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The Impact of Russia–Ukraine Conflict on the Crude Oil Prices

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ABSTRACT

This paper investigates the properties of the crude oil prices in the context of the Ukraine- Russia conflict by using statistical techniques based on long memory and fractional integration. In order to understand the volatility of West Texas Intermediate crude oil prices, data from Federal Reserve Bank of St. Louis for the period September 12, 2012 to September 12, 2022 are used. The results using unit root tests indicate nonstationarity I(1) for the whole sample period but also for the two subsamples created by the war. Additionally, the findings through ARFIMA approach for the whole period as well as pre-Russia-Ukraine war period confirm mean reversion and transitory shock, whereas for the period from the start of Russia-Ukraine war, the shock in crude oil prices is expected to be permanent. There is a need for inter-governmental cooperation in keeping the oil price at its normal value.

Keywords: Russia-Ukraine Conflict, Crude Oil Prices, Persistence, Shocks, Fractional Integration
JEL Classification: C12, C22, Q31, Q41, Q47

1. INTRODUCTION

Crude oil is regarded as a global commodity, making it one of the most traded products worldwide. As a result, changes in crude oil prices have a significant impact on the economic health of countries. Additionally, since crude oil price have such important role in global economy, there are numerous studies analyzing its recent volatilities. Behavior of crude oil price is dependent from many events that have possibility to interfere to the normal production conditions like military conflicts and geopolitical events with or in the producer oil countries; therefore, there is persistence, structural breaks and other issues like long memory in the oil prices series that should be taken into account (Monge et al., 2017a). Exogenous shocks have generally increased price persistence in the EU27 (Caporale et al., 2024). Policy alignment could strengthen the EU's resilience to major shocks (Imeri, et al., 2025; Imeri and Gil-Alana, 2024).

According to OPEC (2022) the current war between Russia and Ukraine that started on February 20, 2022, have impacted in supply and demand of crude oil that thoroughly changed the equilibrium of the price itself. The latest decisions from OPEC and non-OPEC Ministerial Meeting (held on August 03, 2022) are to increase oil production by 0.1 thousand barrels per day for the month of September 2022. Whereas there have been comprehensively a lot of views explaining the impact of different kinds of uncertainties on oil prices, yet, to the best of our knowledge, there are no empirical studies examining the relationship between the Russia-Ukraine war and instability in crude oil prices. For this reason, we endeavor to fill the gap in the literature by giving specific consideration to the temporary and long-lasting shocks. Therefore, the aim of this study is to analyze the characteristics of persistence in crude oil price series. Undoubtedly, laying out the novel findings and applying thorough methodology studying impact in crude oil prices from recent crisis will be of great significance to government institutions (policymakers) in one side and researchers in the other.

Considering the above comments, the commitment of this study is double. The initial commitment is that, as far as we know, it represents the first paper that analyzes the time series of crude oil prices throughout the Russia-Ukraine war utilizing day-to-day information. The second is that the applied techniques are in light of fractional integration methods that are broader compared to other standard techniques like the ARMA (Autoregression Moving Average), ARIMA (AutoRegressive Integrated Moving Average) or other models. This study uses daily crude oil prices for West Texas Intermediate (WTI), sourced from FRED, Federal Reserve Bank of St. Louis, as the dependent variable in the model. The empirical results highlight the impact of the Russia-Ukraine conflict on the persistence of crude oil prices. The remainder of the paper is structured as follows: Section 2 reviews recent studies on the relationship between conflicts and oil prices. Section 3 presents the model, fractional integration, and the empirical results. Section 4 provides a brief discussion of the dataset, illustrated with a time series plot, while Section 5 covers the discussion of the results. Finally, Section 6 offers the concluding remarks.

2. LITERATURE REVIEW

Various examinations endeavored to give sense of the connection among uncertainties and changes in crude oil prices. One part of the studies is focused on economic policy uncertainty and oil price dynamics. In this case, Lin and Bai (2021) empirically examined the relationship between oil prices and the recently developed economic policy uncertainty indices using a time-varying parameter vector autoregression (VAR) framework. The authors suggest that economic policy uncertainty reveals varying responses to oil price shocks, although oil prices themselves react negatively to uncertainty. Similarly, Sharif et al. (2020) investigated the relationship between oil price volatility and economic policy uncertainty, also considering COVID-19, the stock market, and geopolitical risk through Granger causality tests. They found that oil price shocks influence geopolitical risk, economic policy uncertainty, and stock market instability. Meanwhile, Zhang and Yan (2020) explored the effect of economic policy uncertainty on crude oil prices through a DCC-GARCH model to find a significant negative relation of US economic policy uncertainty with the West Texas Intermediate crude oil returns.

The other part of the studies is focused on the relation of other uncertainties and crude oil prices. Gil-Alana and Monge (2020) investigated the impact of COVID-19 on crude oil prices through a fractional integration model and conclude that the crude oil price series is mean returning. Monge et al. (2017b) explore the relationship between US shale oil production and WTI oil price volatility using a wavelet modeling approach.

The results show that in the first period 2003-2009 shale oil production and prices are positively correlated, whereas afterwards negatively related. Another study analyzing the impact of oil prices in the stock market of Nigeria is analyzed by Gil-Alana and Yaya (2014), by also proposing fractional integration and obtaining a strong positive correlation. Political events and geopolitical reasons are part of variable factors of oil price volatility (Demirbas et al., 2017). Chen et al., 2016 suggested that political risk of OPEC (Organization of the Petroleum Exporting Countries) members impact Brent crude oil prices especially if this risk is coming from Middle East OPEC members as well as the internal conflicts are main factor to the oil price oscillations. Related to macroeconomic uncertainty to shocks on worldwide oil production, both oil supply and demand shocks are significant drivers (Sheng et al., 2020). In this regard, if macroeconomic uncertainty increases, it impacts on increase of oil price instability (Van Robays, 2016). Moreover, Zavadska et al. (2020) determined that interruptions on supply and demand are directly related to higher levels of oil prices elasticity during crisis.

Several studies have examined the relationship between energy prices and regional conflicts (wars) using various models. Guo and Ji (2013) applied cointegration and the modified EGARCH model, finding a long-term equilibrium relationship between oil prices and long-term market concerns regarding oil prices and demand. Estrada et al. (2020) developed the "War Oil Crisis Simulator (WOC-Simulator)" to assess the impact of a conflict between the US and Iran on global oil price volatility. Their analysis revealed that a conflict between the US and its allies on one side and Iran on the other would have a significant impact on global oil prices. Su et al. (2021) examined the relationship between geopolitical risk and oil prices using full-sample and subsample rolling-window bootstrap Granger causality tests. They found that wars tend to drive up oil prices, but low geopolitical risk does not lead to a rapid decline in oil prices. Sun (2022) examined similarities and differences between the two Gulf wars, and found oil price to fall as well as predicting that Russia-Ukraine war would likewise bring down the oil price.

3. DATA AND METHODOLOGY

3.1. Data

To analyze the Russia and Ukraine conflict on the crude oil prices we use West Texas Intermediate (WTI) crude oil prices, in daily frequency from September 12, 2012 to September 12, 2022. The time series have been obtained from economic data of the Federal Reserve Bank of St. Louis (FRED).

Figure 1 displays the WTI crude oil prices where the total daily observations covered in the time series are 2609. We observe that crude oil prices have dropped sharply in the beginning of 2020, reaching up to minus 40 Dollars per Barrel. This plunge in oil prices was as a result of fear from the spread of COVID-19 pandemic being related to unprecedented decrease in demand. Afterwards the oil prices started to rebound and it finished the year 2020 to about 48 Dollars per Barrel. Additionally, Figure 1 shows that oil prices continuously increased due to many factors, like increase in optimism from COVID-19 vaccines, emerging from lockdowns, major decrease in production of crude oil, hence the price of oil reached to 90 Dollars per Barrel by the end of January 2022. The appearance of Russia–Ukraine war brought to further increase the pressure to the oil price, and as a result it reached the peak for this last 10 years to 120 Dollars per Barrel in mid of June 2022.

3.2. Unit Roots

Augmented Dickey Fuller (ADF) test, based on Fuller (1976) and Dickey and Fuller (1979) has been used to know the stationarity of the data analyzed in the paper. Other methods have also been examined such as the non-parametric one based on the spectral density at the zero-frequency (Phillips, 1987; Phillips and Perron, 1988; Kwiatkowski et al., 1992; Elliot et al., 1996; and Ng and Perron, 2001).

3.3. ARFIMA (p, d, q) Model

To carry out this research, we also employ fractionally integrated methods, which are more flexible that the unit root tests above mentioned. The idea that is behind is that the number of differences to be adopted in the series to render it stationary I(0) may be a fractional value between 0 or 1, or even above 1.

Using a mathematical notation, a time series x_t, $t = 1,2,\ldots$ follows an integrated of order$d$ process (and denoted as $x_t \approx I(d)$) if:

$$(1-L)^d x_t = u_t, \qquad t = 1, 2, \ldots, \tag{1}$$

where d refers to any real value, L indicates to the lag-operator ($Lx_t = x_{t-1}$)) and u_t is a covariance stationary process I(0) where the behavior of the spectral density function is characterized by being positive and finite at all its frequencies.

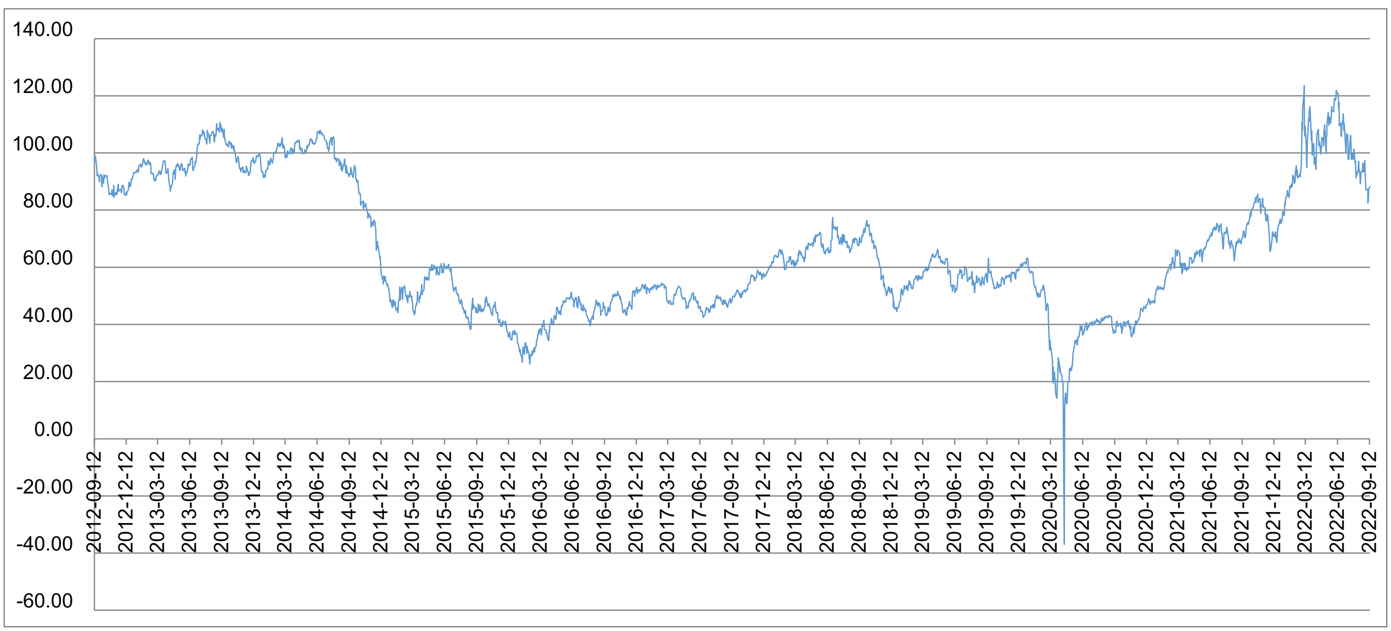
It is said that x_t is ARFIMA (p, d, q) when u_t is ARMA (p, q). So, depending on the value of the parameter d in Equation (1) the reading of the results can be: x_t is anti-persistent if $d < 0$ (Dittmann and Granger, 2002); when $d = 0$ we say that the process is short memory I(0); with a high degree of association over a long time we say that the process displays the property of long memory if $d > 0$; $d < 1$ means that the shock is transitory and the series reverts to the mean; finally, when $d \geq 1$ we expect that the shocks will be permanent.

We follow the methodology based on the likelihood function and proposed by Sowell (1992) instead of other parametric or even semiparametric approaches (Geweke and Porter-Hudak, 1983; Phillips, 1999; Phillips, 2007; Robinson, 1994; Robinson, 1995a; Robinson, 1995b; Shimotsu and Phillips, 2005; Shimotsu and Phillips, 2006; etc.) and to select the most appropriate ARFIMA model we use the Akaike information criterion (AIC) (Akaike, 1973) and the Bayesian information criterion (BIC) (Akaike, 1979).

4. RESULTS

We have first conducted standard unit root test (Dickey and Fuller, 1979; Phillips and Perron, 1988; Kwiatkowski et al., 1992 and Elliot et al., 1996) and the results are displayed in Table 1.

Figure 1: WTI crude oil prices



Source: FRED

Table 1: Unit root tests

	ADF			PP		KPSS	
	(i)	(ii)	(iii)	(ii)	(iii)	(ii)	(iii)
Original Data							
WTI prices	–0.6426	–1.8654	–1.608	–1.7248	–1.443	5.4476	3.5655
Before Russia–Ukraine war							
WTI prices	–0.6178	-1.7709	-1.2492	–1.6772	–1.1233	9.2448	3.4253
After Russia–Ukraine war							
WTI prices	–0.197	–2.8511	–3.0124	–2.8434	–2.9309	0.358*	0.3444

(i) No deterministic components; (ii) intercept, (iii) linear time trend. *Statistic significant at the 5% level

Table 2: Results of long memory tests

Data analyzed	Sample size (days)	Model Selected	d	Std. Error	Interval	I (d)
Original time series						
WTI	2608	ARFIMA (0, d, 0)	0.85	0.013	[0.83, 0.87]	I (d)
Before Russia–Ukraine war						
WTI	2483	ARFIMA (0, d, 0)	0.83	0.013	[0.81, 0.86]	I (d)
After Russia–Ukraine war						
WTI	125	ARFIMA (2, d, 2)	0.52	0.341	[–0.04, 1.08]	I (0), I (1)

The results suggest that the original time series and the two periods analyzed, before and after Russia–Ukraine war, are non-stationary I(1). However, following authors (Diebold and Rudebush, 1991; Hassler and Wolters, 1994; Lee and Schmidt, 1996) and others, it is now a well stylized fact that all unit root methods have very low power if the true data generating process displays long memory or if it is fractionally integrated. Thus, in what follows, fractional orders of differentiation are allowed.

From Table 2 what we observe is that the estimates of the differencing parameter *d* in all cases are lower than 1 ($d < 1$), but only in the original time series and before the Russia and Ukraine conflict we observe a high degree of persistence with all values in the confident bands in the interval (0.5, 1) and showing nonstationary though mean reverting behavior. The time series that includes the entire period analyzed and the subsample that ends when the war begins show the same behavior, where the parameter *d* is 0.85 and 0.83, respectively. These results suggest mean reversion. Thus, shocks are expected to be transitory. On the other hand, if we analyze the behavior of the time series after the war started, we observe that the parameter *d* displays a lower value (0.51) but the confidence interval is so wide that we cannot reject nor the I(0) hypothesis neither the I(1) where the shock is expected to be permanent, causing a change in trend. Due to this non-conclusive results, especially for the post-war data, we also employ another method (Robinson, 1994) and that allows for possible autocorrelation but not of the ARMA form as the one presented above, but based on a non-parametric method where no functional form is presented for the error term. This method (Bloomfield, 1973), has been used in numerous applications of fractional integration to approximate AR structures when describing the short run dynamics of the data. The model considered in this case is the following one,

$$y_t = \beta_0 + \beta_1 t + x_t; \quad (1-B)^d x_t = u_t, \quad t = 1, 2, .., \tag{2}$$

where y_t refers to the original WTI series; β_0 and β_1 are unknown parameters related with a constant and a linear time trend, and x_t is integrated of order d; thus, u_t is I(0) and follows the model of Bloomfield (1973). We report in Table 3 the estimates of the differencing parameter d under three different scenarios: (i) first, we consider the case with no deterministic components, i.e., assuming that β_0 and β_1 are both set up equal to 0 a priori in Eq. (2); (ii) then, we only include a constant, so $\beta_1 = 0$, and (iii) finally, with both coefficients, β_0 and β_1 freely estimated from the data along with d. We mark in bold the selected specification for each of the series samples examined.

We see that for the three samples the model chosen is the one with an intercept but not with a time trend. Using the whole sample size,

Table 3: Estimates of d (and 95% intervals) using the model of Robinson (30)

Series	No deterministic terms	An intercept	An intercept and a linear time trend
WTI	0.96	0.94	0.94
total	(0.93, 1.01)	(0.91, 0.98)	(0.91, 0.98)
WTI	1.00	0.96	0.96
pre-war	(0.95, 1.05)	(0.93, 1.01)	(0.93, 1.01)
WTI	0.96	0.67	0.67
post-war	(0.78, 1.20)	(0.46, 0.96)	(0.46, 0.96)

the estimate of d is 0.94 and the unit root null hypothesis ($d = 1$) is rejected in favour of mean reversion. However, if we separate the sample in two subsamples, one before the war and the other after war, the behavior is significantly different. Thus, before the way, the estimate of d is equal to 0.96 and the unit root null hypothesis cannot be rejected. However, with the data after the war, there is a substantial decrease in the value of d, which is now 0.67 and supporting the hypothesis of mean reversion ($d < 1$).

5. CONCLUSIONS

Oil as a global demand product is very sensitive to the internal or external shocks, especially if the source of the conflict is from the oil producing countries. In this paper we analyze the degree of persistence in West Texas Intermediate (WTI) crude oil prices as a result of Russia-Ukraine war that started in February 2022, whether it will bring temporary or transitory impacts. We investigate the economic data of Federal Reserve Bank of St. Louis in daily frequency for the period from September 12, 2012 to September 12, 2022. By applying standard unit root tests the results of WTI prices after Russia-Ukraine war designate that the impact to the crude oil prices is nonstationary implying permanent shocks.

Additionally, the time series of WTI crude oil prices is also tested through the ARFIMA approach by using the maximum likelihood approach (Sowell, 1992) in two intervals, before and after the Russia-Ukraine war. Moreover, the results for the whole period as well as pre-Russia-Ukraine war period demonstrates mean relapse and the shock is estimated to be temporary, whereas for the period after the war the shock in WTI crude oil prices is predicted to be permanent. Using another approach (Robinson, 1994) that employs a non-parametric method for the autocorrelation of the error term, the results are more precise, and while the unit root null hypothesis cannot be rejected for the pre-war subsample, this hypothesis is decisively rejected in favour of mean reversion with the post-war data. Our findings cannot be lined with other studies, because, so far as of our knowledge is concerned, there is no research done for this issue. The results of this pattern might change once the geopolitics and other unexpected events are focused towards the benefits of consumers. Therefore, inter-governmental active policies are highly recommended to bring back the crude oil prices to the normal values.

6. ACKNOLWEDGEMENT

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