Correlation between Agri-Market Subjects: A Case Study of Ukraine – EU vs. EU – China[1]

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Abstract

Agriculture is vitally important for the survival of mankind in both a general and individual sense, as it provides food for people and forage for domestic animals. Due to the differences in climatic conditions, the availability of water, the costs and skills of the labour force, etc. countries have diverse food security possibilities. Thereby, exporters of agricultural products gain increasing economic, and consequently political, importance either locally or globally as they have agro-produce surpluses which they can deliver to secure food availability. The local and global agricultural product markets function according to their own laws with their colossi players being related with each other, stating their game rules on the said markets. Therefore, the research problem considers whether a small country such as Ukraine, without a great deal of political influence at a global level and not being especially economically developed, has any correlation with a giant player on both the global economic and political stages such as the EU. The purpose of the research is to evaluate whether the export of agricultural products from Ukraine to the EU27 has any correlation with the export of agricultural products from the EU27 to China and, if so, how strong that correlation is. The research has been conducted using such methods and tools as comparative analysis, univariate analysis, the Pearson correlation coefficient, the Spearman rank correlation coefficient, the tabular method, as well as data visualisation tools – a line graph, bar charts, box plots and a scatter plot. The data analysed in the article are the food, drinks and tobacco (SITC 0+1) exports of Ukraine to the EU27 and of the EU27 to China, measured in millions of Euros. The timeframe of the data analysed in the article is 10 years – from 2012 to 2021 in-

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1 This paper is a revised and expanded version of a paper entitled "Ukraine on the European Agricultural Products Market: the Extra-EU Trade Issues" presented at the 12th International Scientific Conference "Business and Management 2022", 12-13 May 2022, Vilnius, Lithuania.

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clusive. The value of the Pearson correlation coefficient points to the existence of a strong positive correlation between the analysed data sets, while the value of the Spearman correlation coefficient points to the existence of strong – indeed close to perfect – positive correlation between the data sets under research. The p-values corresponding to both the abovementioned coefficients point to the statistical significance of the results obtained and the rejection of H0. The research will contribute a great deal to all the spheres of scientific research connected with data analysis, politics and economics, international relations, international trade in general and of agricultural products in particular, etc. The research presented in this paper and the results thereof will be of interest to and highly useful for those involved in all segments of international trade, public administration officials, decision and policy makers, academic society representatives, as well as beginner and experienced data analysts alike.

Key words

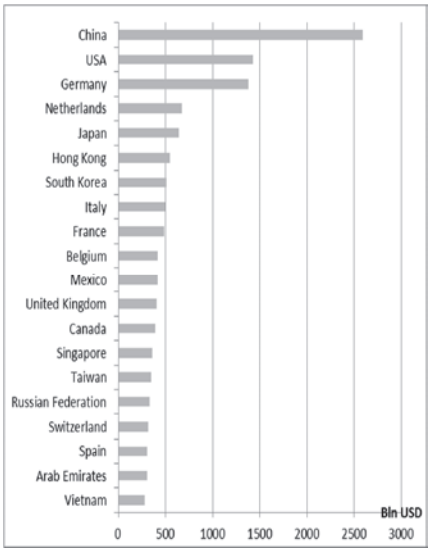
agricultural product exports, correlation, China, the European Union, Ukraine, international trade.

Introduction

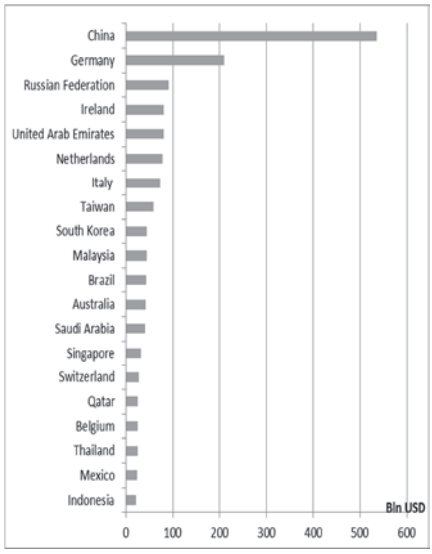
The progress of agriculture approximately 12,000 years ago changed the outline of human life, bringing about a change from the nomadic hunter-gatherer way of life to permanent settlements and farming (National Geographic, n.d.). Since those times, the way humans live has changed a great deal but agriculture has remained of vital importance to humanity in general and in terms of the individual, as well. Agriculture is a significant part of the economy in all countries, but it is especially important for the economic development of developing countries, because it is a source of either food or income and employment, especially for the rural population (Khanna & Solanki, 2014). Due to the differences in the climatic conditions, the availability of water resources, soil fertility, the costs and skills of the labour force and other factors, the availability of agricultural products is not equal in various regions/countries of the world. For that reason, the importance of trade, especially international trade, is particularly vital in the provision of agricultural products from the regions with surplus production to those with a deficit of such products. Moreover, trade is a key factor in maintaining competitiveness in the global economy and lowering the prices of goods internationally, as it stimulates the development of innovation as well as encouraging markets on different levels to become specialised (Qurban, 2022). Countries that are open to international trade have a tendency to grow faster, implement more innovations, increase the productivity of their industries and provide more opportunities to raise the income of the population (The World Bank, 2018). If there were no trade, the constraint on the food systems, either local or national, in ensuring food security would be larger, carrying with it serious burdens on both natural resources and governmental budgets (Ash & Greenville, 2015). To prove everything stated above, the comparative analysis of the

20 countries which are the largest exporters and with the highest trade surpluses as of 2020 is to be undertaken with the help of the visualisation presented in Figure 1.

Figure 1. Top 20 largest exporters worldwide and the 20 countries with the highest trade surplus as of 2020, bln USD



Top 20 largest exporters worldwide in 2020, bln USD



Top 20 countries with the highest trade surplus as of 2020, bln USD

Source: own elaboration based on data from Statista (2021(a), 2021(b))

According to the data presented on the left of the above Figure, the countries which are commonly perceived as being highly economically developed, and therefore in the strongest positions on the global political stage, are among the world's 10 leading exporters as of 2020. It would be naive to think those countries reached their high positions only thanks to the increased volume of their exports. It is rather a combination of many factors, such as geographical location, developed infrastructure and logistics structure, competent political leadership, etc. which played a role in leading those countries to the highest positions in the world rankings. Nonetheless, exports are considered to be a significant tool of a country's improved economic development, as an increase in exports also brings about an influx of foreign currency, and allows for an increased volume of imports of capital goods and services, which are significant in terms of increased productivity and economic wealth (Kalaitzi & Chamberlain, 2020).

Coming back to the analysed data visualised in the figure presented above, first place among the most influential nations in terms of the volume of exports is occupied by China. In addition to being the largest exporter worldwide, China was № 2 in the world in terms of GDP, № 2 in total imports, № 68 in terms of GDP per capita and the 28th most complex economy in accordance with the Economic Complexity Index in 2020 (OEC, n.d. (b)). An explanation should be given here to better understand the analysed data – the European Union (EU) itself

is not included in this particular analysis as only individual countries are included, rather than unions or other groups thereof. Although the EU operates as a single market and conducts all negotiations as one entity on behalf of all its member countries, it is nonetheless still a union of countries, not a single country. Nevertheless, it should be stressed here that six of the 20 largest global exporters are EU member countries. It is also important to note that in 2020 China, together with the US and the EU, accounted for 43% of global trade (Eurostat, 2021).

Despite the myriad shortcomings in the export of goods and services, such as the market trade rules of one country differing from those of another, the possibility of losing a certain amount of control due to the distance inherent in business management, etc., most countries do everything possible to increase the volume of exports, since it is believed that the advantage of exports over imports, the so-called positive trade balance, makes the country more influential on the world stage, both economically and politically. Comparing the list of the 20 countries with the largest positive trade surpluses and the leading exporting countries globally in 2020, as well as the actual location of the countries in these lists, we see that in both cases China is the unchallenged leader. One more country occupies a place among the top three in both lists, namely Germany, which ranks third among the leading exporters and has the second largest trade surplus. Apart from China, there is only one country that occupies the same place in both lists, that being Singapore (15th place). All other countries either occupy different places or are completely absent from one of the lists. Thus, for example, the following countries were listed among the leading exporting countries but are not among the top 20 countries with the largest trade surpluses, namely the United States, Japan, Hong Kong, France, the United Kingdom, Canada, Spain, the Arab Emirates and Vietnam. That is, 45% of the countries on the list of the 20 leading exporters are not among the top 20 countries in terms of the size of their trade surplus.

Both territorially large and small countries, countries with different political systems and religions, politically influential nations and those which we customarily hear very little about are included in the lists above. Nevertheless, in major scientific works and market research, the correlation, and thus the relations and the degree of influence, between the equivalent market players are computed and analysed. The term 'equivalent' is used here to mean being of a similar territory, economic development level, political influence, etc. That is, it goes without saying that a territorially small or underdeveloped or politically non-influential country cannot be considered to have any influence, either economic or political, on territorially large and either economically or politically influential global players. As such, this very gap in the scientific and market research was exactly what motivated the author of the presented research to undertake the current study. Thereby, the research problem is whether such a territorially small country, without a great deal of political influence – at least on the global level – and which is not highly economically developed, such as Ukraine, can be correlated with such a giant player on both economic and political world stages as the EU. Therefore, the purpose of the research is to evaluate whether Ukrainian agricultural exports to the EU27 are correlated with the EU27's agricultural exports to China and, if so, the strength of said correlation.

1. Literature review

Trade has always been vitally important to the development of human civilisation, as trade between countries around the world allows them to make use of raw materials, products, services and technologies which

are not accessible to them on the domestic markets (Pancenko & Ivanova, 2018). Trade also plays a crucial role in the provision of livelihoods to all those employed along the food supply chain, because it makes a major contribution to the reduction of food insecurity in the world and gives consumers a greater choice of available goods (OECD, n.d. (a)). To be more precise, agricultural trade helps to counter food production shortages due to different reasons, contributing to the prosperity of farmers, industries and consumers (European Commission, n.d. (a)). On the other hand, taking countries' involvement in the trade of agricultural products into account, the distribution of the previously mentioned products in areas with specific or various social and natural conditions is still significant as it results in substantial regional differences in the degree and level of involvement of countries in international trade (Abrhám, Vošta, Čajka, & Rubáček, 2021). In addition, trade helps to organise a reliable, well-integrated global agricultural food system, which, in turn, will help countries withstand unexpected challenges such as the COVID-19 pandemic in the early 2020s, when the world agricultural and food markets showed remarkable resilience (Reliefweb, 2022).

Another integral part of the food system mentioned above is robust and properly functioning markets, which have the ability to:

- increase compensation for investments made in agricultural production;
- provide people who live in rural areas with the chance to specialise in the production of fewer items, which in turn will increase the total amount of goods produced and make said products more affordable;
- help supply to complement demand across regions and seasons, while increasing total sales for producers and ensuring food security, access and availability for consumers of different groups and better standards of living;
- lower food costs, which constitute the largest expenditure of the poorest population stratum (USAID, n.d.).

Due to the extreme significance of agriculture as a whole and the trade in agricultural products in particular, topics connected with either the former or the latter enjoy notable popularity among researchers. One group of academics researches agricultural market development, trends and prospects (Minakov & Nikitin, 2019); agricultural marketing and price analysis (Norwood, Lusk, Peel & Riley, 2021); the riskiness of the agricultural markets in terms of price forecasting and the necessity of intervention policies (Scandizzo, Hazell & Anderson, 2019); the transformation of the agri-food markets towards more sustainable functioning patterns (Borsellino, Schimmenti & El Bilali, 2020); the exchange of risks between the energy and agricultural product markets with the help of a dependence-switching CoVaR-copula model (Ji, Bouri, Roubaud & Shahzad, 2018); the adoption of uncertainty, learning, and technology in agriculture (Chavas & Nauges, 2020); the use of econometric modelling in the formation of optimal prices to be implemented in agricultural production (Volontyr & Zelinska, 2019); the implementation of a game theory approach in the study of the impact of governmental subsidies on agricultural production and pollution (Zhang, Ma & Liu, 2021); the study of the role of peaks and troughs in the agricultural futures market in forecasting stock market volatility (Ma, Zhang, Wahab & Lai, 2019); the study of the costs and structure of common agricultural policy (Buckwell, Harvey, Thomson & Parton, 2019); the interrelations of agricultural intensification, dietary diversity, and markets in the global food security narrative (Ickowitz, Powell, Rowland, Jones & Sunderland, 2019); future price prediction of agricultural products with the help of long-and short-term time series networks (Ouyang, Wei & Wu, 2019); the study of agricultural innovation and

inclusive value-chain development (Devaux, Torero, Donovan & Horton, 2018); research on labour, markets, and agricultural production (Van der Ploeg, 2019); the study of the heterogeneous effects of standards on agricultural product trade flows (Fiankor, Haase & Brümmer, 2021); research on market orientation, innovation, and financial performance in the agricultural value chains in emerging economies (Ho, Nguyen, Adhikari, Miles & Bonney, 2018); the study of the types of risks in agriculture (Komarek, De Pinto & Smith, 2020); the impact of the political economy on agricultural and food policies (Swinnen, 2018); and others.

Other scientists concentrate on the factors influencing the way the agricultural markets function as the global impacts of future cropland expansion and intensification on the development of agricultural markets and biodiversity change (Zabel, Delzeit, Schneider et al., 2019); the potential influence of climate change and mitigation on global agriculture by 2050 (Van Meijl, Havlik, Lotze-Campen, Stehfest, Witzke, Domínguez,... & van Zeist, 2018), with a particular subgroup of the latter group containing scientific works on the impact of the COVID-19 pandemic on various aspects of the functioning of the agricultural market (Elleby, Domínguez, Adenauer et al., 2020); the social media impact of COVID-19 on agricultural prices and consumers' buying behaviour (Bansal, Chaturvedi, Saroha, Kaur, Mehra, Ahmad & Vynnychenko, 2020); how the COVID-19 pandemic has influenced agricultural exports (Lin & Zhang, 2020); an overview of lessons from China about the rising concerns over agricultural production during the spread of COVID-19 (Mingzhe & Yu, 2020); mitigation strategies and implications for practitioners in terms of agriculture supply chain risks and COVID-19 (Sharma et al., 2020); an overview of the evidence from food markets in India pertaining to COVID-19 and supply chain disruption (Mahajan & Tomar, 2021); the impact of the COVID-19 pandemic on the agri-food system (Poppe, 2020); and others.

There are a number of articles focused on the peculiarities of the functioning of agricultural markets in particular localities/regions/countries/continents, such as governments and agricultural markets in Africa (Bates, 1988); a study of the results from pilot market channel assessments of community-supported agriculture marketing performance in Colorado (Jablonski, Sullins & Thilmany, 2019); a study of Dutch contributions to agricultural marketing in tropical Africa (Van der Laan, Dijkstra & van Tilburg, 2018); research into the high-frequency volatility of connectedness between US crude oil and Chinese agricultural commodity markets (Luo & Ji, 2018); an overview of actions taken by the government of India and agricultural policy during the COVID-19 lockdown (Narayan & Saha, 2020); an overview of the experience of Ukraine and Poland in terms of the competitive advantages of wholesale agricultural product markets as a type of entrepreneurial activity (Boiko, Kwilinski, Misiuk & Boiko, 2019); a study on the effects of the inclusion of agricultural products in the customs union between Turkey and the EU (Grethe, 2003); an overview of the empirical evidence from agricultural commodity spot and futures markets in India as related to price discovery and volatility spillover (Manogna & Mishra, 2020); a study on the issues, challenges and prospects for the agricultural sector value chain and government policy in Nigeria (Olomu, Ekperiware & Akinlo, 2020); research on the evolution of agricultural policy in Kazakhstan (Baubekova, Tikhonova & Kvasha, 2021); the assumptions pertaining to the utility of agricultural commodity prices as a predictor of Nigerian inflation (Tule, Salisu & Chiemeke, 2019); a study of the implementation of the econometric approach towards agricultural credit and productivity in Bangladesh (Islam, 2020); research on the development of the organic

farming market in Europe and the European Union (Willer, Schaack & Lernoud, 2019); a study on the resilience of agricultural value chains in the context of developing countries (Vroegindewey & Hodbod, 2018); and others. Thus, as far as one can see, there are a great deal of scientific works researching either trade in general or the agricultural products trade in particular as well as the functioning of said markets, but the lack of publications on the correlation/relations between the subjects of those markets constitutes a gap in the scientific research which the author has attempted to fill by conducting the research presented in this article.

2. Methodology

As the agricultural products trade in general and exports in particular are vitally important for the survival and functionality of mankind, the profound analysis of the present state of matters as well as the dynamics thereof and making credible projections are, in turn, very important for the successful functioning of international trade as a whole as well as the export of agricultural products in particular, as a key component of international trade. The data analysed in the article are the food, drinks and tobacco (SITC 0+1) exports of Ukraine to the EU27 and of the EU27 to China, measured in millions of Euros. The abbreviation SITC denotes the Standard International Trade Classification, which is the United Nations product classification used for external trade statistics, including export and import values as well as volumes of goods traded, making it possible to conduct international comparisons of commodities and manufactured goods (Eurostat, n.d.). The timeframe of the data analysed in the article is a period of 10 years, that is, from 2012 to 2021 inclusive.

The aim of the research, as has already been stated above, is to estimate whether such a territorially small country, without a great deal of political influence – at least on the global level – and which is not highly economically developed, such as Ukraine, can be correlated with such a giant player on both economic and political world stages as the EU. The 27 member countries comprising the European Union are hereinafter referred to as the EU27. The novelty value of the research is the estimation of the presence/absence of correlation between one of the spheres of economic activity of a small and politically non-influential country and that of a large, economically and politically strong global player. The scientific question to be answered while conducting the research is whether the export of Ukrainian agricultural products to the EU27 is correlated with the export of EU27 agricultural products to China and, if so, to calculate the strength of said correlation.

In order to answer the scientific question mentioned above to the largest possible degree as well as to achieve the aim of the presented research, the comparative analysis of Ukrainian agricultural exports to the EU27 and from the EU27 to China, as well as the dynamics thereof, was conducted with the help of a line graph to visualise the results of said analysis. The comparative analysis of Ukrainian agricultural exports to the EU27 and from the EU27 to China with differences to previous periods is presented using bar charts to better visualise the analysed data. The visual verification of the presence/absence of the correlation between Ukrainian agricultural exports to the EU27 and similar exports from the EU27 to China was done by means of a scatter plot of the data collected. The simple statistics of both data sets were presented using the tabular method; while the Pearson correlation coefficient as well as the corresponding p-value of Ukrainian agricultural exports to the EU27 with those from the EU27 to China were computed and analysed in the article. It should be noted here that the Pearson correlation coefficient is used to estimate the strength of a linear association between two variables,

where the value r = 1 means a perfect positive correlation and the value r = -1 means a perfect negative correlation (Social Science Statistics, n.d.). The Pearson correlation coefficient is calculated according to the formula presented below:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (1),$$

where:
r – Pearson correlation coefficient;
n – number of stock pairs (Srivastav & Vaidya, n.d.).

In order to make the analysis more credible, Ukrainian agricultural exports to the EU27 and those from the EU27 to China were tested for normality by means of univariate statistical analysis, the results of which were presented using box plots as a data visualisation tool. To be perfectly sure of the research results and to once again verify those from the analyses, the Spearman correlation coefficient and its corresponding *p*-value were calculated and analysed in the article. The Spearman rank correlation coefficient (Spearman ρ) is a nonparametric measurement correlation which is used to assess the relationship between two data sets (Springerlink, n.d.). A simpler formula for the Spearman rank correlation coefficient calculation is presented below:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \quad (2),$$

where:
ρ – Spearman rank correlation coefficient;
di – difference between a pair of ranks;
n – number of observations (Cheusheva, 2022).

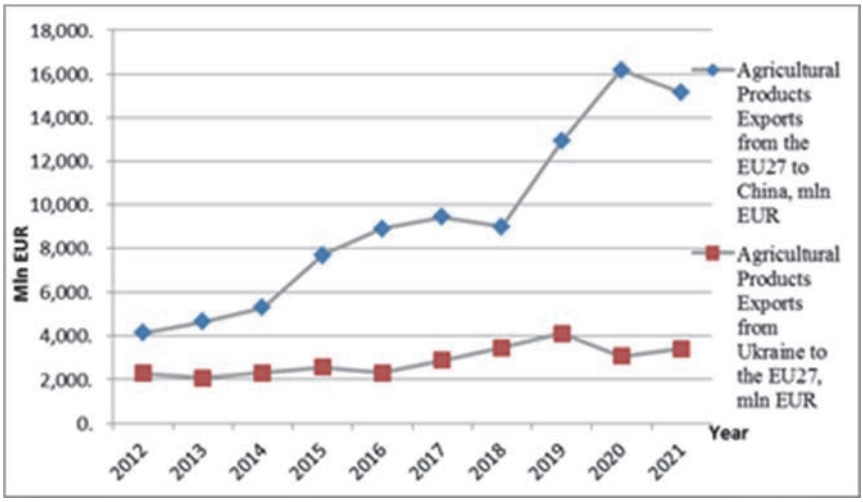
The Spearman rank correlation coefficient test does not require the data to be normally distributed.

3. Research results

The international agri-food products trade has grown enormously during the last 20 years, expanding almost 7% annually in real terms between 2001 and 2019 on an increasingly global scale (OECD, n.d. (b)). The design and pattern of international agricultural trade is undergoing intense changes (Sun Q. et al, 2022). New players are constantly entering the lists of the top producers/exporters/importers of agricultural products, changing either the pattern of the international agri-production trade or the ranking of the global players on the agricultural products market. Countries which have recently been considered underdeveloped and not worth paying a great deal of attention to in the context of global geopolitics have begun to ascend the world rankings of global agricultural producers/exporters/importers, meaning that nominally more powerful nations now take them into account when analysing the world agri-market, modelling, forecasting, etc. An example of such a country is Ukraine, a country situated in Eastern Europe (Britannica, 2022). In 2000 Ukraine exported only 0.47% of the world's cereals, while in 2020 the country was the third largest exporter of cereals worldwide, accounting for 8.14% of global cereal exports (OEC, n.d. (a)), behind only the USA (15.7%) and the Russian Federation (8.95%). Given such a volume, Ukraine is often referred to as the breadbasket of Europe, as approximately 25% of the world's most fertile black soil is on Ukrainian territory. The main agricultural crops of which Ukraine is known to be one of the world's top agricultural producers and exporters are grains and forage crops, including wheat, corn, barley, sunflower, sugar beet, legumes, fruits and vegetables, tobacco, etc. (DLF, 2020). Ukraine has a rather

large consumer market, an educated and cost-competitive work force, as well as rich natural resources. Ukraine's Association Agreement with the EU gives Ukraine preferential market access and is accelerating Ukraine's economic integration with the EU (U.S. Department of State, 2020). The main aim of the Association Agreement (AA) / Deep and Comprehensive Free Trade Area (DCFTA) is to increase the trade in goods and services between the EU and Ukraine by decreasing trade tariffs and gradually changing Ukraine's laws on trade, bringing them in accordance with those of the EU. Thanks to the abovementioned agreements, the European Union is already Ukraine's largest trading partner, accounting for approximately 40% of its total trade as of 2019. In turn, Ukraine is the 18th largest trading partner of the European Union, accounting for approximately 1.1% of the EU's total trade (European Commission, 2021). The comparative analysis of Ukrainian agricultural exports to the EU27 with the same exports from the EU27 to China is the first step of the research, which is presented in Figure 2.

Figure 2. Exports of agricultural products from Ukraine to the EU27 and from the EU27 to China, mln EUR



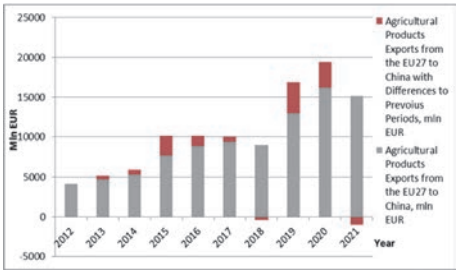
Source: own elaboration based on data from Eurostat (2022 (c))

The visual presentation of the data which was the subject of analysis in the above image allows one to discern the differences in both the amount of exports mentioned above and the dynamics of said exports more clearly. The first difference, which seems obvious when observing the data, is the difference between the dynamics of the research data – Ukrainian agricultural exports to the EU27 are smoother than those of the EU27 to China. Although the difference between the researched export amounts is apparent from the data visualisation presented above, the simple statistics allow one to draw more precise conclusions, namely that the mean of the exports of EU27 agricultural products to China is approximately 3.3 times higher than those from Ukraine to the EU27. The highest observation value of the data set of agricultural exports from the EU27 to China, which can be observed in 2020, is around 3.9 times higher than that of Ukraine to the EU, which was in 2019. The lowest observation value of the EU27 to China agro-exports data set, in this case from 2012, is almost twice as high than that from the data set

pertaining to Ukrainian agricultural product exports to the EU27, observed in the following year of 2013. This leads to another conclusion about the analysed data sets, namely that the years in which the highest and the lowest volumes of exports were observed did not coincide. The changes of the analysed data dynamics, especially during the last years of the research timeframe, may be perceived as being somewhat contradictory, and thus perhaps even more interesting. According to the conventional point of view, the COVID-19 pandemic negatively influenced the main indicators of economic activity; however, according to the data shown in Figure 2, both agro-export figures noted an increase (a relatively small one of approximately 653 mln EUR for Ukrainian exports to the EU27 and a significantly larger one of 3918 mln EUR for EU27 exports to China). In the next year, one may observe a completely different situation in terms of changes in the dynamics of the data – another large increase in exports from the EU27 to China, and the opposite, that is, a decrease in Ukrainian agricultural exports to the EU27 of approximately 1048 mln EUR. The year 2021 was considered to be a year, in which either the global or most local economies recovered from the Covid-19 pandemics' impacts, at least according to numerous scientific and mass media publications. The change in the amount of Ukrainian agricultural products exported to the EU27 proves that, with an increase of approximately 349 mln EUR. However, a completely different picture, contradicting the conventional viewpoint, can be seen in the case of EU27 agro-exports to China, namely a decrease in the level of said exports of approximately 1037 mln EUR. Further analysis of the export of Ukrainian agricultural products to the EU27 and from the EU27 to China can be done using the data visualised in Figure 3.

Figure 3. Export of agricultural products from Ukraine to the EU27 and from the EU27 to China with differences to previous periods, mln EUR

Agricultural products exported from Ukraine to the EU27 with differences to previous periods, mln EUR



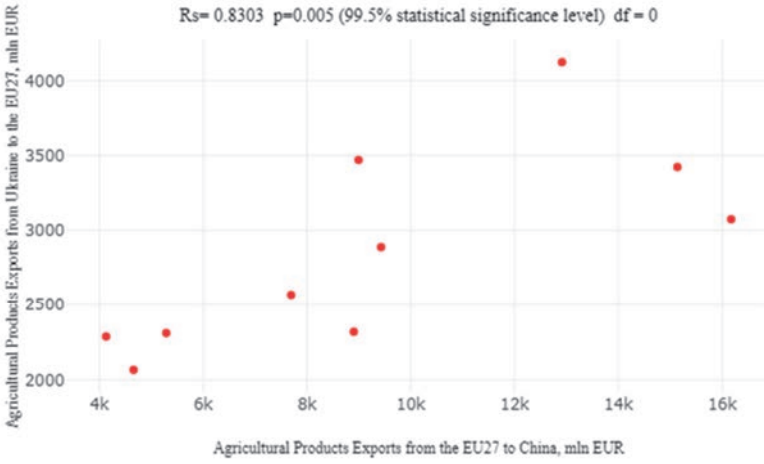
Agricultural products exported from the EU27 to China with differences to previous periods, mln EUR

Source: own elaboration based on data from Eurostat (2022 (c))

Upon further analysis of how Ukrainian agro-exports to the EU27 and those from the EU27 to China changed when compared to previous periods, it should be stated that the negative changes to said exports from Ukraine to the EU may be observed in 2013, 2016 and 2020, while a decrease in exports from the EU27 to China can be seen in 2018 and 2021. This means that there was not a single year in which a decrease in the level of exports is observed in both data sets for that given year. The largest decline in the amount of agro-exports from Ukraine to the EU27 was in 2020, while the smallest was 2013. Furthermore, EU27 agro-exports to China decreased the least in 2018 and

the most in 2021. If Ukrainian agricultural exports to the EU27 appear smoother than those of the EU27 to China, when observing the agro-exports together with the differences to the previous periods included, the Ukrainian ones are more changeable than those of the EU27 to China. One could even mention the cyclicality in the export of Ukrainian agricultural products to the EU27 if the periods were of the same length, but the first period of year-on-year increases lasted two years (2014 and 2015), while the second such period ran for three years (2017-2019). A completely different picture was given in the case of agro-exports from the EU27 to China, that is to say the first period of constant upward trends in the data dynamics lasted from the beginning of the analysed timeframe to 2017 inclusive. It was then interrupted in 2018 by a decline in exports of approximately 433 mln EUR, followed by a second upward period in 2019, which in turn lasted only two years (2019 and 2020). It is worth noting that in all of the years 2014, 2015, 2017 and 2019, increases in both Ukraine – EU27 and EU27 – China agricultural exports could be seen. After obtaining the research results, a scatter plot was used to assist with the visual interpretation of the analysis and the results thereof (Figure 4).

Figure 4. Scatter plot of agricultural product exports from Ukraine to the EU27 vs. from the EU27 to China



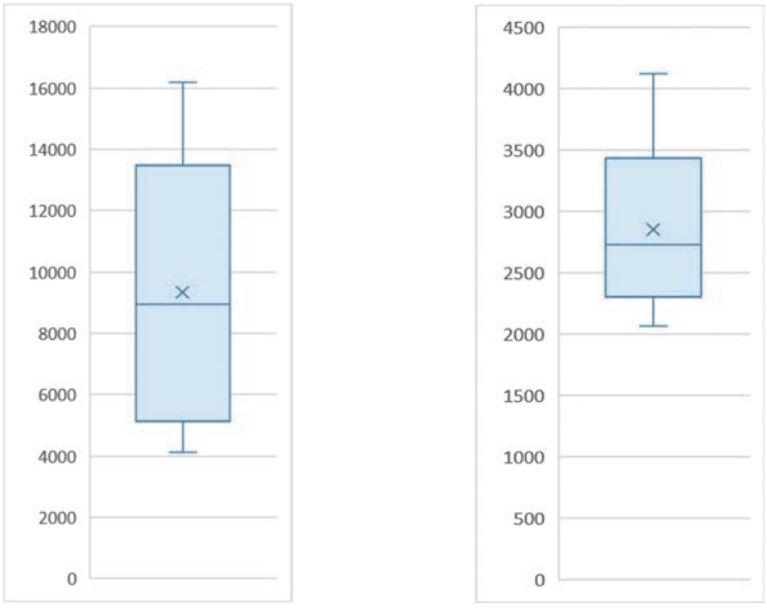
Source: own elaboration with the help of Barcelona Field Studies Centre (2022) based on data from Eurostat (2022 (c))

A scatterplot, also called a scattergram or a scatter diagram, is no mere data visualisation tool as it displays a relationship between two sets of data (Texas Gateway, n.d.). Inspecting the data presented in the figure given above, we conclude that there is a medium to strong positive correlation between Ukrainian agricultural exports to the EU27 and those from the EU27 to China. Such a conclusion has been made as the dots, denoting data observations, do not form a perfect straight line in the plot; nonetheless, an upward tendency can be observed, although the dots are somewhat spread out from the imagined straight line denoting a theoretical perfect correlation. As the upward tendency of the data observations is viewed in the scatter plot, we conclude that there is evidence of the presence of a positive correlation between the analysed data sets, except for the last two observations. It is clear from the scatter plot above that

a correlation between the analysed data sets exists. Despite the fact that a scatter plot is a suitable tool by means of which to visualise the presence/absence of the correlation between the researched data sets, it does not give precise results, only an approximation. In order to obtain more robust results to reach scientifically sound conclusions, the Pearson correlation coefficient (given the H0 of Rho equals zero) and its corresponding *p*-value have been computed, as the Pearson correlation coefficient measures either the strength or the direction of the linear relationship between two continuous variables, whose values can extend from -1 to +1 (Frost, n.d.). The Pearson correlation coefficient of Ukrainian agricultural product exports to the EU27 with those from the EU27 to China has a value of 0.7377 (Social Science Statistics, n.d. (a)). Such a value indicates the existence of a strong positive correlation between the analysed data sets. To ensure that the test results are statistically significant, attention should be paid to the corresponding *p*-value, which in this case is 0.014877. With the confidence intervals of 95%, meaning α=0.05, the *p*-value corresponding to the calculated Pearson correlation coefficient between the analysed data sets defines the abovementioned coefficient as statistically significant. Consequently, we can reject the H0 that there is no correlation between the data sets.

As one of the assumptions of the calculation of the Pearson correlation coefficient is the need for the analysed data sets to be at least approximately normally distributed, the data sets were tested for normality. A visual presentation of the results of normality testing is displayed in Figure 5.

Figure 5. Box plots for agricultural products exported from Ukraine to the EU27 and from the EU27 to China



Agricultural products exported from the EU27 to China

Agricultural products exported from Ukraine to the EU27

Source: own elaboration based on data from Eurostat (2022 (c))

A box plot is a typical way of displaying the distribution of the analysed data based on the summary of five indicators ('minimum', first quartile (Q1), median, third quartile (Q3), and 'maximum') (Galarnyk, 2018). Having observed the box plots given above, we see that the so-called 'whiskers' are not even and the median differs from the mean, which in turn points to the fact that none of the researched data sets can be considered normally distributed, albeit the violations are relatively small. So as not to base the conclusions on the visual presentation of the data alone, the simple statistics for said data were calculated and grouped in Table 1.

Table 1. Simple statistics of the volume of agricultural products exported from the EU27 to China vs. from Ukraine to the EU27

Indicators	Agricultural products exported from the EU27 to China, mln EUR	Agricultural products exported from Ukraine to the EU27, mln EUR
Minimum	4130.9	2066.7
Q1	5289.2	2310.2
Median	8948.7	2728.45
Q3	12913.2	3423.9
Maximum	16174.4	4123
Mean	9332.46	2853.13
Skewness	0.453577	0.699958
Kurtosis	-0.970052	-0.396467
Outliers	None	None

Source: own calculations with the help of Statistics Kingdom (n.d.) based on data from Eurostat (2022 (c))

Judging by the data in the table shown above, the violations of normality are larger for the Ukraine – EU27 data set when compared to those of the EU27 – China one. In addition, both data sets are slightly skewed to the right, albeit some scientists engaged in statistical analysis consider data sets with such small violations to be almost normally distributed. Moreover, both data sets are platykurtic. Nevertheless, none of the analysed data sets have outliers, which justifies the use of Pearson correlation testing. At the same time, due to the violations of normality of the data sets under research, the abovementioned results of the analysis cannot be considered sufficiently credible to draw definitive conclusions on the matter. For this reason, the Spearman correlation coefficient (given a H0 of Rho equals zero) and the corresponding *p*-value have been calculated, as the Spearman rank correlation coefficient is a nonparametric test measuring the correlation based on data ranks, for which approximate normal distribution for the analysed data sets are not required (Penn State, 2022). Having considered the Spearman correlation coefficient of Ukrainian agricultural exports to the EU27 with those from the EU27 to China, which amounts to 0.8303 (Social Science Statistics n.d. (b)), it should be stated that the value of said coefficient indicates the existence of strong – indeed close to perfect – positive correlation between the researched data sets. With the confidence

limits of 95%, that is, $\alpha = 0.05$, the calculated p-value corresponding to the Spearman correlation coefficient of Ukrainian agro-exports to the EU27 with those from the EU27 to China, which has a value of 0.00294, points to the statistical significance of the results obtained, allowing us to reject the H0 of no correlation between the analysed data sets. It should, however, be stressed here that the fact that the H0 was rejected does not automatically mean the acceptance of the alternative.

4. Discussion

The world is still adapting to a post-pandemic reality stressed by inflation shocks, energy scarcity, and geopolitical tensions in various parts thereof (McKinsey & Company, 2022). Markets in different parts of the world have continued to tumble as recession panic reoccurred with the central banks of many countries raising rates in an effort to slow down inflation (Pronina & Valero, 2022). Russia's February 2022 invasion of Ukraine appeared to be the latest in a sequence of events that have sent shockwaves through the global order and raised serious concerns about the nature and frequency of state-to-state military conflicts, the course of globalisation and technological innovation, as well as the utility and legacy of multilateral institutions (CSIS, 2022). Political and economic turbulence in one part of the world causes uncertainty/problems/distortions in another part or parts of the world, be it a small, underdeveloped country, a political/economic union of nations or an entire continent, as politics, economics, sociology, etc. are currently closely interrelated with each other in the globalised world. For example, the ongoing war in Ukraine, which affects a region vitally important to global food security, is giving rise to uncertainty and increased risk of the fragmentation of global agri-food markets, magnifying hunger threats which were already very high because of the COVID-19 pandemic, political and military conflicts in various countries, as well as humanitarian crises in different parts of the world (Reliefweb, 2022). The abovementioned war has also had a significant effect on the global markets and food supply, because blockades of Ukrainian grain exports have worsened hunger in many vulnerable regions of the world, as Ukraine has always been a large exporter of grain, having fed 400 million people around the world in 2021 (IRC, 2022). More than that, the price of fuels has also risen as a consequence of Russia's unprovoked and unjustified aggression against Ukraine, which has also led to the rise of concerns connected with the security of the energy supply, especially in the EU (Council of the European Union, 2022).

The EU itself has experienced some political and economic turbulence including the risks of natural gas stockpiles running out in the middle of the current winter peak demand, if Russian gas supplies through critical pipelines are partially or even completely halted (Pronina & Valero, 2022). In addition, the annual inflation rate in the eurozone was 10.6% in October 2022, compared to 9.9% in September, while in the previous year, the corresponding rate was 4.1%. Annual inflation in the European Union was 11.5% in October 2022, up from 10.9% in September, while a year earlier the rate was 4.4% (Eurostat, 2022 (a)). In addition to the issues listed above, it is possible to add increased rental prices; European sugar prices – already the highest in four years – pushing up the cost of food; the corruption scandal in the European Parliament, etc.

In the midst of the strengthening geopolitical tensions and shifting political dynamics in some member states of the European Union, companies and investors with particular interest in EU – China relations could expect the bilateral relations between said parties to remain rather turbulent despite cautious re-engagement, while taking the risks of further deterioration into account (FIPRA, 2022). In China itself, neither the economic nor political situation can be

seen as cause for optimism. Three factors are largely at fault for this: the so-called zero-Covid policy, a decline in the property sector, which accounts for approximately 30% of China's GDP, and an extensive clampdown on Big Tech (Dutt, P., 2022). The new Chinese leadership elected at the 20th Communist Party Congress is viewed as more ideologically and politically oriented, while those retiring are considered to be more growth- and market-oriented; for this reason, according to Western media, China could be moving away from its decades-long trend of opening up its economy to the world (Duan, 2022). All of the above makes the author's attempt to assess the presence/absence of the correlation between such global market players, interesting from both political and economic points of view, even more interesting and useful, offering an abundance of potential directions for further research.

Conclusions

Agriculture is extremely significant to the survival and successful functioning of humanity in both a general and individual sense. Moreover, sustainable agriculture is pivotal to ensuring of food security (Rampa, 2012), whether on the global level or in a single country/region/village. Due to the myriad challenges which the whole world is faced with nowadays, such as climate change, the rapid increase of the global population, the larger number of people living below the poverty line, epidemics of various diseases that affect the population of different parts of the world, etc., an increasing number of governments understand the vital importance of agriculture as a whole and the consistent availability of agricultural products for their populations in particular. For this reason, the trade of agricultural products plays an increasingly important role, not only for underdeveloped countries, but for highly economically developed and politically influential ones as well. In terms of agricultural production, the European Union is best known for livestock products (including dairy), grains, vegetables, wine, fruits, and sugar. The most commonly exported items are grains (wheat and barley), dairy products, poultry, pork, fruit, vegetables, olive oil, and wine (ERS/USDA, 2022). Extra-EU trade in agricultural products accounted for 9% of the total extra-EU international goods trade as of 2020, while in the period from 2002 to 2020 the volume of the abovementioned trade of the EU doubled (Eurostat, 2022(b).

The European Union is the Ukraine's largest trading partner, while at the same time Ukraine is 18th on the list of EU trading partners (European Commission, 2021). All the main subject matters of EU – Ukraine relations are touched on in the Ukraine–European Union Association Agreement and the Deep and Comprehensive Free Trade Area (DCFTA). EU – China trade relations are outlined in the Comprehensive Agreement on Investment (CAI), which grants investors from the European Union a greater degree of access to the Chinese market. As the CAI has not yet been ratified, said agreement has not yet entered into force (European Commission, n.d. (b)). Though Ukraine is a territorially relatively small country and is not seen as being particularly highly economically developed or politically influential, the research presented in this paper was dedicated to the evaluation of whether a country such as Ukraine is correlated with the most powerful ones in terms of the volume of their agricultural exports.

The dynamics of the export of Ukrainian agricultural products to the EU27 are smoother than those of the EU27 to China. Simple statistical calculations show that the agro-exports of Ukraine to the EU27 are approximately three times smaller than those of the EU27 to China. In addition, there is no similarity between the particular years in which agro-exports declined across the two analysed data sets, as agro-exports from Ukraine to the EU27 decreased in 2013, 2016

and 2020, while those from the EU27 to China did so in 2018 and 2021. By contrast, a rise in the exports of agricultural products in both data sets under analysis may be observed in 2014, 2015, 2017 and 2019. If Ukrainian agricultural exports to the EU27 do not appear as steep as those of the EU27 to China, when observing the agro-exports with their differences to the previous periods, Ukrainian exports are more changeable than those of the EU27 to China. According to the data visualisation on the scatter plot, it is possible to draw a conclusion about the presence of a low to medium positive correlation between Ukrainian agricultural product exports to the EU27 and those from the EU27 to China.

The value of the Pearson correlation coefficient of Ukrainian agricultural product exports to the EU27 and those from the EU27 to China points to the existence of strong positive correlation between the analysed data sets. With the default confidence intervals of 95%, meaning $\alpha=0.05$, the *p*-value corresponding to the Pearson correlation coefficient between the analysed data sets defines the abovementioned coefficient as statistically significant. Consequently, H0 pertaining to there being no correlation between the data sets can be rejected. The Spearman correlation coefficient value of Ukrainian agricultural exports to the EU27 and those from the EU27 to China points to the existence of strong – indeed close to perfect – positive correlation between the data sets mentioned above. With the confidence limits of 95%, that is, $\alpha=0.05$, the *p*-value corresponding to the Spearman correlation coefficient of the agro-exports from Ukraine to the EU27 with those from the EU27 to China points to the statistical significance of the obtained results, allowing for the rejection of H0 pertaining to there being no correlation between the analysed data sets. However, the rejection of the H0 does not automatically mean the acceptance of the alternative. Thus, we see that neither the size of the territory occupied by the country, nor its political system or level of influence on the international arena, can be a determining factor in making the country an important player on the international trade market in general as well as the agricultural products market in particular.

The presented research will contribute a great deal to all the spheres of scientific research connected with data analysis, political economy, international relations, international trade in general and of agricultural products in particular, etc. The research presented in the paper, as well as the results thereof, will be of interest and highly useful to those involved in all segments of international trade, public administration officials, decision and policy makers, academic society representatives, as well as beginner and experienced data analysts alike. A possible direction for further research could be in the investigation of the specific agricultural products between which correlation is the strongest; by further expanding the number of subjects involved in the agro-trade and the evaluation of the strength of correlation between them; or by modelling and forecasting the volume of agro-exports on a regional and global scale, etc.

There are some limitations of the further expansion of the research, of which the main one is the terrible events currently taking place in Ukraine. The estimated amount of the agricultural land taken from Ukraine by the aggressor country is approximately 20%. Moreover, the situation has not been resolved in any shape or form. How long will these terrible events go on for? What steps are to be made to resolve the situation to the satisfaction of all parties? How will it influence agricultural production and, therefore, the export of Ukrainian agricultural products? All such questions may either be considered limitations to the expansion of the research presented in the paper, or alternatively – notwithstanding how strange it might sound – directions for subsequent important research.

References

Abrhám, J., Vošta, M., Čajka, P., & Rubáček, F. (2021). The specifics of selected agricultural commodities in international trade. Agricultural and Resource Economics: International Scientific E-Journal, 7(2), 5-19. https://doi.org/10.51599/are.2021.07.02.01.

Ash, K. & Greenville, J. (2015). The role of agricultural trade in delivering sustainable food systems. Retrieved from: https://www.ciheam.org/publications/145/016_-_OECD_Edited.pdf. (accessed 4 August 2022).

Bansal, E., Chaturvedi, K. R., Saroha, K., Kaur, J., Mehra, P., Ahmad, F., & Vynnychenko, N. (2020). Covid-19: Social media impact on agricultural prices and consumer's buying behavior. International Journal of Agricultural and Statistical Sciences, 16(2) : 953-957.

Barcelona Field Studies Centre. (2022). Create a scatter graph online. Retrieved from: https://geographyfieldwork.com/ScatterGraphCreator.htm. (accessed 4 August 2022).

Bates, R. (1988). Governments and Agricultural Markets in Africa. In R. Bates (Ed.), Toward a Political Economy of Development (pp. 331–358). Berkeley: University of California Press. Retrieved from: https://doi.org/10.1525/9780520314054-015. (accessed 16 December 2022).

Baubekova, A., Tikhonova, A., & Kvasha, A. (2021). Evolution of agricultural policy in Kazakhstan. In Kazakhstan's Developmental Journey (pp. 51-90). Palgrave Macmillan, Singapore.

Boiko, V., Kwilinski, A., Misiuk, M., & Boiko, L. (2019). Competitive advantages of wholesale markets of agricultural products as a type of entrepreneurial activity: the experience of Ukraine and Poland. (Економічний часопис-XXI, 15(1–2), 68-72.

Borsellino, V., Schimmenti, E., & El Bilali, H. (2020). Agri-food markets towards sustainable patterns. Sustainability, 12(6), 2193.

Britannica. (2022). Ukraine. Retrieved from: https://www.britannica.com/place/Ukraine. (accessed 22 January 2022).

Buckwell, A. E., Harvey, D. R., Thomson, K. J., & Parton, K. A. (2019). The costs of the common agricultural policy (Vol. 7). Routledge.

Chavas, J.P. & Nauges, C. (2020). Uncertainty, Learning, and Technology Adoption in Agriculture. Applied Economic Perspectives and Policy. Vol. 42 (1): 42–53. Retrieved from: https://onlinelibrary.wiley.com/toc/20405804/2020/42/1. (accessed 16 December 2022).

Council of the European Union. (2022). Impact of Russia's invasion of Ukraine on the markets: EU response. Retrieved from: https://www.consilium.europa.eu/en/policies/eu-response-ukraine-invasion/impact-of-russia-s-invasion-of-ukraine-on-the-markets-eu-response/. (accessed 18 December 2022).

CSIS. (2022). Central Questions in U.S.-China Relations amid Global Turbulence. Retrieved from: https://www.csis.org/analysis/central-questions-us-china-relations-amid-global-turbulence. (accessed 19 December 2022).

Devaux, A., Torero, M., Donovan, J., & Horton, D. (2018). Agricultural innovation and inclusive value-chain development: a review. Journal of Agribusiness in Developing and Emerging Economies, 8(1), 99-123.

DLF. (2020). Agribusiness is the main growth driver for the Ukrainian economy. Retrieved from: https://dlf.ua/en/agriculture-in-ukraine-overview/. (accessed 22 January 2022).

Duan, J. (2022). China's 20th Party Congress charts a course through turbulence and transformation. Retrieved from: https://www.rbcwealthmanagement.com/en-asia/insights/chinas-20th-party-congress-charts-a-course-through-turbulence-and-transformation. (accessed 19 December 2022).

Dutt, P. (2022). China's Economy: Dragon in Turbulence. Retrieved from: https://knowledge.insead.edu/economics-finance/chinas-economy-dragon-turbulence. (accessed 19 December 2022).

Elleby, C., Domínguez, I.P., Adenauer, M. et al. (2020). Impacts of the COVID-19 Pandemic on the Global Agricultural Markets. Environ Resource Econ 76, 1067–1079. https://doi.org/10.1007/s10640-020-00473-6. (accessed 16 December 2022).

ERS/USDA. (2022). Agriculture In The European Union. Retrieved from: https://beef2live.com/story-agriculture-european-union-131-108887. (accessed 21 January 2022).

European Commission. (2021). Countries and regions: Ukraine. Retrieved from: https://ec.europa.eu/trade/policy/countries-and-regions/countries/ukraine/. (accessed 20 January 2022).

European Commission, (n.d.(a). Agricultural markets and international trade. Retrieved from: https://joint-research-centre.ec.europa.eu/scientific-activities-z/agricultural-markets-and-international-trade_en. (accessed 13 December 2022).

European Commission. (n.d.). China. Retrieved from: https://policy.trade.ec.europa.eu/eu-trade-relationships-country-and-region/countries-and-regions/china_en. (accessed 1 August 2022).

Eurostat. (2021). International trade in goods. Retrieved from: https://ec.europa.eu/eurostat/statistics-ex-plained/index.php?title=International_trade_in_goods. (accessed 5 February 2022).

Eurostat. (2022(a). Annual inflation up to 10.6% in the euro area. Retrieved from: https://ec.europa.eu/eurostat/documents/2995521/15265521/2-17112022-AP-EN.pdf/b6953137-786e-ed9c-5ee2-6812c0f8f07f. (accessed 18 December 2022).

Eurostat. (2022(b). Extra-EU trade in agricultural goods. Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Extra-EU_trade_in_agricultural_goods. (accessed 21 January 2022).

Eurostat. (2022(c). Extra-EU trade of food, drinks and tobacco (SITC 0+1) by partner. Retrieved from: https://ec.europa.eu/eurostat/databrowser/view/ext_lt_mainagri/default/table?lang=en. (accessed 20 January 2022).

Eurostat. (n.d.). Glossary: Standard international trade classification (SITC). Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Standard_international_trade_classification_(SITC). (accessed 21 January 2022).

Fiankor, D. D. D., Haase, O. K., & Brümmer, B. (2021). The heterogeneous effects of standards on agricultural trade flows. Journal of Agricultural Economics, 72(1), 25-46.

FIPRA. (2022). 2022: Continued turbulence in EU-China relations. Retrieved from: https://fipra.com/update/2022-continued-turbulence-in-eu-china-relations/. (accessed 18 December 2022).

Frost, J. (n.d.). Interpreting Correlation Coefficients. Retrieved from: https://statisticsbyjim.com/basics/correlations/. (accessed 7 August 2022).

Galarnyk, M. (2018). Understanding Boxplots. [online] https://towardsdatascience.com/understanding-boxplots-5e2df7bcbd51. (accessed 7 August 2022).

Grethe, H. (2003). Effects of Including Agricultural Products in the Customs Union between Turkey and the EU. Retrieved from: https://www.jstor.org/stable/pdf/j.ctv9hj7sw.1.pdf. (accessed 16 December 2022).

Ho, K. L. P., Nguyen, C. N., Adhikari, R., Miles, M. P., & Bonney, L. (2018). Exploring market orientation, innovation, and financial performance in agricultural value chains in emerging economies. Journal of Innovation & Knowledge, 3(3), 154-163.

Ickowitz, A., Powell, B., Rowland, D., Jones, A., & Sunderland, T. (2019). Agricultural intensification, dietary diversity, and markets in the global food security narrative. Global Food Security, 20, 9-16.

IRC. (2022). Ukraine war: What are the impacts on the world today? Retrieved from: https://www.rescue.org/article/ukraine-war-what-are-impacts-world-today. (accessed 18 December 2022).

Islam, M. M. (2020). Agricultural credit and agricultural productivity in Bangladesh: an econometric approach. International Journal of Food and Agricultural Economics (IJFAEC), 8(1128-2020-1530).

Jablonski, B. B. R., Sullins, M., & Thilmany McFadden, D. (2019). Community-Supported Agriculture Marketing Performance: Results from Pilot Market Channel Assessments in Colorado. Sustainability, 11(10), 2950. MDPI AG. Retrieved from: http://dx.doi.org/10.3390/su11102950. (accessed 16 December 2022)

Ji, Q., Bouri, E., Roubaud, D., & Shahzad, S. J. H. (2018). Risk spillover between energy and agricultural commodity markets: A dependence-switching CoVaR-copula model. Energy Economics, 75, 14-27.

Kalaitzi, A.S. & Chamberlain, T. W. (2020). Exports and Economic Growth: Some Evidence from the GCC. Retrieved from: https://link.springer.com/article/10.1007/s11294-020-09786-0. (accessed 3 August 2022).

Khanna, N. & Solanki, P. (2014). Role of agriculture in the global economy. Retrieved from: https://www.walshmedicalmedia.com/proceedings/role-of-agriculture-in-the-global-economy-15024.html. (accessed 4 August 2022).

Komarek, A. M., De Pinto, A., & Smith, V. H. (2020). A review of types of risks in agriculture: What we know and what we need to know. Agricultural Systems, 178, 102738.

Lin, B. X., & Zhang, Y. Y. (2020). Impact of the COVID-19 pandemic on agricultural exports. Journal of Integrative Agriculture, 19(12), 2937-2945.

Luo, J., & Ji, Q. (2018). High-frequency volatility connectedness between the US crude oil market and China's agricultural commodity markets. Energy Economics, 76, 424-438.

Ma, F., Zhang, Y., Wahab, M. I. M., & Lai, X. (2019). The role of jumps in the agricultural futures market on forecasting stock market volatility: New evidence. Journal of forecasting, 38(5), 400-414.

Mahajan, K. & Tomar, S. (2021). COVID-19 and Supply Chain Disruption: Evidence from Food Markets in India. https://doi.org/10.1111/ajae.12158. Retrieved from:

https://onlinelibrary.wiley.com/doi/full/10.1111/ajae.12158. (accessed 16 December 2022).

Manogna, R. L., & Mishra, A. K. (2020). Price discovery and volatility spillover: an empirical evidence from spot and futures agricultural commodity markets in India. Journal of Agribusiness in Developing and Emerging Economies, 10(4), 447-473.

McKinsey & Company (2022). Building resilience in a time of economic and political turbulence. Retrieved from: https://www.mckinsey.com/featured-insights/themes/building-resilience-in-a-time-of-economic-and-political-turbulence. (accessed 18 December 2022).

Minakov, I. A., & Nikitin, A. V. (2019). Agricultural market development: trends and prospects. International journal of innovative technology and exploring engineering, 9(1), 3842-3847.

Mingzhe Pu, Yu Zhong, (2020). Rising concerns over agricultural production as COVID-19 spreads: Lessons from China, Global Food Security, Vol. 26: 100409. https://doi.org/10.1016/j.gfs.2020.100409. Retrieved from: https://www.sciencedirect.com/science/article/pii/S2211912420300638. (accessed 16 December 2022).

Narayan, S., & Saha, S. (2020). One step behind: the government of India and agricultural policy during the covid-19 lockdown. Review of Agrarian Studies, 10 : 2369-2020-1855.

National Geographic. (n.d.). The Development of Agriculture. Retrieved from: https://education.nationalgeographic.org/resource/development-agriculture. (accessed 4 August 2022).

Norwood, F. B., Lusk, J. L., Peel, D. S., & Riley, J. M. (2021). Agricultural marketing and price analysis. Waveland Press.

OEC. (n.d.(a). Cereals. Retrieved from: https://oec.world/en/profile/hs/cereals?yearSelector1=tradeYear1. (accessed 5 August 2022).

OEC. (n.d.(b). China. Retrieved from: https://oec.world/en/profile/country/chn. (accessed 3 August 2022).

OECD. (n.d.(a). Agricultural trade. Retrieved from: https://www.oecd.org/agriculture/topics/agricultural-trade/. (accessed 14 December 2022).

OECD. (n.d.(b). Monitoring the changing landscape of agricultural markets and trade. Retrieved from: https://www.oecd.org/agriculture/topics/agricultural-trade/. (accessed 23 January 2021).

Olomu, M. O., Ekperiware, M. C., & Akinlo, T. (2020). Agricultural sector value chain and government policy in Nigeria: issues, challenges and prospects. African Journal of Economic and Management Studies.

Ouyang, H., Wei, X., & Wu, Q. (2019). Agricultural commodity futures prices prediction via long- and short-term time series network. Journal of Applied Economics, 22(1), 468-483.

Pancenko, E. & Ivanova, T. (2018). Evaluation of the export potential of Latvia with EU countries categorized by groups of goods. Forum Scientiae Oeconomia, 6(4), 37–50. https://doi.org/10.23762/FSO_VOL6_NO4_3. Retrieved from: https://ojs.wsb.edu.pl/index.php/fso/article/view/62. (accessed 13 December 2022).

PennState. (2022). Spearman Correlation Coefficient. Retrieved from: https://online.stat.psu.edu/stat509/lesson/18/18.2. (accessed 4 August 2022).

Poppe, K. (2020). Covid-19 will Change the Agri-food System–but how?. EuroChoices, 19(3), 20-25.

Pronina, L. & Valero, J. (2022). EU Aims for Calm Amid Economic Turbulence. Retrieved from: https://www.bloomberg.com/news/newsletters/2022-06-17/eu-aims-for-calm-amid-economic-turbulence. (accessed 18 December 2022).

Qurban, M. (2022). Why is trade important and how does it work? Retrieved from: https://www.tradefinanceglobal.com/posts/why-is-trade-important-how-does-it-work/. (accessed 5 August 2022).

Rampa, F. (2012). Agriculture Development for Food Security. Retrieved from: https://ecdpm.org/great-insights/boosting-intra-african-trade/trade-agriculture-development-food-security-potential-regional-agricultural-trade/. (accessed 2 August 2022).

Reliefweb. (2022). The State of Agricultural Commodity Markets 2022 – The geography of food and agricultural trade: Policy approaches for sustainable development. Retrieved from: https://reliefweb.int/report/world/state-agricultural-commodity-markets-2022-geography-food-and-agricultural-trade-policy-approaches-sustainable-development. (accessed 14 December 2022).

Scandizzo, P. L., Hazell, P. B., & Anderson, J. (2019). Risky Agricultural Markets: Price Forecasting and the Need for Intervention Policies. CRC Press.

Sharma, R et al. (2020) Agriculture supply chain risks and COVID-19: mitigation strategies and implications for the practitioners, International Journal of Logistics Research and Applications, DOI: 10.1080/13675567.2020.1830049.

Social Science Statistics. (n.d.(a). Pearson Correlation Coefficient Calculator. Retrieved from: https://www.socscistatistics.com/tests/pearson/. (accessed 4 August 2022).

Social Science Statistics. (n.d.(b). Spearman's Rho Calculator. Retrieved from: https://www.socscistatistics.com/cite.aspx. (accessed 4 August 2022).

Springerlink. (n.d.). Spearman Rank Correlation Coefficient. Retrieved from: https://link.springer.com/referenceworkentry/10.1007/978-0-387-32833-1_379. (accessed 4 August 2022).

Srivastav, A. K. & Vaidya, D. (n.d.). Pearson Correlation Coefficient. Retrieved from: https://www.wallstreetmojo.com/pearson-correlation-coefficient/#h-pearson-correlation-coefficient-formula. (accessed 4 August 2022).

Statista. (2021(a). Leading export countries worldwide in 2020. Retrieved from: https://www.statista.com/statistics/264623/leading-export-countries-worldwide/. (accessed 5 February 2022).

Statista. (2021(b). The 20 countries with the highest trade surplus in 2020. Retrieved from: https://www.statista.com/statistics/256642/the-20-countries-with-the-highest-trade-surplus/. (accessed 5 February 2022).

Statistics Kingdom. (n.d.). Box Plot Maker. Retrieved from: https://www.statskingdom.com/boxplot-maker.html. (accessed 5 February 2022).

Sun, Q. et al. (2022). The Influence of Country Risks on the International Agricultural Trade Patterns Based on Network Analysis and Panel Data Method. Retrieved from: https://www.mdpi.com/2077-0472/12/3/361/htm. (accessed 5 August 2022).

Swinnen, J. (2018). The political economy of agricultural and food policies. In The Routledge Handbook of Agricultural Economics (pp. 381–398). Routledge.

Texas Gateway. (n.d.). Interpreting Scatterplots. Retrieved from: https://www.texasgateway.org/resource/interpreting-scatterplots. (accessed 3 August 2022).

The World Bank. (2018). Stronger Open Trade Policies Enable Economic Growth for All. Retrieved from: https://www.worldbank.org/en/results/2018/04/03/stronger-open-trade-policies-enables-economic-growth-for-all. (accessed 3 August 2022).

Tule, M. K., Salisu A. A. & Chiemeke, C. C. (2019). Can agricultural commodity prices predict Nigeria's inflation? Journal of Commodity Markets, Vol. 16 : 100087. https://doi.org/10.1016/j.jcomm.2019.02.002. Retrieved from: https://www.sciencedirect.com/science/article/pii/S2405851318301107. (accessed 16 December 2022).

USAID. (n.d.). Agricultural Markets and Trade. Retrieved from: https://2012-2017.usaid.gov/what-we-do/agriculture-and-food-security/expanding-and-enhancing-agricultural-markets-and-trade. (accessed 14 December 2022).

U.S. Department of State. (2020). 2020 Investment Climate Statements: Ukraine. Retrieved from: https://www.state.gov/reports/2020-investment-climate-statements/ukraine/. (accessed 20 January 2022).

Van der Laan, H. L., Dijkstra, T., & van Tilburg, A. (Eds.). (2018). Agricultural marketing in tropical Africa: Contributions of the Netherlands. Routledge.

Van der Ploeg, J. D. (2019). Labor, markets, and agricultural production. CRC Press.

Van Meijl, H., Havlik, P., Lotze-Campen, H., Stehfest, E., Witzke, P., Domínguez, I. P., … & van Zeist, W. J. (2018). Comparing impacts of climate change and mitigation on global agriculture by 2050. Environmental research letters, 13(6), 064021.)

Volontyr, L. & Zelinska, O. (2019). Econometric Modeling in Formation of Optimal Price for Implementation of Agricultural Products©. Economy. Finances. Management: topical issues of science and practice., Vol. 5 (45): 83–93. Retrieved from: http://efm.vsau.org/storage/articles/December2019/NOe2WT3K9GAlLP-470T4o.pdf. (accessed 16 December 2022).

Vroegindewey, R., & Hodbod, J. (2018). Resilience of agricultural value chains in developing country contexts: A framework and assessment approach. Sustainability, 10(4), 916.

Willer, H., Schaack, D., & Lernoud, J. (2019). Organic farming and market development in Europe and the European Union. In The World of Organic Agriculture. Statistics and Emerging Trends 2019 (pp. 217-254). Research Institute of Organic Agriculture FiBL and IFOAM-Organics International

Zabel, F., Delzeit, R., Schneider, J. et al. (2019) Global impacts of future cropland expansion and intensification on agricultural markets and biodiversity. Nat Commun 10, 2844. https://doi.org/10.1038/s41467-019-10775-z. (accessed 16 December 2022)

Zhang, R., Ma, W., & Liu, J. (2021). Impact of government subsidy on agricultural production and pollution: A game-theoretic approach. Journal of cleaner production, 285, 124806.

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