

The Impact of the Outbreak of Russia-Ukraine War on Commodity, Stock and Cryptocurrency Markets

Jacek Karasiński*, Jan Zadrożny**

Purpose: This paper analyzes the impact of the Russian invasion of Ukraine in February 2022 on returns of three groups of assets, i.e., commodities, stocks, and cryptocurrencies.

Methodology: The study was conducted using the event study method which allows for quantifying the reaction of market participants to releases of various types of information.

Findings: The cumulative abnormal returns (CARs) suggest a mostly positive effect of the conflict outbreak on returns of several commodities, especially precious metals. The obtained results suggest that in times of global crises, investors may consider precious metals as a safe haven. The study also indicates that on the event day the examined stock markets reacted negatively to information about the war, but to varying degrees. The Russian aggression against Ukraine did not affect the cryptocurrency markets in a statistically significant manner.

Research limitations: The future studies related to the issue of the impact of Russian aggression against Ukraine on different markets may utilize larger research samples. They also may look for some factors affecting the reaction of markets to information related to the Russian military aggression, like the size of markets, trading volume, or geographical proximity, and economic dependence in the case of equity markets.

Value: The study may provide some practical implications for both investors and regulators, especially in relation to the expected behavior of the markets and their informational efficiency in times of global crisis.

Keywords: event study, global crisis, Russia-Ukraine war, Russian invasion of Ukraine 2022.

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Wpływ wybuchu wojny rosyjsko-ukraińskiej na rynki towarów, akcji i kryptowalut

Cel: w artykule zbadano wpływ rosyjskiej inwazji na Ukrainę w lutym 2022 roku na stopy zwrotu trzech grup aktywów, tj. towarów, akcji oraz kryptowalut.

Metodyka: badanie zostało przeprowadzone za pomocą metodyki analizy zdarzeń, która pozwala na ilościowe określenie reakcji uczestników rynku na publikacje różnego rodzaju informacji.

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Wyniki: skumulowane anormalne stopy zwrotu wskazują głównie na pozytywny wpływ wybuchu konfliktu na stopy zwrotu niektórych towarów, zwłaszcza metali szlachetnych. Uzyskane wyniki sugerują, że w czasach globalnych kryzysów inwestorzy mogą uważać metale szlachetne za aktywa należące do grupy tzw. bezpiecznej przystani. W dniu badanego wydarzenia rynki akcji reagowały negatywnie na informacje o wojnie, ale w różnym stopniu. Rosyjska agresja na Ukrainę nie wpłynęła w sposób statystycznie istotny na rynki kryptowalut.

Ograniczenia: w przyszłych badaniach warto wykorzystać większe próby badawcze, a także dokonać analizy czynników dodatkowo oddziałujących na reakcję rynków na informacje związane z rosyjską inwazją, takich jak wielkość rynku, wolumen obrotu, bliskość geograficzna czy zależność ekonomiczna w przypadku rynków akcji.

Wartość: badanie może stanowić wartość dodaną dla inwestorów i regulatorów, zwłaszcza w odniesieniu do oczekiwanego zachowania rynków oraz ich efektywności informacyjnej w czasie globalnego kryzysu.

Słowa kluczowe: analiza zdarzeń, kryzys globalny, wojna rosyjsko-ukraińska, inwazja Rosji na Ukrainę 2022.

JEL: G10, G12, G14

1. Introduction

Before the outbreak of the war in Ukraine in February 2022, societies and investors around the world faced the resumption of the economic activity after the COVID-19 pandemic. They also faced the fears of a new virus that would stop the entire economies again. On February 24, 2022, Russian armed forces attacked Ukraine and started a human tragedy. As secondary to immense humanitarian concerns, the invasion had a variety of negative effects on different markets and the global economy.

In some studies, the Russia-Ukraine conflict is considered a black swan event (Yousaf et al., 2022), but in fact, this event does not meet the criteria proposed by Taleb (2007). Therefore, the authors of this study do not use the term 'swan event' for the outbreak of Russian-Ukraine war in February 2022, but instead, they sometimes refer to it as a "global crisis". The economies of Russia and Ukraine are shrinking as a direct result of the war and the sanctions imposed on Russia. The effects of this crisis have also started to be felt in the world economy (Mbah & Wasum, 2022).

In our empirical study, we use three groups of assets, that is, commodities, stocks, and cryptocurrencies, to investigate the impact of the outbreak of war on three different types of markets. There are two objectives of this paper. The first objective is to verify whether global crisis events such as war have any impact on commodity, stock and cryptocurrency markets. The

second objective is to compare the reaction of commodity, stock and cryptocurrency markets to global crisis events based on the outbreak of the conflict between Russia and Ukraine in February 2022.

The existing literature provides evidence that precious metals such as gold, silver, and platinum have been considered safe haven assets in crisis situations (Baur & Lucey 2010; Ji et al., 2020; Bourri et al., 2020). In this context, it is worth noticing that Russia is the second biggest gold mining nation in the world, which was responsible for nearly 10% of the global supply in 2020 (World Gold Council, 2022). When it comes to other commodities, Russia is the third largest oil producer in the world, accounting for around 12% of global production (Statista, 2022a), and the second largest producer of natural gas. Total oil and gas revenues in 2021 accounted for 45% of the Russian budget (IEA, 2022). From this perspective, it is relevant to examine how the global crisis affected the commodity markets.

The foregoing studies on the impact of crisis events have shown that stock markets responded mainly negatively to natural disasters (Lee & Chen, 2020), terrorist attacks (Kollias et al., 2011), political uncertainty (Hillier & Loncan, 2019) and the coronavirus pandemic (Baker et al., 2020). An armed conflict on such a scale is a new event in modern history. Therefore, the research question about the magnitude of the reaction of stock markets seems to be relevant.

The advent of cryptocurrencies forms a new paradigm of economic relations in which the exchange of assets takes place without any 'middle-man', i.e., financial institutions. Unlike the fiat currencies, cryptocurrencies are not backed by government authorities or central banks, and are classified as high-risk assets (Borri, 2019). The cryptocurrency market has unique features which set it apart from traditional markets. These features include continuous trading, the possibility of trading anonymously, and transparency. As of February 2022, over 10 000 different cryptocurrencies existed on cryptocurrency markets and the number was still growing (Statista, 2022b). In this paper, the authors focus on twelve largest cryptocurrencies by market capitalization. However, stablecoins are not considered in this study. Bitcoin is a market leader with 39.5% of the market capitalization (CoinMarketCap, n.d.a) while Ethereum contributes to 17.3% (CoinMarketCap, n.d.b).

The study was conducted using the event study method. This method allows researchers to quantify the reaction of market participants to releases of various types of information. It assumes that due to release of economically important information, the actual returns on an asset may deviate from the normal returns estimated on the basis of historical data. The event study method is considered one of the main methods of verification of the semi-strong efficient market hypothesis (Czekaj, 2014).

The conducted study contributes to the academic discussion by delivering a description of the market response to the armed conflict between Russia and Ukraine. Our findings can be an important source of information for both investors and regulators. Regulators would like to know whether the markets are informationally efficient, immune to shocks, and whether they deliver safe and convenient conditions to investors. Investors would like to know which assets are safe and immune to global crises. Some investors would like to know which assets may deliver high positive returns during crisis events.

The impact of the Russia-Ukraine war on the markets has already attracted attention of some researchers. Boungou and Yatié (2022) examine the impact of the conflict on global stock indices. Their results show

negative and significant effects. Boubaker et al. (2022) find negative CARs for the global stock market, but with heterogeneous effects. Diaconășu et al. (2022) investigate the effects of the war outbreak on the global commodity and stock markets. Their study suggests that both gold and bitcoin were not perceived as a safe haven and the impact on the markets vanished quickly. Umar et al. (2022) demonstrate that during the event day none of the metals showed abnormal returns. Fiszeder and Małecka (2022) propose that the reaction to the outbreak of war was very limited and the accuracy of forecasts before and after the start of the war remained at a similar level. Chortane and Pandey (2022) proposed that the outbreak of war had a negative impact on world currencies, especially in regions close to the conflict, such as the Polish zloty.

2. Data and Methodology

The study was performed for 12 selected stock market indices, 12 cryptocurrencies and 12 commodities. The selected stock market indices come from some of the most capitalized stock exchanges in August 2022 according to the World Federation of Exchanges. 4 stock market indices were selected for each of 3 regions proposed by the World Federation of Exchanges, namely, for Americas, APAC and EMEA. The authors of this study aimed to select price return indices which had the highest possible number of constituents. A list of selected indices is presented in Table 1.

12 selected cryptocurrencies constituted the most capitalized ones according to Yahoo Finance as at August 31, 2022. A list of examined cryptocurrencies is presented in Table 2. All cryptocurrencies were quoted in relation to USD. We did not consider stablecoins. Table 2 also presents a list of examined commodities. 4 out of 12 selected commodities were precious metals, i.e., gold, silver, platinum, and palladium, for which the spot fix AM daily prices were retrieved from the website of the London Bullion Market Association. The following commodities were petroleum and other liquids for which the spot prices were retrieved from the U.S. Energy Information Administration website.

The main research method applied in this study is the event study. The event day

Table 1. Stock Market Indices Examined in This Study

Ordinal	Region	Exchange	Index
1	Americas	NYSE	NYSE Composite Index
2	Americas	Nasdaq - US	NASDAQ Composite
3	APAC	Shanghai Stock Exchange	SSE Composite Index
4	APAC	Japan Exchange Group	TOPIX
5	APAC	Shenzhen Stock Exchange	SZSE Composite Index
6	APAC	Hong Kong Exchanges and Clearing	Hang Seng Composite Index
7	EMEA	LSE Group London Stock Exchange	FTSE All-Share Index
8	EMEA	Saudi Exchange (Tadawul)	The Tadawul All-Share Index TASI
9	Americas	TMX Group	S&P/TSX Composite Index
10	EMEA	SIX Swiss Exchange	Swiss All Share
11	EMEA	Deutsche Boerse AG	Classic All Share
12	Americas	B3 - Brasil Bolsa Balcão	Brazil Broad-Based Index

Table 2. Cryptocurrencies and Commodities Examined in This Study

Ordinal	Cryptocurrency	Commodity
1	Bitcoin	Gold
2	Ethereum	Silver
3	Binance Coin	Platinum
4	XRP	Palladium
5	Cardano	Crude Oil WTI
6	Solana	Crude Oil Brent
7	Dogecoin	Conventional Gasoline
8	Polkadot	RBOB Regular Gasoline
9	HEX	No. 2 Heating Oil
10	Wrapped TRON	Ultra-Low-Sulfur No. 2 Diesel Fuel
11	Polygon	Kerosene-Type Jet Fuel
12	Shiba Inu	Propane

is February 24, 2022, that is, the first day of the Russian aggression of Ukraine. We distinguish 16 event windows. The first event window covers only one day, namely, the event day. The following event windows include one day more, up to the 15th day after the event day. In addition, 7 pre-event windows are distinguished. The first pre-event window covers only one day, that is, the day before the event day. The following pre-event windows include one day more, up to the 7th day before the event day.

Estimation window should not be affected by the influence of any other important events. Thus, due to rising tensions related to the Russia-Ukraine conflict, we decided to begin the estimation period 41 days before the event date. A similar approach was proposed by Diaconășu et al. (2022). The estimation window comprises 230 trading days.

Normal returns were estimated with the use of the market model proposed by Sharpe (Formula 1). $ER_{i,t}$ refers to expected returns estimated in the event window for

asset i at time t . Rm_t refers to returns of benchmark, which constitutes a proxy for the market portfolio. For stock indices, the benchmark was MSCI World Index. In the case of commodities, as the benchmark we chose S&P GSCI Cash. When it comes to cryptocurrencies, the benchmark was S&P Cryptocurrency Broad Digital Market Index.

$$ER_{i,t} = \alpha_i + \beta_i Rm_t + \varepsilon_{i,t} \quad (1)$$

When normal returns were estimated, in each event window and pre-event window, we computed the difference between the actual returns and normal returns in order to calculate abnormal returns (AR) and then cumulative abnormal returns (CAR). CAR is a sum of ARs. The statistical significance of CAR was assessed with the use of traditional parametric t-test. All calculations were conducted for daily logarithmic returns.

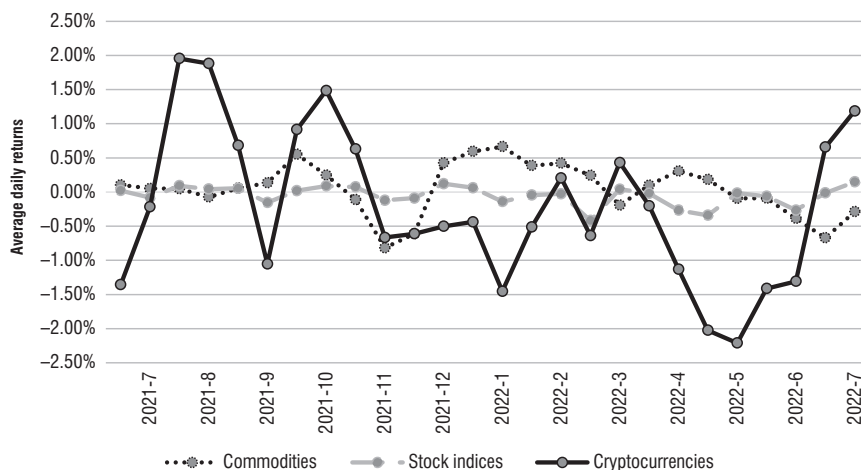
The event study will be supplemented with the examination of behavior of average daily returns and average standard deviation of daily returns calculated for commodities, stock indices, and cryptocurrencies. This analysis will allow us to verify whether any significant changes in returns and volatility occurred in the periods strictly related to the Russian aggression against Ukraine. The average daily

returns and average standard deviation of daily returns were calculated with the use of rolling window methodology, as at the half and the end of a given month, taking into account last 21 daily returns. First, the average daily return and standard deviation of daily returns were calculated for each commodity, stock index, and cryptocurrency, in each window. Then, obtained descriptive statistics were averaged for each window, across commodities, stock indices and cryptocurrencies. First results will be presented as at July 15, 2021. Last results will be presented as at July 31, 2022.

3. Results and Discussion

Figure 1 presents the average daily returns for commodities, stock indices, and cryptocurrencies, calculated with the use of the rolling window methodology. The average returns were calculated as at the half and the end of a given month, taking into account last 21 daily returns. The labels of the horizontal axis refer to months in which the windows end. Returns on commodities significantly increased from November 2021 to January 2022. In the following months, they began to systematically fall. A significant drop can be observed in the window ending at the end of March 2022. During the following month, the returns recovered and then con-

Figure 1. The Average Daily Returns for Commodities, Stock Indices, and Cryptocurrencies



Note. The returns were calculated with the use of the rolling window methodology. The average returns were calculated as of the half and the end of a given month, taking into account last 21 daily returns. The labels of the horizontal axis refer to months in which the windows end.

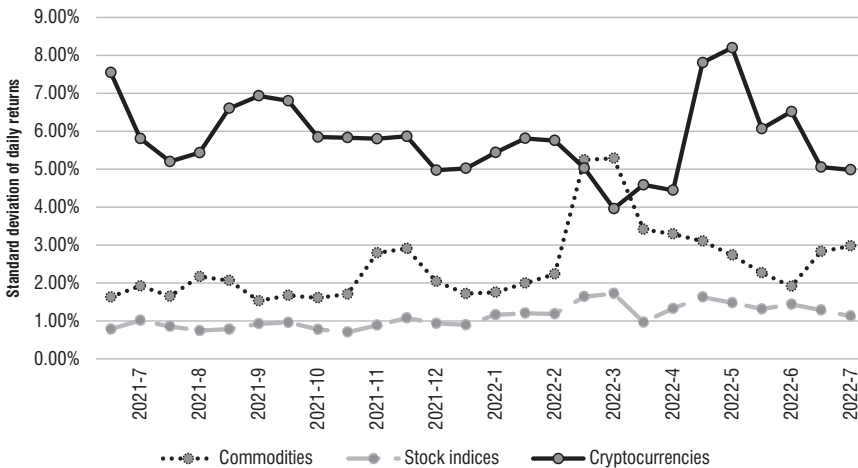
tinued a downward trend. Returns on stock indices seem to oscillate around 0.00% without such significant changes as in the case of commodities. Returns on cryptocurrencies tended to increase from January 2022 to March 2022. However, in April and May 2022, they plunged. In the following months, they recovered significantly. The obtained results suggest no significant changes in behavior of the average daily returns in the periods strictly related to the beginning of the Russian aggression against Ukraine.

Figure 2 presents results similarly to Figure 1. However, this time, the figure pertains to the average standard deviation. In the case of commodities, a rapid and significant increase of volatility can be observed in the window ending in the first half of March 2022. The volatility even increased a little more in the following window ending at the end of March 2022. In the following months, the volatility decreased significantly and returned to levels from the rapid increase described above. Similarly as in the case of the average daily returns, the volatility of stock indices did not change much over the examined period. The most significant changes seemed to occur from March 2022 to May 2022. Regarding cryptocurrencies, their volatility tended to decrease up to the window ending at the

end of April 2022. In two windows ending in May 2022, it increased significantly. However, in the following months, it plunged to the levels from the significant increase described above. The obtained results suggest that only in the case of commodities some significant changes in volatility could be observed in the periods strictly related to the beginning of the Russian aggression against Ukraine.

Moving to the results of the event study conducted for commodities, Table 3 presents cumulative abnormal returns (CARs) and their statistical significance for each pre-event and event window. The obtained results suggest that the most significant impact of the beginning of the Russian aggression against Ukraine on daily returns could be observed in the case of gold, palladium, silver, and RBOB Regular Gasoline. In the case of gold, palladium, and silver, highly significant and positive CARs could be observed only on the event day. Especially in the case of gold and silver, the information on the aggression was quickly reflected in prices. When it comes to RBOB Regular Gasoline, the highly significant impact of information on the Russian aggression was observable not only on the event day but also in the second event window and in the first pre-event window. The negative CARs turned to positive ones

Figure 2. The Average Standard Deviation of Daily Returns for Commodities, Stock Indices, and Cryptocurrencies



Note. The deviation was calculated with the use of the rolling window methodology. Standard deviation was calculated as of the half and the end of a given month, taking into account last 21 daily returns. The labels of the horizontal axis refer to months in which the windows end.

Table 3. Cumulative Abnormal Returns (CARs) and Their Statistical Significance in Particular Windows for the Examined Commodities

Windows	Conventional Gasoline	Crude Oil Brent	Crude Oil WTI	Kerosene-Type Jet Fuel	No. 2 Heating Oil	Propane	RBOB Regular Gasoline	Ultra-Low-Sulfur No. 2 Diesel Fuel	Gold	Palladium	Platinum	Silver
<0,15>	-0.02	0	-0.03	0.07	0.13	-0.01	0.25	0.11	0.02	0.03	-0.07	0.04
<0,14>	-0.02	0	-0.03	0.04	0.1	-0.05	0.31	0.08	0.01	0.07	-0.06	0.04
<0,13>	-0.04	-0.01	-0.03	-0.02	0.04	-0.05	0.29	0.02	0.02	0.03	-0.06	0.02
<0,12>	-0.02	-0.01	-0.02	0.01	0.08	-0.02	0.14	0.06	0.03	0.07	-0.05	0.04
<0,11>	-0.02	0	-0.02	0.02	0.08	0.17	0.15	0.07	0.04	0.2	-0.05	0.04
<0,10>	-0.04	0	-0.02	0.01	0.07	0.18	0.12	0.06	0.04	0.2	-0.03	0.05
<0,9>	-0.02	-0.02	-0.03	-0.01	0.11	0.16	0.13	0.09	0.05	0.21	-0.01	0.05
<0,8>	-0.04	-0.03	-0.06	0.1	0.19**	0.11	0.1	0.17**	0.03	0.18	-0.02	0.02
<0,7>	-0.04	-0.03	-0.06	0.03	0.1	0.12	0.04	0.09	0.03	0.28	-0.01	0.01
<0,6>	-0.03	-0.04	-0.05	0.04	0.08	0.03	0.06	0.08	0.01	0.11	-0.06	-0.01
<0,5>	-0.03	-0.03	-0.04	0.03	0.08	0.12	0.04	0.08*	0.01	0.11	-0.03	0.01
<0,4>	-0.01	0	-0.02	0.05	0.08*	0.06	0.04	0.08**	0	0.07	-0.06	0
<0,3>	0.03	0	0	0.02	0.05	0.08	0.04	0.04	0.01	0.06	-0.04	0
<0,2>	-0.01	0.01	0.01	0.03	0.03	0.06	0.05	0.03	0	0.05	-0.02	0.01
<0,1>	0.01	0.01	0.01	0.02	0.03	0.08	0.08**	0.02	0.01	0.06	-0.02	0.01
<0,0>	0	0	-0.01*	0	0.01	-0.01	0.06***	0	0.04***	0.1***	0.03*	0.05***
<-1,-1>	0.01	0	-0.01	0.01	0	-0.01	-0.05***	0.01	0	-0.01	0	0
<-2,-1>	-0.02	0	-0.03*	-0.01	-0.03	-0.03	-0.02	-0.02	0	0.01	-0.02	0.01
<-3,-1>	-0.01	0	-0.04	-0.01	-0.04	-0.04	-0.02	-0.03	0	0.01	-0.01	0.02
<-4,-1>	0.02	0	-0.04	0	-0.03	-0.02	0.01	-0.02	0.02	0.03	0.04	0.02
<-5,-1>	-0.02	-0.04	-0.05	-0.05	-0.09*	0	-0.04	-0.07*	0.02	0.02	0.05	0.03
<-6,-1>	-0.03	-0.04	-0.05	-0.06	-0.09	0.01	-0.03	-0.08	0.02	0.02	0.05	0.02
<-7,-1>	-0.04	-0.02	-0.05	-0.08	-0.1	0.01	-0.04	-0.09*	0.04	0.05	0.05	0.05

Note. The shortest event window (<0,0>) covers only one day, namely the event day. The following event windows include one day more, up to the 15th day after the event day (<0,15>). The shortest pre-event window (<-1,-1>) covers only one day, namely the day before the event day. The following pre-event windows include one day more, up to the 7th day before the event day (<-7,-1>). ***, ** and * refer to significance at the 1%, 5% and 10% levels, respectively.

starting from the first event window. Some CARs, significant at the level of 10% on the event day, were obtained for Platinum and Crude Oil WTI. In the case of No. 2 Heating Oil and Ultra-Low-Sulfur No. 2 Diesel Fuel, significant CARs were obtained for some pre-event and event windows. How-

ever, no significant CARs were related to windows that were close to the event day. It is worth noting that in the case of No. 2 Heating Oil and Ultra-Low-Sulfur No. 2 Diesel Fuel, the negative CARs in pre-event windows turned into positive ones in event windows.

Table 4. Cumulative Abnormal Returns (CARs) and Their Statistical Significance in Particular Windows for the Examined Stock Market Indices

Windows	Brazil Broad-Based Index (IBrA)	Deutsche Boerse Classic All Share	FTSE All-Share Index	Hang Seng Composite Index	NASDAQ Composite	NYSE Composite Index	S&P/TSX Composite Index	SSE Composite Index	Swiss All Share	SZSE Composite Index	The Tadawul All-Share Index TASI	TOPIX
<0,15>	0.01	-0.05	-0.03	-0.09	0.02	0.01	0.03	-0.08	-0.01	-0.1	-0.01	0
<0,14>	0	-0.04	-0.03	-0.15	0.02	0.01	0.03	-0.09	-0.01	-0.11	-0.02	-0.02
<0,13>	0	-0.05	-0.03	-0.24	0.02	0.01	0.03	-0.12	-0.02	-0.14	-0.03	-0.02
<0,12>	0.02	-0.03	-0.02	-0.17	0.01	0.01	0.04	-0.07	-0.01	-0.1	-0.02	-0.02
<0,11>	0.03	-0.05	-0.03	-0.11	0.02	0.01	0.05	-0.05	-0.03	-0.07	-0.01	-0.03
<0,10>	0.04	-0.08	-0.05	-0.1	0.03	0.01	0.05	-0.05	-0.04	-0.07	-0.01	-0.02
<0,9>	0.04	-0.06	-0.04	-0.12	0.03	0.01	0.04	-0.07	-0.03	-0.1	-0.01	-0.06
<0,8>	0.04	-0.1*	-0.05	-0.1	0.04	0.02	0.05	-0.05	-0.06	-0.08	0.01	-0.05
<0,7>	0.03	-0.11**	-0.06	-0.08	0.03	0.01	0.05*	-0.03	-0.05	-0.05	0	-0.03
<0,6>	0.04	-0.11**	-0.07	-0.06	0.03	0.01	0.03	-0.01	-0.05	-0.03	0	-0.02
<0,5>	0.03	-0.08*	-0.04	-0.04	0.02	0.01	0.01	0	-0.03	-0.02	0	0
<0,4>	0.02	-0.06*	-0.02	-0.05	0.03	0	0.01	0	-0.02	-0.01	-0.01	-0.02
<0,3>	0.01	-0.05*	-0.03	-0.03	0.03	0	0.01	0	-0.01	-0.01	0	0.01
<0,2>	-0.01	-0.03	-0.02	-0.05	0.02	-0.01	0	-0.01	-0.01	-0.01	-0.01	-0.01
<0,1>	-0.01	-0.03*	-0.02	-0.04*	0.02	0	0	-0.01	-0.01	-0.02	-0.02**	-0.01
<0,0>	0	-0.04***	-0.04***	-0.03**	0.03***	0	0	-0.02**	-0.02***	-0.02**	-0.02***	-0.01
<-1,-1>	0.01	0	0.01	0.01	-0.01	0	0	0.01	0.01	0.02*	0	0.01
<-2,-1>	0.03	0.01	0.01	0	-0.01	0	0	0	0.01	0.01	0	0
<-3,-1>	0.02	-0.01	0.01	-0.01	0	0	0.01	0	0.01	0.02	0	-0.01
<-4,-1>	0.02	-0.02	0.01	-0.02	0	0.01	0	0.01	0	0.02	0	-0.01
<-5,-1>	0.02	-0.01	0.01	0	-0.01	0.01	0.01	0.02	0	0.03	0	-0.01
<-6,-1>	0.02	-0.01	0.01	0.01	-0.01	0.01	0	0.02	0	0.03	0.01	0.01
<-7,-1>	0.02	0.01	0.01	0	-0.01	0.01	0	0.02	0.01	0.04	0.02	-0.01

Note. The shortest event window (<0,0>) covers only one day, namely the event day. The following event windows include one day more, up to the 15th day after the event day (<0,15>). The shortest pre-event window (<-1,-1>) covers only one day, namely the day before the event day. The following pre-event windows include one day more, up to the 7th day before the event day (<-7,-1>). ***, ** and * refer to significance at the 1%, 5% and 10% levels, respectively.

When it comes to stock market indices, according to Table 4, a significant impact of information on the Russian aggression was observed for the majority of indices. However, unlike commodities, the impact was mostly negative. For most indices, the impact was highly significant only on the

event day. The Classic All Share index from Deutsche Boerse was an exception here, as a significant and negative impact could be observed in several following event windows.

Regarding cryptocurrencies, according to results presented in Table 5, none of

Table 5. Cumulative Abnormal Returns (CARs) and Their Statistical Significance in Particular Windows for the Examined Cryptocurrencies

Windows	Binance Coin	Wrapped TRON	Bitcoin	Cardano	Dogecoin	Ethereum	HEX	Polkadot	Solana	Shiba Inu	XRP	Polygon
<0,15>	-0.03	-0.18	0.05	-0.02	-0.12	0.08	-0.36	0.06	0.03	-0.17	0.12	0.14
<0,14>	-0.04	-0.16	0.05	-0.03	-0.11	0.07	-0.35	0.08	0.01	-0.16	0.12	0.14
<0,13>	-0.03	-0.15	0.04	-0.03	-0.11	0.05	-0.4	0.06	0.02	-0.16	0.12	0.12
<0,12>	0	-0.12	0.06	-0.01	-0.07	0.06	-0.33	0.08	0.02	-0.13	0.16	0.14
<0,11>	-0.02	-0.11	0.04	-0.03	-0.09	0.03	-0.25	0.06	-0.01	-0.14	0.15	0.1
<0,10>	-0.05	-0.11	0.03	-0.04	-0.11	0.02	-0.12	-0.03	0	-0.15	0.03	0.09
<0,9>	-0.04	-0.12	0.06	-0.03	-0.11	0.02	-0.14	-0.04	0.02	-0.13	0.02	0.11
<0,8>	0.01	-0.06	0.04	-0.03	-0.09	0.03	-0.33	-0.01	0.02	-0.11	0.03	0.08
<0,7>	0.05	-0.03	0.04	-0.01	-0.05	0.03	-0.28	-0.01	0.05	-0.08	0.06	0.09
<0,6>	-0.01	-0.05	0.03	-0.01	-0.06	0.03	-0.25	-0.02	0.06	-0.08	0.03	0.07
<0,5>	0	-0.05	0.06	0.01	-0.06	0.05	-0.18	-0.02	0.09	-0.06	0.02	0.11
<0,4>	-0.03	-0.05	0.06	0.02	-0.06	0.06	-0.17	-0.02	0.12	-0.04	0.01	0.12
<0,3>	-0.04	-0.07	0.05	0.03	-0.07	0.05	-0.06	-0.03	0.08	-0.01	0.02	0.11
<0,2>	-0.02	-0.02	0.07	0.05	-0.04	0.07	-0.01	0.01	0.13	-0.04	0.05	0.11
<0,1>	-0.03	-0.01	0.02	-0.01	-0.04	0.03	0	0.02	0.05	-0.06	0.04	0.03
<0,0>	-0.05	-0.07	0	-0.07	-0.07	-0.03	-0.11	-0.04	0	-0.1	-0.04	0
<-1,-1>	-0.01	0.01	-0.01	0.02	-0.01	0.01	0.01	0	0.01	0.03	-0.01	-0.01
<-2,-1>	0.03	0.02	0.01	0.02	-0.01	0.02	-0.09	0.01	0.01	0.03	-0.02	0.01
<-3,-1>	0.02	0.01	-0.01	0	-0.01	0.06	-0.06	0.02	-0.04	0.02	-0.05	0.02
<-4,-1>	0.03	-0.02	0	-0.02	0	0.04	-0.12	0.03	-0.07	0.02	-0.01	0.02
<-5,-1>	0.05	-0.03	-0.01	0	0.01	0.03	-0.16	0.03	-0.09	-0.01	-0.02	0
<-6,-1>	0.04	-0.03	-0.02	-0.02	-0.01	0.03	-0.19	0.03	-0.1	-0.01	-0.01	-0.01
<-7,-1>	0.04	-0.02	-0.03	-0.02	-0.04	0.04	-0.21	0.02	-0.1	-0.02	-0.03	-0.01

Note. The shortest event window (<0,0>) covers only one day, namely the event day. The following event windows include one day more, up to the 15th day after the event day (<0,15>). The shortest pre-event window (<-1,-1>) covers only one day, namely the day before the event day. The following pre-event windows include one day more, up to the 7th day before the event day (<-7,-1>). ***, ** and * refer to significance at the 1%, 5% and 10% levels, respectively.

cryptocurrencies turned out to be significantly affected by the Russian aggression against Ukraine. CARs of many cryptocurrencies seemed to have high values on the event day. However, they turned out to be statistically insignificant. The insignificance can result from high volatility of returns. Relatively high volatility of cryptocurren-

cies compared to other examined asset types can be seen in Figure 2.

To sum up, a supplementary examination of the behavior of returns and volatility conducted with the use of the rolling window method suggested no significant changes in the periods strictly related to the beginning of the Russian aggression

against Ukraine (except for substantial changes in the volatility of commodities). Surprisingly, the results of the event study suggested that the beginning of the Russian aggression had a statistically significant impact on the returns on many assets. In the case of commodities, the impact was observed especially for RBOB Regular Gasoline, gold, palladium, and silver. A significant impact was positive and could be observed especially on the event day. As far as stock indices are concerned, most examined indices (8 out of 12) turned out to be significantly and mostly negatively affected by the Russian aggression. Again, a significant impact could be observed mainly on the event day. In the case of cryptocurrencies, no statistically significant CARs could be observed. However, the statistical insignificance of CARs may be caused by relatively high volatility of cryptocurrencies compared to commodities and stock indices.

Positive and negative CARs may suggest directions of flows between the markets. In the case of 8 commodities, CARs in the event windows were mostly positive. On the other hand, in the case of stock indices, the reverse was true. When it comes to cryptocurrencies, CARs in the event windows were mostly positive in the case of 4 cryptocurrencies. They were mostly negative in the case of 5 of them. In the case of the rest, it was hard to say. Such results may suggest that the capital escaped from some assets and flew into some assets considered safe. However, such conclusions should be approached with caution due to a low rate of statistically significant results especially for commodities and cryptocurrencies.

When comparing the results received for three different groups of the analyzed assets, the Russian aggression against Ukraine which commenced on February 24, 2022 most significantly (in a statistical manner) impacted stock markets. A significant and negative impact of the Russian aggression on stock markets was also suggested by Boungou and Yatié (2022). The researchers also proposed that the geographical proximity of countries to the conflict additionally exacerbated the negative impact of the conflict outbreak on stock markets. This finding may at least partially explain a clearly more negative reaction of the German stock market observed in this study. However, the level

of dependence of different economies on the economies of Ukraine and Russia may play an even more important role in this matter than geographical proximity itself. According to Diaconășu et al (2022), the German stock market was also harmed severely compared to the other markets. A mostly negative effect of the Russian aggression against Ukraine on the global equity markets was also observed by Bou-baker et al. (2022).

Similarly to Diaconășu et al. (2022), we found that gold was positively affected by the outbreak of the examined conflict. However, unlike them, our results suggest that gold could be perceived as a safe asset during the conflict outbreak, similarly to palladium and silver. Yet, due to positive but insignificant CARs in the event windows, this conclusion should be approached with caution. A positive impact of the conflict outbreak on the returns on precious metals was also proposed by Umar et al. (2022). Unlike Diaconășu et al. (2022) and Umar et al. (2022), our study does not suggest any significant and positive impact of the Russian aggression against Ukraine on fuels, except for No. 2 Heating Oil, RBOB Regular Gasoline.

The results referring to Bitcoin obtained in this study are similar to the results obtained by Diaconășu et al. (2022). Bitcoin turned out not to be significantly affected by the conflict outbreak. However, its CARs were mostly high and positive in the event windows. Such results suggest that Bitcoin and other cryptocurrencies examined in this study should not be perceived as a safe haven during crisis events.

4. Conclusions

The results of the conducted event study suggest a mostly positive effect of the conflict outbreak on the returns of several commodities, especially precious metals. In addition, the obtained results suggest that in times of global crises, investors may consider precious metals as a safe haven. The study also indicates that on the event day, the examined stock markets reacted negatively to information about the war, but to varying degrees. The Russian aggression against Ukraine did not affect the cryptocurrency markets in a statistically significant manner. The statistical insig-

nificance may be due to the relatively high volatility of cryptocurrencies compared to commodities and stock indices. The study may provide some practical implications for both investors and regulators, especially in relation to the expected behavior of the markets and their informational efficiency in times of global crises.

Similarly to the vast majority of other studies that apply the event study methodology, this study considered only daily returns. Other intervals were not taken into account. Future studies related to the issue of the impact of the Russian aggression against Ukraine on different markets may utilize larger research samples. They also may look for some factors affecting the reaction of markets to information related to the Russian military aggression, like the size of markets, trading volume, or geographical proximity and economic dependence in the case of equity markets.

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