COINTEGRATION BETWEEN THE BLACK SEA AND KANSAS CITY WHEAT FUTURES: THE IMPACT OF RUSSIAN INVASION OF UKRAINE

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ABSTRACT

We investigate the effect of the Russian invasion of Ukraine on Black Sea Wheat Futures. Black Sea Wheat Futures are cointegrated with the Kansas City Wheat Futures, the global standard for wheat prices; however, the relationship between these two series significantly changes as a reaction to the main geopolitical events in the region. A significant drop in open interest after the invasion is also documented. The results of this study are relevant to many market participants, such as Ukrainian farmers and consumers in developing countries, including the World Food Program, which buys about forty percent of its wheat supplies from Ukraine.

Keywords: Black Sea Wheat Futures; Kansas City Wheat Futures; Russian invasion of Ukraine; error correction model; cointegration of wheat prices

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INTRODUCTION

Ukraine is one of the largest producers of wheat in the world and plays an essential role in global wheat markets. About 97 percent of Ukrainian wheat is so-called "winter wheat." Winter wheat is planted from early September to mid-November and harvested between July and September. Most of the grain is produced in the Southeast region of the country. In 2021, Ukraine was the seventh largest wheat producer in the world, and its wheat export reached a value of $5.1 billion. The primary destinations of wheat shipments were Egypt, Indonesia, Turkey, Pakistan, and Bangladesh ("Ukraine Agricultural Production and Trade").

On February 24, 2022, Russia invaded Ukraine with widespread missile and airstrikes that were felt across the country ("2022 Russian invasion of Ukraine") and occupied large portions of the northeast and southeast regions in the following months. By early April, Ukrainian resistance forced Russian troops to retreat from the northeast regions. The southeast regions, however, remained occupied throughout the summer. Most of the wheat from this region is exported by ships using deep-water seaports, such as those at Pivdennyi, Odesa, Mykolaiv, and Chornomorsk ("Ukraine Agricultural Production and Trade"). However, Russia blocked the Black Sea ports during the occupation, and Ukraine's grain export ceased. This blockade created widespread food insecurity, especially in developing countries that largely depend on Ukrainian wheat. In addition to facilitating direct trade between Ukraine and many developing countries, the World Food Program (WFP) buys about forty percent of its wheat supplies from Ukraine. David Beasley, the executive director of WFP, stated in his address to the United Nations Security Council: "Failure to open those ports… will be a declaration of war on global food security… And it will result in famine and destabilization and mass migration around the world" ("David Beasley (WFP) on Conflict and Food Security - Security Council, 9036th Meeting").

On July 22, 2022, Russia and Ukraine signed an agreement to resume exports of Ukrainian grain through the Black Sea. This agreement, also referred to as the Black Sea Grain Initiative, was backed by the United Nations and facilitated by Turkey. As a result, the first ship loaded with grain left the port of Odessa on August 1, 2022 (Luxmoore et al., 2022). While the resumption of shipments is promising for Ukrainian farmers and buyers worldwide, the grain flow will be lower than before the war. The U.S. Department of Agriculture predicts Ukraine will export only about half the tonnage of the season before. In addition, Russian officials continue to threaten the deal (Malsin and Kantchev, 2022).[1] As of January 2023, over 18 million tonnes of grain and other food products have been exported through this initiative. About 28 percent, i.e. over 5 million tonnes, was wheat. The majority of this wheat (about 65 percent) was destined for developing countries such as Ethiopia, Yemen, Djibouti, Somalia, and Afghanistan (Ukrainian grain exports explained, 2023). Maintaining the export of grain from Ukraine continues to be a pivotal issue in ensuring global food security.

Research on wheat futures concentrates primarily on identifying the determinants of futures prices, as well as their volatility or seasonality (see, for example, Dawson, 2015, Goodwin, 2000, Karali, 2010, Koekebakker, 2004), and focuses mainly on U.S. markets. Little research has been done on regional wheat futures, although more research has emerged in recent years. The general conclusion of these studies is that the creation of Black Sea Wheat Futures significantly increased the participation of Black Sea wheat markets in the price formation of the global wheat market (Svanidze and Đurić, 2021).

In this paper, the effect of the Russian invasion of Ukraine on the trading and pricing of Black Sea Wheat Futures is examined using data on the Black Sea and Kansas City Wheat Futures. Black Sea Wheat Futures track the price and movement of the current wheat price in the Black Sea region, while the Kansas City Wheat Futures represent expected global wheat prices. This research finds that the Black Sea and Kansas City Wheat Futures are cointegrated and a stationary series of order one. Whether the invasion significantly affected the structural stability of the relation between prices of the Black Sea and Kansas City Wheat Futures is a further point of investigation.

The rest of this paper proceeds as follows: in the Data and Summary Statistics section, the data is described and the summary statistics of the Black Sea and KC Wheat Futures is presented. In the Methodology section, the methodology, including the detection of structural breakpoints, is explained. In the Regression Results section, the results of the error correction model are summarized. The last section details the study’s conclusions.

DATA AND SUMMARY STATISTICS

We use data on Black Sea Wheat Futures and Kansas City Wheat Futures gathered from Bloomberg. The data series are daily and cover a period from January 2020 to August 2022.

The Russian invasion of Ukraine has had a tremendous effect on the Russian stock market as the market expected additional Western sanctions and increased pressure on public finance and labor supply. The impact of the invasion on Russian markets can be well demonstrated by examining the Russian volatility index and comparing this index with

[1] Russia suspended its participation in allowing safe corridor for transport of Ukrainian wheat on Sunday, October 30, 2022 (Person and Polityuk, 2022). The agreement was resumed on November 2, 2022 (Meldrum and Fraser, 2022).

VIX. Data on VIX (CBOE volatility index) and the Russian volatility index (RVI) are from the CBOE Exchange and Investing.com.

VIX

The VIX is the CBOE volatility index, based on the volatility of short-term options on the S&P 500 index. It is widely recognized as a benchmark index of the market's expectation of future volatility and is considered the leading indicator of the broad U.S. stock market. High levels of VIX are indicators of fear in the market.

RVI

RVI is the Russian volatility index, calculated from short-term RTS (Russian Trading System) index options. The RTS index is a value-weighted composite index calculated based on the prices of the 50 most liquid Russian stocks, denominated in U.S. dollars. Thus, the RVI represents the market's expectation of the 30-day volatility of the Russian market.

Figure 1 depicts the development of the VIX and RVI during the period studied. Both indices tend to move together until the invasion. After the invasion, RVI rises significantly, indicating fear in the Russian market, and the co-movement of these two volatility measures ceases. The rise in the RVI is not surprising since the Russian market plummeted after the invasion and became isolated from the global equity markets.

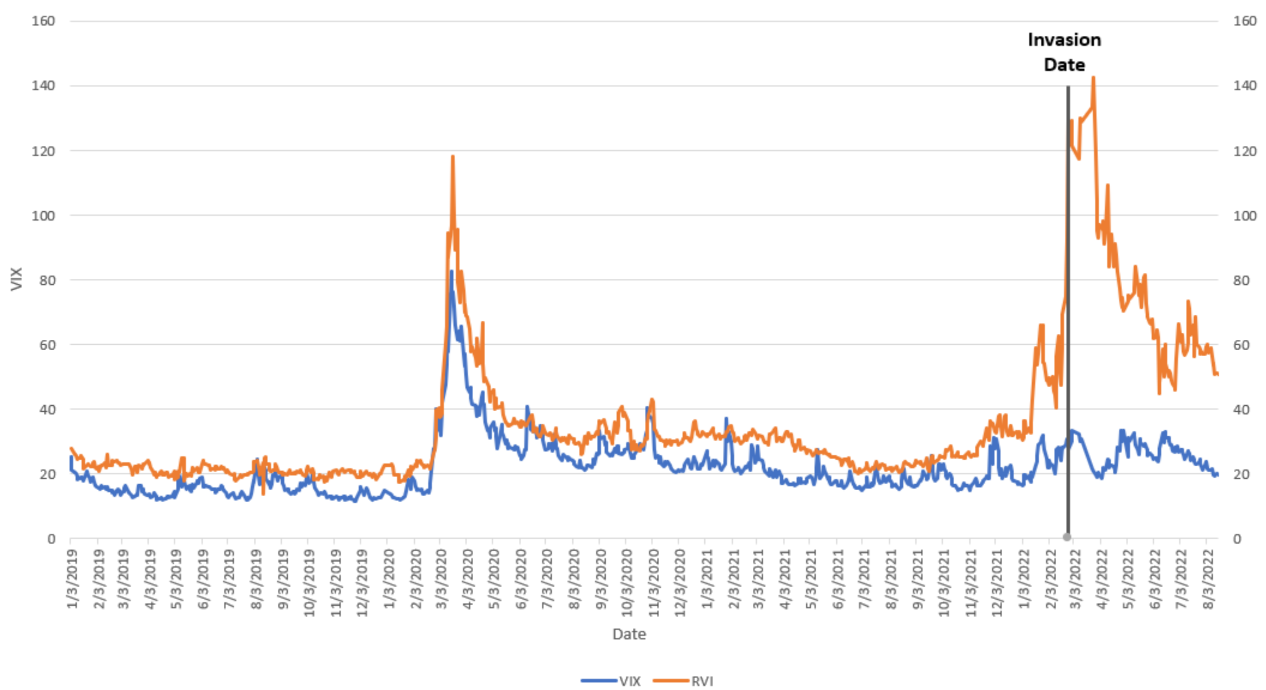

Figure 1: VIX and RVI indices

Sourse: CBOE Exchange and Investing .com

Note: VIX is the U.S. volatility index, RVI is the Russian volatility index. The black vertical line depicts the Russian invasion of Ukraine on February 24, 2022. Data on VIX are from the CBOE Exchange, and data on RVI from Investing.com.

Kansas City Wheat Futures

Wheat futures contracts are agreements between buyers and sellers on the price of the wheat upon delivery at a future designated date. Their prices reflect the market expectation, under the assumption of risk-neutral participants, for future spot prices of wheat. Kansas City Hard Red Winter Wheat Futures (KC HRW) are the global industry standards for wheat price risk management. They trade on the Chicago Mercantile Exchange (CME) and lead to the delivery of physical grain. Each contract is for

5,000 bushels (approximately 136 metric tons of wheat). Monthly contracts are listed for March, May, July, September, and December, with expirations of up to fifteen months.

Similar to other commodity futures, KC Wheat Futures are used by hedgers (producers, exporters, and processors) and speculators. Therefore, they have position limits, currently set at 12,000 contracts. Data on KC Wheat Futures are from the Bloomberg database.

Black Sea Wheat Futures

In the past two decades, wheat exports from the Black Sea region (Ukraine, Russia, Romania, and Bulgaria) have increased significantly, representing about 35% of the world's wheat exports in 2020 ("Hedging Opportunities Using Black Sea Wheat Futures"). This created a demand for Black Sea Wheat Futures contracts (BWF) that correlate highly with Black Sea regional spot prices. Trading these contracts was launched in December 2017, and Black Sea Wheat Futures became a tool for price discovery, hedging, and trading opportunities on emerging grain markets. By April 2020, the total contracts traded reached 430,000 lots, equivalent to 22 million tons of wheat. The Black Sea Wheat Futures contracts are based on the average price of "Russian Wheat 12.5% Fob Black Sea Deep Water," published by Platts. Data on Black Sea Wheat Futures are from the Bloomberg database.

The trading volume and open interest of Black Sea Wheat Futures are shown in Figure 2. Shortly after the Russian invasion of Ukraine, trading volume remained strong, and even increased. This high trading volume was likely due to closing futures contracts as open interest (O.I.) steadily declined. The O.I. is the total number of contracts held by market participants, while the trading volume refers to the number of contracts traded on a particular day. Closing an open contract increases the trading volume, but decreases O.I., which is apparent shortly after the invasion.

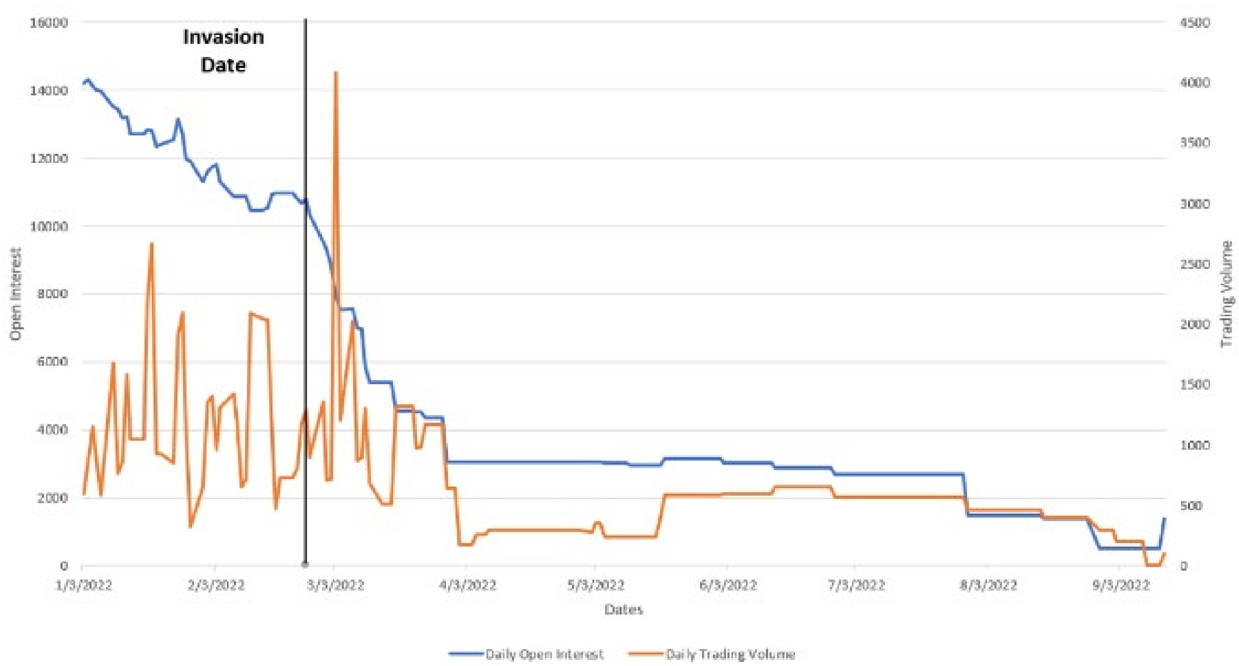

Figure 2: Volume and Open interest of Black Sea Wheat Futures
Sourse: Bloomberg L.P.

Black Sea Wheat Futures trade on the CME. They are priced in U.S. dollars and though they are financially settled, do not lead to the actual delivery of the grain ("Black Sea Wheat Financially Settled (Platts)"). Each contract is for 50 metric tons of wheat, and contracts are listed every month from January to December for 15 consecutive months. The position limit is 6,000 contracts. Hedgers can request exemption of these limits from CME.

Spot prices for KC wheat and Russian wheat are shown in Figure 3. Casual observation suggests that global and regional wheat prices move together, which is especially noticeable before the Russian invasion of Ukraine. After the invasion, however, the relationship changes.

Figure 3: Wheat spot prices
Source: Bloomberg L.P. (2022)

Worldwide cointegration of agricultural commodity prices has been well documented in the literature. This cointegrated relationship results from efficient arbitrage and trade activities in commodity markets. Some barriers to arbitrage, however, such as transportation costs, differences in quality, or separation of the markets may decrease the efficiency of arbitrage and thus their price cointegration.

The introduction of commodity futures makes arbitrage easier and contributes to the cointegration of agricultural commodities. Not surprisingly, therefore, studies prior to the introduction of regional wheat futures only find cointegration among wheat prices in some, but not all, regions. For example, Goychuk and Meyers (2014) find that Russian wheat prices are cointegrated with those of France and the U.S., but not with Canadian wheat prices, while Ukrainian wheat prices are cointegrated with French wheat prices, but not with U.S. or Canadian wheat prices. Heigermoser, Götz, and Svanidze (2021) show that the wheat prices in the Black Sea region are led by French and US export prices. They explain that Russian wheat traders use French export prices as reference prices. Similarly, Janzen and Adjemian (2017), using high-frequency data, document information leadership of the Euronext commodity futures exchange and Chicago Board of Trade in the international wheat markets.

KC and Black Sea Wheat Futures reflect the expected global and regional wheat prices. Here, cointegration methodology is used to explore the relationship between the Black Sea and KC Wheat Futures. The co-movement of the Black Sea and KC Wheat Futures are illustrated in Figure 4, and correlations and descriptive statistics for futures are summarized in Tables 1 and 2.

Figure 4: Co-movement of the Black Sea and KC Wheat Futures Price
Source: Bloomberg L.P. (2022)

Figure 4 suggests a cointegrated relationship between the Black Sea and the KC Wheat Futures prices before the invasion date. Notably, the KC Wheat Futures price always moves slightly before the Black Sea Wheat Futures price, indicating that the peaks and troughs of KC Wheat Futures are evident several days earlier than in the Black Sea Wheat Futures. After the invasion, both futures prices increase, reflecting market expectations concerning rising wheat prices. The co-movement is still apparent, though not as strong, which is different still from the spot prices, where co-movement almost ceases. That said, a divergence between spot and futures prices of agricultural commodities is well documented in the literature (Ameur et al. (2022), Aslan et al. (2018), Bohl (2020), Brooks et al. (2001), Kaldor (1983), Kawaller et al. (1987), Turnovsky (1983), Wang et al. (2017)). The explanation of this phenomenon lies in the seasonal dynamics of agricultural commodities' consumption, convenience yield, storage cost, thin trading, or lags in information transmission. Considering the forward-looking nature of futures, the persistence of co-movement of Black Sea and KC Wheat Futures may also suggest that the market perceives regional conflicts as temporary.

Correlations between the Black Sea and KC Wheat spot and futures prices are very large, which is consistent with the integration of global agricultural markets. The correlations, however, sharply decrease after the invasion. The reduction in correlations in spots is much larger than in futures prices (reduction from 0.945 to 0.417 in spots versus 0.967 to 0.786 in futures).

Table 1: Pearson correlations between the Black Sea and KC Wheat spot and futures prices

Period	Pearson Correlation	
	Spot Prices	Futures Prices
January 2020 to August 2022	0.945	0.967
January 2020 to July 2021	0.841	0.963
July 2021 to February 2022	0.681	0.833
February 2022 to August 2022	0.417	0.786

Table 2 provides the summary statistics for the Black Sea and KC Wheat Futures prices. Again, there is a significant price increase in futures during recent periods. On average, Black Sea Wheat Futures have 14.88 actively traded contracts per day and KC Wheat Futures have 13.20. The average number of Black Sea Wheat Futures contracts and their open interest significantly decreased after the invasion.

Table 2: Summary statistics of the Black Sea and KC Wheat Futures

	Periods	N	Price	Trading Volume (Number of Contracts)	Open Interest (Number of Contracts)
Panel A: Black Sea Wheat Future					
1	January 2020 to August 2022 (All)	10493	275.9	97.7	1110.7
			SD=57.3	SD=197.1	SD=2310.7
2	January 2020 to July 2021	5970	233	119.8	1456.2
			SD = 22.9	SD=213.6	SD=2631.3
3	July 2021 to February 2022	2394	308.4	96.6	1056.3
			SD=23.4	SD=208.6	SD=2215.4
4	February 2022 to August 2022	2129	358.7	36.8	202.8
			SD=30.7	SD=97.9	SD=471.1
5	Diff between 4 and 2		diff=125.7***	diff=-83***	diff=-1253.4***
			t=172	t=-23.833	t=-35.255
6	Diff between 3 and 2		diff=75.4***	diff=-23.2***	diff=-399.9***
			t=133.51	t=-4.573	t=-7.059
Panel B: Kansas Wheat Future					
1	January 2020 to August 2022 (All)	9300	679.3	3851.5	16594.4
			SD=178.1	SD=8179.4	SD=31909.8
2	January 2020 to July 2021	5180	555.4	4196.5	18116.2
			SD=64.9	SD=8821.6	SD=34334.3
3	July 2021 to February 2022	2273	743.8	3596.7	15942.2
			SD=61.3	SD=7959.2	SD=31483.9
4	February 2022 to August 2022	1847	947.5	3197.7	13128.9
			SD=152	SD=6314.9	SD=24144.1
5	Diff between 4 and 2		diff=392.1***	diff=-998.8***	diff=-4987.3***
			t=107.43	t=-5.220	t=-6.767
6	Diff between 3 and 2		diff=188.4***	diff=-599.8***	diff=-2174***
			t=119.92	t=-2.896	t=-2.669

Note: The table shows summary statistics of the Black Sea and KC Wheat Futures during different time periods. S.D. is the standard deviation, and N is the number of contracts per period. Trading Volume and Open Interest are averaged across all contracts. Statistical significance is denoted at the ** 5% and *** 1% levels.

METHODOLOGY

To model a cointegrated series of the Black Sea and K.C. Wheat Futures, the Error Correction Model (ECM) was used. For a detailed discussion of ECM, see, for example, Engle and Granger (1987). First, the Black Sea and KC Wheat Futures were established to be stationary after the first differencing, i.e., I (1) series.

To test the stationarity of the time series of futures prices, the augmented Dickey-Fuller test (ADF, Dickey and Fuller, 1979) was used. The null hypothesis is that a unit root exists. Results of the ADF test for Black Sea and KC Wheat Futures prices and their first differences are shown in table 3. The ADF statistics are not significant at five or one percent levels for the raw data, indicating that the data are not stationary. To remove the trend and seasonality from the futures prices, the first differences between consecutive observations were used. After differencing, the test was applied again and found that the statistics were highly significant for both the Black Sea and KC Wheat Futures in all subperiods.

Table 3: Augmented Dickey-Fuller test for testing stationarity of the time series of futures prices and for their first differences

	ADF test statistics				
	Black Sea Wheat Futures			KC Wheat Futures	
	Futures prices	Change in futures prices		Futures prices	Change in futures prices
January 2020 to August 2022 (All)	-2.9028	-8.4815***		-3.199*	-7.7763***
January 2020 to July 2021	-2.9197	-6.9071***		-3.2376*	-6.5829***
July 2021 to February 2022	-2.1259	-5.3855***		-2.8865	-5.199***
February 2022 to August 2022	-1.5675	-5.3039***		-1.3162	-5.2705***

Then, cointegration was tested for using a two-step test (Engle and Granger, 1987). The Black Sea Wheat Futures prices were regressed on different lags of KC Wheat Futures prices. Then, an ADF test was run on the residuals. Results are shown in table 4.

Table 4: Cointegration of the Black Sea and KC Wheat Futures prices

Independent variable	ADF test of residuals
KCW_t	-2.7244
KCW_{t-1}	-2.7223
KCW_{t-2}	-2.6871
KCW_{t-3}	-2.9680
KCW_{t-4}	-2.8849
KCW_{t-5}	-3.3150*
KCW_{t-6}	-3.5009**
KCW_{t-7}	-3.5499**
KCW_{t-8}	-3.4949**

Note: The table provides test statistics for a two-step cointegration test (Engle and Granger, 1987). The dependent variable is the Black Sea Wheat Futures price; the independent variables are the KC Wheat Futures price and its lags up to eight days. Statistical significance is denoted at the *10%, ** 5%, and *** 1% levels.

The ADF statistics are significant at the 5% level at the sixth lag, suggesting that the Black Sea Wheat Futures are cointegrated with the sixth lag term of KC Wheat Futures. Therefore, their long-term equilibrium can be expressed as:

$$BSW_t^E = \alpha + \beta KCW_{t-6}^E, \quad (1)$$

where BSW_t refers to the Black Sea Wheat Futures' price and KCW_{t-6} to the sixth lag of the KC Wheat Futures' price. In the short term, the relationship as can be expressed as:

$$BSW_t = \delta_0 + \theta_1 KCW_{t-6} + \theta_2 KCW_{t-7} + \theta_3 BSW_{t-1} + \varepsilon_t. \quad (2)$$

In the short term, the price of the Black Sea Wheat Futures in the current period t deviates from its long-term relationship with KC wheat future price because of information given in the previous period (t-1 for the Black Sea and t-7 for the KC Wheat Futures). Because the price change in Black Sea Wheat Futures also correlates with its first lag, the regression equation is obtained:

$$\Delta BSW_t = \beta_0 + \beta_1 \Delta KCW_{t-6} + \beta_2 \Delta BSW_{t-1} - \lambda(BSW_{t-1} - \alpha - \delta KCW_{t-7}) + e_t, \quad (3)$$

where $BSW_{t-1} - \alpha - \delta KCW_{t-7}$ is the series of residuals from the long-term equilibrium, called the Error Correction Term (ECT). The coefficient λ indicates the reversion to the long-term equilibrium. In the ECM model, λ should be between 0 and 1. In this case, a significant negative coefficient between -1 and 0 is expected. Then, whenever the Black Sea Wheat Futures price is higher than the long-term equilibrium, the negative coefficient pulls it back down in the direction of the long-term equilibrium. Similarly, if the futures price is below the long-run equilibrium, the negative coefficient will pull the price back up.

Structural Break Points Detection

Over time, the parameters of long-term equilibrium may change. These changes are called structural breaks and are due to unexpected forces affecting wheat prices. Most often, these changes are related to significant financial or economic policy changes. In the case of Black Sea Wheat Futures, assuming that major geopolitical events, such as the Russian invasion of Ukraine, would affect the relationship between the Black Sea and KC wheat futures, inciting structural changes, is natural. As such, the Quandt Likelihood Ratio test and Bai and Perron methods are used to detect structural changes (Chow, 1960, Bai and Perron, 1998). The Quandt Likelihood Ratio test is an extension of the Chow test. The Chow test uses an F-test to determine whether a single regression of the overall sample is more efficient than two or more separate regressions of data split into sub-samples. The Chow test is used for already known dates of the breakpoint. In this paper, the breakpoints are not assumed, but detected from futures prices. Therefore, the Quandt Likelihood Ratio (QLR) is used to test for unknown structural breakpoints. The QLR test calculates the F-statistics of each data point first and then finds the maximum of the Chow F-statistics over a range of time (t_0 to t_1).

$$QLR = \max[F(t_0), F(t_0 + 1), \ldots, F(t_1 - 1), F(t_1)]. \quad (4)$$

The method used to detect the exact date point of structural breakpoints is called the Bai and Perron method (Bai and Perron 1998). This method is used for detecting multiple structural breakpoints. The dynamic programming algorithm described in Bai and Perron is guaranteed to find the sample partition, which minimizes the sum of squared residuals when the coefficients are allowed to break completely. The the null hypothesis of no change in regression coefficients versus the alternative hypothesis of an arbitrary number of breakpoints is then tested. Table 5 shows the results of the Bai and Perron test. The first column shows the number of breakpoints detected (m), and the other columns show where these breakpoints occur (observation number). Under the assumption of one breakpoint, the breakpoint occurs at observation 562, which is February 28, 2022. The Russian invasion started on Thursday, February 24, 2022. February 28 is then the first trading day after the weekend. Under the assumption of two breakpoints, the breakpoints occur at observations 403 and 559, i.e. July 20, 2021 and February 28, 2022. The first structural break point at the end of July 2021corresponds to the announcement of the military exercise Zapad (Samus, 2021). The Zapad is a joint quadrennial military exercise with the Republic of Belarus on Belarusian territory. In 2021, the exercise was scheduled for September 10 to 16. However, the first trains carrying Russian troops and equipment started arriving in Belarus on July 21. This created suspicion among NATO-nations that the Russian forces may have some other purpose, and the exercise may act as a cover for the occupation of Belarus, which would have direct implications for the region, mainly Ukraine. The second breakpoint corresponds to the time of the Russian invasion of Ukraine at the end of February 2022.

Table 5: Test for structural breakpoints

Breakpoints at observation number:								
m = 1								562
m = 2					403			559
m = 3		89			403			559
m = 4		89			403		533	572
m = 5		89		335	404		533	572
m = 6	49	89		335	404		533	572
m = 7	49	89		335	404	487	533	572
m = 8	49	89	123	335	404	487	533	572

Sourse: Bai and Perron (1998)

Figure 5 shows the Residual Sum Square and the Bayesian Information Criterion (BIC) (Yao, 1988) for multiple breakpoints. The minimum BIC is achieved by four breakpoints (m=4). These breakpoints include the Covid period, military exercise Zapad, one month before the invasion, and the actual invasion. Since the information related to the invasion is the focus of this study, two breakpoints corresponding to observations 403 and 559, i.e., July 20, 2021 and February 28, 2022 are used for further analysis.

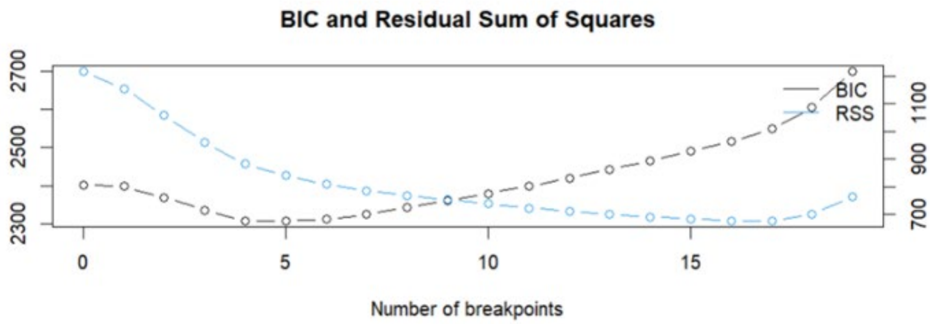

Figure 5: BIC and Residual Sum Squares for tests of multiple structural breakpoints
Source: Authors work

REGRESSION RESULTS

Regression results of the ECM model are shown in Table 6, column (1). The negative and significant coefficient λ indicates the adjustment to the long-term equilibrium. The half-life of the response of the Black Sea Wheat Futures price to a random shock is about nine days. A significant coefficient on KC Wheat Futures (β_1) confirms the cointegrating relationship with KC Wheat Futures.

Columns (2), (3), and (4) of Table 6 show the regression coefficients during periods between the breakpoints. The increasing β_1 coefficient on lagged KC Wheat Futures in 2020 and 2021 indicates the growing globalization of wheat markets. However, this price dependence sharply decreases after the invasion (β_1 coefficient drops from 0.073 to 0.026 after the invasion). The λ coefficient remains negative and significant in all periods and increases in absolute magnitude. This is consistent with the increasing price efficiency of the Black Sea Wheat Futures. After the invasion, however, the λ coefficient drops, allowing for larger relative mispricing.

Table 6: Error Correction Model: Regression of Changes in Black Sea Wheat Futures on its lags and lagged KC Wheat Futures

	Period			
	Ful time period	1/9/2020 to 7/26/2021	7/27/2021 to 2/24/2022	2/26/2022 to 9/13/2022
Constant	0.043	-0.062	1.550***	-0.13
β_1	0.038***	0.056***	0.073***	0.026***
β_2	-0.109***	-0.159***	-0.031	-0.194**
λ	-0.034***	-0.048***	-0.234***	-0.045***
N	697	403	157	138
Adjusted R2	0.171	0.239	0.292	0.217
F-statistics	48.959***	43.083***	22.476***	13.636***

Note: Table reports results of the ECM regression: $\Delta BSW_t = \beta_0 + \beta_1 \Delta KCW_{t-6} + \beta_2 \Delta BSW_{t-1} - \lambda(BSW_{t-1} - \alpha - \delta KCW_{t-7}) + e_t$, where BSW and KCW represent the Black Sea and KC Wheat Futures prices. N is the number of observations. Statistical significance is denoted at the ** 5% and *** 1% levels.

CONCLUSION

The Russian invasion of Ukraine significantly affected the export of Ukrainian wheat by blocking seaports, stealing large quantities of grain from Ukrainian silos, and creating environemental difficulties in harvesting the crop. In recent months, therefore, Ukrainian wheat exports have become the focal point of food security in developing countries.

In this paper, the effect of the invasion on Black Sea Wheat Futures is investigated. Black Sea Wheat Futures prices correlate with wheat prices in the Black Sea region. Like other agricultural futures, they facilitate price discovery and risk transfer among their users. This study documents a drop in the open interest of the Black Sea Wheat Futures after the invasion, and further investigates the cointegration of Black

Sea Wheat Futures with the global wheat standard, the KC Wheat Futures, followed by documenting the structural change in their relationship due to the invasion. Using the Error Correction Model, structural breakpoints that correspond to the Russian invasion of Ukraine and previous major military exercises in the region are detected. The decrease in Black Sea Wheat Futures' open interest and changing relationship with global wheat prices have enormous adverse effects on managing the risk of regional wheat prices. This affects not only Ukrainian wheat producers, but also commercial and retail consumers, especially those in the developing countries that rely on Ukrainian wheat.

A provocative conjecture is that financial markets can lead ahead of geopolitical events because informed participants (insiders) take advantage of monopolistic access to information. There appear to be no signals in the wheat futures markets that the Russian invasion was imminent. Instead, only financial movements synchronous with the invasion can be observed.

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