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Cryptocurrencies and economic sanctions

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ABSTRACT

This study examines the role of cryptocurrencies in modern War, specifically during the Russia-Ukraine conflict. Utilizing a Time-Varying Parameter Vector Autoregression (TVP-VAR) model, the research assesses the dynamic financial behaviors of cryptocurrencies, focusing on changes in liquidity, safe haven status, and their use in circumventing economic sanctions. The analysis distinguishes financial behaviors across three distinct phases: Pre-Conflict, Conflict, and financial sanctions periods, highlighting the interaction between cryptocurrencies and traditional financial markets. The findings indicate shifts in the role of cryptocurrencies from net transmitters to net receivers of spillovers in both returns and volatility, particularly during the financial sanctions phase. This study provides insights into the integration of cryptocurrencies with traditional financial assets and their potential impact on local economies during military conflicts. The results document the increased liquidity and interconnectedness of cryptocurrencies during military conflict periods and explore their potential use in evading sanctions and supporting War efforts.

1. Introduction

In the landscape of modern military conflict, cryptocurrencies have emerged not just as financial instruments, but as influential factors in the dynamics of military conflict. The Russia-Ukraine conflict has provided stark illustrations of this new reality, revealing a complex and often contradictory roles that digital currencies can play in times of geopolitical unrest (Arasasingham & DiPippo, 2022).

News from various outlets reveal that this military conflict marks the first major conflict where cryptocurrencies have played a prominent role. Not surprisingly, it is emphasized that in response to western sanctions, crypto trading in Russia surged. The volume of transactions involving the Ruble and leading cryptocurrencies has significantly risen (Wilson & Howcroft, 2022). This trend suggests a widespread movement among Russian savers to convert their holdings into cryptocurrencies.

As such, we argue that as economic sanctions can restrict access to global financial markets, diminish the value of the local currency, and increase economic isolation; cryptocurrencies offer a strategic alternative for circumventing these restrictions grounded on their decentralization, anonymity, borderless transactions, resistance to censorship, transaction speed, accessibility, and diversification features. Furthermore, Ivan Chebeskov[1] said "The idea of using digital currencies in transactions for international settlements is being actively discussed" (Reuters, 2022). In essence, this paradigm positions cryptocurrencies not merely as alternative investments but as fundamental instruments in navigating the complexities of global economic sanctions and military conflicts.

Research into the impact of cryptocurrencies within contexts of military conflict reveals interesting insights (Almeida & Gonçalves,

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2023). Studies suggest Bitcoin's resilience against the adverse economic effects precipitated by warfare (Santorsola et al., 2022), alongside observations that cryptocurrency investors seek liquidity in response to war-related developments (Khalfaoui et al., 2023; Theiri et al., 2022). Contrarily, Diaconaşu et al. (2022) and more recently Mo et al. (2025) found that cryptocurrencies, specially Bitcoin, did not serve as a safe haven during the military conflict. Also, Appiah-Otoo (2023) noted a decline in Bitcoin trading volumes as the Russia-Ukraine conflict unfolded. Complementary evidence shows these patterns don't stand still. Mensi et al. (2025) find asymmetric multifractality and regime-dependent efficiency around COVID-19 and also around the Russia-Ukraine conflict. Studies on BRICS equities likewise show that crypto-equity links and the value of crypto as a hedge (relative to gold) change over time (Wang et al., 2025; Wang et al., 2024).

Taken together these findings underscore the intricate challenge of delineating cryptocurrencies' roles in time of military conflict. Their properties appear to be contingent on market conditions and the specific phase of the conflict.

Adding to this complexity, every cryptocurrency brings to the table distinct features. From Bitcoin being frequently proclaimed as 'digital gold,' fulfilling dual roles as both a medium of exchange and a store of value, to Ripple facilitating fast and cost-efficient international transactions, and Monero ensuring transaction anonymity. These diverse functionalities underscore their pivotal roles in scenarios of military conflict, proving to be indispensable tools within the global financial ecosystem.

To empirically understand the role of cryptocurrencies in a military conflict context we explore the dynamic connections of cryptocurrencies. This study employs a TVP-VAR model capturing the time-varying properties of cryptocurrencies returns and volatilities. Additionally, the study focuses the analysis on the financial sanctions period where greater dynamics are evident, offering insights into market behaviour before and during the Russia-Ukraine conflict. This analysis sheds light on returns and volatility predictability across different periods for various cryptocurrencies with different functionalities.

This research diverges from existing studies on cryptocurrencies by uncovering distinctive behavioural patterns over different conflict periods. It conducts a cross-crypto analysis, finding that BTC, ETH and XRP exhibit higher variation from net transmitter to net receivers of spillovers of both returns and volatility, while other cryptos exhibit more constant roles.

A deeper investigation within the beginning of the conflict period (financial sanctions period) reveals a shock-like behaviour when Russia invaded Ukraine, followed by a normalization of that effect dissipated over the subsequent periods. During the financial sanction period cryptocurrencies such as BTC showed a shift towards being a receiver of returns spillovers from Gold, suggesting re-evaluation of what constitutes a "safe-haven" in a digitally interconnected global economy. Additionally, the transition of BTC, ETH, and XRP to net receivers of returns for RUB/USD spillovers suggests that the value of these cryptocurrencies is increasingly influenced by the instability of the Ruble, which was under pressure due to economic sanctions, suggesting a possible capital flight-to-crypto (Wilson & Howcroft, 2022). Inversely, UAH/USD acting as a net receiver from all cryptocurrencies returns spillovers is suggestive of a net inflow of capital from cryptocurrencies into the Ukrainian currency, possibly supporting the Ukrainian military effort (Feingold, 2023).

Our results contribute to extant literature in several ways. Firstly, we extend the work of Santorsola et al. (2022) and Appiah-Otoo (2023), among others that focused on cryptocurrencies' role in a military conflict context. We provide evidence for different types of cryptos, moving beyond the concentration of studies that merely focus on Bitcoin. As such, we explore the impact of different crypto features in the context of military conflict and economic sanctions.

Secondly, this study demonstrates the impact of major military conflicts and economic sanctions on the liquidity of various cryptocurrencies. Different from previous studies (Kamal & Wahlstrøm, 2023) we observe increased liquidity in most cryptocurrencies during the conflict period.

Thirdly, we analyse the time-varying returns and volatility spillovers over different periods (Pre-Conflict, Conflict, and financial sanctions periods). By applying a TVP-VAR model, we unveil different dynamics for different cryptocurrencies. We find shock like behaviour when Russia invaded Ukraine, followed by a normalization of that effect dissipated over the subsequent periods. However, during the financial sanctions period cryptocurrencies become more interconnected with traditional financial markets, revealing a higher total connectedness index (TCI) for both returns and volatility.

Fourthly, different from previous studies (Appiah-Otoo, 2023; Kamal & Wahlstrøm, 2023; Kumar et al., 2023) we enhance the existing research through a bidirectional net spillover analysis for both returns and volatility, examining their fluctuations from the pre-conflict period to the financial sanctions and conflict periods, based on the TVP-VAR model. This approach allows us to capture nuanced shifts in financial dynamics across these distinct phases, for specific cryptocurrencies, offering a deeper understanding of their impact in the context of the conflict.

Finally, we contribute to the scarce literature analysing the potential use of cryptocurrencies to evade economic sanctions. Our findings align with Kamal & Wahlstrøm (2023) and Almeida et al. (2024) suggesting that cryptocurrencies can indeed be potentially used as a means to circumvent Western sanctions imposed on Russia or to provide aid to Ukraine.

2. Methodology and Data

To assess the dynamic connectedness and analyse the degree of return and volatility spillovers in times of economic sanctions, we employ a Time-Varying Parameter Vector Autoregression (TVP-VAR) model (Cunado et al., 2021; Gabauer & Gupta, 2018). This technique is effective for capturing time-varying relationships and the directional flow of influences, making it an appropriate model to analyse markets characterized by continuously changing conditions and interdependencies.

A TVP-VAR model of order p can be written as follows:

$$Y_t = \theta_t Z_{t-1} + \epsilon_t, \epsilon_t\ N(0, \sum\nolimits_t) \tag{1}$$

$$vec(\theta_t) = vec(\theta\omega_{t-1}) + \eta_t, \eta_t\ T(0, \Omega_t) \tag{2}$$

Where $Z_{t-1} = (Y_{t-1},\ Y_{t-2,} \cdots Y_{t-p,})$ is an np × 1 vector, $\theta_t = (\theta_{1t},\ \theta_{2t,} \cdots,\ \theta_{pt})$ is an n × np coefficient matrix with n × n coefficient sub-matrices θ_{it}, i = 1, 2,…, p. ϵ_t is a n × 1 and η_t is a np × 1, that normally distribute error vectors with time-varying variance–covariance matrices $\sum_t$ and Ω_t, that are n × n and np × np , respectively.

The dynamic connectedness approach, is based on the Generalized Forecast Error Variance Decomposition (GFEVD) method as described by Pesaran and Shin (1998). The normalized GFEVD enables the computation of the overall directional connectedness, either from market i to other markets or from other markets to market i (Diebold & Yılmaz, 2014). In line with this, we calculate the following indices to capture the dynamic spillovers across our variables:

$$TCI_t(H) = \frac{\sum_{ij=1, i\neq j}^{n} \widetilde{\vartheta}_{ij,t}(H)}{\sum_{ij=1}^{n} \widetilde{\vartheta}_{ij,t}(H)} \tag{3}$$

$$PCI_{ij,t}(H) = 2\left(\frac{\widetilde{\vartheta}_{ij,t}(H) + \widetilde{\vartheta}_{ji,t}(H)}{\widetilde{\vartheta}_{ii,t}(H) + \widetilde{\vartheta}_{ij,t}(H) + \widetilde{\vartheta}_{ji,t}(H) + \widetilde{\vartheta}_{jj,t}(H)}\right) \tag{4}$$

$$TO_{i\rightarrow j,t}(H) = \frac{\sum_{j=1, i\neq j}^{n} \widetilde{\vartheta}_{ij,t}(H)}{n} \times 100 \tag{5}$$

$$FROM_{i\leftarrow j,t}(H) = \frac{\sum_{j=1, i\neq j}^{n} \widetilde{\vartheta}_{ji,t}(H)}{n} \times 100 \tag{6}$$

$$NET_{it}(H) = TO_{i\rightarrow j,t}(H) - FROM_{i\leftarrow j,t}(H) \tag{7}$$

This research employs daily data[2] spanning from[3] March 18, 2020, to February 28, 2024, covering Bitcoin (BTC), Ethereum (ETH), Tether (USDT), Ripple (XRP), Monero (XMR), the Global Geopolitical Risk Index (GPR), the Russia Stock Market Index (MOEX), RUB/USD, UAH/USD, Gold, and Oil. The timeframe encompasses 948 days of analysis and is segmented into two distinct periods: a Pre-Conflict Period, from March 18, 2020, to February 23, 2022, and a Conflict Period, from February 24, 2022, to February 28, 2024. Data for the GPR index was sourced from www.matteoiacoviello.com, while the remaining variables were obtained from www.finance.yahoo.com.

3. Results and Discussion

Table 1 shows the descriptive statistics comparing performance of the variables before and during the Russia-Ukraine Conflict. Results show a decrease in the mean returns of all variables during the Conflict period, which is accompanied by a reduction in volatility levels in most variables, apart from MOEX, RUBUSD, and UAHUSD, that, as expected, presented increased volatility.

We employ Amihud (2002)[4] measure of illiquidity to test illiquidity levels' changes in Pre-Conflict and Conflict periods (Table 2). The illiquidity ratio shows a decrease for most of the cryptocurrencies under study from the Pre-Conflict period to the Conflict period. Hence, revealing that the levels of liquidity in the crypto market increased in the Conflict period.

The coexistence of reduced mean returns with higher liquidity levels during the Conflict period is suggestive of active market with high participation and transaction volumes, that might be driven by the perceived safety, anonymity, and accessibility offered by cryptocurrencies amidst economic sanctions during geopolitical uncertainties. At the onset of the Conflict period, cryptocurrencies experienced a significant surge in value, maybe due to initial capital flight, as investors and individuals sought safe havens in financial assets that are decentralized and detached from the traditional financial system. Demand for cryptocurrencies as an alternative to fiat

[2] In this study we use daily log returns and volatility as absolute returns. Due to the impossibility of acquiring daily opening, high, and low prices for GPR index, other volatility estimators could not be chosen. To maintain a parsimonious analysis, we consider absolute returns as a proxy for volatility across all variables under study. According to Forsberg and Ghysels (2007) absolute return is one of the most popular academic definitions of volatility, and it present several benefits in volatility prediction such as better sampling error behavior, immunity to jumps (Aharon et al., 2023; Forsberg & Ghysels, 2007; G. J. Wang et al., 2016).

[3] Following the approaches of Antonakakis & Gabauer (2017), MacKinlay (1997), and Muñoz et al. (2024), our baseline window was designed to be symmetric around the event, with equal numbers of daily observations before and after the conflict's onset (474 each), to enable like-for-like pre/post comparisons and to avoid estimates being dominated by one side of the window. This design prioritizes internal validity, improves cross-regime comparability, and ensures consistent measurement for the event-centered analysis, and the TVP-VAR connectedness results. We start on March 2020 as the pre-onset start to avoid contamination from the early 2020 microstructure dislocation associated with the initial COVID-19 shock which showed an independent structural break marked by extreme volatility which is unrelated to the Russia–Ukraine military conflict.

[4] The formula for calculating Amihud's (2002) market illiquidity ratio can be expressed as $ILLIQ = \frac{1}{D_{it}}\sum_{d=1}^{D_{it}} \frac{|r_{i,d}|}{dVol_{id}}$. In this equation, $|r_{i,d}|$ represent the daily absolute returns, $dVol_{id}$ denotes the dollar trading volume on each day, and D_{it} is the total trading days.

Table 1
Descriptive statistics.

Variables	Obs.	Mean	Std. Deviation	Min.	Max.	Skewness	Kurtosis	ADF
Panel A: Returns								
Panel A1: Full sample								
BTC	948	0.00262	0.04097	−0.270	0.192	−0.307	7.968	−8.815***
ETH	948	0.00358	0.05366	−0.318	0.325	−0.282	8.946	−9.388***
GOLD	948	0.00030	0.01015	−0.051	0.058	0.006	7.104	−9.182***
GPR	948	0.00057	0.43917	−1.637	1.357	−0.114	3.706	−14.093***
MOEX	948	0.00039	0.02063	−0.405	0.183	−7.575	166.373	−11.435***
OIL	948	0.00113	0.03846	−0.437	0.320	−1.008	36.400	−9.917***
RUBUSD	948	−0.00022	0.12972	−2.727	2.718	−0.097	411.496	−15.099***
UAHUSD	948	−0.00039	0.00808	−0.205	0.033	−17.114	433.642	−9.753***
USDT	948	0.00003	0.00201	−0.019	0.029	3.092	77.814	−16.470***
XMR	948	0.00140	0.05733	−0.534	0.345	−2.051	23.083	−10.669***
XRP	948	0.00146	0.06951	−0.551	0.627	0.922	23.208	−9.641***
Panel A2: Pre-Conflict sample								
BTC	474	0.00420	0.04505	−0.148	0.192	0.099	4.842	−7.550***
ETH	474	0.00663	0.06088	−0.317	0.325	−0.085	6.713	−7.842***
GOLD	474	0.00047	0.01119	−0.051	0.058	−0.121	7.659	−8.220***
GPR	474	0.00219	0.52381	−1.637	1.357	−0.152	3.071	−11.711***
MOEX	474	0.00069	0.01483	−0.095	0.074	−0.877	10.795	−7.724***
OIL	474	0.00260	0.04783	−0.437	0.320	−1.213	29.724	−6.936***
RUBUSD	474	−0.00016	0.00912	−0.072	0.037	−1.618	13.853	−7.529***
UAHUSD	474	−0.00015	0.00413	−0.019	0.021	−0.375	7.376	−8.360***
USDT	474	0.00005	0.00282	−0.019	0.029	2.228	40.356	−12.938***
XMR	474	0.00306	0.06289	−0.534	0.345	−1.399	16.326	−7.947***
XRP	474	0.00340	0.08364	−0.551	0.627	0.581	16.864	−8.020***
Panel A3: Conflict sample								
BTC	474	0.00103	0.03641	−0.270	0.181	−1.133	13.989	−7.519***
ETH	474	0.00053	0.04516	−0.318	0.247	−0.907	13.294	−7.380***
GOLD	474	0.00014	0.00899	−0.034	0.039	0.220	4.734	−7.554***
GPR	474	−0.00104	0.33432	−1.203	1.295	0.045	3.623	−10.734***
MOEX	474	0.00010	0.02514	−0.405	0.183	−8.179	149.451	−8.026***
OIL	474	−0.00034	0.02587	−0.086	0.204	0.618	10.875	−8.135***
RUBUSD	474	−0.00028	0.18332	−2.727	2.718	−0.068	206.767	−12.462***
UAHUSD	474	−0.00063	0.01066	−0.205	0.033	−14.868	285.835	−7.746***
USDT	474	0.00000	0.00039	−0.004	0.003	−1.267	37.304	−9.242***
XMR	474	−0.00025	0.05117	−0.454	0.284	−3.228	35.521	−7.701***
XRP	474	−0.00048	0.05169	−0.377	0.549	1.849	36.418	−7.570***
Panel B: Volatility								
Panel B1: Full sample								
BTC	948	0.02798	0.03002	0.000	0.270	2.444	12.342	−6.933***
ETH	948	0.03672	0.03927	0.000	0.325	2.722	14.808	−7.060***
GOLD	948	0.00718	0.00717	0.000	0.058	2.371	11.985	−9.342***
GPR	948	0.33715	0.28122	0.000	1.637	1.346	4.880	−8.214***
MOEX	948	0.01037	0.01784	0.000	0.405	13.078	264.038	−6.742***
OIL	948	0.02219	0.03142	0.000	0.437	6.337	60.251	−5.496***
RUBUSD	948	0.01730	0.12856	0.000	2.727	19.938	415.697	−9.593***
UAHUSD	948	0.00320	0.00743	0.000	0.205	21.396	572.998	−8.977***
USDT	948	0.00070	0.00188	0.000	0.029	7.972	88.499	−6.037***
XMR	948	0.03587	0.04472	0.000	0.534	4.916	41.713	−7.276***
XRP	948	0.04083	0.05626	0.000	0.627	4.754	37.029	−7.269***
Panel B2: Pre-Conflict sample								
BTC	474	0.03255	0.03139	0.000	0.192	1.688	6.286	−5.279***
ETH	474	0.04433	0.04220	0.000	0.325	2.292	11.728	−5.866***
GOLD	474	0.00776	0.00807	0.000	0.058	2.509	12.243	−8.026***
GPR	474	0.41322	0.32136	0.000	1.637	1.031	3.666	−6.817***
MOEX	474	0.01016	0.01081	0.000	0.095	3.269	19.290	−3.758**
OIL	474	0.02482	0.04095	0.000	0.437	5.325	39.592	−4.408***
RUBUSD	474	0.00631	0.00658	0.000	0.072	3.832	30.440	−4.063***
UAHUSD	474	0.00289	0.00296	0.000	0.021	2.533	11.838	−5.496***
USDT	474	0.00120	0.00255	0.000	0.029	5.843	47.932	−5.736***
XMR	474	0.04355	0.04544	0.000	0.534	4.222	36.417	−6.099***
XRP	474	0.05105	0.06630	0.000	0.627	3.991	26.756	−5.304***

(*continued on next page*)

Table 1 (*continued*)

Variables	Obs.	Mean	Std. Deviation	Min.	Max.	Skewness	Kurtosis	ADF
Panel B3: Conflict sample								
BTC	474	2.34E-02	2.79E-02	3.51E-04	0.270	3.572	23.543	−6.964***
ETH	474	2.91E-02	3.45E-02	1.01E-04	0.318	3.516	22.221	−6.511***
GOLD	474	6.60E-03	6.09E-03	0.00E + 00	0.039	1.697	6.680	−7.029***
GPR	474	2.61E-01	2.08E-01	4.14E-04	1.295	1.331	5.377	−6.064***
MOEX	474	1.06E-02	2.28E-02	9.05E-06	0.405	12.164	196.596	−8.177***
OIL	474	1.96E-02	1.69E-02	0.00E + 00	0.204	3.568	32.890	−7.462***
RUBUSD	474	2.83E-02	1.81E-01	0.00E + 00	2.727	14.100	208.031	−7.650***
UAHUSD	474	3.51E-03	1.01E-02	0.00E + 00	0.205	17.016	336.813	−7.791***
USDT	474	2.13E-04	3.31E-04	0.00E + 00	0.004	5.921	56.869	−6.568***
XMR	474	2.82E-02	4.27E-02	1.60E-04	0.454	6.163	54.362	−6.513***
XRP	474	3.06E-02	4.16E-02	1.39E-05	0.549	6.254	64.495	−7.380***

Note: This table summarizes descriptive statistics (sample mean, standard deviation, minimum, maximum, skewness, kurtosis), and the results for the Augmented Dickey–Fuller (ADF) test for a unit root for both returns and volatility over a full sample, pre-Conflict and Conflict periods. *** denote statistical significance at 1% level.

Table 2
Amihud (2002) illiquidity measure.

Index	Observations	Mean	Median	SD	Skewness	Kurtosis
Pre-Conflict period						
BTC	736	3.93844E-17	1.95E-17	8.23E-17	12.82791	248.0014
ETH	736	4.25348E-15	1E-15	1.1E-14	11.98486	216.6801
USDT	736	3.07023E-14	7.25E-15	7.34E-14	6.255998	56.38122
XMR	736	1.7942E-12	5.47E-13	4.58E-12	13.76529	275.2558
XRP	736	3.095E-11	1.56E-11	4.98E-11	6.77756	86.38107
Conflict Period						
BTC	736	2.67572E-17	1.91E-17	2.45E-17	1.582353	5.977701
ETH	736	1.21352E-15	8.77E-16	1.12E-15	1.727139	6.7579
USDT	736	5.33626E-15	2.76E-15	7.3E-15	3.281462	19.1543
XMR	736	1.49747E-12	1.06E-12	1.55E-12	3.056035	18.367
XRP	736	3.93114E-11	3.09E-11	3.59E-11	1.643348	6.303561

Note: This table summarizes descriptive statistics (sample mean, standard deviation, minimum, maximum, skewness, kurtosis for Amihud (2002) illiquidity measure for both pre-conflict and Conflict periods.

currencies devaluation like the RUB and UAH might increase. However, as more rational assessments of market conditions prevail[5] ("shock normalization"), corrections may occur, leading to reduced mean returns despite overall higher demand.

Fig. 1 further supports this as it shows that all cryptos exhibit a rapid increase in price followed by an accentuated decrease. Similarly, GPR clearly reflected the beginning of the Russia-Ukraine Conflict presenting an inverted "V" shaped pattern, indicating a positive impact, which reveals that the geopolitical risk increased at the time of the event and decreased afterwards.

As such, this raises several questions: How do traditional safe-haven assets like gold, and/or currency exchange rates of the affected countries connect to cryptocurrencies during these times? How did the relationships between these assets change with the conflict? Does the role of cryptocurrencies as a potential hedge or sanctions evasion tool increase during the conflict?

To answer these questions, we employ a TVP-VAR model to analyse the possible changes in returns and volatility connectedness from Pre-Conflict to Conflict period.

As seen by Figs. 2 and 3 the TCI decreases as the event onset is further away. This reinforces the idea of a shock like behaviour when Russia invaded Ukraine, followed by a normalization of that effect dissipated over the subsequent periods.

Tables 3 and 4 present the results of the TVP-VAR for both returns and volatility connectedness. The average TCI for returns (volatility) is 44.79 % (43.85 %) in the Pre-Conflict period and slightly decreases to 41.40 % (39.36 %) during the Conflict period. This reveals that the variables are less interconnected on average during the Conflict period compared to the Pre-Conflict period. However, as evidenced by Fig. 3 when the event took place, the total connectedness was higher (above 80 %). Similarly, as evidenced by Fig. 2, high levels of total connectedness (above 80 %) are evident around the beginning of 2020, suggesting a high interconnectedness between the variables during the COVID-19. Hence, it is evident that when extreme economic shocks occur the interconnectedness between variables is higher. However, it seems that, as expected, the COVID-19 presented a longer effect (maybe due to its specific characteristics), thus influencing the average TCI levels in the Pre-Conflict period.

[5] More rational assessments of market conditions may arise influenced by the high volatility of crypto markets and a sentiment of a new normal as conflict goes by, along with the sanctions imposed to Russia in the Fifth package related to deposits to crypto-wallets.

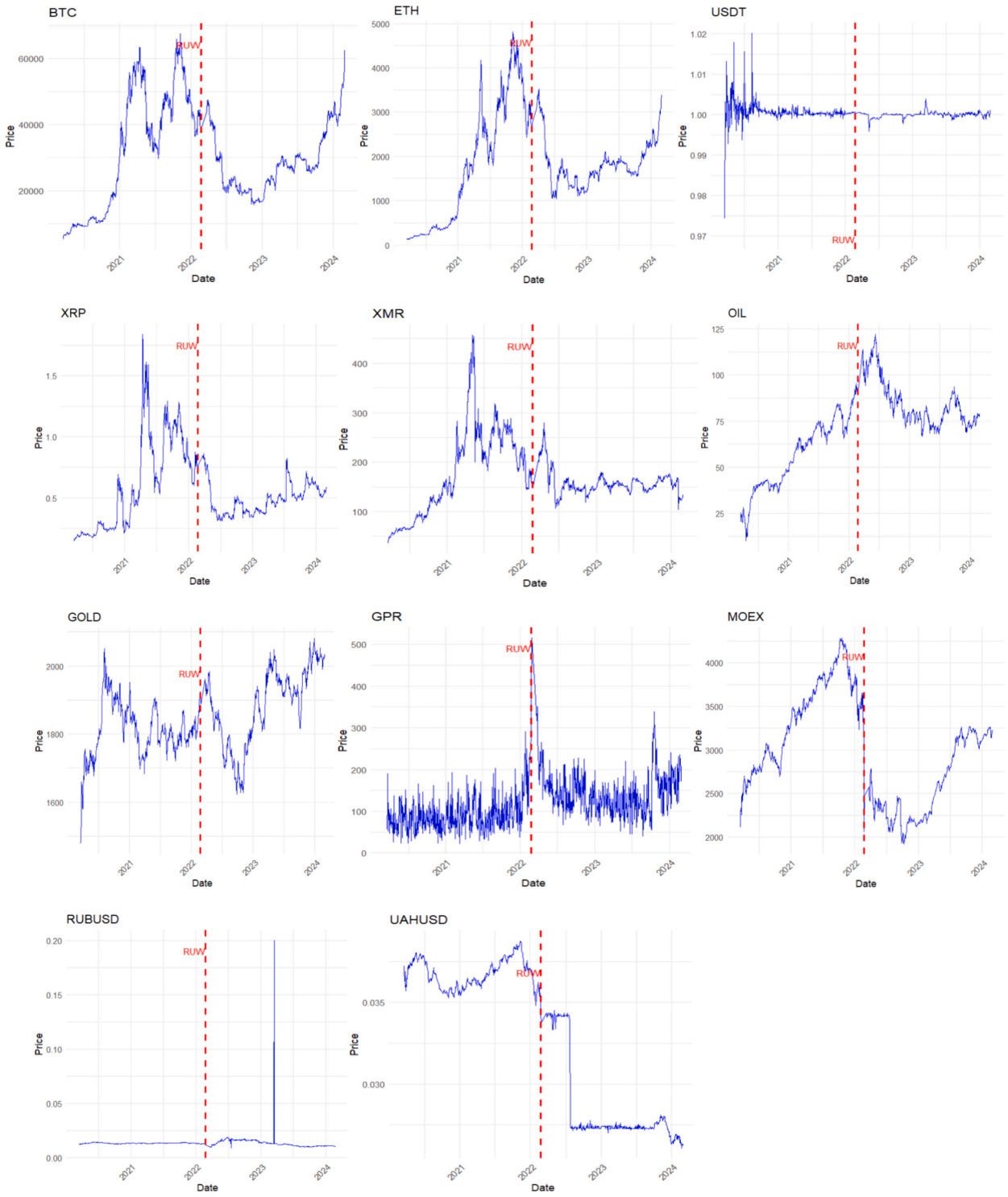

Fig. 1. Evolution of time series over time.

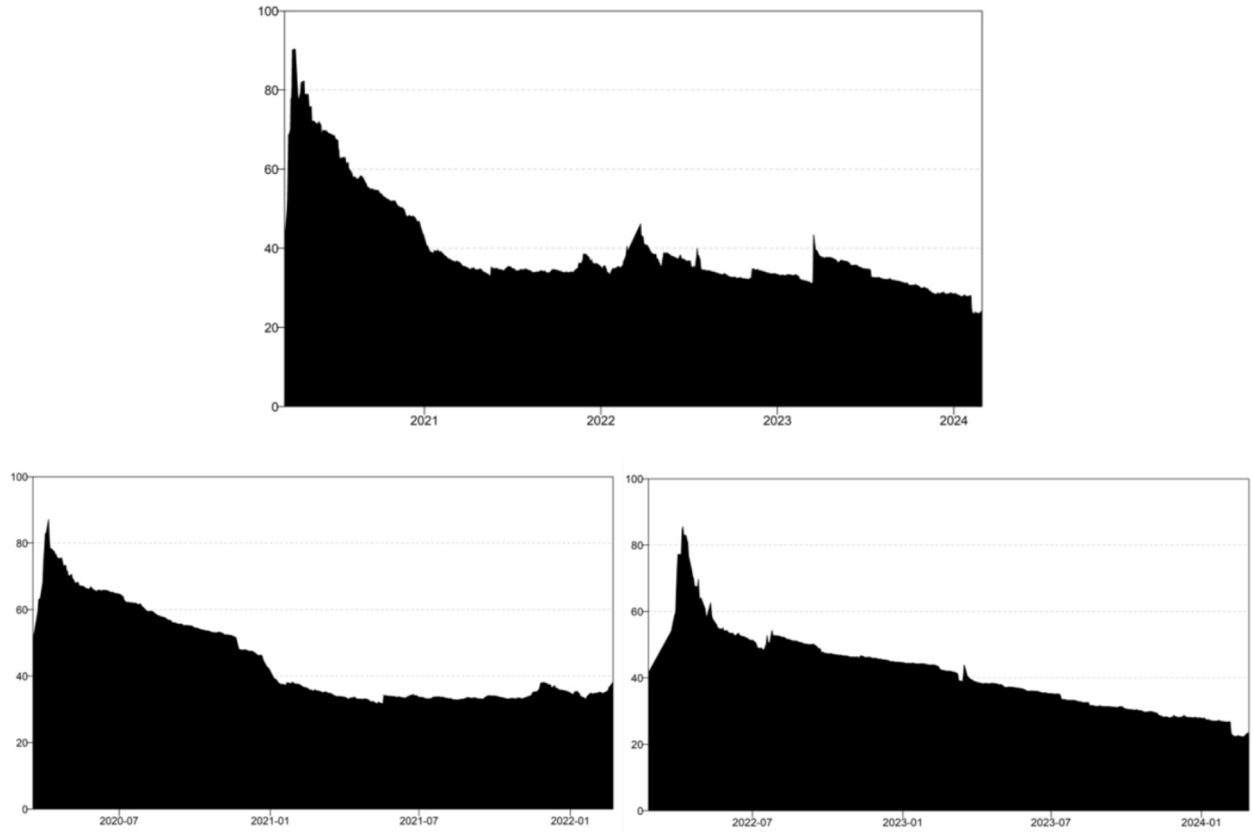

Fig. 2. TCI returns (Full, Pre-conflict, Conflict).

Figs. 4 and 5 depict the variables roles as net receivers and net transmitters over time. This dynamic analysis clearly shows a greater frequency of role-shifting for both returns and volatilities spillovers during the beginning of the Conflict period and reflects higher levels of returns and volatility spillovers, followed by a normalization of these relationships back to Pre-Conflict periods in most cases. This period is aligned with a concentration of financial sanction packages (package 1 to 7),[6] that along with the higher TCI levels evidenced in Figs. 2 and 3 might suggest cryptocurrencies potential to be used to evade financial sanctions during this period. Furthermore, Figs. 2 and 3 also show a decreasing of the TCI from April onwards, which is aligned with the application of the Fifth package of sanctions that targets deposits to crypto-wallets, reflecting the peak on TCI levels followed by an accentuated reduction, suggesting that the sanctions may have been effective in reducing cryptocurrency transactions potentially used to evade earlier sanctions.

Thus, to control for these heightened relationships during the concentration of financial sanction we isolate the event in a window from February 24, 2022, until August 31, 2022, and rerun the TVP-VAR model, to understand the significant changes that occur in these relationships in the financial sanctions period.

Table 5 presents the results for the sub-sample of the financial sanctions period, and Appendix A and B that present the summary results of sub periods analysed (Pre-Conflict, financial sanctions period, and Conflict).

The analysis of these results reveals the intricate dynamics of digital assets in times of Conflict and financial sanctions. Cryptocurrencies' transition from net receivers to net transmitters of volatility to oil during the conflict period suggests a growing influence of crypto markets on traditional commodities. The findings that BTC, ETH, and XRP become net receivers of oil returns during the financial sanctions period[7] further indicate, that investors might pivot towards cryptocurrencies based on perceived instability in the oil market, suggesting that cryptocurrencies can be used to circumvent sanctions by allowing transactions to be conducted more anonymously and without the intermediation of financial institutions that comply with the sanctions. Thus, hinting that under sanctions cryptocurrencies might be used to sell oil directly to buyers who prefer to avoid the traditional financial system. Thus, cryptocurrencies' relationship with oil in a Conflict context suggest that a segment of the market views cryptocurrencies as a modern

[6] This period is market by the high concentration of financial sanctions to Russia, namely: from packages 1 to package 7. https://www.consilium.europa.eu/en/policies/why-sanctions/sanctions-against-russia/timeline-sanctions-against-russia/.

[7] Sixth package of sanctions in response to Russia's invasion of Ukraine considers a ban on imports from Russia of crude oil and refined petroleum products. https://www.consilium.europa.eu/en/policies/why-sanctions/sanctions-against-russia/timeline-sanctions-against-russia/.

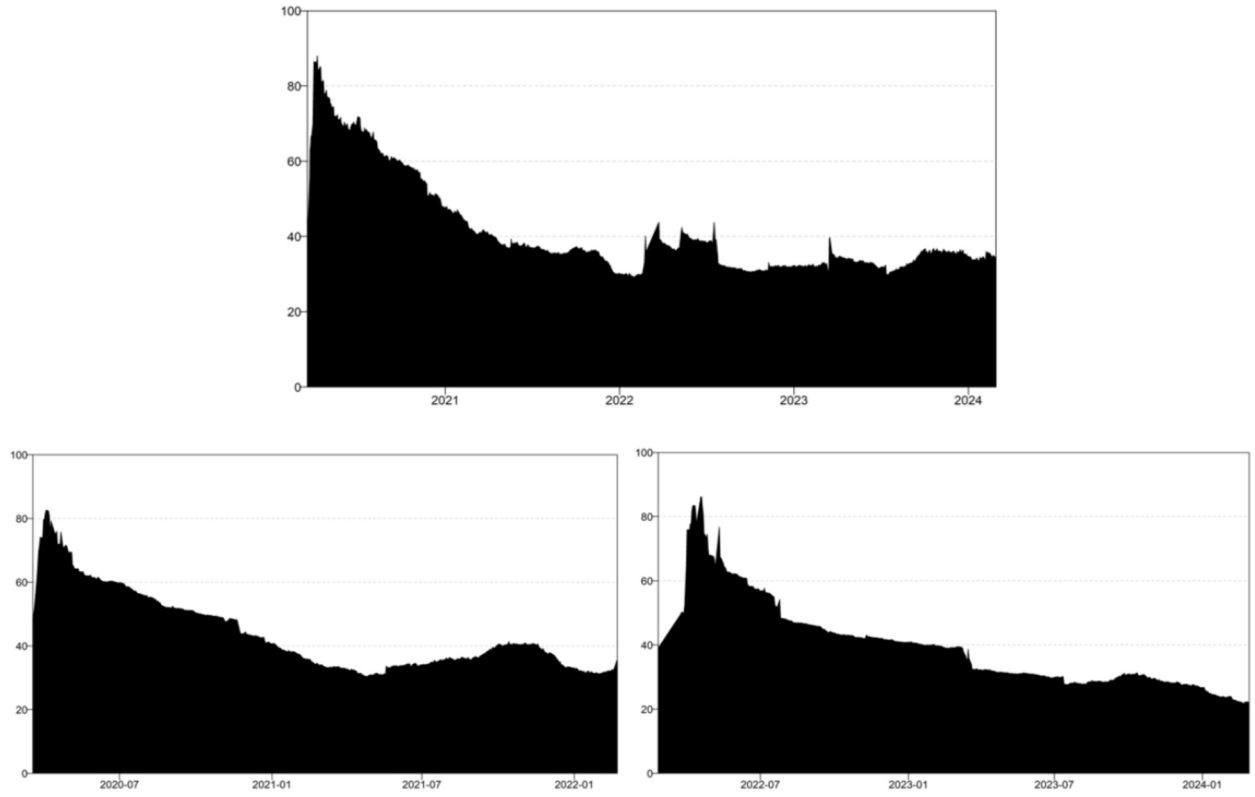

Fig. 3. TCI volatility (Full, Pre-conflict, Conflict).

safe-haven asset in line with Enilov and Mishra (2023), and Oosterlinck et al. (2023) findings, and a way to evade economic sanctions to oil (Liang, 2022).

To further test this, we analyse cryptocurrencies connectedness with Gold. Cryptocurrencies consistently transmitted volatility to Gold suggests that fluctuations within the crypto market have a discernible impact on Gold's market, which may reflect the increasing role of cryptocurrencies as an alternative investment to Gold, even during geopolitical tensions. During conflict, traditional assets like Gold often see increased demand as safe havens. The persistent transmission of volatility from cryptos to Gold suggests that even in times of heightened uncertainty the behaviour of cryptocurrency markets can spill over into the Gold market.

The beginning of the conflict and the implementation of the financial sanctions, likely heighten the attractiveness of BTC and ETH as alternative investment vehicles, since only BTC and ETH showed a shift to receiving returns spillovers from Gold during the financial sanctions period.[8] Investors might interpret these leading cryptocurrencies not just as speculative assets but as digital safe-havens that can provide returns in turbulent times. This shift could be driven by several factors, including a desire for assets unrelated with the geopolitical factors, the ease of transacting in cryptocurrencies compared to physical Gold, or a broader re-evaluation of what constitutes a "safe haven" in a digitally interconnected global economy. The reception of returns spillovers from Gold to BTC and ETH suggests that, at least for these leading cryptocurrencies, there's a perceived value or safety comparable to Gold during crisis moments contradicting Mo et al. (2025) results, however similar to Oosterlinck et al. (2023) and Wang et al. (2025) findings. This shift suggests that digital assets are being perceived as alternative save-havens reinforcing the narrative of "digital Gold" (Selmi et al., 2022).

Simultaneously, the role of cryptocurrencies as net transmitters of volatility to MOEX indicates that fluctuations in the crypto market can influence the broader financial market in Russia. The specific increase in volatility transmission during the financial sanction period suggests that cryptocurrencies become more prominent in investor strategies or when traditional financial systems face greater scrutiny and potential sanctions. This period represents a peak in financial sanctions where the broader implications for the Russian economy and its financial markets are most uncertain, prompting investors to react more sensitively to developments in the crypto market. The role of most cryptocurrencies as net transmitters of returns to MOEX decreased. These results seem to align with Wang et al. (2025) findings which show that for Russia, cryptocurrencies are seen as safe haven assets against equity market. Nonetheless, MOEX's status as a net receiver of returns from all cryptocurrencies is similar to the Pre-Conflict period, further

[8] "Maintenance and alignment" package (seventh package) of sanctions in response to Russia's invasion of Ukraine considers the prohibition to purchase, import or transfer Russian-origin gold. https://www.consilium.europa.eu/en/policies/why-sanctions/sanctions-against-russia/timeline-sanctions-against-russia/.

Table 3
TVP-VAR Returns.

TVP-VAR RETURNS
Panel A – Full period

	BTC	ETH	USDT	XRP	XMR	OIL	GOLD	GPR	MOEX	RUBUSD	UAHUSD	FROM
BTC	36.14	25.03	1.34	12.14	15.83	1.42	0.94	0.56	2.74	2.95	0.92	63.86
ETH	24.64	36.59	1.24	14.45	15.04	1.27	0.57	0.41	2.76	2.52	0.51	63.41
USDT	2.77	3.9	71.19	2.42	2.46	3.52	1.23	0.76	5.5	5.12	1.13	28.81
XRP	14.99	18.66	0.89	47.64	12.47	0.81	0.36	0.53	1.68	1.41	0.57	52.36
XMR	18.23	17.85	1.24	11.72	42.42	1.73	1.5	0.41	2.11	1.9	0.89	57.58
OIL	3.22	3.66	3.24	2.26	2.63	71.12	2.57	1.02	6.13	3.2	0.95	28.88
GOLD	1.99	2.09	1.9	2.3	2.88	3.16	76.37	1.07	2.59	3.44	2.2	23.63
GPR	1.17	1.8	1.63	2.02	0.92	2.42	1.48	84.86	1.53	1.68	0.49	15.14
MOEX	3.98	4.67	4.37	3.58	2.78	4.83	1.42	0.61	65.56	6.16	2.04	34.44
RUBUSD	5.16	5.71	4.47	2.8	2.64	6.85	1.92	0.62	8.73	59.39	1.7	40.61
UAHUSD	1.54	1.66	1.52	2.28	2.18	2.7	1.86	0.6	5.31	7.72	72.64	27.36
TO	77.69	85.03	21.82	55.98	59.83	28.71	13.84	6.59	39.08	36.11	11.41	436.09
Inc.Own	113.83	121.62	93	103.62	102.25	99.83	90.21	91.46	104.64	95.5	84.04	TCI = 39.64
NET	13.83	21.62	−7	3.62	2.25	−0.17	−9.79	−8.54	4.64	−4.5	−15.96	

PANEL B – Pre-Conflict period

	BTC	ETH	USDT	XRP	XMR	OIL	GOLD	GPR	MOEX	RUBUSD	UAHUSD	FROM
BTC	36.57	21.91	1.51	11.52	16.35	1.47	0.82	0.87	4.66	2.28	2.03	63.43
ETH	21.76	36.45	1.52	14.46	14.75	1.22	0.48	0.71	4.84	2.01	1.79	63.55
USDT	2.11	2.6	62.61	2.66	1.18	1.87	2.62	0.9	6.33	6.25	10.87	37.39
XRP	13.31	17.14	1.27	46.12	12.8	1.16	0.22	0.57	3.57	2.24	1.59	53.88
XMR	18.48	16.78	0.79	12.22	42.28	1.09	2.02	0.51	2.64	1.91	1.29	57.72
OIL	3.24	2.42	2.03	1.79	1.41	70.22	0.63	2.37	11.78	2.34	1.77	29.78
GOLD	1.81	1.65	3.93	1.59	2.8	1.36	74.39	1.76	4.31	2.98	3.41	25.61
GPR	1.17	1.18	1.24	1.43	0.68	3.47	2.11	84.81	1.62	1.52	0.78	15.19
MOEX	6.31	6.99	5.49	5.11	3.29	9.11	1.63	0.99	50.97	5.82	4.29	49.03
RUBUSD	4.02	4.46	4.93	4.45	2.94	9.09	1.58	1.25	12.8	46.41	8.06	53.59
UAHUSD	2.15	2.83	9.75	3.13	1.89	2.09	1.72	0.67	5.75	13.52	56.5	43.5
TO	74.36	77.98	32.45	58.36	58.1	31.93	13.83	10.61	58.28	40.87	35.89	492.66
Inc.Own	110.94	114.43	95.06	104.48	100.38	102.16	88.22	95.43	109.25	87.28	92.39	TCI = 44.79
NET	10.94	14.43	−4.94	4.48	0.38	2.16	−11.78	−4.57	9.25	−12.72	−7.61	

PANEL C – Conflict period

	BTC	ETH	USDT	XRP	XMR	OIL	GOLD	GPR	MOEX	RUBUSD	UAHUSD	FROM
BTC	30.75	24.01	3.98	14.68	14.82	2.45	2.5	0.27	0.88	4.04	1.63	69.25
ETH	24.47	31.54	3.06	15.75	15.07	2.28	1.53	0.31	0.98	3.76	1.24	68.46
USDT	7.92	5.92	65.71	6.3	5.38	0.78	1.63	0.8	1.49	2.82	1.23	34.29
XRP	17.02	18.02	3.33	37.88	14.52	2.34	1.09	0.46	1.3	2.28	1.75	62.12
XMR	17.44	17.24	3.1	14.92	36.81	2.22	2.32	0.5	1.1	2.47	1.88	63.19
OIL	4.99	5.3	1.21	5.05	4.13	61.11	4.65	0.53	6.5	3.94	2.59	38.89
GOLD	5.41	4.19	2.13	3.28	4.92	5.91	63.97	0.64	3.39	4.9	1.24	36.03
GPR	1.04	1.21	1.16	1.28	1.15	0.99	1.45	87.92	0.73	1.45	1.62	12.08
MOEX	2.23	2.45	2.42	3.66	2.95	7.19	3.03	0.79	68.44	2.23	4.61	31.56
RUBUSD	5.31	5.9	2.62	2.82	2.78	2.88	3.02	1.16	1.02	71.11	1.4	28.89
UAHUSD	1.12	1	1.49	2.21	2.07	0.79	0.39	0.27	0.9	0.4	89.36	10.64
TO	86.96	85.23	24.49	69.94	67.8	27.84	21.62	5.72	18.3	28.29	19.19	455.39
Inc.Own	117.71	116.78	90.2	107.82	104.61	88.95	85.59	93.64	86.74	99.4	108.55	TCI = 41.40
NET	17.71	16.78	−9.8	7.82	4.61	−11.05	−14.41	−6.36	−13.26	−0.6	8.55	

Note: Results of the returns spillovers are based on a TVP-VAR model with a lag length of order one (BIC) for Full period (Panel A), pre-Conflict period (Panel B), and Conflict period (Panel C).

highlighting the Russian economy growing sensitivity to the crypto sector (Chavez-Dreyfuss, 2022). This growing connection is further confirmed by the Head of the Financial Policy Department at the Ministry of Finance of the Russian Federation, who acknowledged the use of digital currencies in transactions for international settlements, as reported by Reuters (2022), and also by Russian President Vladimir Putin who revealed that Russia could face electricity disruptions due to uncontrolled crypto mining (Melkozerova, 2024). This highlights the increasingly role that digital currencies play in Russia's economic strategies.

On the other hand, the transition of BTC, ETH, and XRP to net receivers of returns for RUB/USD spillovers suggests that the value of these cryptocurrencies is increasingly influenced by the instability of the Ruble, which was under pressure due to economic sanctions. This aligns with news reports that reveal that in response to Western sanctions, crypto trading in Russia has significantly increased, especially with the Russian Ruble hitting all-time lows (Wilson & Howcroft, 2022). Trading volumes between the Ruble and major cryptocurrencies have seen substantial increases, indicating a rush to convert savings into crypto in Russia (Wilson & Howcroft, 2022).

Seen from the other side of the trenches, the role of BTC, USDT, and XRP as net transmitters of volatility to the UAH/USD across all periods highlights their influence on the Ukrainian currency. UAH/USD acting as a net receiver from all cryptocurrencies returns

Table 4
TVP-VAR Volatility.

TVP-VAR Volatility Panel A – Full period	BTC	ETH	USDT	XRP	XMR	OIL	GOLD	GPR	MOEX	RUBUSD	UAHUSD	FROM
BTC	39.46	22.06	4.3	8.42	14.74	1.2	2.87	0.56	1.86	2.91	1.62	60.54
ETH	21.16	40.06	5.13	11.08	14.03	1.12	2.22	0.78	0.96	2.46	1.01	59.94
USDT	2.83	3.87	63.28	3.06	3.48	5.16	5.06	0.6	3.39	6.83	2.45	36.72
XRP	10.07	14.4	3.99	53.81	9.94	0.95	0.86	1.19	1.42	1.78	1.58	46.19
XMR	14.3	15.38	5.36	8.2	42.76	1.66	4.8	0.39	1.73	1.34	4.08	57.24
OIL	1.23	2.37	3.56	1.88	2.91	71.76	3.8	2.6	2.22	4.82	2.85	28.24
GOLD	2.49	4.57	6.03	1.53	5.22	3.64	61.02	1.18	1.43	2.58	10.33	38.98
GPR	1.08	2.06	6.1	2.39	1.62	2.51	1.78	76.22	1.09	3.74	1.41	23.78
MOEX	2.01	2.7	5.17	1.5	4.06	4.11	5.05	0.82	63.41	4.16	7	36.59
RUBUSD	2.64	2.86	3.53	2.19	1.77	5.28	3.53	1.51	3.75	68.55	4.38	31.45
UAHUSD	1.37	2.45	2.46	1.68	4.7	2.22	9.89	0.69	4.29	2.84	67.41	32.59
TO	59.18	72.72	45.64	41.92	62.48	27.84	39.86	10.3	22.15	33.46	36.7	452.26
Inc.Own	98.64	112.79	108.92	95.74	105.24	99.6	100.88	86.52	85.56	102.01	104.11	TCI = 41.11
NET	−1.36	12.79	8.92	−4.26	5.24	−0.4	0.88	−13.48	−14.44	2.01	4.11	
PANEL B – Pre-Conflict period												
	BTC	ETH	USDT	XRP	XMR	OIL	GOLD	GPR	MOEX	RUBUSD	UAHUSD	FROM
BTC	42.33	20.5	2.44	9.51	13.95	1.28	1.12	0.83	3.19	4	0.84	57.67
ETH	20.26	41.5	2.34	13.27	14.11	0.82	1.12	0.8	1.81	3.3	0.68	58.5
USDT	2.67	2.54	53.12	2.47	0.8	10.93	3.5	0.85	9.04	12.6	1.47	46.88
XRP	10.57	15.29	1.88	53.66	8.49	1.1	2.09	0.86	1.9	3.58	0.59	46.34
XMR	16.05	16.43	1.36	8.72	49.46	0.66	1.44	0.74	2.59	1.5	1.05	50.54
OIL	0.63	0.56	10.35	1	0.37	76.44	0.94	1.8	3.97	2.75	1.19	23.56
GOLD	1.33	1.7	7.16	3.26	1.67	2.46	67	1.34	2.58	7.22	4.29	33
GPR	1.59	1.64	1.37	2.05	1.94	1.5	1.32	84.24	1.93	1.72	0.69	15.76
MOEX	4.37	3.1	12.74	2.59	2.78	9.72	3.44	1.13	48.11	5.84	6.19	51.89
RUBUSD	3.42	2.99	15.06	3.33	1.25	12.76	5.06	1.42	8.61	43.38	2.73	56.62
UAHUSD	1.47	1.28	8.01	1.58	2.94	5.96	2.92	0.99	9.99	6.43	58.45	41.55
TO	62.35	66.03	62.7	47.78	48.3	47.2	22.96	10.74	45.61	48.95	19.71	482.32
Inc.Own	104.67	107.52	115.83	101.43	97.75	123.63	89.96	94.98	93.73	92.32	78.16	TCI = 43.85
NET	4.67	7.52	15.83	1.43	−2.25	23.63	−10.04	−5.02	−6.27	−7.68	−21.84	
PANEL C – Conflict period												
	BTC	ETH	USDT	XRP	XMR	OIL	GOLD	GPR	MOEX	RUBUSD	UAHUSD	FROM
BTC	35.17	24.86	4.66	9.73	16.65	1.06	3.8	0.29	0.91	1.7	1.15	64.83
ETH	24.33	35.34	3.74	11.16	15.78	1.34	4.74	0.48	1.11	1.28	0.71	64.66
USDT	5.9	5.17	62.17	10.71	7.24	0.92	2.98	0.84	2.14	1.04	0.9	37.83
XRP	11.01	14.01	8.31	47.89	10.66	0.77	2.59	0.92	1.34	0.96	1.54	52.11
XMR	17.46	17.06	5.19	9.55	38.38	3.16	4.57	0.56	1.38	1.5	1.19	61.62
OIL	2.37	3.81	2.47	2.23	6.22	64.42	9.3	0.56	1.42	3.49	3.72	35.58
GOLD	4.77	7.08	5.11	3.51	6.42	7.05	56.52	0.85	3.39	2.56	2.72	43.48
GPR	0.5	0.9	1.75	1.91	1.09	0.72	1.56	87.84	1.54	1.24	0.96	12.16
MOEX	2.08	2.15	4.63	1.85	2.95	0.92	5.6	2.49	70.35	4.52	2.48	29.65
RUBUSD	1.17	2.13	1.48	0.66	0.85	1.99	2.92	0.35	0.6	85.91	1.93	14.09
UAHUSD	1.98	1	1.64	1.81	0.7	1.03	3.24	0.88	2.98	1.71	83.01	16.99
TO	71.58	78.17	38.98	53.12	68.56	18.96	41.3	8.21	16.81	20.01	17.31	433
Inc.Own	106.75	113.51	101.16	101.01	106.94	83.38	97.82	96.04	87.16	105.92	100.32	TCI = 39.36
NET	6.75	13.51	1.16	1.01	6.94	−16.62	−2.18	−3.96	−12.84	5.92	0.32	

Note: Results for the volatility spillovers are based on a TVP-VAR model with a lag length of order one (BIC) for Full period (Panel A), pre-Conflict period (Panel B), and Conflict period (Panel C).

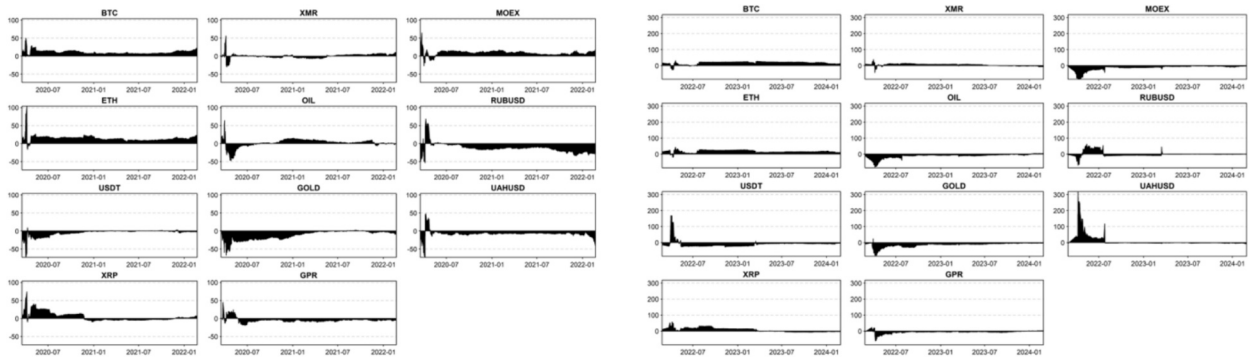

Fig. 4. Dynamic Net total directional connectedness returns (Pre-conflict, Conflict).

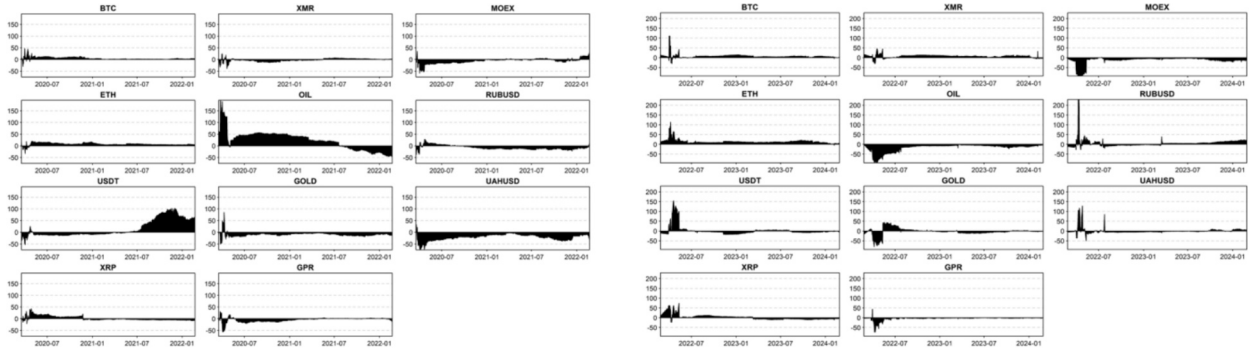

Fig. 5. Dynamic Net total directional connectedness volatility (Pre-conflict, Conflict).

spillovers is suggestive of a net inflow of capital from cryptocurrencies into the Ukrainian currency. This aligns with news reports that state that Ukraine has turned to cryptocurrencies as a new source of financial support, raising millions of dollars directly for its war effort against the Russian invasion (Feingold, 2023). During the initial period of the conflict over $212 million in crypto donations have been made to support pro-Ukrainian efforts, of which about $80 million went directly to the Ukrainian government (Beaty, 2022). This further reveals the use of cryptocurrencies usage in conflict financing.

The observed shifts in these relationships provide evidence of the growing relevance of crypto assets in a Military Conflict context, and their possible usefulness to evade financial sanctions, war financing, and to be used as hedgers or safe-havens.

4. Conclusion

This study advances our understanding of cryptocurrencies' roles during geopolitical conflict, using the Russia–Ukraine military conflict as a natural experiment. Employing a TVP-VAR model, we uncover the dynamic financial behaviours of cryptocurrencies, revealing their increased liquidity, shifting roles as average net transmitter/receivers of both returns and volatility, and their potential strategic use in circumventing economic sanctions. The findings of this study offer relevant insights for various stakeholders. For investors, they highlight the need to view cryptocurrencies not only as speculative assets but also as potential instruments for diversification and hedging during periods of geopolitical instability, while acknowledging the heightened risks of volatility and sudden changes in their safe-haven role. For regulators, the results underline the urgency of developing flexible, transnational mechanisms to monitor and mitigate illicit uses of crypto assets without stifling innovation. For central banks, the evidence suggests the importance of incorporating cryptocurrency behavior into financial stability assessments, particularly in contexts of economic sanctions where capital flows can shift rapidly toward these assets. Finally, for governments, the findings reinforce the need for international cooperation and public policies capable of balancing economic security, financial resilience, and technological innovation, while minimizing the risk of cryptocurrencies being used for sanctions evasion or military conflict financing.

The authors note that the findings should be interpreted with caution, as one of the study's limitations is its exclusive focus on the Russia–Ukraine military conflict, which may restrict the generalizability of the results to other geopolitical contexts. Another limitation lies in the use of daily data, which may overlook intraday dynamics triggered by sanction-related news and other high-frequency market reactions.

Future research should explore how shifts in market sentiment amplify or mute crypto shocks (Almeida & Gonçalves, 2025), with special attention to stablecoin convertibility stress (de-pegs). It should also examine whether ESG shocks, such as energy-use changes and PoW-to-PoS transitions, carry distinct risk premia when sentiment deteriorates. Finally, future studies should also focus on CBDCs

Table 5
TVP-VAR Financial Sanctions Period Returns and Volatility.

TVP-VAR Financial Sanctions
Panel A – Returns

	BTC	ETH	USDT	XRP	XMR	OIL	GOLD	GPR	MOEX	RUBUSD	UAHUSD	FROM
BTC	12.43	12.01	6.13	10.82	11.39	12.52	5.18	6.91	7.08	9.45	6.1	87.57
ETH	13.14	13.14	6.35	10.8	11.59	12.8	4.86	6.3	6.58	8.84	5.59	86.86
USDT	8.09	7.58	35.35	10.65	11.21	5.33	4.16	1.72	4.62	5.33	5.96	64.65
XRP	12.37	12.56	7.35	14.05	13.03	9.91	4.34	5.48	6.19	8.97	5.75	85.95
XMR	12.67	12.56	6.79	12.69	14.39	9.07	5.29	5.82	7.14	8.08	5.5	85.61
OIL	3.53	3.39	8.41	6.34	9.48	22.89	7.11	4.78	11.14	14.16	8.76	77.11
GOLD	3.57	3.14	8.47	5.13	5.6	25.97	9.98	7.27	12.14	9.55	9.19	90.02
GPR	10.38	9.48	6.06	5.64	7.99	18.56	5.36	12.78	6.63	10.68	6.43	87.22
MOEX	7.31	7.05	7.3	7.62	8.93	11.21	9.78	6.73	19.03	10.19	4.86	80.97
RUBUSD	4.2	4.77	7.03	7.96	9.92	13.91	6.21	6.35	9.18	23.16	7.31	76.84
UAHUSD	10.37	9.75	7.12	9.36	11.83	9.69	3.97	3.01	5.71	7.93	21.26	78.74
TO	85.63	82.29	71.01	87.01	100.94	128.97	56.26	54.38	76.41	93.18	65.45	901.55
Inc.Own	98.05	95.43	106.36	101.06	115.33	151.86	66.24	67.16	95.44	116.34	86.72	TCI = 81.96
NET	−1.95	−4.57	6.36	1.06	15.33	51.86	–33.76	–32.84	−4.56	16.34	−13.28	

PANEL B – Volatility

	BTC	ETH	USDT	XRP	XMR	OIL	GOLD	GPR	MOEX	RUBUSD	UAHUSD	FROM
BTC	26.99	21.37	9.76	15.65	16.27	0.86	2.68	1.05	0.44	1.97	2.97	73.01
ETH	24.08	29.32	6.22	13.09	14.02	1.57	3.39	0.78	0.51	3.2	3.81	70.68
USDT	11.48	6.41	34.23	25.42	13.16	3.34	1.42	0.74	0.24	1.8	1.77	65.77
XRP	17.57	12.8	20.65	25.91	14.49	2.5	1.55	0.5	0.15	1.84	2.05	74.09
XMR	19.28	14.81	11.42	15.25	26.65	1.68	4.46	1.04	1.25	1.67	2.49	73.35
OIL	4.9	4.51	9.9	8.53	3.74	28.5	12.05	1.57	3.46	8.37	14.47	71.5
GOLD	6.6	5.62	13.29	13.11	6.94	10.39	24.93	1.78	2.4	5.67	9.26	75.07
GPR	4.76	3.08	6.97	5.77	3.05	1.68	1.44	66.16	0.57	2.78	3.74	33.84
MOEX	3.83	3.03	9.23	7.29	4.94	4.76	4.02	1.79	39.32	5.6	16.2	60.68
RUBUSD	1.85	6.19	3.94	3.3	1.17	4.18	2.32	1.2	0.89	71.38	3.58	28.62
UAHUSD	3	2	4.56	3.74	1.7	2.46	2.29	1.15	2.29	1.24	75.57	24.43
TO	97.34	79.82	95.94	111.15	79.48	33.41	35.6	11.61	12.21	34.15	60.33	651.05
Inc.Own	124.34	109.14	130.17	137.06	106.13	61.91	60.53	77.77	51.53	105.52	135.9	TCI = 59.19
NET	24.34	9.14	30.17	37.06	6.13	−38.09	−39.47	–22.23	−48.47	5.52	35.9	

Note: Results for the financial sanction period are based on a TVP-VAR model with a lag length of order one (BIC) for returns spillovers (Panel A), and volatility spillovers (Panel B).

efficiency, particularly under stress.

CRediT authorship contribution statement

José Almeida: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Tiago Cruz Gonçalves:** Writing – review & editing, Visualization, Validation, Supervision, Resources, Investigation, Funding acquisition, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix

Appendix A. . Returns summary results

Returns

		BTCisa			ΔPre-CFL/CFL	ΔPre-CFL/Financial Sanctions	ETHisa			ΔPre-CFL/CFL	ΔPre-CFL/Financial Sanctions	USDTisa			ΔPre-CFL/CFL	ΔPre-CFL/Financial Sanctions	XRPisa			ΔPre-CFL/CFL	ΔPre-CFL/Financial Sanctions	XMRisa			ΔPre-CFL/CFL	ΔPre-CFL/Financial Sanctions
		Pre-CFL	CFL	Financial Sanctions			Pre-CFL	CFL	Financial Sanctions			Pre-CFL	CFL	Financial Sanctions			Pre-CFL	CFL	Financial Sanctions			Pre-CFL	CFL	Financial Sanctions		
OIL	TO (column)	3.24	4.99	3.53	54.0%	9%	2.42	5.3	3.39	119.0%	40%	2.03	1.21	8.41	-40.4%	314%	1.79	5.05	6.34	182.1%	254%	1.41	4.13	9.48	192.9%	572%
	FROM (line)	1.47	2.45	12.52	66.7%	752%	1.22	2.28	12.8	86.9%	949%	1.87	0.78	5.33	-58.3%	185%	1.16	2.34	9.91	101.7%	754%	1.09	2.22	9.07	103.7%	732%
	Net Receiver/Transmitter	1.77	2.54	-8.99	43.5%	-607.9%	1.2	3.02	-9.41	151.7%	-884.2%	0.16	0.43	3.08	168.8%	1825.0%	0.63	2.71	-3.57	330.2%	-666.7%	0.32	1.91	0.41	496.9%	28.1%
GOLD	TO (column)	1.81	5.41	3.57	198.9%	97%	1.65	4.19	3.14	153.9%	90%	3.93	2.13	8.47	-45.8%	116%	1.59	3.28	5.13	106.3%	223%	2.8	4.92	5.6	75.7%	100%
	FROM (line)	0.82	2.5	5.18	204.9%	532%	0.48	1.53	4.86	218.8%	913%	2.62	1.63	4.16	-37.8%	59%	0.22	1.09	4.34	395.5%	1873%	2.02	2.32	5.29	14.9%	162%
	Net Receiver/Transmitter	0.99	2.91	-1.61	193.9%	-262.6%	1.17	2.66	-1.72	127.4%	-247.0%	1.31	0.5	4.31	-61.8%	229.0%	1.37	2.19	0.79	59.9%	-42.3%	0.78	2.6	0.31	233.3%	-60.3%
GPR	TO (column)	1.17	1.04	10.38	-11.1%	787%	1.18	1.21	10.38	2.5%	780%	1.24	1.16	6.06	-6.5%	389%	1.43	1.28	5.64	-10.5%	294%	0.68	1.15	7.99	69.1%	1075%
	FROM (line)	0.87	0.27	6.91	-69.0%	694%	0.71	0.31	6.91	-56.3%	873%	0.9	0.8	1.72	-11.1%	91%	0.57	0.46	5.48	-19.3%	861%	0.51	0.5	5.82	-2.0%	1041%
	Net Receiver/Transmitter	0.3	0.77	3.47	156.7%	1056.7%	0.47	0.9	3.47	91.5%	638.3%	0.34	0.36	4.34	5.9%	1176.5%	0.86	0.82	0.16	-4.7%	-81.4%	0.17	0.65	2.17	282.4%	1176.5%
MOEX	TO (column)	6.31	2.23	7.31	-64.7%	16%	6.99	2.45	7.05	-64.9%	1%	5.49	2.42	7.3	-55.9%	33%	5.11	3.66	7.62	-28.4%	49%	3.29	2.95	8.93	-10.3%	171%
	FROM (line)	4.66	0.88	7.08	-81.1%	52%	4.84	0.98	6.58	-79.8%	36%	6.33	1.49	4.62	-76.5%	-27%	3.57	1.3	6.19	-63.6%	73%	1.91	1.1	7.14	-42.4%	274%
	Net Receiver/Transmitter	1.65	1.35	0.23	-18.2%	-86.1%	2.15	1.47	0.47	-31.6%	-78.1%	-0.84	0.93	2.68	210.7%	419.0%	1.54	2.36	1.43	53.2%	-7.1%	1.38	1.85	1.79	34.1%	29.7%
RUBUSD	TO (column)	4.02	5.31	4.2	32.1%	4%	4.46	5.9	4.77	32.3%	7%	4.93	2.62	7.03	-46.9%	43%	4.45	2.82	7.96	-36.6%	79%	2.94	2.78	9.92	-5.4%	237%
	FROM (line)	2.28	4.04	9.45	77.2%	314%	2.01	3.76	8.84	87.1%	340%	6.25	2.82	5.33	-54.9%	-15%	2.24	2.28	8.97	1.8%	300%	1.91	2.47	8.08	29.3%	323%
	Net Receiver/Transmitter	1.74	1.27	-5.25	-27.0%	-401.7%	2.45	2.14	-4.07	-12.7%	-266.1%	-1.32	-0.2	1.7	84.8%	228.8%	2.21	0.54	-1.01	-75.6%	-145.7%	1.03	0.31	1.84	-69.9%	78.6%
UAHUSD	TO (column)	2.15	1.12	10.37	-47.9%	382%	2.83	1	9.75	-64.7%	245%	9.75	1.49	7.12	-84.7%	-27%	3.13	2.21	9.36	-29.4%	199%	1.89	2.07	11.83	9.5%	526%
	FROM (line)	2.03	1.63	6.1	-19.7%	200%	1.79	1.24	5.59	-30.7%	212%	10.87	1.23	5.96	-88.7%	-45%	1.59	1.75	5.75	10.1%	262%	1.29	1.88	5.5	45.7%	326%
	Net Receiver/Transmitter	0.12	-0.51	4.27	-525.0%	3458.3%	1.04	-0.24	4.16	-123.1%	300.0%	-1.12	0.26	1.16	123.2%	203.6%	1.54	0.46	3.61	-70.1%	134.4%	0.6	0.19	6.33	-68.3%	955.0%

Note: pre-CFL = pre-Conflict period, CFL = Conflict period, and Financial Sanctions = Financial Sanctions Period.

Note: pre-CFL = pre-Conflict period, CFL = Conflict period, and Financial Sanctions = Financial Sanctions Period.

Appendix B. . Volatility summary results

Volatility

		BTC is a					ETH is a					USDT is a					XRP is a					XMR is a				
		Pre-CFL	CFL	Financial Sanctions	Δ Pre-CFL/CFL	Δ Pre-CFL/Financial Sanctions	Pre-CFL	CFL	Financial Sanctions	Δ Pre-CFL/CFL	Δ Pre-CFL/Financial Sanctions	Pre-CFL	CFL	Financial Sanctions	Δ Pre-CFL/CFL	Δ Pre-CFL/Financial Sanctions	Pre-CFL	CFL	Financial Sanctions	Δ Pre-CFL/CFL	Δ Pre-CFL/Financial Sanctions	Pre-CFL	CFL	Financial Sanctions	Δ Pre-CFL/CFL	Δ Pre-CFL/Financial Sanctions
OIL	TO (column)	0.63	2.37	4.9	276.2%	678%	0.56	3.81	4.51	580.4%	705%	10.35	2.47	9.9	-76.1%	-4%	1	2.23	8.53	123.0%	753%	0.37	6.22	3.74	1581.1%	911%
	FROM (line)	1.28	1.06	0.86	-17.2%	-33%	0.82	1.34	1.57	63.4%	91%	10.93	0.92	3.34	-91.6%	-69%	1.1	0.77	2.5	-30.0%	127%	0.66	3.16	1.68	378.8%	155%
	Net Receiver/Transmitter	-0.65	1.31	4.04	301.5%	721.5%	-0.26	2.47	2.94	1050.0%	1230.8%	-0.58	1.55	6.56	367.2%	1231.0%	-0.1	1.46	6.03	1560.0%	6130.0%	-0.29	3.06	2.06	1155.2%	810.3%
GOLD	TO (column)	1.33	4.77	6.6	258.6%	396%	1.7	7.08	5.62	316.5%	231%	7.16	5.11	13.29	-28.6%	86%	3.26	3.51	13.11	7.7%	302%	1.67	6.42	6.94	284.4%	316%
	FROM (line)	1.12	3.8	2.68	239.3%	139%	1.12	4.74	3.39	323.2%	203%	3.5	2.98	1.42	-14.9%	-59%	2.09	2.59	1.55	23.9%	-26%	1.44	4.57	4.46	217.4%	210%
	Net Receiver/Transmitter	0.21	0.97	3.92	361.9%	1766.7%	0.58	2.34	2.23	303.4%	284.5%	3.66	2.13	11.87	-41.8%	224.3%	1.17	0.92	11.56	-21.4%	888.0%	0.23	1.85	2.48	704.3%	978.3%
GPR	TO (column)	1.59	0.5	4.76	-68.6%	199%	1.64	0.9	3.08	-45.1%	88%	1.37	1.75	6.97	27.7%	409%	2.05	1.91	5.77	-6.8%	181%	1.94	1.09	3.05	-43.8%	57%
	FROM (line)	0.83	0.29	1.05	-65.1%	27%	0.8	0.48	0.78	-40.0%	-3%	0.85	0.84	0.74	-1.2%	-13%	0.86	0.92	0.5	7.0%	-42%	0.74	0.56	1.04	-24.3%	41%
	Net Receiver/Transmitter	0.76	0.21	3.71	-72.4%	388.2%	0.84	0.42	2.3	-50.0%	173.8%	0.52	0.91	6.23	75.0%	1098.1%	1.19	0.99	5.27	-16.8%	342.9%	1.2	0.53	2.01	-55.8%	67.5%
MOEX	TO (column)	4.37	2.08	3.83	-52.4%	-12%	3.1	2.15	3.03	-30.6%	-2%	12.74	4.63	9.23	-63.7%	-28%	2.59	1.85	7.29	-28.6%	181%	2.78	2.95	4.94	6.1%	78%
	FROM (line)	3.19	0.91	0.44	-71.5%	-86%	1.81	1.11	0.51	-38.7%	-72%	9.04	2.14	0.24	-76.3%	-97%	1.9	1.34	0.15	-29.5%	-92%	1.5	1.38	1.25	-8.0%	-17%
	Net Receiver/Transmitter	1.18	1.17	3.39	-0.8%	187.3%	1.29	1.04	2.52	-19.4%	95.3%	3.7	2.49	8.99	-32.7%	143.0%	0.69	0.51	7.14	-26.1%	934.8%	1.28	1.57	3.69	22.7%	188.3%
RUBUSD	TO (column)	3.42	1.17	1.85	-65.8%	-46%	2.99	2.13	6.19	-28.8%	107%	15.06	1.48	3.94	-90.2%	-74%	3.33	0.66	3.3	-80.2%	-1%	1.25	0.85	1.17	-32.0%	-6%
	FROM (line)	4	1.7	1.97	-57.5%	-51%	3.3	1.28	3.2	-61.2%	-3%	12.6	1.04	1.8	-91.7%	-86%	3.58	0.96	1.84	-73.2%	-49%	1.5	1.5	1.67	0.0%	11%
	Net Receiver/Transmitter	-0.58	-0.53	-0.12	8.6%	79.3%	-0.31	0.85	2.99	374.2%	1064.5%	2.46	0.44	2.14	-82.1%	-13.0%	-0.25	-0.3	1.46	-20.0%	684.0%	-0.25	-0.65	-0.5	-160.0%	-100.0%
UAHUSD	TO (column)	1.47	1.98	3	34.7%	104%	1.28	1	2	-21.9%	56%	8.01	1.64	4.56	-79.5%	-43%	1.58	1.81	3.74	14.6%	137%	2.94	0.7	1.7	-76.2%	-42%
	FROM (line)	0.84	1.15	2.97	36.9%	254%	0.68	0.71	3.81	4.4%	460%	1.47	0.9	1.77	-38.8%	20%	0.59	1.54	2.05	161.0%	247%	1.05	1.19	2.49	13.3%	137%
	Net Receiver/Transmitter	0.63	0.83	0.03	31.7%	-95.2%	0.6	0.29	-1.81	-51.7%	-401.7%	6.54	0.74	2.79	-88.7%	-57.3%	0.99	0.27	1.69	-72.7%	70.7%	1.89	-0.49	-0.79	-125.9%	-141.8%

Note: pre-CFL = pre-Conflict period, CFL = Conflict period, and Financial Sanctions = Financial Sanctions Period.

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Data availability

Data will be made available on request.

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