WARTIME IMPORT RESTRICTIONS OF UKRAINE'S AGRICULTURAL PRODUCTS TO THE EU: ARE THEY JUSTIFIED?

by

Oleksandr Shevchenko

A thesis submitted in partial fulfillment
of the requirements for the degree of

MA in Economic Analysis

Kyiv School of Economics

2024

Thesis Supervisor: ____________________________ Professor Oleg Nivievskyi

Approved by ____
Head of the KSE Defense Committee, Professor

____

____

____

Date ______________________________________

Kyiv School of Economics

Abstract

WARTIME IMPORT RESTRICTIONS OF UKRAINE'S AGRICULTURAL PRODUCTS TO THE EU: ARE THEY JUSTIFIED?

by Oleksandr Shevchenko

Thesis Supervisor: Professor Oleg Nivievskyi

This thesis investigates the impact of Ukrainian exports of wheat, maize, and rapeseed on Ukraine's neighbors, with a specific focus on the Polish and Hungarian markets since the beginning of the Russian invasion of Ukraine. Before 2022, Ukraine relied on traditional export routes, such as transportation via the Black Sea ports. After February 2022, these pathways were disrupted, prompting Ukraine to explore alternative routes. The initiative of the EU Commission to assist Ukraine in transporting its products through its neighbors was implemented. However, this action led to the blockade of Ukrainian borders by Polish farmers, who accused Ukrainian farmers of harming the Polish agricultural market.

This thesis adds to the ongoing discussion regarding the impact of Ukrainian exports on the internal markets of agricultural products in Poland and Hungary. The findings of this study offer valuable insights for stakeholders and policymakers involved in addressing the blockade of Ukrainian borders by Polish farmers.

TABLE OF CONTENTS

LIST OF FIGURES

Number *Page*

LIST OF TABLES

Number *Page*

ACKNOWLEDGMENTS

I extend my heartfelt gratitude to my thesis adviser, Prof. Dr. Oleg Nivievskyi, for his invaluable guidance, unwavering support, and scholarly expertise throughout the entirety of this research endeavor. His mentorship, encouragement, and insightful feedback have been instrumental in shaping this thesis and enhancing its quality. I am deeply appreciative of his dedication, patience, and commitment to my academic and intellectual growth. Oleg's encouragement and constructive criticism have inspired me to strive for excellence and to push the boundaries of my scholarly pursuits. I am truly fortunate to have had the opportunity to work under his supervision and am profoundly grateful for his invaluable contributions to this thesis.

I would like to express my gratitude to the all faculty members of the Kyiv School of Economics for their expertise and proficiency, which have greatly influenced my academic journey.

LIST OF ABBREVIATIONS

EU. European Union.

GDP. Gross Domestic Product.

USDA. United States Department of Agriculture

VECM. Vector Error Correction Model

EXW. Ex-works price

VAT. Value Added Tax

Chapter 1

INTRODUCTION

The dynamics of global agricultural trade has undergone significant transformations in recent years, with Ukraine emerging as a pivotal player in this intricate web of commerce. Nestled in the heart of Eastern Europe, Ukraine boasts an expansive and fertile agricultural landscape, positioning itself as a key contributor to the world's food supply.

Ukraine's agricultural perfection is exemplified by its status as a grain powerhouse, with wheat, corn, and barley exports playing a central role in meeting the growing global demand for staple crops. Furthermore, as of 2022, the agricultural sector accounted for 11% of Ukraine's GDP and providing jobs for roughly 15% of the population (USDA 2022).

Ukraine stands as a formidable force in global agriculture, particularly in the realm of grain production. Blessed with vast expanses of fertile land and a climate conducive to cultivation, the country has emerged as one of the world's leading producers and exporters of grains. The primary grains driving Ukraine's agricultural prowess include wheat, corn, barley, and rye, each playing a distinctive role in the nation's agricultural landscape.

Wheat, both winter and spring varieties, takes center stage in Ukraine's grain production. This staple crop serves not only as a cornerstone of the nation's food security but also as a vital export commodity. Ukraine's commitment to cultivating high-quality wheat has positioned it prominently in the global wheat market, with its produce finding its way into diverse food products around the world. Ukraine's wheat exports in 2021 were worth an estimated $5.1 billion, finding their primary markets in Egypt, Indonesia, Turkey, Pakistan, and Bangladesh (USDA 2022).

Ukraine has solidified its standing as a major global player in corn production. With applications ranging from animal feed to food processing and ethanol production, Ukrainian corn contributes significantly to international markets. The country's commitment to technological advancements and sustainable practices has propelled its corn industry to new heights. Export of maize was bigger, than wheat's, accounted for $5.9 billion, where the main importers of this product where China – 32% and the Europe Union – 30%. Turkey, Egypt, Iran and Qatar form the third part of total export by the end of 2022 (USDA 2022).

Also Ukraine exports a notable portion of its rapeseed and rapeseed products to international markets. Ukraine faces competition from various countries: Canada, Germany, France and Russia. These countries, among others, are major players in the global oilseed market, and their production and export activities can influence the dynamics of rapeseed trade.

Logistics play a crucial role in the export process. Transportation methods, such as trucks and railways, are used to move corn from storage facilities to ports for shipment. Ukraine has several major ports on the Black Sea, including ports in Odessa and Mykolaiv, which are vital for the export of agricultural products, including corn. Over 90% of Ukraine's agricultural exports were shipped through these two main ports (Martyshev, Niveivskyi and Bogonos 2023).

Russia's war on Ukraine has significantly impacted the maritime transport industry, particularly its ports. The conflict has led to disruptions in commercial shipping, compelling operators to reroute freight transport and alter vessel itineraries. Due to the unpredictable operational challenges, many major shipping companies have temporarily halted shipments to and from Ukraine.

Crucial shipping routes in the Black Sea, such as those around Odesa and the Sea of Azov, are either blocked or under occupation (Jacobs 2022).

This blockade led to a sharp drop in prices for Ukrainian products. Before the occupation, prices for Ukrainian corns were lower than for Polish or Hungarian products. At the same time, world product prices were constantly rising.

Nevertheless, due to Russia's Black Sea ports blockade which continued to the end of July 2023, despite on the Black Sea Grain Initiative, Ukraine finds itself severed from its conventional export channels, compelling it to depend on alternative pathways like the overland transit routes spanning Poland, Slovakia, Hungary, and Romania. Complications have surfaced, particularly in Poland, where a portion of the grain intended for other markets ended up in the Polish market, causing price declines and occupying storage capacity, as reported by Polish farmers and politicians. Following farmer protests, both Poland and Hungary implemented import restrictions on Ukrainian grain in mid-April, prompting the EU to enforce a temporary import ban across the entire union.

At the same time, the Ukrainian future within the European Union (EU) is intricately tied to the economic agreements forged with Ukrainian partners, particularly concerning the export of cereals. However, challenges may arise, including the need for ongoing dialogue to address any issues related to market access, trade barriers, or regulatory divergence. Both sides must engage in continuous communication and cooperation to navigate these challenges and ensure the long-term success of their economic partnerships.

There is no mathematical proof demonstrating that Ukrainian grain exports distort markets. In my perspective, these allegations are substantial, and it is imperative to establish econometric evidence to resolve this controversy.

In conclusion, this thesis underscores the importance of empirical evidence in resolving contentious issues surrounding Ukrainian grain exports and market distortions in neighboring countries. Through rigorous econometric analysis, this study aims to contribute to the existing literature by providing empirical clarity on the relationship between Ukrainian grain exports and local market dynamics in the region. By doing so, it seeks to inform policymakers, stakeholders, and the broader academic community, facilitating evidence-based decision-making and fostering a deeper understanding of the complex interactions within the global agricultural trade landscape.

My research efforts have been made to assess whether Ukrainian prices for wheat, corn, and rapeseed could lead to a decrease in the prices of Polish and Hungarian agricultural products, or if their prices depend on world prices for these types of products and whether the volume of Ukrainian imports has any effect, and if so, whether it is positive or negative. This study seeks to fill this gap by conducting an econometric analysis to determine whether Ukrainian prices could potentially result in a reduction in the prices of agricultural products in Poland and Hungary.

Through the implementation of regression analysis, this study aims to detect any structural breaks in the pricing of these commodities and quantify their significance. The findings derived from this research hold potential value for researchers and policymakers in the agricultural sector.

This thesis is structured into several chapters: Chapter 2 comprises an examination of pertinent literature, Chapter 3 describes the methodology used in the research, Chapter 4 offers an in-depth elucidation of the data, and Chapter 5 presents the main results of the study. The final chapter, Chapter 6, encompasses the derived conclusions from the study and presents policy recommendations grounded in the uncovered findings.

Chapter 2

LITERATURE REVIEW

Polish and Hungarian farmers began to strike in late 2022, when Ukraine began to rapidly increase its exports of grains. The farmers were concerned that this would lead to lower prices for their own crops, as they would now be competing with a much larger producer. They also worried that the influx of Ukrainian grains would drive down the prices of other agricultural products, such as dairy and meat, which would also hurt their businesses.

The strikes were successful in bringing attention to the issue, and the Polish and Hungarian governments have taken some steps to address the concerns of their farmers. For example, they have increased subsidies for agricultural producers and have implemented import quotas on Ukrainian grains. However, the farmers remain concerned that these measures are not enough to protect them from the effects of competition from Ukraine.

This subject has attracted considerable interest in academic spheres, prompting researchers to delve into the consequences of one price influencing another.

In this section, we provide a survey of pertinent literature in this domain, incorporating a variety of studies that seek to ascertain the interplay between global and local market prices, the VEC model for to analyzing the long-run and short-run relationships between multiple time-series variables.

Ghoshray (2011) examines the extent to which increases in international food prices during the past few years have been transmitted to domestic prices in selected Asian developing countries. The author used commodity-specific monthly data for rice, wheat, and edible oil, and estimated price transmission elasticity using regression models and econometric techniques like unit root tests and error correction models with threshold adjustment. The study found that there is a strong linkage between international and domestic food prices in Asian developing countries, but that the extent of transmission varies across commodities and countries. On average, increases in international food prices are transmitted by about 65% to domestic prices in the short run, and by about 80% to 90% in the long run. The highest transmission rates are found for rice and edible oil, while wheat prices exhibit a relatively lower transmission. The paper also found that there was a significant degree of asymmetry in price transmission, meaning that increases in international prices are more likely to be transmitted to domestic prices than decreases in international prices. This is likely due to the fact that domestic producers are more willing to absorb decreases in international prices than they are to pass on increases to consumers.

The study by Ivanic and Martin (2014) discusses the collective action problem associated with domestic price insulation policies. When one country insulates its market, it shifts the burden of adjustment for price fluctuations to other countries. This can lead to a spiral of protectionism, which can further increase the volatility of global food prices. Specifically, the authors utilized an error-correction model (ECM) to analyze the dynamic adjustment of domestic prices to changes in world prices. In the second part of the analysis, the authors employed a global model to simulate stochastically the implications of insulating behavior for the volatility of international and domestic prices. This simulation exercise provided a broader perspective on the potential consequences of domestic price insulation policies, considering the interconnectedness of global food markets. Overall, the article provides valuable insights into the complex relationship between domestic price insulation policies and global food price behavior. The authors' findings suggest that domestic price insulation policies may not be the most effective way to reduce the volatility of domestic food prices, and may even contribute to the volatility of global food prices.

Götz et al. (2016) studies the impact of extreme weather events and export controls on the wheat market of Russia and Ukraine. It finds that while both extreme weather events and export controls can have a significant impact on wheat prices, their effects vary across regions and depend on the specific characteristics of each market. However, the authors find that the impact of export controls is more localized, with prices rising most in regions that are directly linked to the global market. The authors employ a price transmission model framework to discern the effects of export controls on domestic prices, taking into account the influence of harvest failures as well. The findings of the paper have important implications for understanding the dynamics of the wheat market in Russia and Ukraine and for designing policies to mitigate the impact of weather shocks and export controls on domestic consumers. By identifying the heterogeneous effects of these factors, the paper provides valuable insights for policymakers and market participants. The research reveals that the mitigating impact on wheat prices can extend up to 67%, with the most significant influence observed in the primary wheat-exporting region that has direct access to the global market.

In a recent study Rose et al. (2023) find that there is a unidirectional transmission of milk prices for UK market, with shocks to producer prices being fully transmitted to retailer prices but not vice versa. The study also finds that there is a significant delay in the transmission of price shocks, with prices regaining equilibrium at 14% of their initial shock approximately 7 months after the shock occurs. These findings suggest that the UK milk market is not perfectly competitive and that retailers have the bargaining power to capture a larger share of the value of milk. The study finds that all of the examined series are stationary at the first difference and that there are multiple structural breaks in the data. The Johansen cointegration test identifies one cointegrating factor, which suggests that there is a long-run relationship between producer and retailer prices. Overall, this work is a valuable contribution to the literature on price transmission in the agricultural sector. The study provides a clear and concise analysis of the UK milk market and its implications for producers, retailers, and the government.

Martin and Minot (2023), most relevant for our research, examines the role of price insulation in exacerbating global wheat price fluctuations during the Covid-19 pandemic and the Russia-Ukraine war. The paper finds that price insulation significantly amplifies the transmission of global wheat price shocks to domestic markets. In their econometric analysis, the researchers employed Error Correction Models to investigate that domestic markets remain insulated from shifts and their subsequent effects on global prices, revealing stable long-term relationships between global wheat prices and the majority of domestic prices for wheat products. However, the rate of price transmission exhibited significant variations across countries. Additionally, their scrutiny of price shocks during the Covid-19 pandemic and the Russian-Ukrainian war indicated that price insulation doubled the overall surge in global wheat prices, concurrently intensifying their volatility during periods of both price increase and decline.

In general, the literature underscores the intricate dynamics of price interactions and how shifts in one local market can trigger changes in another market, accompanied by other effects and changes. Grasping these effects is essential for policymakers and individuals seeking to comprehend the mathematical and genuine factors behind price fluctuations.

Chapter 3

METHODOLOGY

In this chapter I describe the methodology we have adopted to evaluate the interrelation of the Ukrainian wheat, maize and rapeseed exports on respective prices of our neighbors and which influence of their volume has on the prices.

The model we have selected for this study is similar to those used by Baylis et al. (2014), Gotz et al. (2016, 2013) and Ihle et al. (2009), the goal of their price transmission approach is to analyze how price changes in one market (origin) are reflected in another market (destination). This analysis is important for a variety of reasons, the most important of which is interdependence of the prices. A high degree of integration indicates that prices in both countries tend to move together, while a low degree of integration suggests that prices are less responsive to changes in each other.

Several models can be used to analyze the price transmission mechanism: Vector Autoregression, Error Correction Model, Simultaneous Equation Models, Linear Regression Model, Vector Error Correction Model, Linear Regression Model. Comparing advantages and disadvantages, we decided to use Vector Error Correction Model (VECM). This model are particularly suited for investigating long-run equilibrium relationships and short-run dynamics between multiple price series. It captures how prices adjust back to their long-run equilibrium following any deviations. Steps involved in using VECM cover all our analysis which is necessary for model deployment: test for cointegration, estimate the cointegrating vector, specify the lag structure, estimate the VECM model and diagnostic testing.

The advantages of VECM are ability to provide insights into the direction and magnitude of price influence and allow for testing the significance of the relationships.

This analysis uses the Johansen multivariate approach (VECM), cointegration and Granger causality test. The Johansen's approach is employed to test the presence of co-integration between the prices of wheat, maize and rapeseed for Poland, Hungary prices and Euronext. This method can be described as follow:

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_p \Delta Y_{t-p} + \Pi \Delta Y_{t-p} + \varepsilon_t \qquad (1)$$

where Δ is the difference operator, Y_t is a vector with the 2 variables (prices for each pair of cereals for Euronext and country's price), Γ_1, Γ_p represents the matrix of the short-run dynamics, $\Pi = \alpha\beta$ with α and β are both matrices containing the adjustment coefficients and the cointegrating vector respectively and Π represents the long-run dynamics.

In order to identify the number of cointegration vectors, Johansen proposes a trace test and a maximum eigenvalue test. These tests analyze the long-run relationships between non-stationary time series data. By employing both the trace test and the maximum eigenvalue test, we can statistically determine the appropriate number of cointegration vectors within our VECM, allowing for a better understanding of the long-term equilibrium relationships between the analyzed variables.

The trace test equation is established as:

$$\lambda_{trace} = -T \sum_{j=r+1}^{n} \ln\left(1 - \lambda_j\right), \qquad (2)$$

where T represents the number of observations (# obs) and λ_j shows the estimated values of the roots.

The eigenvalue test equation is established as follow:

$$\lambda_{max} = -T\, ln(1 - \lambda_{r+1}) \quad (3)$$

After tests and model results, within the VECM framework, we can conduct Granger causality tests to determine if one variable has a statistically significant predictive power for another, in our case, if Euronext price has a statistically significant impact on other prices (Polish and Hungarian), when Ukraine export is more than average during the observed period. If it is significant, we can conclude that Ukrainian import has influence on internal price of these countries. This helps us to understand the direction of causal relationships within the system.

To validate our hypothesis and fulfill the objectives of this thesis, we opt to examine the effects of exports using a regime-switching long-run price transmission model, which is articulated as follows:

$$\Delta p_t^d = \alpha + \sum_{i=1}^{k-1} \beta_i \Delta p_{t-1}^d + \sum_{j=1}^{k-1} \gamma_j \Delta p_{t-1}^w + \\ + \sum_{m=1}^{k-1} D_m \delta_m \Delta p_{t-1}^w + \lambda * ECT_{t-1} + u_t, \\ t = 1, \dots, n \quad (4)$$

where p^d is the domestic price (in our case – Poland and Hungary) and p^w is the relevant world price (Euronext), with the intercept parameter α. β_i, γ_j and δ_m – short-run dynamic coefficients of the model's adjustment long-run equilibrium. β_i and γ_j – influence of the past prices by domestic price and relevant world price respectively, δ_m influence of Ukrainian exports to the domestic price of specific country. If δ_m is insignificant – we can conclude that Ukrainian exports don't disturb the internal price, if $\delta_m$is significant, a positive value suggests that increased Ukrainian exports lead to internal price growth, and vice versa.

D_t denotes a dummy variables with $D_t = 1$ if trade regime 'significant' is applied and $D_t = 0$ when regime 'non-significant' is applied. In the context of this thesis, a 'significant' trade regime refers to a scenario where the export of Ukrainian products surpasses a predetermined threshold value, typically the average for the period under examination. This situation prompts the hypothesis that such exports may disrupt the internal price.

λ is the speed of adjustment parameter with a negative sign, measures the speed at which p^d returns to equilibrium after the change in p^w. ECT equals the error correction term, is the lagged value of the residuals obtained from the cointegrating regression of the dependent variable on the regressor. Contains long-run information derived from the long-run cointegrating relationship. The ECT explains that previous period's deviation from LR equilibrium influences short-run movement in the dependent variable. u_t – residuals (stochastic error term).

Our analysis aims to uncover the influence of regime export trade on the internal price. We'll achieve this by examining two key pieces of evidence: the p-value and the coefficients. The p-value will tell us how likely it is that the observed regime occurred by chance, indicating their statistical significance. The coefficients, being associated with the dependent variable, signify the variations in the trade regime corresponding to either increases or decreases in price. Assessing their magnitude will offer insights into the intensity and direction of this impact.

Validating a VECM is crucial to ensure the model is correctly specified and that the inferences drawn from it are reliable. This process confirms that the model's assumptions hold true, the relationships identified are meaningful, and the forecasts and policy implications derived from the model are sound. To achieve these objectives, we will conduct a series of diagnostic checks and tests to ensure that the model adequately captures the underlying economic dynamics and provides a robust tool for analysis and decision-making. Specifically, we will:

1. Check Stationarity and Cointegration: assess the stationarity of the time series and the presence of cointegration relationships among the variables.
2. Examine Residual Diagnostics: ensure the residuals meet the assumptions of no serial correlation, normality, and homoscedasticity.
3. Perform Granger Causality Tests: determine the direction of causality between the variables.
4. Analyze Impulse Response Functions : understand the dynamic response of the system to shocks in one of the variables.

C h a p t e r 4

DATA

In this section, we explore the data utilized in our study, focusing on the top three grain exports from Ukraine: wheat, maize and rapeseed. We collect data from five main sources—world international prices, indicated by Euronext prices and SWOT, Ukrainian prices, specifically EXW prices, Polish prices and Hungarian prices. All prices are converted from local prices to dollars using the official dollar rate of each country. Our research relies on daily observations of international and domestic grain prices, spanning workdays from January 1, 2018, to October 27, 2023.

We utilize EXW prices, which measures the grain's cost at its origin point, excluding transportation and other additional expenses. One reason, why we decided to exclude VAT, because before March 2022, VAT was 20% and after March 2022 VAT is 14%.

Table 1 displays the statistical information for 2 world grain markets and 3 local grain markets, specifically prices for wheat, maize and rapeseed. The table presents descriptive statistics for each variable, comprising the number of observations (Obs), the count of missing values (NA), the minimum, maximum, median, mean values and standard deviation (sd) and standard error (se).

Euronext prices for grains refer to the market prices of agricultural commodities, as traded on the Euronext exchange. The Chicago Board of Trade (CBOT) is a major hub for trading futures and options contracts related to various agricultural commodities, including grains. These prices are expressed in U.S. dollars and function as a standard for global grain markets.

Table 1. Descriptive statistics for wheat, maize and rapeseed for 5 indicators

Kind	Indicator for	Obs	NA	Min,$	Max,$	Median,$	Mean	sd	se
Wheat	Euronext	1 520	-	182	484	244	258	60.4	1.55
	World	1 520	8	153	524	213	232	60.1	1.55
	Ukr	1 520	69	84	274	176	179	40.3	1.06
	Pol	1 520	6	159	427	222	238	61.2	1.57
	Hun	1 520	45	163	389	205	231	60.3	1.57
Maize	Euronext	1 520	-	177	425	224	241	55.9	1.44
	World	1 477	43	120	322	171	194	54.7	1.41
	Ukr	1 450	70	83	249	146	155	40.2	1.05
	Pol	1 514	6	149	359	201	223	51.9	1.33
	Hun	1 475	45	133	361	184	211	62.5	1.63
Rapeseed	Euronext	1492	28	372	1 170	461	539	157	4.05
	World	1 509	11	369	1 108	460	534	150	3.86
	Ukr	1 422	98	233	640	372	388	86.8	2.3
	Pol	1 520	-	338	1 117	434	525	167	4.28
	Hun	1 520	-	359	903	445	505	127	3.25

The presented statistics in the table reveal a non-normal distribution in both international and domestic prices for wheat, maize and rapeseed. The skewed nature of the distribution, notably to the right, suggests a more frequent occurrence of lower prices in comparison to higher prices, mostly for Ukraine than for our neighbors.

Figure 1, Figure 2 and Figure 3 depict the time trends of wheat, maize and rapeseed prices, encompassing both international and domestic prices variations. Before 2022 (specially before full-scale invasion) we observe common trend, when prices grow simultaneously, also Ukrainian prices were less than prices of our neighbors and world prices, but the difference wasn't large as after February 2022. Before 2022, various factors contribute to the rising volatility, with the impact of the COVID-19 pandemic being a significant driver. The pandemic disrupted global supply chains and exerted substantial effects on agricultural markets, resulting in heightened price fluctuations and increased market uncertainties.

Before 2022 wheat and rapeseed markets demonstrated the tendency of ideal markets where local prices are equal to world prices, maize market didn't show this trajectory. This declining pattern indicates an optimization process wherein the costs linked to the transportation and trading of grains were undergoing reduction.

Figure 1. Wheat prices since 2018 to 2023

Figure 2. Maize price since 2018 to 2023

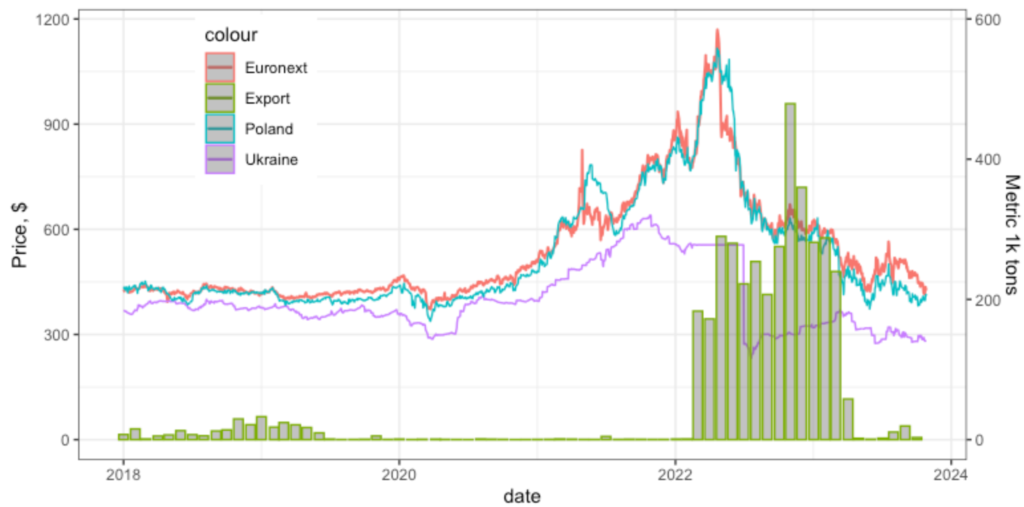

Figure 3. Rapeseed prices since 2018 to 2023

Figure 4 illustrates Ukrainian exports to Poland since the onset of Russia's full invasion of Ukraine. The average export volume was 165 thousand tons, showing a significant decline in exports since April 2023 compared to the previous month. From March 2022 to March 2023, exports exceeded the average for the observed period. The peak of exports was in November 2022. After April 2023 the Ukrainian export is insignificant.

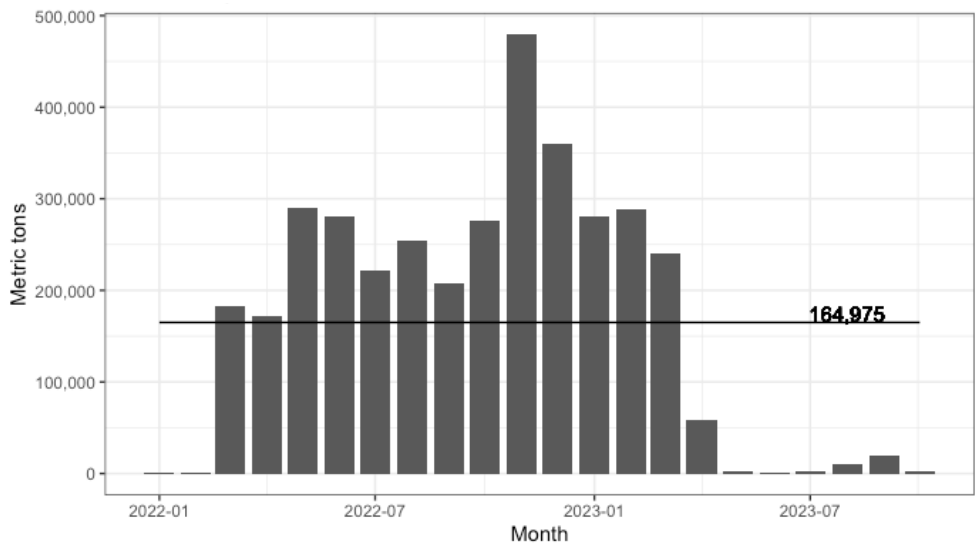

Figure 4. Ukraine exports to Poland since 2022

Figure 5 demonstrates a more detailed analysis of the difference between prices for the cereals. The box plots show the median, quartiles, and outliers for each group. The prices are highest in Euronext and World, and lowest in Poland, Hungary and Ukraine. The distributions of prices are more spread out in Euronext and World than in Ukraine, Poland, and Hungary. This means that there is more variation in the price of world. Wheat and rapeseed markets suffered more than maize market, because the last has few outliers. Maize market shows a lot of outliers, except for Hungary.

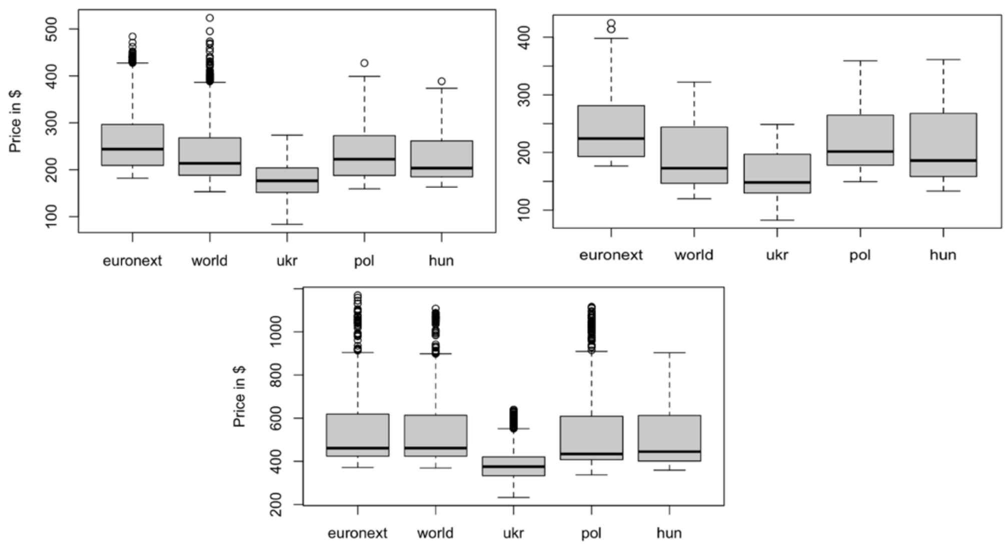

Figure 5. Boxplots for wheat, maize and rapeseed prices respectively

Figure 6 provides annual information about price for 3 types of grain. The average price of wheat, maize and rapeseed have been increasing steadily since 2018. In 2018, the average price of wheat was around \$200 per metric ton, while in 2023, it was around \$300 per metric ton. This is an increase of 50%. There was a sharp increase in the price of wheat in 2022, which is likely due to a number of factors, including the war in Ukraine, which is a major wheat producer. The price of wheat has stabilized somewhat in 2023, but it is still significantly higher than it was in previous years. The same situation is for prices for other 2 crops.

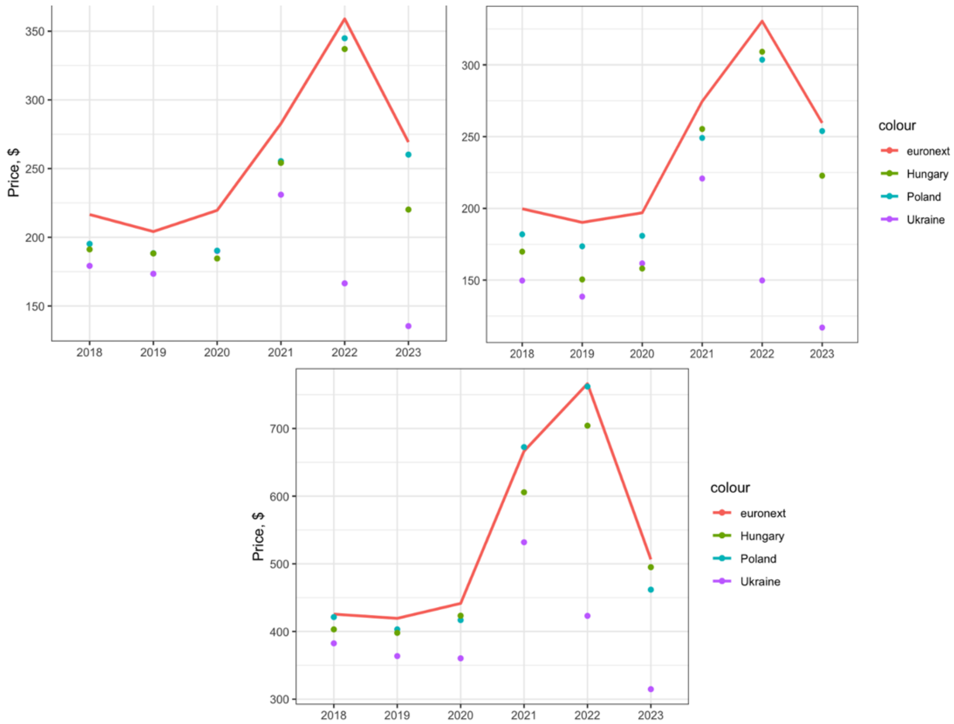

Figure 6. Average prices of wheat, corn and rapeseed respectively every year

Figure 7 illustrates the correlation maps for 3 products for period 2018 – 2023 (before the Russian invasion, when Ukrainian products were transported mostly using the sea, and after invasion). Comparing these 3 graphs, we can conclude that the price of wheat in Ukraine (ukr) is not moderately correlated to 4 other indicators, in addition, there is not at all correlation with Polish wheat prices (pol). Considering maize price, we are able to constate the fact slightly correlation, mostly is notable with Hungarian price (coefficient is 0.25) and the least notable with Polish price (coefficient is 0.11, more two times less than with Hungary). Comparing correlation map for rapeseed price, we observe significant correlation with all indicators, so we conclude that there are strong influence each of them.

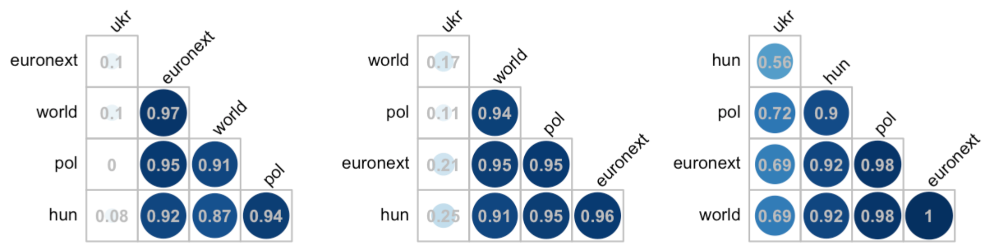

Figure 7. Correlation maps for wheat, maize and rapeseed respectively

To the main dataset were added dummy variables which indicate the situation before and after February 24, 2022 (Russian full invasion) and May 2, 2023 when the EU Commission agreed to a temporary restriction on the import of four agricultural products - wheat, corn, rapeseed and sunflower seeds - from Ukraine to five countries (include Poland, which initiated this restriction and Hungary) until June 5, 2023 while continuing to allow those products to be shipped through these countries. Subsequently the Commission extended the ban to September, when the new harvest began to come in. Since November, with a brief pause around the New Year, Polish farmers have been blocking numerous vital border crossings. This action comes in response to EU ambassadors agreeing on an extension to the tariff-free shipment of agricultural products, with farmers claiming it has led to an excess of grains within the country.

Chapter 5

ESTIMATION RESULTS

In this section of the master's thesis, we unveil the outcomes of our estimation process, executed through the model delineated in the methodology section. Our methodology comprises two primary stages. Initially, we preprocess our data to conform to the requirements of the VECM hypothesis. Subsequently, we apply the VECM model to scrutinize the estimated parameters.

Our dataset exhibits non-stationarity, as confirmed by the results of the Augmented Dickey-Fuller test presented in Table 2. To address this, we performed first-order differencing on our data, resulting in a stationary dataset of the same order, suitable for subsequent analysis.

Table 2. ADF test for 3 cereals

	Wheat	Maize	Rapeseed
Euronext	0.74	0.77	0.93
World	0.56	0.80	0.93
Ukraine	0.54	0.79	0.69
Poland	0.76	0.95	0.83
Hungary	0.97	0.95	0.94

For optimal number of lags we performed commonly used lag selection criteria, including AIC, BIC, HQIC, and information criteria adapted for cointegrated systems. The final decision was reached by selecting the value that appeared most frequently. Rapeseed data exhibits significant lag, suggesting that historical prices wield greater influence on current prices compared to wheat and maize prices. This is evident in the similarity of lag numbers, with 46 and 69 lags for Polish and Hungarian prices of wheat and maize, respectively (Table 3).

Table 3. Optimal number of Lags

	Wheat	Maize	Rapeseed
Poland	46	46	74
Hungary	69	69	72

We identified two cointegrating vectors for three types of cereals and two countries at 5% significant level. In each case, these vectors delineate the long-term equilibrium relationship between local prices and Euronext prices, with and without the impact of Ukrainian exports.

Table 4. Johansen-Procedure for cointegrating vectors

	k	Wheat	Maize	Rapeseed	5 %
	0	136.66	161.51	162.47	34.91
Poland	1	65.44	80.37	79.91	19.96
	2	23.35	24.32	29.31	9.24
	0	95.95	90.31	14.43	34.91
Hungary	1	44.17	43.63	43.81	19.96
	2	10.26	10.94	14.43	9.24

In this study, we employ the Granger-causality test to examine the dynamic interactions between the Polish stock market represented by prices for wheat, maize and rapeseed and the Hungarian stock market of the same products concerning their relationship with the Euronext market.

Our analysis reveals compelling insights into the relationship between the Polish stock market and the Euronext market, Hungarian stock market and the Euronext market. The Granger-causality test indicates that there exists a positive causal relationship in two cases at the 5% significance level. This finding suggests that changes in one market can Granger-cause changes in the other. The regional price does not have impact on the world price at the significance level 5%.

Table 5. Results of Granger-causality test

Country	H_0: world price does not GC regional price			H_0: regional price does not GC world price		
	Wheat	Maize	Rapeseed	Wheat	Maize	Rapeseed
Poland	0.000	0.000	0.000	0.1	0.12	0.11
Hungary	0.000	0.000	0.000	0.13	0.17	0.07
Ukraine	0.014	0.05	0.75	0.33	0.42	0.34

From the consequences of the Granger-causality test we assume the long-run price equilibrium regression model with dependent variable of domestic price and exogeneous variable – world price. This VECM model facilitate explanation of the result parameters and gives economical explanation and interpretation.

The results of VECM model are presented in Table 6. For these 2 models, there are common trends. Firstly, it's noteworthy that both ECT1 and ECT2 share the same sign, and both are statistically significant. These parameters signify the pace at which deviations from the long-term equilibrium among variables are rectified. A negative value for an error correction parameter suggests that prices tend to readjust towards their equilibrium levels when they stray from them.

ECT1 suggests the presence of a stabilizing force within the system, exerting pressure to bring prices back towards their long-term relationship whenever they deviate from it. ECT2 indicates that there is a tendency for the prices to adjust away from their equilibrium levels when they deviate from these levels. We don't observe this effect for Hungary for maize and rapeseed prices.

Table 6. Results of VECM model

	Poland			Hungary		
	Wheat	Maize	Rape	Wheat	Maize	Rape
ECT1	-0.7***	-1.25**	-2.23**	-1.1***	-1.7**	-0.32
	(0.23)	(0.27)	(0.45)	(0.31)	(0.45)	(0.37)
ECT2	0.72**	0.88**	2.14***	0.8**	0.52	0.24
	(0.24)	(0.24)	(0.52)	(0.31)	(0.5)	(0.30)
Intercept	0.008	0.02	-0.09	-0.04	0.02	-0.03
	(0.07)	(0.07)	(0.22)	(0.12)	(0.13)	(0.33)
$D_m \delta_m \Delta p_{t-1}^w$:						
m = 1	0.01	-0.05	0.14***	-0.21*	-0.38**	-0.06
	(0.06)	(0.05)	(0.03)	(0.10)	(0.10)	(0.13)
m = 2	-0.01	-0.05	0.14***	-0.21*	-0.38**	-0.06
	(0.06)	(0.05)	(0.03)	(0.10)	(0.10)	(0.13)
m = 3	-0.00	-0.04	0.14***	-0.2*	-0.38**	-0.06
	(0.06)	(0.05)	(0.03)	(0.10)	(0.09)	(0.12)
m = 4	0.00	-0.03	0.15***	-0.21*	-0.38**	-0.06
	(0.06)	(0.05)	(0.03)	(0.10)	(0.09)	(0.12)
m = 5	0.00	-0.02	0.16***	-0.16.	-0.38**	-0.1
	(0.06)	(0.05)	(0.03)	(0.10)	(0.09)	(0.12)
m = 46	0.004	0.00	0.13***	-0.13	-0.05	0.1
	(0.06)	(0.05)	(0.03)	(0.07)	(0.06)	(0.06)

Significance codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 '.' 1

The significance of $D_m \delta_m \Delta p_{t-1}^w$ depends on the market kind. The insignificance of certain variables, particularly Ukrainian exports, in influencing Polish wheat and maize prices suggests a crucial insight into the dynamics of these markets. Specifically, it indicates that the level of Ukrainian exports does not distort Polish prices for these cereals. Instead, the primary determinant of Polish wheat and maize prices appears to be the global market price, represented by indicators such as Euronext. While Ukrainian exports may have the potential to impact regional markets, their influence seems to be overshadowed by broader international price trends. As a result, domestic price fluctuations in Poland for wheat and maize are primarily driven by movements in the global market, rather than by specific regional factors.

For Polish rapeseed prices, the dummy variables representing Ukrainian exports exhibit a positive and statistically significant effect within a 95% confidence interval. With an average value of 0.14, this indicator implies a long-term positive relationship. Essentially, when Ukraine exports rapeseed to Poland, it tends to elevate prices for Polish farmers.

In the Hungarian market, we obtained reversed results compared to Poland, suggesting that Ukrainian exports can lead to a negative impact on internal prices. This effect is particularly pronounced for maize prices, with the parameter showing a negative sign and a magnitude of 0.38. Although wheat prices also show a negative effect, it is less significant. Regarding the rapeseed market, we do not observe any discernible influence from Ukrainian exports.

Overall, the findings indicate a lack of negative influence from Ukrainian exports on Polish prices. Moreover, there appears to be a positive impact on rapeseed prices, which varies depending on the volume of exports. Hungarian rapeseed prices were not affected by Ukrainian imports. However, when it comes to the wheat and maize markets, we observe an insignificant but negative impact.

For model validation, we conducted the multivariate Portmanteau and Breusch-Godfrey tests to check for serially correlated errors. The results are presented in Table 7. We found no evidence of autocorrelation in the three Polish markets and the Hungarian markets for wheat and rapeseed. However, the Hungarian maize market failed the test, indicating the presence of autocorrelation. This failure compromises one of the three essential requirements for a quality model.

Table. 7. The result of the serial correlation

Country	H_0: No serial correlation at lag h ( ), p-value		
	Wheat	Maize	Rapeseed
Poland (46, 46, 74)	0.08	0.07	0.08
Hungary (69, 69, 72)	0.11	0.03	0.05

To validate the presence of heteroskedasticity, we applied the ARCH (Autoregressive Conditional Heteroskedasticity) effect test. The results of this analysis are presented in Table 8. We can conclude that there is no evidence of heteroskedasticity in any of the markets for the two countries analyzed.

Table. 8. The result of the heteroskedasticity test

Country	H_0: heteroskedasticity exists at lag h ( ), p-value		
	Wheat	Maize	Rapeseed
Poland (46, 46, 74)	1	1	1
Hungary (69, 69, 72)	1	1	1

The normality of residuals was assessed using the Shapiro-Wilk test, and the results are presented in Table 9. Since we are unable to reject the null hypothesis, we conclude that the distribution of the residuals does not significantly differ from a normal distribution.

Test. 9. The result of the normality residuals test

Country	H_0: normality distribution of the residuals, p-value		
	Wheat	Maize	Rapeseed
Poland	0.04	0.05	0.03
Hungary	0.04	0.03	0.06

According to the tests, two out of the three required conditions for a valid VECM are satisfied. This indicates that the model meets most of the necessary criteria, allowing us to confidently use the results generated by the model. In our case, the residuals deviate significantly from normality, which may indicate model misspecification or the presence of outliers. This deviation can lead to biased estimates and reduce the overall robustness of the VECM. In the analyzed dataset, we observed a high difference between two pairs of prices, which could be contributing to this issue. Addressing these discrepancies is crucial for improving the model's accuracy and reliability.

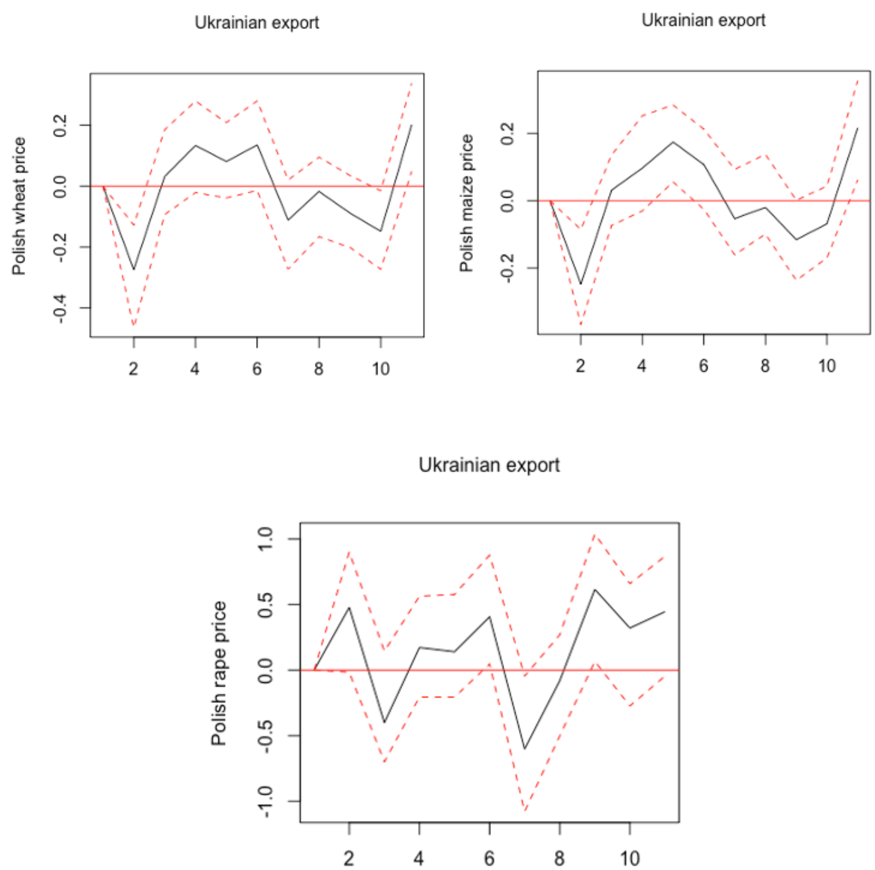

Figure. 8. Impulse response function for Polish prices

Figure 8 illustrates the immediate impact of a Ukrainian export shock on both Ukrainian and Polish prices for three types of cereals. Initially, we observe an increase in Polish prices for all three types of cereals. However, after six lags, this relationship turns negative, before returning to positive after eight lags.

For the future improvements, we can use advanced techniques to fight against the non-normality of the residuals. Consider using advanced techniques such as generalized least squares (GLS) or autoregressive conditional heteroskedasticity (ARCH) models to explicitly model autocorrelation. These advanced techniques not only enhance the robustness of the estimation process but also ensure that the assumptions underlying the model are more closely aligned with the actual characteristics of the data.

Chapter 6

CONCLUSIONS AND POLICY RECOMENDATIONS

We investigate the influence of Ukrainian exports on the internal prices of our neighboring countries (Poland and Hungary) under two possible regimes: when Ukrainian exports are significant compared to historical exports observed in 2022 and non-significant.

Based on the conducted analysis, not all parameters of the proposed model were significant. However, Ukrainian exports have been found to promote the growth of internal prices for the Polish rapeseed market, which continues to rise over time. Regarding maize and wheat, there has been a slight decline in prices, but all parameters were statistically insignificant. For wheat, we observed that since lag 3, the parameters have been consistently equal to 0. Meanwhile, the impact of Ukrainian maize exports has diminished over time.

In Hungarian markets, we observed differences compared to the Polish market. For instance, we consistently observed a negative effect on the maize market, with the parameter value remaining at -0.38 over time. Similarly, the influence on the wheat market was negative and significant at the 1% confidence level. However, the value of the parameter decreased over time. The Hungarian rapeseed market does not appear to be affected by Ukrainian exports, as the parameters were consistently negative and statistically insignificant.

The positive impact on the rapeseed market and the lack of impact on the wheat and maize markets could be discussed with the Polish government to demonstrate that transit Ukrainian exports do not affect internal prices significantly. Instead, they may promote insignificant growth in these markets.

This negotiation is crucial for Ukrainian farmers and middle producers in anticipation of the 2024 season. Negotiations can help ensure smooth trade relations, reduce barriers to entry, and facilitate market access for Ukrainian farmers and producers. They can also help prevent the blockage of the border by Polish farmers and activists. Strengthening trade relations with Poland can contribute to the economic growth of Ukraine by increasing export revenues and generating employment opportunities in the agricultural sector. This, in turn, can improve the livelihoods of Ukrainian farmers and producers during such difficult times when the usual export channels are undefined.

In view of these challenges, certain general policy recommendations can be made. Firstly, it is imperative to maintain and enhance international partnerships with Poland, as a blockade could strain relations with the Polish and Hungarian governments, potentially resulting in diplomatic tensions or retaliatory actions. Secondly, the blockade of the border could also have humanitarian consequences, especially if it hinders the delivery of essential goods and services to affected areas, thereby exacerbating the suffering of populations on both sides of the border.

Indeed, the financial well-being of Ukrainian farmers is intricately tied to the situation at the Polish border. The uninterrupted flow of goods and services across this border is crucial for Ukrainian farmers to access markets in Poland and beyond. Any disruption, such as a blockade, can have severe economic repercussions for these farmers. They rely on exporting their produce to Poland for income generation and to sustain their livelihoods. Without access to these markets, Ukrainian farmers face significant challenges in selling their products, which can lead to financial strain and instability. Therefore, the stability and openness of the Polish border directly impact the financial state and prosperity of Ukrainian farmers.

WORKS CITED

Baylis, K., Jolejole-Foreman, C. and Mallory, M. 'Impact of wheat and rice export ban on Indian market integration', Contributed Paper, IAMO-Forum 2014 on The Rise of the 'Emerging Economies': Towards Functioning Agricultural Markets and Trade Relations', 25–27 June 2014, Halle (Saale), Germany.

Deininger, Klaus, Daniel Ayalew Ali, Ming Fang. Impact of the Russian Invasion on Ukrainian Farmers' Productivity, Rural Welfare, and Food Security. *Policy Research Working Paper* 10464. https://documents1.worldbank.org/curated/en/099854505312323587/pdf/IDU05ff5b311039670490b086000005b896147f3.pdf

EastFruit. Polish farmers lag behind Ukraine in the development of agricultural technologies and agribusiness, which is why they help Russia. *EastFruit International paper*. *https*://east-fruit.com/en/news/polish-farmers-lag-behind-ukraine-in-the-development-of-agricultural-technologies-and-agribusiness-which-is-why-they-help-russia/

Ghoshray Atanu 2021. Underlying Trends and International Price Transmission of Agricultural Commodities. *ADB Economics Working Paper Series* https://www.adb.org/sites/default/files/publication/28900/economics-wp257.pdf

Götz, L., Glauben, T. and Br€ummer, B. "Wheat export restrictions and domestic market effects in Russia and Ukraine during the food crisis', Food Policy, Vol. 38, (2013) pp. 214–226.

Götz, L., Djuric, Ivan; Nivievskyi, Oleg, 2016, Regional wheat price effects of extremeweather events and wheat export controls in Russia and Ukraine, *Working paper* https://www.econstor.eu/bitstream/10419/130715/1/857497596.pdf

Götz, L., Qiu, F., Gervais, J.-P. and Glauben, T. 'Export Restrictions and Smooth Transition Cointegration: Export Quotas for Wheat in Ukraine', Journal of Agricultural Economics, Vol. 67, (2016) pp. 398–419.

Ihle, R., von Cramon-Taubadel, S. and Zorya, S. 'Markov-switching estimation of spatial maize price transmission processes between Tanzania and Kenya', American Journal of Agricultural Economics, Vol. 91, (2009) pp. 1432–1439.

Hassen Tarek Ben, Hamid El Bilali. Impacts of the Russia-Ukraine War on Global Food Security: Towards More Sustainable and Resilient Food Systems. https://www.mdpi.com/2304-8158/11/15/2301

Jacobs, Karin. Russia's war on Ukraine: Maritime logistics and connectivity. July 2022. *Working paper EPRS* https://www.europarl.europa.eu/RegData/etudes/ATAG/2022/733603/EPRS_ATA(2022)733603_EN.pdf

Maros, Ivanic and Will, Martin April 2014. Implications of domestic price insulation for global food price behavior. https://www.sciencedirect.com/science/article/abs/pii/S0261560613001174?via%3Dihub

Martyshev, Pavlo, Nivievskyi, Oleg and Bogonos, Maria. 2023. "Regional war, global consequences: Mounting damages to Ukraine's agriculture and growing challenges for global food security." IFPRI (blog), March 27, 2023. https://www.ifpri.org/blog/regional-war-global-consequences-mountingdamages-ukraines-agriculture-and-growing-challenges

Meriem Bel Haj Mohamed, Imen Skima, Sami Saafi, and Abdeljelil Farhat 2014. Price modeling: Analysis with a Vector Error Correction Model. https://ipco-co.com/ESMB/IEM'14%20papers/172.pdf

Rachel, Rose and Dimitrios, Paparas. March 2023. "Price Transmission: The Case of the UK Dairy Market".https://www.researchgate.net/publication/369429653_Price_Transmission_The_Case_of_the_UK_Dairy_Market

Ruta Michele. The Impact of the War in Ukraine on Global Trade and Investment. Equitable growth, finance & institutions insight 2022. *World Bank Document.* https://documents1.worldbank.org/curated/en/099750104252216595/pdf/IDU0008eed66007300452c0beb208e8903183c39.pdf

USDA. Ukraine Agricultural Production and Trade, April 2022. https://fas.usda.gov//sites/default/files/2022-04/Ukraine-Factsheet-April2022.pdf

Vos Rob and Glauber Joseph. Eastern European farmers protest gluts of Ukraine food exports: The struggle to keep solidarity lanes open. https://www.ifpri.org/blog/eastern-european-farmers-protest-gluts-ukraine-food-exports-struggle-keep-solidarity-lanes

Will, Martin and Nicholas, Minot. March 2023. "The Impact of Price Insulation on World Wheat Markets during Covid-19 and the Ukraine Crisis", *IFRI Discussion* Paper https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/136616/filename/136833.pdf