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TIME VARYING COINTEGRATION AND CAUSALITY : A COMPARATIVE CASE STUDY FOR RUSSIA, UKRAINE, HUNGARY AND ROMANIA USING VECM AND CCC – MGARCH MODELS

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Abstract: *THIS PAPER AIMED TO INVESTIGATE COINTEGRATION AND CAUSALITY EFFECT WITH BASE TO RUSSIAN FINANCIAL MARKET OVER UKRAINE, HUNGARY AND ROMANIA, (2) WHETHER IS THERE ANY OPPORTUNITY FOR HEDGE THE INVESTMENT IN ONE MARKET BY INVESTING IN ANOTHER MARKET. FOR THIS PURPOSE WE EMPLOY VECTOR ERROR CORRELATION MODEL (VECM) AND CCC GARCH ON THE SAMPLE DATA FROM JANUARY 2013 TO AUGUST 2022 COLLECTED FROM BLOOMBERG. AIC CRITERIA HAS BEEN USED TO DETERMINE THE IDEAL LAG DURATION, WHICH IS DETERMINED TO BE 8 DAYS FOR PFTS - UKRAINE AND MOEX - RUSSIA, 9 DAYS FOR BET - ROMANIA AND MOEX - RUSSIA, AND 8 DAYS FOR BUX - HUNGARY AND MOEX*

- RUSSIA. THIS IS BECAUSE COINTEGRATION RESULTS ARE SENSITIVE TO LAG LENGTH. CAUSALITY MUST EXIST IF TWO PARAMETERS (EXTRINSIC AND INTRINSIC) COINTEGRATE IN AT LEAST ONE DIRECTION (GRANGER, 1986). ADDITIONALLY, IT WAS ASSERTED BY GHOSH (1993), LIEN AND LUO (1994), AND LIEN (1996) THAT IF THE TWO PRICE SERIES ARE DISCOVERED TO BE COINTEGRATED, THEN THERE ARE VIABLE ERROR CORRECTION REPRESENTATIONS OF THE PRICE SERIES THAT CONTAIN BOTH SHORT-TERM DYNAMICS AND LONG-TERM INFORMATION. THE STUDY USES THE VECTOR ERROR CORRECTION MODEL (VECM) BECAUSE SPOT AND FUTURES PRICES ARE COINTEGRATED IN ORDER TO EXAMINE THE LEAD-LAG RELATIONSHIP, THE LONG- AND SHORT-RUN SPEED ALTERATION TOWARDS EQUILIBRIUM, OR THE LONG-RUN STEADY STATE (CAUSALITY), BETWEEN PFTS INDEX (UKRAINE) AND MOEX INDEX – (RUSSIA) STOCK MARKET PRICES OF SAMPLE VARIABLES.

Keywords: VECM MODEL, CCC – MGARCH MODELS, RUSSIA AND UKRAINE CONFLICT, COVID-19 PANDEMIC, COINTEGRATION, CAUSALITY, EXTREME EVENTS

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I. Introduction

According to Karolina Lindholm Billing, UN Refugee Agency (UNHCR) Representative in Ukraine, only in the first month since Russian military armed forces started the attacks on 24 February, 2022, more than 3.7 million people have fled the country, but "some 13 million people are estimated to be stranded in affected areas or unable to leave due to heightened security risks, destruction of bridges and roads, as well as lack of resources and information on where to find safety and accommodation" (United Nations News, 2022). So this war between Russia and Ukraine is considered as the "fastest-growing refugee crisis since World War II".

The invasion of Ukraine by Russia in February 2022 has determined the start of a new war which still seems far from ending. Unfortunately, the economic and financial consequences massively affect almost all the countries in Europe and implicitly many of the countries of the world that interact with them. Moreover, representative western countries such as United States of America and United Kingdom, but also European Union member states requested to be applied drastic economic sanctions to Russia, in order to discourage the continuation of the armed conflict.

On the other hand, the global economy had not yet recovered from the devastating effects of the COVID 19 pandemic. This new extreme event brings even more damage to European countries that had not even recovered after a period of more than two years of major restrictions and limitations. Batool et al. (2020) argued that the recent COVID-19 pandemic has disrupted the economies all around the world considering that the economic decline which was generated by preventive measures such as lockdown is significant.

2. LITERATURE REVIEW

Alam et al. (2022) investigated the effects of the conflict between Russia and Ukraine on global financial markets (G7 and BRIC) considering mainly commodities prices (for instance, oil, gas, platinum, gold, and silver). The empirical results revealed that gold and silver (commodities) and the stock markets from United States, Canada, China, and Brazil represent the so-called "receivers from the rest of the commodities/market's transmitters of shocks during this invasion crisis".

Jagtap et al. (2022) argued that despite direct financial losses, the Russia - Ukraine Conflict generated a high ravage of physical and human capital which will determine serious negative effects on labor productivity instantly and cripple economic growth for the next period. Prohorovs (2022) examined the economic consequences of the Russian war in Ukraine for European countries for the sample period April to June 2022. The important aspects found include both the end of the war and the removal of commercial and financial restrictions and sanctions affecting Russia. Shaker et al. (2022) examined the implications of the conflict between Russia and Ukraine on European stock markets while concluding that this political instability crisis affected global economy even considering the severe sanctions imposed on Russia. Moreover, Russia's armed aggression on Ukraine has generated disturbances on the behavior of the European stock markets while shaken global politics.

Lim et al. (2022) suggested the fact that the Russian war in Ukraine can trigger negative effects on the business environment based on the following: "limited access to funds, reduced purchasing power, an increasing inflation rate, and a threat to sustainable growth and restrictions on trade as a result of sanctions". In addition, Martinho (2022) argued that the impact generated by the Russian-Ukrainian military conflict was stronger than the crisis caused by the COVID-19 pandemic, especially considering the constraints regarding food security and agri-food chains.

Kyriazis (2022) investigated the effects of the war between Russia and Ukraine on global financial markets using optimal portfolios based on national currencies, precious metals and fuel, agricultural commodities and also cryptocurrencies in the context of high geopolitical risk. The empirical findings suggested that agricultural commodities represent the strongest generator of profits for the sample period from 24 February 2022 to 17 May 2022 while also considering risk-adjusted portfolios' performance.

Spulbar et al. (2020) examined the presence of abnormal volatility transmission patterns between selected emerging and developed stock markets, such as: USA, UK, France, Canada, Spain, Germany, Japan (developed stock markets), Hungary, Romania, China, Poland and India (emerging stock markets) for the sample period from January 2000 to June 2018. The econometric framework was based on asymmetric GARCH models, i.e. EGARCH and GJR models, but also other statistical test. The empirical findings suggested that in most cases, selected emerging stock markets have followed the volatility movement patterns of particular developed stock markets.

3. RESEARCH METHODOLOGY

Vector Error Correction Model (VECM)

In order to be used with non-stationary series that are known to be cointegrated, it is a restricted VAR with cointegration constraints included into the specification. While permitting a broad range of short-run dynamics, the VEC specification limits the long-run behaviour of the dependent variable to convergence to their cointegrating relationships. Since a succession of partial short-run adjustments gradually correct the departure from long-run equilibrium, the cointegration term is also known as the error correction term (ECT).

Both upward and downward error correction models are created, one with the dependent variable and the other with the independent variable. Referring to how these correlations should be interpreted, Ferret and Page (1998:76) state the following: Yt leads Xt if the change in Xt depends not only on its own prior modifications but also on the equilibrium error and those of Yt.
The causation estimates for the long and short terms were made by:

$$\Delta S_t = \alpha_S + \lambda_S Z_{t-1} + \sum_{i=2}^{k} \beta_{Si} \Delta S_{t-i} + \sum_{j=2}^{l} \gamma_{Fj} \Delta F_{t-j} + \varepsilon_{St} \ldots \ldots \quad (1)$$

$$\Delta F_t = \alpha_F + \lambda_F Z_{t-1} + \sum_{i=21}^{k} \beta_{Fi} \Delta F_{t-i} + \sum_{j=2}^{l} \gamma_{Sj} \Delta S_{t-j} + \varepsilon_{Ft} \ldots \ldots .(2)$$

Where, α_S and α_F are the intercepts and ε_{St} and ε_{Ft} are the error terms. The error correction term, Z_{t-1}, assesses how the dependent variable responds to the departure from the long-run equilibrium during the preceding period:

$$Z_{t-1} = S_{t-1} - \alpha - \delta F_{t-1}$$

As, δ is the cointegrating vector and α is the intercept, two-variable error correction model expressed in Equations (1) and (2) which is a bivariate VAR(n) model in first difference augmented by the error-correction terms, $\lambda_S Z_{t-1}$ and $\lambda_F Z_{t-1}$.The coefficients λ_S and λ_F are interpreted as the speed of adjustment parameters. The larger λ_S indicates greater the response of S_t to the deviation from the previous factors for the long-run equilibrium. And λ_S and λ_F, the error correction coefficients, have two uses. They are (a) to determine the direction of causality between dependent and independent variables, and (b) to gauge the rate at which price changes in dependent and independent variables can correct for long-run relationship aberrations.

Estimation of presence of Short-run Causality between Commodity Futures and Spot Prices using Wald Chi-square (χ2) Test

The "short-term" causal effects are indicated by the Wald Chi-square (2) test (or strict exogeneity of the variables). The equation's null proposition; (1), $H_0: \sum_{j=2}^{l} \gamma_{Fj} = 0$, suggests that the lagged terms of ΔF do not belong to the regression, i.e. ΔF does not cause ΔS. Conversely, the null hypothesis for the Equation (2) is $H_0: \sum_{j=2}^{l} \gamma_{Sj} = 0$, suggesting that the lagged terms of ΔS do not belong to the regression, i.e. ΔS do not cause ΔF. The joint test of these null hypotheses can be tested by Wald Chi-square (χ^2) test. If the coefficients of γ_{Sj} are statistically significant, but the coefficients of γ_{Fj} are not statistically significant, then dependent variable (*S)* is said to cause independent variable (*F)* (unidirectional). The reverse causality holds if coefficients of γ_{Fj} are statistically significant while γ_{Sj} are not, i.e. *F* causes *S* (unidirectional). Yet, γ_{Sj} and γ_{Fj} are both statistically significant; causality is bidirectional (bidirectional). The presence of non-significant γ_{Sj} and γ_{Fj} coefficients in both regressions indicates the existence of independence. The null hypothesis that the joint value of the coefficients of future prices at certain selected lag lengths is zero is tested in the current study using the Wald Chi-square (χ^2) (2) test.

Time-varying optimal Hedge Ratio using Constant Conditional Correlation (CCC) – VECM-MGARCH

Time series data typically have a heteroscedastic volatility structure that changes over time (ARCH-effect). The estimation of a constant hedge ratio and hedging effectiveness may not be adequate due to the ARCH impact in the return of the dependent variable (spot prices) and independent variable (futures prices) and their time-varying joint distribution. In order to estimate time-varying optimal hedge ratios, Cecchetti et al. (1988) employed the ARCH model to describe time variation in the conditional covariance matrix of treasury bond returns and bond futures. They discovered that the optimal hedging ratios varied significantly over time. The VECM-MGARCH model calculates the time-varying hedge ratio while taking into account the ARCH effect in the time series. In order to determine the time-varying hedge ratio, we employ the constant conditional correlation (CCC) model. In order to model each error, a univariate GARCH model is first applied to the errors from the VECM model, and the covariance is then determined as follows:

$$h_{ss,t} = \omega_s + \alpha_{s,1}\varepsilon_{s,t-1}^2 + \beta_{s,1}h_{ss,t-1}$$
$$h_{ff,t} = \omega_f + \alpha_{f,1}\varepsilon_{f,t-1}^2 + \beta_{f,1}h_{ff,t-1}$$
$$h_{sf,t} = \rho(h_{ss,t} \times h_{ff,t})^{1/2}$$

Where, $h_{ss,t}$ is the conditional spot variance at time t, $h_{ff,t}$ is conditional futures variance, $h_{sf,t}$ is covariance and ρ is the constant conditional correlation. The parameters are estimated through the MLE developed by Bollerslev et al. (1990). Time varying hedge ratio is calculated as follows:

$$H_t = \frac{h_{sft}}{h_{fft}}$$

Results for descriptive property for selected samples provided in Table 1, indicates negatively skewed returns except for Ukraine, as the trading for the same is being halted since Russia's invasion into Ukraine. Kurtosis provides strong leptokurtic effect across the samples.

Table 1 Property of Descriptive Statistics (Daily observations count 2400)

Variable	Mean	Std. Dev.	Minimum	Maximum	Skewness	Ex. kurtosis
RUSSIA	0.00015	0.01554	-0.4047	0.18262	-7.237	203.19
ROMANIA	0.00035	0.00976	-0.1189	0.06817	-1.6387	21.707
UKRAINE	0.00019	0.0107	-0.0686	0.24431	5.7577	128.3
HUNGARY	0.00035	0.01249	-0.1227	0.06003	-1.1951	11.555

Source: Author's computation using daily closing prices

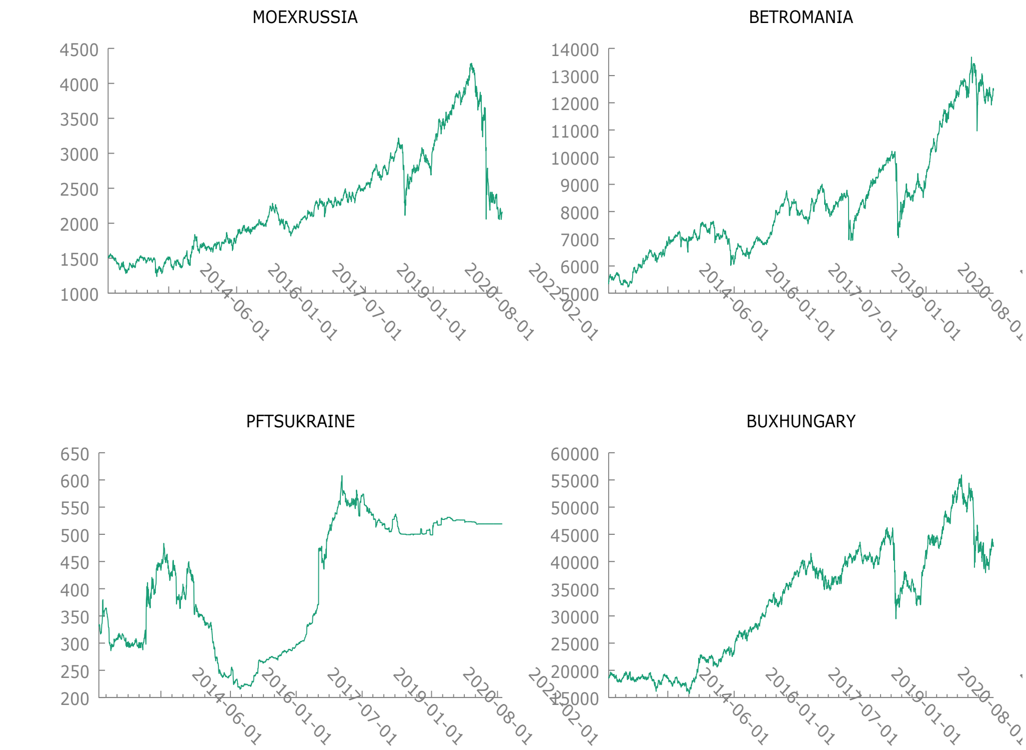
Correlation coefficient considering the 5% critical value indicates that none of the selected indices are correlated (See Table 2).

Table 2 Correlation coefficients,
5% critical value (two-tailed) = 0.0400 for n = 2399

RUSSIA	ROMANIA	UKRAINE	HUNGARY	
1	0.0205	-0.0358	-0.0083	RUSSIA
	1	0.0038	-0.0005	ROMANIA
		1	-0.0014	UKRAINE
			1	HUNGARY

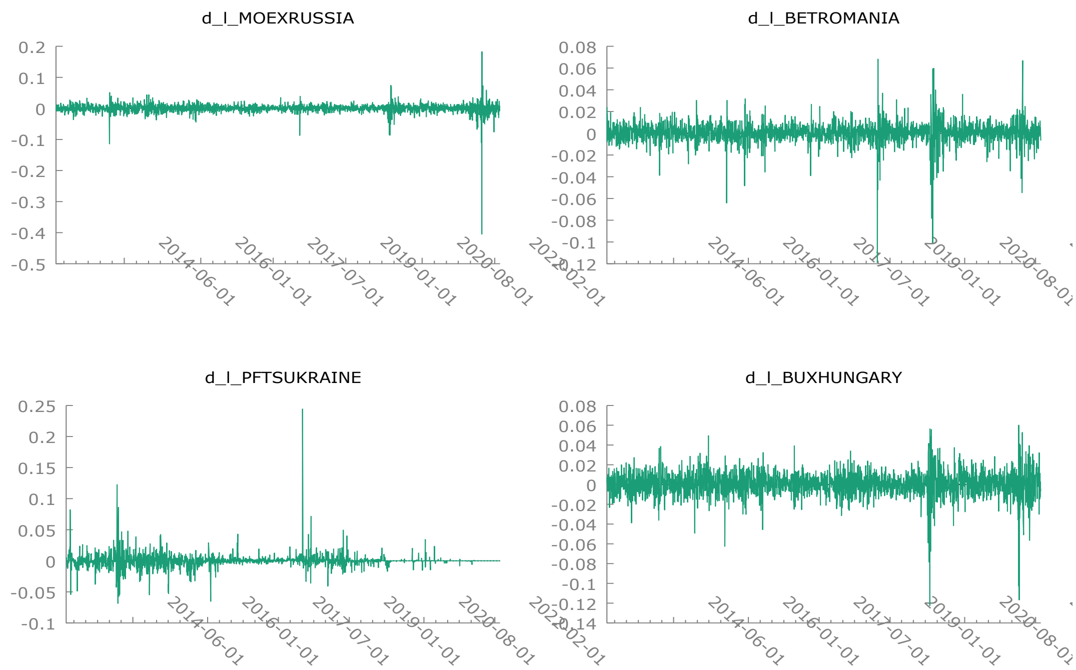
Source: Author's computation using daily closing prices

Figure 1 Time-Series Trend for Russia, Ukraine, Romania and Hungary



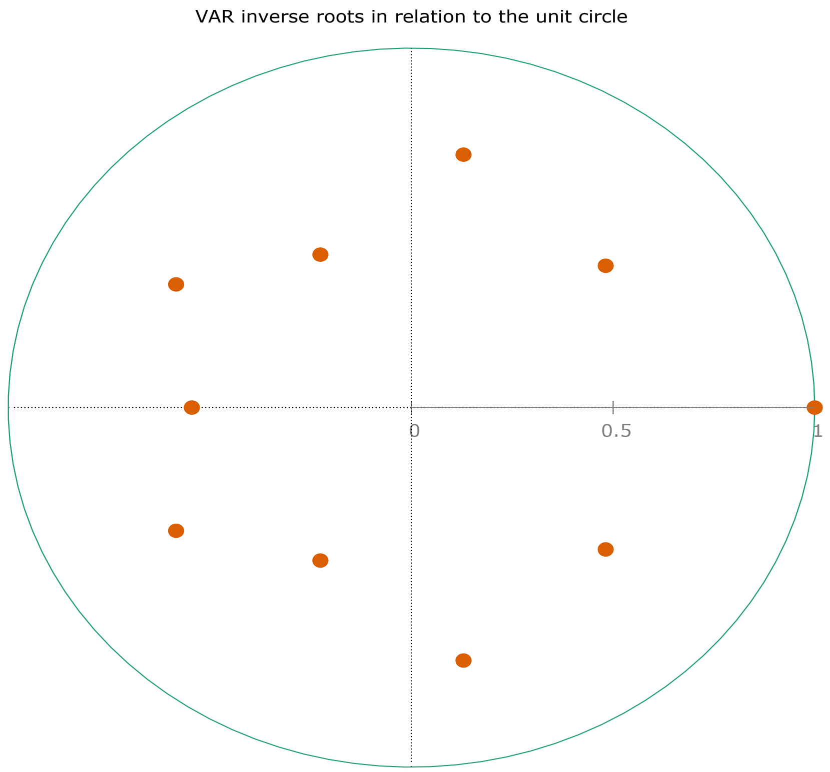
Source: Author's computation using daily closing prices

Figure 2 Stationary return (Shocks) – Russia, Ukraine, Romania and Hungary



Source: Author's computation using closing prices

Figure 2 VAR inverse roots for Ukraine, Hungary and Romania over Russia



Source: VAR inverse root response in relation to the unit circle

VECM - Vector Error Correction Estimates of PFTS - UKRAINE, BET - ROMANIA, BUX - HUNGARY, MOEX - RUSSIA

The error correction terms (ECT) of the price series of PFTS - UKRAINE & MOEX - RUSSIA, BET - ROMANIA & MOEX - RUSSIA, and BUX - HUNGARY & MOEX - RUSSIA are shown in Tables 1A, 1B, and 1C (refer to appendices 2) for various lags and show the long- and short-run speed adjustments (convergence) towards equilibrium When the error correction term's coefficient (coefficient of CointEq1) is both substantial and negative in sign, it can be concluded that there is a long-term causal relationship extending from the MOEX - RUSSIA values to the dependent PFTS - UKRAINE, BET - ROMANIA, and BUX - HUNGARY prices.

The ECTs of *ln* prices of variables understudy are negative in sign (PFTS - UKRAINE: -0.001, BET - ROMANIA: -0.003 and BUX - HUNGARY: -0.001) and significant ($p < 0.05$) for BET - ROMANIA. This implies that there is a long-run causality running from MOEX – RUSSIA prices to prices of PFTS - UKRAINE, BET – ROMANIA and BUX - HUNGARY which enable the Ukraine, Romania, and Hungary markets to adjust to the short-run deviation from long-run equilibrium path with nearly 0.1%, 0.3% and 0.1% speed of adjustments in the respective markets respectively. The Russian market is very informational, as seen by the 0.06% correction rate in comparison to the Hungary market. At the same time, negligible ECTs of 0.01% and -0.04% in Russian market prices show Russian market effectiveness in maintaining steady long-term equilibrium.

Table 1 A Property of Wald Chi-square (χ2) test

Test Statistic	PFTS - UKRAINE & MOEX - RUSSIA			BET - ROMANIA & MOEX - RUSSIA			BUX - HUNGARY & MOEX - RUSSIA		
	Value	df	Prob.	Value	df	Prob.	Value	df	Prob.
F-statistic	0.561273	(8, 2373)	0.8103	2.646185	(9, 2370)	0.0047	2.808448	(8, 2373)	0.0042
Chi-square	4.490182	8	0.8104	23.81567	9	0.0046	22.46759	8	0.0041

Source: Author's computation using sample indices

According to the Wald Chi-square (2) test results shown in Table 2, there is a short-run causal relationship between the Russian, Romanian, and Hungarian markets under investigation when the joint value of all coefficients of ln prices for PFTS - UKRAINE, BET - ROMANIA, BUX - HUNGARY, and MOEX - RUSSIA at particular lag lengths is greater than zero. However, the joint value of all the price coefficients for PFTS-UKRAINE and MOEX-RUSSIA at particular lag lengths is equal to zero, indicating the absence of any short-run causality between the studied Russian and Ukrainian markets. Cointegrated VAR or Vector Error Correlation Model that follows the order p – 1 on the differences of the variables where error-correlation from cointegrated relationship, the model used to explore the relationship and cointegrations for larger areas including economies, GDP, foreign exchange rates, gold, other commodities, financial markets etc.

Time series data typically have a heteroscedastic volatility structure that changes over time (ARCH-effect). The estimation of a constant hedge ratio and hedging effectiveness may not be adequate due to the ARCH impact in the return of the dependent variable (spot prices) and independent variable (futures prices) and their time-varying joint distribution. In order to estimate time-varying optimal hedge ratios, Cecchetti et al. (1988) employed the ARCH model to describe time variation in the conditional covariance matrix of treasury bond returns and bond futures. They discovered that the optimal hedging ratios varied significantly over time. The VECM-MGARCH model calculates the time-varying hedge ratio while taking into account the ARCH effect in the time series. In order to determine the time-varying hedge ratio, we employ the constant conditional correlation (CCC) model.

Table 1 BCCC – VECM – MGARCH Property

CCC-VECM-MGARCH	PFTS - UKRAINE & MOEX - RUSSIA	BET - ROMANIA & MOEX - RUSSIA	BUX - HUNGARY & MOEX - RUSSIA
Hsst	-0.0610	0.1088	0.8221
Hfft	-0.0391	0.0526	0.1102
Rsf	0.8050	0.7985	0.9170
Hsft	0.0393	0.0604	0.2760
Hedge Ratio	**0.1988**	**0.2634**	**0.8314**

Source: Author's computation using sample indices

Results from the CCC-VECM-MGARCH show that the markets for PFTS - UKRAINE, BET - ROMANIA, BUX - HUNGARY, and MOEX - RUSSIA respectively give variance reductions of 19.88% (for both UKRAINE and RUSSIA), 26.34% (for both ROMANIA and RUSSIA), and 52% (for both HUNGARY and RUSSIA). This demonstrates that market participants that are attempting to reduce price risk through hedging in the relevant markets are able to do so by 19.88%, 26.34%, and 83.14% for Ukraine, Romania, and Hungary, respectively. For instance, (Mwaanga & Njebele, 2017) investigated relationship between exchange rate and stock market prices using Vector Autoregression based cointegration, confirms that existence of cointegration long-run effect, despite insignificant auto-regression distributions, study finds existence of long-run relationship and no evidence of short-run relationship between the exchange rate and stock market prices on the samples of Zambia.

Conclusions

This paper concludes the evidence of effect of Russian stock market over Ukraine, Hungary and Romania with cross-causality impact. Results clears that Ukraine has no short-term causality with Russia but found the insignificant evidence of long-term causality effect. We observed the same pattern of causality effect with Romanian stock market. However, there is positive and significant evidence of long-term causality for Russian and Hungarian markets.

Russia's invasion over Ukraine impacted heavily on the exchange trading activity at a large scale despite where there was least cointegration between the relationship of Russian market and Ukraine market. As a result of positive and significant cointegraions among selected samples, there might be possibilities for investors to earn excess returns from Russia, Hungary and Romania. Thought this contrasts with efficient market hypothesis since prices will adjust immediately to arrival of new information. However, the opportunity remains open and enlarge depending upon the category of news and possibility of lasting the news effect over price adjustments.

Therefore, investors need to remain calculated and remain ready to mitigate investment risks by continuous monitoring movement of news impact and price discovery. The study also proves that how deeply domestic financial markets exposed to foreign markets. For instance, during the normal market behaviour, the correlation matrix confirms no relationship among the sample markets. This means that increase or decrease of any basis points in one market scale is not a much interest to alternate domain index to follow the same pattern.

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Appendices

Appendices no.1

VAR Lag Order Selection Criteria –

Endogenous variables: **PFTS - UKRAINE & MOEX – RUSSIA**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	3446.329	NA	0.000192	-2.882283	-2.87745	-2.880524
1	17999.63	29070.06	9.90e-10	-15.05743	-15.0429	-15.05215
2	18035.67	71.92882	9.64e-10	-15.08424	-15.06006*	-15.07544*
3	18042.68	13.98530	9.62e-10	-15.08676	-15.0529	-15.07444
4	18045.92	6.450574	9.62e-10	-15.08612	-15.0426	-15.07029
	18054.83	17.75447	9.58e-10	-15.09024	-15.037	-15.07088
6	18057.98	6.253310	9.59e-10	-15.08952	-15.0267	-15.06665
7	18066.97	17.87252	9.55e-10	-15.0937	-15.0212	-15.0673
8	18071.86	9.701208*	9.54e-10*	-15.09444*	-15.0122	-15.06453
9	18074.96	6.149924	9.55e-10	-15.09369	-15.0018	-15.06025
10	18076.99	4.025099	9.56e-10	-15.09204	-14.9905	-15.05508

Endogenous variables: **BET - ROMANIA & MOEX – RUSSIA**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	5141.954	NA	4.65e-05	-4.301217	-4.29638	-4.299457
1	18224.27	26131.78	8.20e-10	-15.24541	-15.2309	-15.24013
2	18243.44	38.26312	8.10e-10	-15.25811	-15.2339	-15.24931
3	18263.27	39.54412	7.99e-10	-15.27135	-15.23750*	-15.25904
4	18264.74	2.933917	8.01e-10	-15.26924	-15.2257	-15.2534
	18286.69	43.70232	7.89e-10	-15.28426	-15.2311	-15.2649
6	18301.91	30.26828	7.82e-10	-15.29365	-15.2308	-15.27077*
7	18306.61	9.339849	7.81e-10	-15.29423	-15.2217	-15.26784
8	18309.00	4.746828	7.82e-10	-15.29289	-15.2107	-15.26297
9	18317.19	16.25289*	7.80e-10*	-15.29639*	-15.2045	-15.26296
10	18319.77	5.123260	7.81e-10	-15.29521	-15.1937	-15.25825

Endogenous variables: **BUX - HUNGARY & MOEX – RUSSIA**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	4664.677	NA	6.93e-05	-3.901822	-3.89699	-3.900062
1	17632.59	25903.27	1.35e-09	-14.75028	-14.73578*	-14.745
2	17647.33	29.41398	1.33e-09	-14.75927	-14.7351	-14.75047
3	17653.92	13.14318	1.33e-09	-14.76144	-14.7276	-14.74912

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	17665.27	22.61382	1.32e-09	-14.76759	-14.7241	-14.75175*
5	17671.27	11.94469	1.32e-09	-14.76926	-14.7161	-14.7499
6	17677.80	12.98515	1.32e-09	-14.77138	-14.7085	-14.7485
7	17685.64	15.59285*	1.31e-09	-14.7746	-14.7021	-14.7482
8	17689.65	7.952544	1.31e-09*	-14.77460*	-14.6924	-14.74468
9	17692.25	5.165757	1.32e-09	-14.77343	-14.6816	-14.74
10	17694.14	3.741766	1.32e-09	-14.77166	-14.6701	-14.73471

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Appendices 2

PFTS - UKRAINE & MOEX – RUSSIA

Table 1 A: VECM - Vector Error Correction Estimates of PFTS - UKRAINE and MOEX - RUSSIA

Error Correction:	PFTS - UKRAINE & MOEX - RUSSIA							
	PFTS - UKRAINE				MOEX - RUSSIA			
	Coefficient	Std. Error	t-stats	Prob.	Coefficient	Std. Error	t-stats	Prob.
CointEq1	-0.001	0.001	-1.232	0.218	0.001	0.001	1.205	0.228
PFTS - UKRAINE (-1)	0.135	0.021	6.581	0.000	0.001	0.030	0.020	0.984
PFTS - UKRAINE (-2)	-0.019	0.021	-0.924	0.356	0.059	0.030	1.954	0.051
PFTS - UKRAINE (-3)	0.052	0.021	2.506	0.012	0.022	0.030	0.733	0.464
PFTS - UKRAINE (-4)	-0.064	0.021	-3.108	0.002	-0.024	0.030	-0.779	0.436
PFTS - UKRAINE (-5)	-0.056	0.021	-2.712	0.007	-0.016	0.030	-0.544	0.586
PFTS - UKRAINE (-6)	0.061	0.021	2.952	0.003	-0.019	0.030	-0.621	0.534
PFTS - UKRAINE (-7)	0.058	0.021	2.795	0.005	-0.012	0.030	-0.398	0.691
PFTS - UKRAINE (-8)	0.004	0.021	0.173	0.863	0.015	0.030	0.492	0.623
MOEX - RUSSIA (-1)	0.012	0.014	0.858	0.391	-0.103	0.021	-5.006	0.000
MOEX - RUSSIA (-2)	-0.017	0.014	-1.217	0.224	0.053	0.021	2.560	0.011
MOEX - RUSSIA (-3)	-0.009	0.014	-0.643	0.520	-0.003	0.021	-0.143	0.886
MOEX - RUSSIA (-4)	0.005	0.014	0.331	0.741	0.049	0.021	2.351	0.019
MOEX - RUSSIA (-5)	-0.010	0.014	-0.708	0.479	-0.014	0.021	-0.699	0.485
MOEX - RUSSIA (-6)	-0.008	0.014	-0.540	0.589	-0.046	0.021	-2.207	0.027
MOEX - RUSSIA (-7)	0.003	0.014	0.200	0.841	0.019	0.021	0.910	0.363
MOEX - RUSSIA (-8)	0.012	0.014	0.867	0.386	-0.047	0.021	-2.267	0.023
C	0.000	0.000	0.778	0.437	0.000	0.000	0.474	0.636
R-squared	0.037				0.026			
Adj. R-squared	0.030				0.019			
F-statistic	5.408				3.724			
Prob(F-statistic)	0.000				0.000			

Note: p values denote significant at 5% level of significance

BET - ROMANIA & MOEX – RUSSIA

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2/2022 https://alss.utgjiu.ro

Table 1 B: VECM - Vector Error Correction Estimates of BET - ROMANIA and MOEX - RUSSIA

Error Correction:	BET - ROMANIA & MOEX - RUSSIA							
	BET - ROMANIA				MOEX - RUSSIA			
	Coefficient	Std. Error	t-stats	Prob.	Coefficient	Std. Error	t-stats	Prob.
CointEq1	-0.003	0.002	-1.892	0.059	-0.004	0.003	-1.355	0.176
BET - ROMANIA (-1)	0.021	0.021	1.019	0.308	0.074	0.032	2.274	0.023
BET - ROMANIA (-2)	0.106	0.021	5.152	0.000	0.019	0.032	0.600	0.549
BET - ROMANIA (-3)	-0.029	0.021	-1.385	0.166	0.014	0.032	0.435	0.663
BET - ROMANIA (-4)	-0.028	0.021	-1.361	0.174	0.190	0.032	5.853	0.000
BET - ROMANIA (-5)	0.045	0.021	2.175	0.030	0.162	0.033	4.958	0.000
BET - ROMANIA (-6)	-0.041	0.021	-1.982	0.048	0.009	0.033	0.271	0.786
BET - ROMANIA (-7)	-0.001	0.021	-0.046	0.963	0.049	0.033	1.499	0.134
BET - ROMANIA (-8)	-0.016	0.021	-0.784	0.433	0.039	0.033	1.204	0.229
BET - ROMANIA (-9)	0.008	0.021	0.392	0.695	0.038	0.033	1.175	0.240
MOEX - RUSSIA (-1)	-0.035	0.013	-2.646	0.008	-0.125	0.021	-6.059	0.000
MOEX - RUSSIA (-2)	-0.027	0.013	-2.057	0.040	0.038	0.021	1.829	0.068
MOEX - RUSSIA (-3)	0.018	0.013	1.368	0.172	-0.019	0.021	-0.936	0.349
MOEX - RUSSIA (-4)	0.019	0.013	1.452	0.147	0.031	0.021	1.476	0.140
MOEX - RUSSIA (-5)	0.011	0.013	0.805	0.421	-0.019	0.021	-0.916	0.360
MOEX - RUSSIA (-6)	0.003	0.013	0.231	0.817	-0.041	0.020	-1.995	0.046
MOEX - RUSSIA (-7)	0.007	0.013	0.544	0.586	0.017	0.021	0.807	0.420
MOEX - RUSSIA (-8)	0.036	0.013	2.787	0.005	-0.059	0.020	-2.898	0.004
MOEX - RUSSIA (-9)	0.016	0.013	1.240	0.215	-0.031	0.020	-1.512	0.131
C	0.000	0.000	1.519	0.129	0.000	0.000	-0.088	0.930
R-squared	0.028				0.052			
Adj. R-squared	0.021				0.044			
F-statistic	3.634				6.840			
Prob(F-statistic)	0.000				0.000			

Note: p values denote significant at 5% level of significance

BUX - HUNGARY & MOEX – RUSSIA

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MOEX - RUSSIA (-3)	0,018	0,013	1,368	0,172	-0,019	0,021	-0,936	0,349
MOEX - RUSSIA (-4)	0,019	0,013	1,452	0,147	0,031	0,021	1,476	0,140
MOEX - RUSSIA (-5)	0,011	0,013	0,805	0,421	-0,019	0,021	-0,916	0,360
MOEX - RUSSIA (-6)	0,003	0,013	0,231	0,817	-0,041	0,020	-1,995	0,046
MOEX - RUSSIA (-7)	0,007	0,013	0,544	0,586	0,017	0,021	0,807	0,420
MOEX - RUSSIA (-8)	0,036	0,013	2,787	0,005	-0,059	0,020	-2,898	0,004
MOEX - RUSSIA (-9)	0,016	0,013	1,240	0,215	-0,031	0,020	-1,512	0,131
C	0,000	0,000	1,519	0,129	0,000	0,000	-0,088	0,930
R-squared	0,028				0,052			
Adj. R-squared	0,021				0,044			
F-statistic	3,634				6,840			
Prob(F-statistic)	0,000				0,000			

Note: p values denote significant at 5% level of significance

Table 1 C: VECM - Vector Error Correction Estimates of BUX - HUNGARY and MOEX - RUSSIA

Error Correction:	BUX - HUNGARY & MOEX - RUSSIA							
	BUX - HUNGARY				MOEX - RUSSIA			
	Coefficient	Std. Error	t-stats	Prob.	Coefficient	Std. Error	t-stats	Prob.
CointEq1	-0,001	0,002	-0,813	0,416	0,006	0,002	2,645	0,008
BUX - HUNGARY (-1)	0,010	0,021	0,490	0,625	0,028	0,025	1,080	0,280
BUX - HUNGARY (-2)	-0,039	0,021	-1,886	0,059	0,003	0,025	0,115	0,909
BUX - HUNGARY (-3)	0,064	0,021	3,115	0,002	-0,069	0,025	-2,707	0,007
BUX - HUNGARY (-4)	0,017	0,021	0,818	0,414	0,010	0,025	0,392	0,695
BUX - HUNGARY (-5)	-0,038	0,021	-1,833	0,067	0,026	0,025	1,032	0,302
BUX - HUNGARY (-6)	-0,054	0,020	-2,627	0,009	0,050	0,025	1,957	0,050
BUX - HUNGARY (-7)	0,032	0,021	1,536	0,125	0,039	0,025	1,529	0,126

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