad, Serbia, Phone: 0653025205, E-mail: sanja.bakic991@gmail.com, ORCID: (https://orcid.org/0000-0003-2706-519X)

in demand for products and services, which in turn caused a drop in commodity prices and a significant global economic downturn. In addition to the health crisis, the pandemic has led to the unemployment of numerous individuals, threatening their livelihoods (Eroğlu et al, 2020). Also, the COVID-19 pandemic caused significant disruptions in the agricultural sector (Zahraee et al, 2022). Various theories have been proposed in recent years to explain the correlation between oil prices and food prices. Regarding agricultural products, it can be explained that the oil and agriculture sectors are closely related due to the high energy needs of agricultural production. Consequently, as the price of oil rises, it leads to increased costs for fertilizers, chemicals and transportation, which in turn leads to an increase in the prices of agricultural products (Pal & Mitra, 2018). Ready (2018) presents a new approach for analyzing factors affecting oil prices by separating them into three different shocks in the context of factors affecting oil: demand shocks, supply shocks, and risk shocks.

Currently, the financial and economic literature widely acknowledges that crude oil and agricultural commodity prices significantly affect global economic activity (Charfeddine et al., 2018, 2020; Vu et al., 2020; Vo, 2019). Crude oil is a key resource for oil exporting and importing countries. Thus, significant fluctuations in crude oil prices will increase global economic unpredictability and deeply affect the economic performance of both economies (Naeem et al., 2022). Moreover, agricultural products have significant importance as strategic resources for all nations at the global level. Consequently, any significant volatility in their prices can lead to serious consequences for both agricultural commodity exporting countries and countries struggling with food insecurity. Therefore, due to the changing characteristics and increasing interdependence of both commodities, it is crucial to prioritize a comprehensive understanding of the nexus between energy and agriculture in order to maintain commodity price stability. This research seeks to address this gap by investigating the co-explosiveness and causality between Brent crude oil price shocks and stock prices of agricultural, food and oil companies.

Han et al. (2015) argued that the price ratio between the crude oil market and the agricultural product market is vulnerable to financial shocks. The correlation between the crude oil market and the agricultural market has been shown to intensify after the financial crisis (Ji & Fan, 2012). Chen et al. (2010) showed that price fluctuations of individual grains between the third week of 2005 and the twentieth week of 2008 were significantly affected by fluctuations in crude oil prices and other food costs. Cabrera & Schulz (2016) noted that the increased linkage between crude oil and agricultural products signifies growing market integration. Furthermore, advances in biofuels have resulted in an increased impact of crude oil price shocks on agricultural prices. World economic activity could potentially affect the situation, as it is possible to assume that global economic growth could lead to higher demand for oil and food, resulting in higher prices for both commodities. Dong et al. (2019) exclusively examined the impact of global economic activity on oil prices and found a significant correlation between them. Another explanation is related to the financialization of the commodity

market. Financialization is a term used to describe the phenomenon when commodity prices exhibit similar behavior to financial assets (Adams et al., 2020).

Umar et al. (2021) conducted a study that examined how COVID-19 affected commodity price fluctuations using wavelet analysis. The researchers used a global index of the coronavirus pandemic and commodity prices from the first seven months of 2020. Their findings have hedging significance, as different levels of coherence indicate different levels of association in both the time and frequency domains between Covid-19 outbreaks and commodity market volatility. In their study, Shahzad et al. (2018) examined unilateral risk transmission from oil prices to agricultural commodities, specifically wheat, corn, soybeans, and rice. The researchers noted evidence of tail-dependent symmetry between the variables, but observed asymmetry in spillovers from oil to agricultural products. The spillover effect was particularly evident during periods of financial instability.

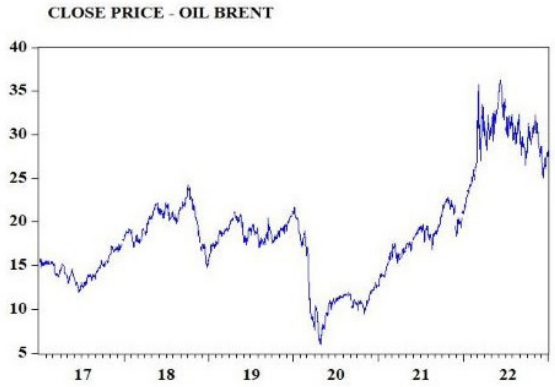
Yip et al. (2020) investigated volatility transmission from crude oil to agricultural products using fractionally integrated VAR and autoregressive Markov Switching models. Their research shows that volatility transmission from crude oil to agricultural products decreased during periods of low volatility but increased during periods of high volatility. Gokmenoglu et al. (2020) conducted a study in Nigeria where they analyzed the dynamic correlation between oil prices and prices of agricultural products. They used monthly data from 2006 to 2015, focusing on cocoa, coffee, wheat, palm oil, soy, livestock and crude oil. Panel techniques show that over time there is a significant and favorable effect of oil prices on prices of agricultural products. However, there was no direct cause and effect relationship between oil prices and agricultural products in Nigeria. A study by Sun et al. (2021) found a reciprocal relationship between the price of oil and agricultural products, as evidenced by the results of comprehensive sample causality tests and sliding windows. Moreover, both agricultural and oil prices have shown resilience to the shocks that have occurred in both markets throughout the duration of the COVID-19 epidemic. Kumar et al. (2021) examined the ratio between oil and five agricultural commodity markets using a dependence shift copula to explore their dependence structure. The findings point to the simultaneous occurrence of oil market crashes and declines in agricultural products, especially during periods of crisis, in contrast to normal economic situations. Moreover, they presented compelling evidence of risk transfer from oil markets to agricultural markets, especially in the context of the financial crisis. Oseni and Kinbode (2018) conducted a study to examine the impact of oil price shocks on agricultural commodity prices in Nigeria. They used a nonlinear autoregressive distributed lag (NARDL) approach and studied monthly oil, corn, wheat, soybean, and exchange rate data from 1997 to 2016. It has been found that the rise in oil prices consistently leads to an increase in agricultural products. Similarly, the exchange rate, viewed as a control variable, showed a statistically significant positive correlation with agricultural products. They provided evidence of the unequal impact of oil prices on agricultural prices in Nigeria. Zafeiriou et al. (2018) examined the correlation between crude oil and futures prices of agricultural products (corn and

soybeans) using the ARDL model. Crude oil has been found to exhibit a strong and persistent relationship with agricultural commodity prices, which is relevant in both the long and short term. Eissa and Refai (2019) used linear and nonlinear ARDL models to estimate the dynamic relationship between oil and agricultural commodity prices. Although the linear model indicates no long-term correlation between these series, the non-linear model shows that barley, corn and canola oil show a long-term correlation with oil prices. Furthermore, the impact of dynamic multipliers shows that barley, corn and canola oil prices show quick and strong responses to cyclical declines in oil prices over a short period of time.

The main goal of this work is to determine the impact of shocks from the Brent oil market on the movement of share prices of companies from three industries, oil, agriculture and food industry. Crude oil and its trading is very widespread, and any kind of oscillation in the price of oil greatly affects the movements in the financial market.

Namely, oil plays a very large role in agriculture and the food industry. According to economic theory, there is a direct impact of rising crude oil prices on agricultural prices. Agriculture, as a sector that requires a large amount of energy, significantly affects the demand for energy. The agricultural sector is directly affected by elevated and fluctuating global oil prices, which consequently affects the costs associated with agricultural production (Aye & Odhiambo, 2021).

Figure 1. Oil price trends 2017-2022. year (in USD)



Most of the authors researched the impact of oil shocks on stock prices (Dai & Kang, 2021; Jingjian et al., 2023). Figure 1 shows the movement of the price of Brent oil in the period from 2017-2022. year. As we can see based on the results obtained during the Covid-19 pandemic, there was a significant drop in the price of oil. Our obtained results are in agreement with results and conclusions reached in his research by McMillan et al (2021), proving the consistency of the findings.

Their focus in this research is primarily on the American market and American companies. Initially, the US market served as the primary catalyst for spillover effects to

other markets. Subsequently, COVID-19 spread rapidly throughout the United States, mirroring the crisis that had previously unfolded in China, Italy, and Korea. It is clear that US economic policymakers were well informed about the challenges posed by COVID-19, drawing from the experiences of these aforementioned nations. Not only have the financial markets of the United States of America been affected by COVID-19, but other major financial markets have also been significantly disrupted by the drop in oil prices. After the outbreak of the pandemic, there was a significant drop in the price of oil by 30% within two months (Sharif et al, 2020).

Based on their knowledge, so far no work has dealt with the implementation of research in this sense. Quantile regression approach and Least Square Method - OLS approach will be used in this research.

This paper is organized into several segments. After the previously given introduction, there follows a chapter in which there is an explanation of the methodology used in this research. After that segment of the research, the empirical results are shown, while the last segment gives the conclusion of the research, followed by a list of the literature used.

Material and methods

Linear regression is a statistical technique used to model the linear relationship between a dependent variable and one or more independent variables, including an error component. The fit and regression results improve as the value of the error term decreases. The ordinary least squares (OLS) method provides estimates for the conditional mean of the dependent variable based on the specified independent variables. The efficiency of ordinary least squares (OLS) decreases noticeably when applied to extreme values in distributions or in the context of detailed analysis. The concept of quantile regression was first developed by Koenker & Bassett (1978). This approach is based on the use of conditional quantile functions. Quantile regression is a statistical method used to estimate the conditional median or conditional quartile of a dependent variable, given a set of independent factors. In an ordinary least squares (OLS) context, the regression coefficients of the independent variables represent the magnitude of the effects resulting from a one-unit increase in the respective predictor variables. Similarly, the coefficients obtained from quantile regression represent the changes in a given quantile when the predictor variables experience a one-unit change. Quantiles and percentiles are used to divide data samples into different categories (Maiti, 2021). The OLS model focuses mostly on the conditional mean of the dependent variable, the application of the quantile regression model allows us a more complete way of the variability of the dependent variable in specific quantiles. In situations where the disturbance moment is not normally distributed, the application of quantile estimators allows us a higher degree of efficiency than the OLS estimator.

At time t, for a given X variable, while the quantile regression of the y variable can be expressed as follows:

$$Q_{yt}(\tau|X) = a(\tau) + x'_t \beta_{(\tau)}$$

According to Koenkar and Bassett (1978), Qyt(τ|x) represents the τ conditional quantile of yt, α(τ) indicates effects not observed in the quantile model, Ks′t = (k1t, k2t,…, kmt) includes all independent variables kkt(k = 1, 2..., m) that represent the cause of change (Cao, Xie, 2023).

The data set included in this research includes daily data from two different sectors of the economy. Daily data were converted to logarithmic values using the following equation:

$$r_{it} = 100 \, x \ln(p_{it} / p_{it-1})$$

In this way, they corrected the disparities that manifest themselves within the time series. Specifically, all observed variables are matched to correct for dimensional differences across the time series. In other words, all variables are treated as growth rates. The data was obtained from stooq.com statistical records, with the research period from 2017 to 2022. This research period also includes the period of the COVID-19 pandemic, and they will observe its impact on shocks in the oil market, and consequently on the impact of oil on the price of company shares. The survey included 9 companies from three different industries, the oil, food and agricultural industries. The main focus of our research is on the US market and US companies for several reasons. Initially, the US market played a central role in causing spillover effects in other markets. After that, COVID-19 spread rapidly across the United States, similar to what happened earlier in China, Italy, and Korea. US economic policymakers have demonstrated a clear understanding of the challenges posed by COVID-19, drawing on insights from the experiences of other nations (Shariff et al, 2020).

Results of empirical research

Table 1 shows the descriptive statistics of the time series.

Table 1. Descriptive statistics

	Mean	Sd	Min	Max	Skewness	Kurtosis	Jarque - Bera	Dickey-Fuller GLS
Panel A. Oil companies								
BPL Plc	0.001	0.916	-9.413	8.488	-0.268	18.831	15829.17	-36.888
Petroleo Brasileiro SA	0.016	1.468	-16.108	8.547	-1.698	20.849	20757.96	-11.932
Total Energies SE	0.013	0.845	-8.526	6.174	-0.980	20.697	23606.26	-25.893
Panel B. Food companies								
General Mills INC	0.015	0.633	-5.262	4.837	-0.685	12.047	5195.149	-8.432

	Mean	Sd	Min	Max	Skewness	Kurtosis	Jarque - Bera	Dickey-Fuller GLS
Kraft Heinz Co	-0.014	0.843	-13.943	7.733	-2.770	62.656	225694.6	-8.652
Tyson Food INC	0.003	0.799	-6.653	8.884	0.212	20.550	19377.57	-2.989
Panel C. Agricultural companies								
Agco Corporation	0.028	1.003	-9.034	7.922	-0.375	12.663	5907.351	-1.449
Bunge Limited	0.014	0.893	-6.694	6.670	-0.516	11.621	4740.782	-6.353
Deere & Company	0.033	0.862	-6.586	5.441	-0.557	9.877	3519.120	-2.993

JB stands for the Jarque-Bera coefficients of normality, DF-GLS is Dickey-Fuller generalized least squares test with 10 lags assuming only constant, and 1% and 5% critical values are 2.566 and 1.941, respectively.

Sourse: Own calculation

As they can conclude that time series are primarily stationary, that is, the mean value of the data tends to zero. The companies Petroleo Brasileiro SA and Agco Corporation show the highest degree of riskiness, i.e. dispersion around the mean value. Also, the value of skewness indicates that the tail of the distribution is extended to the left, i.e. there is a negative asymmetry in most of the observed companies. A high value of kurtosis indicates the fact that the values are concentrated within the middle of the distribution, that is, they indicate the existence of extreme shocks. The Jarque-Bera test indicates the non-normality of the observed time series. The Dickey-Fuller GLS test suggests the stationarity of the observed time series.

Results obtained using the Least Square regression - OLS model. The following table shows the results obtained using the Least Square regression - OLS model. By looking at the obtained parameters, they can conclude that most of them are statistically significant. First, they will present the results obtained using the least squares method. In this case, they tried to determine whether there is a strong or weak relationship between the observed independent variable Brent oil and the stock price of the observed companies, in this case the dependent variables. In their work, they dealt with the price of shares of companies from two industrial sectors, the first one is the oil industry, and the second one is the agricultural industry. In the majority of observed companies, they observe the statistical significance of the obtained data.

Table 2. Least Square regression - Brent oil and companies from the oil, agricultural and food industries

Companies	Least Squere regression OLS
BPL Plc	0.416 (0.019)***
Petroleo Brasileiro SA	0.597 (0.031)***
Total Energies SE	0.402 (0.018)***
General Mills INC	0.023 (0.015)***
Kraft Heinz Co	0.138 (0.019)***
Tyson Food INC	0.141 (0.018)***
Agco Corporation	0.094 (0.021)***
Bungle Limited	0.115 (0.016)***
Deere & Company	0.161(0.017)***

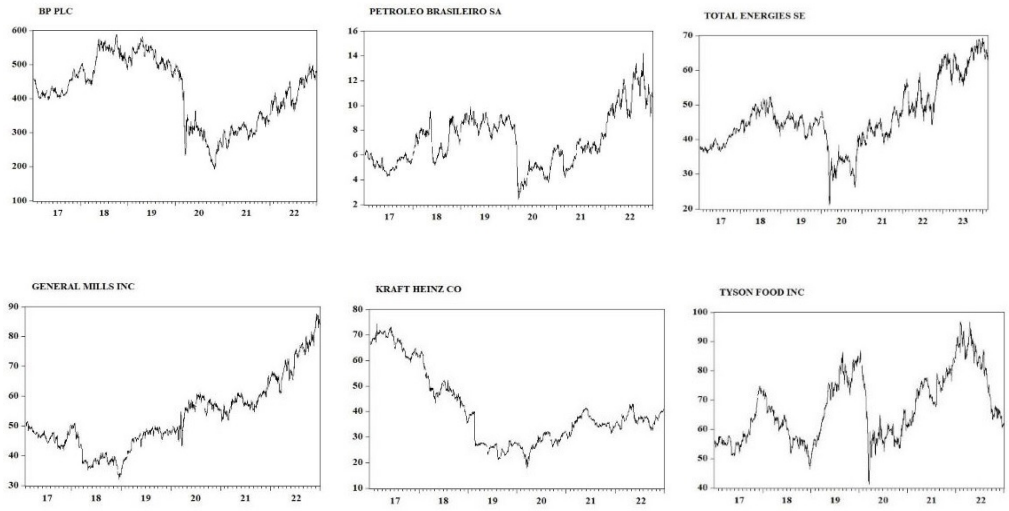
Note: ***, **, * represent statistical significance at the 1%, 5% and 10% level, respectively; numbers in parentheses represent standard error

Source: Own calculation

The results obtained and shown in table 2 indicate that the results of companies from the agricultural and food industry are several times lower than companies from the oil industry, which is economically logical. This happens depending on whether the companies are more or less energy dependent on oil. Given that companies from the oil industry are more energy dependent on oil, based on the parameters we can see a stronger effect on their share prices.

The use of the OLS regression method, which is used frequently, can be sensitive if the data does not conform to the assumptions, which can result in unreliability. Among other things, there is the disadvantage of handling non-linear relationships and missing values.

Figure 2. Graphic representation of changes in share prices of observed companies from the oil, agricultural and food industries



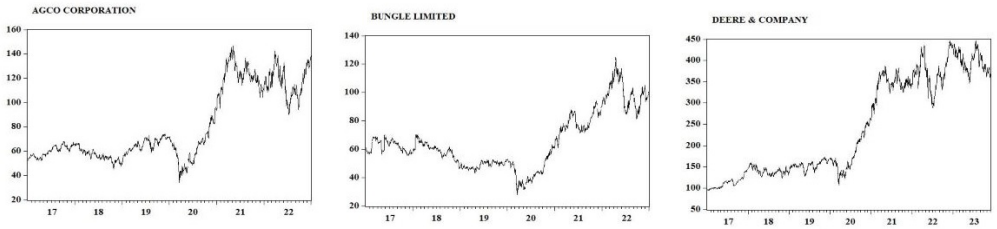


Chart 2 gives them a view of the change in share prices of the observed 9 companies from the oil, agricultural and food sectors in relation to changes in the price of Brent oil. As they can see, the Covid-19 pandemic has significantly affected the observed companies, and the majority of companies have recorded a drop in the price of the observed companies' shares. Lee (2022) in his research determines that COVID-19 has a significant impact on stock price volatility in the banking sector, as well as that there is a strong spillover effect on America's economic and financial systems. Insaidoo et al (2023) dealt in their research with the cause of changes in the financial market in developing countries (Brazil, India, Kenya and South Africa) and although they consider that a deeper research of the financial market is limited, they confirm that the COVID-19 pandemic is the biggest cause of changes in the financial market. As Tian et al (2023) confirms in their research, predicting the price of crude oil is of great importance considering that it is one of the world's most important commodities and sources of energy. Its influence is very uncertain, especially during the pandemic, but also under the conditions of the Russian-Ukrainian conflict.

Results obtained using the quantile regression model. In the next part of the research, they will analyze the results obtained through the estimated quantile parameters, which are shown in the interval from $\tau^{0.05}$ to $\tau^{0.95}$. As they can see

the following table presents the obtained research data, while the Figure shows the obtained quantiles. For most observed quantiles, the obtained parameters are statistically significant, ie the probability is greater than 99%. The application of quantiles gives them the opportunity to see what shocks are in the oil market, that is, shocks in a recession, in stable economic growth, as well as in a state of high economic growth. They will present seven quantiles, i.e. quantiles $\tau^{0.05}$ and $\tau^{0.15}$ indicate the state of the economy in recession, $\tau^{0.35}$, $\tau^{0.50}$ and $\tau^{0.65}$ indicate the state of stable economic growth, while quantiles $\tau^{0.8}$ and $\tau^{0.95}$ indicate the state of high economic growth. In the table, they have presented the impact of shocks from the Brent oil market on the price of shares of companies from the oil, agricultural and food industries, that is, they will look at 9 companies. The period covered by the research is 2017-2022. where, among other things, changes are expressed as a result of the COVID-19 pandemic. The results include data before the pandemic, during the pandemic, and after it.

Table 3. Representation of quantile regression - Brent oil and the price of shares of companies from the oil and agricultural industry

Companies	0.05	0.20	0.35	0.50	0.65	0.80	0.95
BPL Plc	0.496 (0.027)***	0.424 (0.030)***	0.390 (0.026)***	0.382 (0.033)***	0.366 (0.028)***	0.376 (0.030)***	0.361 (0.036)***
Petroleo Brasileiro SA	0.665 (0.027)***	0.519 (0.039)***	0.451 (0.040)***	0.480 (0.036)***	0.505 (0.040)***	0.534 (0.051)***	0.501 (0.141)***
Total Energies SE	0.470 (0.023)***	0.404 (0.030)***	0.405 (0.026)***	0.396 (0.022)***	0.381 (0.022)***	0.379 (0.029)**	0.345 0.058
General Mills INC	0.109 (0.052)***	0.021 (0.013)***	0.031 (0.013)***	0.017 (0.017)***	-0.005 (0.018)***	0.006 (0.017)**	0.069 (0.015)***
Kraft Heinz Co	0.220 (0.014)***	0.127 (0.027)***	0.093 (0.016)***	0.094 (0.016)***	0.077 (0.022)***	0.071 (0.024)***	0.096 (0.021)*
Tyson Food INC	0.226 (0.066)***	0.153 (0.036)***	0.124 (0.017)***	0.103 (0.027)***	0.078 (0.022)***	0.054 (0.020)***	0.056 (0.035)
Agco Corporation	0.278 (0.070)***	0.262 (0.026)***	0.267 (0.032)***	0.181 (0.038)***	0.189 (0.028)***	0.206 (0.024)***	0.193 (0.042)***
Bunge Limited	0.197 (0.044)***	0.109 (0.016)***	0.062 (0.026)***	0.067 (0.031)***	0.071 (0.031)***	0.070 (0.033)***	0.144 (0.070)***
Deere & Company	0.296 (0.072)***	0.272 (0.028)***	0.191 (0.025)***	0.180 (0.030)***	0.185 (0.024)***	0.209 (0.044)***	0.187 (0.040)***

Note: ***, **, * represent statistical significance at the 1%, 5% and 10% level, respectively; numbers in parentheses represent standard error.

Source: Own calculation

Observing the obtained results, they will first analyze the company from the oil industry - BPL Plc. It is interesting to note that the estimated quantile parameters on the left and right sides of the distribution $\tau^{0.05}$ and $\tau^{0.95}$ are the highest in companies from the oil industry, which leads them to conclude that Brent oil has the greatest impact on those companies that have a higher level of energy dependence, that is, with those companies that are looking for a much higher level of energy compared to other industries. Thus, they can see that at the observed quantile $\tau^{0.05}$ $\tau^{0.20}$ at the moment of a drop in the price of oil by 1%, there was also a drop in the price of shares of BPL Plc by 0.49% and 0.42%. The conditions of stable economic growth are characterized by quantiles that depict a lower level of influence of oil on company share prices. In a period of high economic growth, that is, the quantile parameters $\tau^{0.80}$ and $\tau^{0.95}$ indicate that if there is a 1% increase in the price of Brent oil, it will contribute to the increase in the price of the company's shares by 0.37% and 0.36%, respectively.

The next observed company is Petroleo Brasileiro SA, and they can see that at the observed quantile $\tau^{0.05}$ and $\tau^{0.20}$, at the moment of a drop in the price of oil by 1%, there was also a drop in the share price of Petroleo Brasileiro SA by 0.66% and 0.52%. The conditions of stable economic growth are illustrated by the quantiles $\tau^{0.35}$, $\tau^{0.50}$ and $\tau^{0.65}$, and an increase in the price of Brent oil by 1% is likely to be followed by an increase in the price of Petroleo Brasileiro SA shares by about 0.45%, 0.48% and 0.50%, which implies that there is positive association between these two markets. In the conditions of high economic growth illustrated by the quantiles $\tau^{0.80}$ and $\tau^{0.95}$, a 1% increase in Brent oil contributes to an increase in the company's share price by 0.53% and 0.50%, respectively.

The next observed company is Total Energies SE, and they can see that at the observed quantiles $\tau^{0.05}$ and $\tau^{0.20}$ at the moment of a drop in the price of oil by 1%, there was also a drop in the price of shares of Total Energies SE by 0.47% and 0.40%. . In the conditions of stable economic growth and the corresponding quantiles, the impact of the price of Brent oil on the price of the company's shares is observed at 0.40%, 0.39% and 0.38%. In conditions of high economic growth illustrated by the quantiles $\tau^{0.80}$ and $\tau^{0.95}$, a 1% increase in Brent oil contributes to an increase in the company's share price by 0.37% and 0.34%, respectively.

The company from the food industry that they looked at next is General Mills INC, and they can see that at the observed quantile $\tau^{0.05}$ and $\tau^{0.20}$ at the moment of a drop in the price of oil by 1%, there was also a drop in the price of shares of General Mills INC by 0.10% and 0 .02%. In conditions of stable economic growth, a weaker influence of the price of Brent oil on the price of the company's shares is observed in 0.03% and 0.01% compared to the other quantiles they observed. In the conditions of high economic growth depicted by the quantiles $\tau^{0.80}$, the impact of shocks from the oil market is not pronounced, while on the quantile $\tau^{0.95}$ and 0.06%, respectively.

The company from the food industry that they observed next is Kraft Heinz Co, and they can see that at the observed quantile $\tau^{0.05}$ and $\tau^{0.20}$ at the moment of the drop in the price of oil by 1%, there was also a drop in the price of shares of Kraft Heinz Co by 0.22% and 0. , 12%. The conditions of stable economic growth are illustrated by the quantiles $\tau^{0.35}$, $\tau^{0.50}$ and $\tau^{0.65}$, and an increase in the price of Brent oil by 1% is likely to be accompanied by an increase in the price of the company's shares by about 0.09%, 0.09% and 0.07%, which implies that there is a weaker positive association between the two markets. In conditions of high economic growth illustrated by quantiles $\tau^{0.80}$ and $\tau^{0.95}$, a 1% increase in Brent oil contributes to an increase in Kraft Heinz Co's stock price by 0.07% and 0.09%, respectively.

The company from the food industry that we looked at next is Tyson Food INC, and they can see that at the observed quantile $\tau^{0.05}$ and $\tau^{0.20}$ at the moment of the drop in the price of oil by 1%, there was also a drop in the price of shares of Tyson Food INC by 0.22% and 0. , 15%. The conditions of stable economic growth are illustrated by the quantiles $\tau^{0.35}$, $\tau^{0.50}$ and $\tau^{0.65}$, and an increase in the price of Brent oil by 1% is likely to be followed by an increase in the price of the company's shares by about 0.12%, 0.10%

and 0.07%, which implies that there is a weaker positive association between the two markets. In conditions of high economic growth depicted by the $\tau^{0.80}$ and $\tau^{0.95}$ quantiles, a 1% increase in Brent oil contributes to a 0.05% and 0.05% increase in Tyson Food INC's share price, respectively.

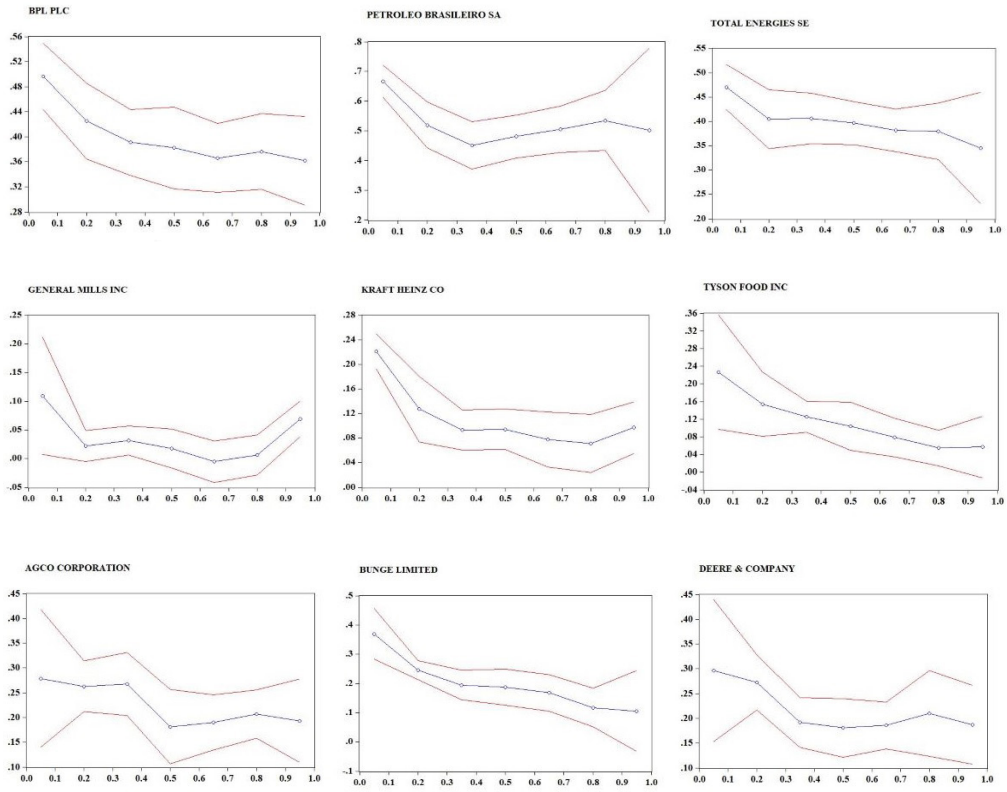
The company from the agricultural industry that they observed is Agco Corporation, and they can see that at the observed quantiles $\tau^{0.05}$ and $\tau^{0.20}$ at the moment of a drop in the price of oil by 1%, there was also a drop in the price of shares of Agco Corporation by 0.27% and 0.26% . The conditions of stable economic growth are illustrated by the quantiles $\tau^{0.35}$, and an increase in the price of Brent oil by 1% is likely to be followed by an increase in the price of the company's shares by about 0.26%, while the quantiles $\tau^{0.50}$ and $\tau^{0.65}$ show the impact of shocks from the oil market by 0.18 % and 0.18%. In conditions of high economic growth illustrated by quantiles $\tau^{0.80}$ and $\tau^{0.95}$, a 1% increase in Brent oil contributes to an increase in Agco Corporation's stock price by 0.20% and 0.19%, respectively.

The company from the agricultural industry that they looked at next is Bunge Limited, and they can see that at the observed quantile $\tau^{0.05}$ and $\tau^{0.20}$ at the moment of the drop in the price of oil by 1%, there was also a drop in the price of Bunge Limited's shares by 0.19% and 0.10 %. The conditions of stable economic growth are illustrated by the quantiles $\tau^{0.35}$, $\tau^{0.50}$ and $\tau^{0.65}$, and an increase in the price of Brent oil by 1% is likely to be followed by an increase in the price of the company's shares by about 0.06%, 0.06% and 0.07%, which implies that there is a positive association between these two markets. In conditions of high economic growth, which are illustrated by the quantiles $\tau^{0.80}$ and $\tau^{0.95}$, oil growth Brent by 1% contributes to the growth of Bunge Limited's share price by 0.07% and 0.14%, respectively.

The next agricultural company that they looked at next is Deere & Company, and they can see that at the observed quantile $\tau^{0.05}$ and $\tau^{0.20}$ at the moment when the price of oil fell by 1%, the share price of Deere & Company fell by 0.29% and 0. , 27%. The conditions of stable economic growth are illustrated by the quantiles $\tau^{0.35}$, $\tau^{0.50}$, $\tau^{0.65}$, and an increase in the price of Brent oil by 1% is likely to be followed by an increase in the price of the company's shares by about 0.19%, 0.18%, 0.18%, which implies that there is a positive correlation between these two markets. In conditions of high economic growth, which are depicted by the quantiles $\tau^{0.80}$ and $\tau^{0.95}$, they also observe that there is an evident influence of the price of oil on the price of shares by 0.20% and 0.18%.

As they can see in the conducted research, more intense effects are found in the industry that is more energy dependent on oil, that is, in the oil industry. Also, the obtained results suggest that the spillover effects of shocks from the oil market on the price movement of shares of the agricultural industry are much smaller. Yang et al (2023) confirms the findings obtained by this research. Namely, the price of oil has a very significant effect on companies from the oil industry compared to other industries.

Figure 3. Graphic representation of quantiles $\tau^{0.05}$ and $\tau^{0.95}$



On the Figure shown, they can see the movement of quantiles in different periods. They can notice that the quantiles located on the left edge of the distribution have a greater degree of change in the period of economic recession, while those quantiles located on the right side indicate that there is a lesser degree of change in the period of high economic growth. The middle quantiles show them the normal state of the economy, in which the price of oil and the price of shares usually move together. As they can see from the graphic representation, companies from the oil industry suggest a much higher degree of sensitivity to shocks in the oil market than companies from the agricultural and food industry. The companies Agco Corporation indicate that there is no influence of the oil price on the price of shares of these companies on the left quantile $\tau^{0.05}$, the company Deere & Company indicates that there is no spillover of shocks from the oil market to the observed company on the quantiles $\tau^{0.65}$, $\tau^{0.80}$ and $\tau^{0,95}$. Tyson Food INC shows that there is no impact of shocks from the oil market on the company's share price, which is confirmed in the parameters they have listed in the table.

Conclusion

This research presents a comprehensive analysis of the impact of Brent oil, the most important commodity at the global level, on the share prices of companies operating in three different sectors, i.e. the oil industry, the agricultural industry and the food industry in the period (before) the COVID-19 era and the war between Russia and of Ukraine. To obtain the research results, they used quantile regression and OLS approach. By applying these two techniques, it is guaranteed that the results achieved will be objective and credible. The obtained results further show the limited applicability of the OLS methodology, while the use of quantile regression provides more comprehensive data. With the aim of the research, they wanted to determine the existence of shocks from the Brent oil market on the share price of companies from three different sectors, and with the obtained results they determined that there is a connection between shocks from the Brent oil market and companies, while the degree of influence is different.

First of all, the results of the research indicate that oil, as the most valuable resource at the global level, affects the price fluctuations of various organizations, as well as their supply, which facilitates the execution of a wide range of economic undertakings. Consequently, it can be concluded that the decrease in the value of Brent oil is particularly noticeable in periods of economic decline, characterized by a significant contraction of economic activity. Moreover, the findings indicate that the fall in the price of Brent oil has a particularly significant impact on companies in the oil industry, making them the most disadvantaged.

The proposal for future research could cover a longer time period of analysis, and therefore a longer-term analysis of the effects of these shocks, cover different sectors, cover some other factors such as geopolitical risks, economic activities or technological innovations. The scientific impact of this research can be seen as a contribution to the understanding of the complex ratio between oil prices and share prices of companies from the oil, food and agriculture industries, providing useful insights for the academic community, analysts and economic policy makers.

Conflict of interests

The authors declare no conflict of interest.

References

1. Adams, Z., Collot, S., & Kartsakli, M. (2020). Have commodities become a financial asset? Evidence from ten years of Financialization. *Energy Economics*, *89*, 104769.
2. Aye, G. C., & Odhiambo, N. M. (2021). Oil prices and agricultural growth in South Africa: A threshold analysis. *Resources Policy*, *73*, 102196.
3. Cabrera, B. L., & Schulz, F. (2016). Volatility linkages between energy and agricultural commodity prices. *Energy Economics*, *54*, 190-203.

4. Cao, G., & Xie, F. (2023). The asymmetric impact of crude oil futures on the clean energy stock market: Based on the asymmetric variable coefficient quantile regression model. *Renewable Energy*, *218*, 119303. https://doi.org/10.1016/j.renene.2023.119303
5. Charfeddine, L., Klein, T., & Walther, T. (2018). Oil price changes and US real GDP growth: is this time different?. *University of St. Gallen, School of Finance Research Paper*, (2018/18).
6. Chen, S. T., Kuo, H. I., & Chen, C. C. (2010). Modeling the relationship between the oil price and global food prices. *Applied Energy*, *87*(8), 2517-2525.
7. Dai, Z., & Kang, J. (2021). Bond yield and crude oil prices predictability. *Energy Economics*, *97*, 105205.
8. Dong, M., Chang, C. P., Gong, Q., & Chu, Y. (2019). Revisiting global economic activity and crude oil prices: A wavelet analysis. *Economic Modelling*, *78*, 134-149.
9. Eissa, M. A., & Al Refai, H. (2019). Modelling the symmetric and asymmetric relationships between oil prices and those of corn, barley, and rapeseed oil. *Resources Policy*, *64*, 101511.
10. Eroğlu, A. Y., Çakır, Ö., Sağdıç, M., & Dertli, E. (2020). Bioactive characteristics of wild Berberis vulgaris and Berberis crataegina Fruits. *Journal of Chemistry*, *2020*, 1-9.
11. Gokmenoglu, K. K., Güngör, H., & Bekun, F. V. (2021). Revisiting the linkage between oil and agricultural commodity prices: Panel evidence from an Agrarian state. *International Journal of Finance & Economics*, *26*(4), 5610-5620. https://doi.org/10.1002/ijfe.2083.
12. Han, L., Zhou, Y., & Yin, L. (2015). Exogenous impacts on the links between energy and agricultural commodity markets. *Energy Economics*, *49*, 350-358.
13. Insaidoo, M., Ullah, A., Dziwornu, R. K., Amoako, S., & Abdul-Mumuni, A. (2023). COVID-19 pandemic and stock market performance: A comparative study of emerging economies. *Heliyon*, *9*(5). https://doi.org/10.1016/j.heliyon.2023.e16054
14. Jahanshahi, H., Uzun, S., Kaçar, S., Yao, Q., & Alassafi, M. O. (2022). Artificial intelligence-based prediction of crude oil prices using multiple features under the effect of Russia–Ukraine war and COVID-19 pandemic. *Mathematics*, *10*(22), 4361. https://doi.org/10.3390/math10224361.
15. Ji, Q., & Fan, Y. (2012). How does oil price volatility affect non-energy commodity markets?. *Applied Energy*, *89*(1), 273-280.
16. Jingjian, S., Xiangyun, G., Jinsheng, Z., Anjian, W., Xiaotian, S., Yiran, Z., & Hongyu, W. (2023). The impact of oil price shocks on energy stocks from the perspective of investor attention. *Energy*, 127987.
17. Koenker, R., & Bassett Jr, G. (1978). Regression quantiles. *Econometrica: journal of the Econometric Society*, 33-50. https://doi.org/10.2307/1913643

18. Kumar, S., Tiwari, A. K., Raheem, I. D., & Hille, E. (2021). Time-varying dependence structure between oil and agricultural commodity markets: A dependence-switching CoVaR copula approach. *Resources Policy*, *72*, 102049. https://doi.org/10.1016/j. resourpol.2021.102049

19. Li, S. (2022). COVID-19 and A-share banks' stock price volatility: From the perspective of the epidemic evolution in China and the US. *Global Finance Journal*, *54*, 100751. https://doi.org/10.1016/j.gfj.2022.100751

20. Maiti, M. (2021). Quantile regression, asset pricing and investment decision. *IIMB Management Review*, *33*(1), 28-37. https://doi.org/10.1016/j.iimb.2021.03.005

21. Mati, S., Radulescu, M., Saqib, N., Samour, A., Ismael, G. Y., & Aliyu, N. (2023). Incorporating Russo-Ukrainian war in Brent crude oil price forecasting: A comparative analysis of ARIMA, TARMA and ENNReg models. *Heliyon*, *9*(11).

22. McMillan, D. G., Ziadat, S. A., & Herbst, P. (2021). The role of oil as a determinant of stock market interdependence: The case of the USA and GCC. *Energy Economics*, *95*, 105102.

23. Naeem, M. A., Karim, S., Hasan, M., Lucey, B. M., & Kang, S. H. (2022). Nexus between oil shocks and agriculture commodities: Evidence from time and frequency domain. *Energy Economics*, *112*, 106148.

24. Oseni, I., & Oladele, K. S. (2018). Oil price shock and agricultural commodity prices in Nigeria: A Non-Linear Autoregressive Distributed Lag (NARDL) Approach. *African Journal of Economic Review*, *6*(2).

25. Pal, D., & Mitra, S. K. (2018). Interdependence between crude oil and world food prices: A detrended cross correlation analysis. *Physica A: Statistical Mechanics and its Applications*, *492*, 1032-1044.

26. Ready, R. C. (2018). Oil prices and the stock market. *Review of Finance*, *22*(1), 155-176.

27. Shahzad, S. J. H., Hernandez, J. A., Al-Yahyaee, K. H., & Jammazi, R. (2018). Asymmetric risk spillovers between oil and agricultural commodities. *Energy Policy*, *118*, 182-198.

28. Sharif, A., Aloui, C., & Yarovaya, L. (2020). COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: Fresh evidence from the wavelet-based approach. *International review of financial analysis*, *70*, 101496. https://doi.org/10.1016/j.irfa.2020.101496

29. Sun, Y., Mirza, N., Qadeer, A., & Hsueh, H. P. (2021). Connectedness between oil and agricultural commodity prices during tranquil and volatile period. Is crude oil a victim indeed?. *Resources Policy*, *72*, 102131. https://doi.org/10.1016/j. resourpol.2021.102131, 1-8.

30. Tian, G., Peng, Y., & Meng, Y. (2023). Forecasting crude oil prices in the COVID-19 era: Can machine learn better?. *Energy Economics*, 106788. https://doi.org/10.1016/j.eneco.2023.106788

31. Umar, Z., Gubareva, M., & Teplova, T. (2021). The impact of Covid-19 on commodity markets volatility: Analyzing time-frequency relations between commodity prices and coronavirus panic levels. *Resources Policy*, *73*, 102164.
32. Vo, D. H., Vu, T. N., Vo, A. T., & McAleer, M. (2019). Modeling the relationship between crude oil and agricultural commodity prices. *Energies*, *12*(7), 1344.
33. Vu, T. N., Ho, C. M., Nguyen, T. C., & Vo, D. H. (2020). The determinants of risk transmission between oil and agricultural prices: an IPVAR approach. *Agriculture*, *10*(4), 120.
34. Wang, X., Li, X., & Li, S. (2022). Point and interval forecasting system for crude oil price based on complete ensemble extreme-point symmetric mode decomposition with adaptive noise and intelligent optimization algorithm. *Applied Energy*, *328*, 120194. https://doi.org/10.1016/j.apenergy.2022.120194.
35. Yip, P. S., Brooks, R., Do, H. X., & Nguyen, D. K. (2020). Dynamic volatility spillover effects between oil and agricultural products. *International Review of Financial Analysis*, *69*, 101465.
36. Zafeiriou, E., Arabatzis, G., Karanikola, P., Tampakis, S., & Tsiantikoudis, S. (2018). Agricultural commodities and crude oil prices: An empirical investigation of their relationship. *Sustainability*, *10*(4), 1199.
37. Zahraee, S. M., Shiwakoti, N., & Stasinopoulos, P. (2022). Agricultural biomass supply chain resilience: COVID-19 outbreak vs. sustainability compliance, technological change, uncertainties, and policies. *Cleaner Logistics and Supply Chain*, *4*, 100049.
38. Yang, J., Li, Y., & Sui, A. (2023). From black gold to green: Analyzing the consequences of oil price volatility on oil industry finances and carbon footprint. *Resources Policy*, *83*, 103615. https://doi.org/10.1016/j.resourpol.2023.103615