International Trade of Agricultural Products in Disruptive Times – The Correlation between Exports Subjects

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Keywords: International trade; Agricultural products; European Union; Ukraine; Canada; Correlation

Abstract: International trade helps reduce food insecurity by connecting the regions with limited agricultural potential and large populations to the regions with comparative advantages in agriculture. The international trade of agricultural products appeared to be vitally important in times of such challenges of nowadays as the COVID-19 pandemic, climate changes, turbulence on the political scene, etc., which the whole humanity has to face and overcome. The purpose of the article is to assess if the exports of the agricultural products from Ukraine to the EU and from Canada to the EU are correlated and, if they are, how strong the correlation is. The data under analysis are the export amount of goods from the Standard International Trade Classification (SITC) groups 0, which comprises food and live animals, and 1, which contains beverages and tobacco. The timeframe under analysis is 10 years – from 2011 to 2020 included. Such simple statistics of the data sets under analysis as mean, standard deviation, sum as well as minimum and maximum values were calculated and compared. The dynamics, yearly changes and general trend lines of the data sets under research were analysed and compared. The general trend lines of the data under analysis were built and the projections for the following two periods were made in the article using the appropriate functions, having chosen from the exponential, linear, logarithmic, polynomial and power ones, taking into consideration the values of $R^2$ coefficients. The analyses for the data normality distributions were conducted. The Pearson and Spearman correlation coefficients as well as their $p$-values of the data researched were calculated and analysed. The research itself as well as its results would be interesting and useful for the public administration officials, business people, decision-makers as well as beginners and experienced specialists in data analysis and statistics.

1. INTRODUCTION

People have traded since times immemorial, being more precise – for about five thousand years. Besides goods exchange, trade was also a boon for human interaction, bringing cross-cultural contact to a whole new level (Whipps, 2008). That is the development of trade was an absolute necessity for the further development of human civilization. The need for trading exists due to the variations in availability of resources and comparative advantages (Prachi Juneja, n.d.), as well as in the possibility to decrease the said variations with its help.

But, before proceeding with the peculiarities, advantages, etc., of trade, let’s remember what the notion of “trade” means. So, trade is a basic economic concept involving the buying and selling of goods and services, with compensation paid by a buyer to a seller, or the exchange of goods or services between parties (Heyes, 2021). It’s a matter of common knowledge that trade is very important all in all, but the challenges to meet growing global food demand include population and income growth and supply uncertainties complicated by a changing climate, environmental pressures and water scarcity point to the increasing importance of trade (Glauber, 2020).

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The importance of the local trade, that is the trade between the subjects within the defined territory/borders, shouldn’t be underestimated, but the vital significance of the international trade should be paid special attention to as the international trade allows individuals and businesses to take advantage of lower prices and increased choice of goods and services (The Heritage Foundation, n.d.). Besides all the advantages of international trade, it also helps create new jobs in the trading partner countries, helping decrease the unemployment rate and increasing the living standards. Though many researchers and practitioners write about the extreme importance of exports, because of their ability to “earn” foreign currency, increase the budgets inflow, etc., it should be stated, that imports are not less important at all, as they give people access to a wider assortment of goods and services at lower prices. One of the most important features of international trade is that it helps reduce food insecurity by connecting the regions with limited agricultural potential and large populations to the regions with comparative advantages in agriculture (Bouët & Laborde, 2017).

Agriculture remains one of the strategically important sectors of the world economy as it provides food security and many raw materials for the other related industries (Khitakhunov, n.d.). Traditionally, societies and their governments have pursued agricultural development to ensure adequate food is available and affordable (Anderson & Martin, n.d.). For countries that have a competitive agricultural sector, the expansion of international trade in agricultural commodities can have a growth-enhancing effect and improve their trade balance (De Schutter, 2009). Agricultural product trade helps to answer possible food production shortages due to climatic or other reasons (European Commission, n.d.). Long-distance trade has contributed to agricultural development and global economic growth for millennia (Anderson & Martin, n.d.).

The international trade of agricultural products appeared to be vitally important in times of such challenges of nowadays as the COVID-19 pandemic, climate changes, turbulences on the political scene, etc., which the whole humanity has to face and overcome.

Taking into account everything stated above, the article aims to answer the scientific question of whether the exports of the agricultural products from Ukraine to the EU and from Canada to the EU are correlated and, if they are, how strong the correlation is.

2. MATERIALS AND METHODS

The dynamic development of the agricultural markets requires them to be permanently monitored and prospectively analysed (European Commission, n.d.) as a deep and precise analysis both gives us the overview of the present state of matters in the definite sphere and allows us make the most accurate projections to be ready for the eventual future options and react on them at the quickest and best way possible.

The data analysed are the agricultural products exports of Ukraine and Canada to the EU. The EU means EU27, that is the European Union comprising 27 member states. The data under analysis are the export amount of goods from the Standard International Trade Classification (SITC) groups 0, which comprises food and live animals, and 1, which contains beverages and tobacco. The timeframe under analysis is 10 years – from 2011 to 2020 included. Such simple statistics of the data sets under analysis as mean, standard deviation, and sum as well as minimum and maximum values were calculated and compared to get more in-depth knowledge about the subjects under analysis. The dynamics and general trend lines of the data sets under
research were analysed and compared. The general trend lines of the data under analysis were built and the projections for the following two periods were made in the article using the appropriate functions, having chosen from the exponential, linear, logarithmic, polynomial and power ones, taking into consideration the values of R² coefficients. The analyses for the data normality distributions were conducted to be used in further research. The Pearson and Spearman correlation coefficients as well as their corresponding p-values of the data researched were calculated and analysed to make the conclusions about the presence/absence of the correlation between the researched data, the strength of the correlation in case of its presence and the statistical significance of the obtained results.

The research itself as well as its results would be interesting and useful for the public administration officials, business people, decision-makers as well as beginners and experienced specialists in data analysis and statistics.

3. RESULTS

Ukraine, located in Eastern Europe, is the second-largest country on the said continent. It is situated at the crossroads of Europe and Asia. The geographical location, weather conditions, fertile lands and availability of a skilled and affordable workforce make Ukraine a prominent agricultural producer and exporter. Of Ukraine’s total land area of 60 million hectares, roughly 42 million is classified as agricultural land, which includes cultivated land (grains, technical crops, forages, potatoes and vegetables, and fallow), gardens, orchards, vineyards, and permanent meadows and pastures (World Data Center, n.d.). Ukraine is among the leading producers and exporters of such agricultural crops as sunflower seeds and oil, wheat, barley, soybeans, and corn. Due to the horrible events taking place in Ukraine, the country is much spoken about nowadays. The changes in the geopolitical situation of the country are very important, especially for the European neighbours having common borders with Ukraine. But, what is vitally important not only for Europe but for the whole world as well, is the role of the big agricultural producer and exporter Ukraine plays nowadays and the impact of the changes in the geopolitical state of the country on the global food security situation. The trade relations of Ukraine with the European Union (the EU) are regulated by the Association Agreement, including a Deep and Comprehensive Free Trade Area (DCFTA), which was negotiated between 2007 and 2011 and signed on 21 March and 27 June 2014 (European Commission, 2021(b). The EU is Ukraine’s largest trading partner, accounting for more than 40% of its trade in 2019. Ukraine is the 18th trading partner of the EU accounting for around 1.1% of the EU’s total trade (European Commission, 2021(b).

Canada, situated in North America, extends from the Atlantic to the Pacific Ocean and is the world’s second-largest country in terms of total territory. Though only about 7 per cent of Canada’s land can be farmed, agriculture is an important industry in Canada (Hein, 2021).

Among Canada’s top agricultural products are canola, cattle and calves, beef and veal, vegetables and poultry (Hein, 2021). The trade relations of Canada with the EU are regulated by the EU-Canada Comprehensive Economic and Trade Agreement (CETA), which provisionally entered into force on the 21st of September 2017 (European Commission, 2021(a). In 2020, Canada was the tenth largest partner for EU goods exports and the 16th largest partner for EU goods imports (European Commission, 2021(a). To have the fullest possible picture of the data under research, let’s compare the agricultural products exports of Ukraine and Canada to the EU dynamics (Figure 1).
Taking into account everything mentioned above concerning the geo-economic characteristics of the countries under research, the agricultural products exports dynamics depicted in Figure 1 seem to be even more interesting to be analysed. On the one hand, the countries under research are difficult to be compared in terms of their territories (Canada is approximately 16.5 times bigger than Ukraine), but, at the same time, the agricultural products exports amount of each of the countries were very much alike in 2011, that is at the beginning of the timeframe under analysis. In 2012 the difference between the said amounts doubled but not according to the territories difference, just on the contrary, that is the agricultural products exports of Ukraine were two times bigger than those of Canada. In general, the agro – exports dynamics of Ukraine to the EU are more changeable with sharp positive peaks in 2012 and 2019 and a negative change – in 2020. By the way, the changes in the exports of the agricultural products in 2020 are an interesting thing to be paid special attention to, that is they are completely different either according to the direction or the difference. That means, the agro – exports of Ukraine to the EU decreased by 1049.5 mln EUR (being the biggest decrease of the said exports during the timeframe under analysis) while the said exports of Canada to the EU increased by 221.5 mln EUR. Such a negative change of the agro – exports amount of Ukraine can be explained by the negative impact the COVID-19 made on all the activity spheres, but the increase of the agro – exports amount of Canada, that occurred in the same year, is hard to be explained. To further deepen the analysis, let’s compare the simple statistics of the agricultural products exports of Ukraine and Canada to the EU (Table 1).

### Table 1. Simple Statistics of the Agricultural Products Exports of Ukraine and Canada to the EU

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Sum</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Products Exports of Ukraine to the EU, mln EUR</td>
<td>10</td>
<td>2639</td>
<td>791.96216</td>
<td>26391</td>
<td>1285</td>
<td>4123</td>
</tr>
<tr>
<td>Agricultural Products Exports of Canada to the EU, mln EUR</td>
<td>10</td>
<td>1383</td>
<td>217.67292</td>
<td>13833</td>
<td>1077</td>
<td>1686</td>
</tr>
</tbody>
</table>

Source: author’s own elaboration on the basis of the data from (Eurostat, 2022).
analysis, it should be stated, that the mean for the agricultural products exports of Ukraine to the EU is almost two times bigger than that of Canada. The same result we have having compared the sum of the variables from the data sets under research. The difference is absolutely smaller when we compare the minimum values of the analysed data sets, that is the minimum value of the Ukrainian agro–exports to the EU is only 1.2 times bigger than that of the Canadian one. While the maximum value of the agro – exports from Ukraine to the EU is almost 2.5 times bigger than that of Canada. The difference between the simple statistics items becomes much bigger, when we compare the standard deviations of the data in the analysed data sets – the standard deviation of the agro – exports of Ukraine to the EU is approximately 3.4 times bigger than that of the Canadian agro–exports, meaning – the data in the agro – exports of Ukraine to the EU data set are 3.6 times more dispersed than those of the said Canadian exports. The next step of the research will be the building of the general trend line for the agricultural products exports of Ukraine to the EU with the attempt to make a projection of the said exports amount for the following two periods, that is for two years (Figure 2).

Figure 2. Agricultural Products Exports of Ukraine to the EU, mln EUR
Source: author’s own elaboration on the basis of the data from (Eurostat, 2022).

Though the data depicted in Figure 2 are rather changeable, the general trend line is upward through the whole timeframe under analysis as well as through the following two periods taken for the projection making. The trend line was built using the power function, having chosen from the exponential, linear, logarithmic, polynomial and power ones. The criterion for the choice of the appropriate function was the values of the R² coefficients. Let’s have a more precise look at two years taken for the projection making – though, as it has been previously mentioned, the general trend line is upward and the projections for the following two years is the agro – exports increase, the agro – exports amount will not “approach” the level of the year 2019, under the circumstances unchanged. To compare the agricultural product exports of Canada to the EU with those of Ukraine, analysed earlier, let’s visualise the said Canadian exports in Figure 3.

Despite the fact, that the agricultural products exports of Canada to the EU are not as changeable as those of Ukraine, the trend line for both export dynamics was built using the same function type, that is the power one. The list of the functions, as well as the criterion for the right choice, is the same as in the case with the Ukrainian agro – exports. Though the general trend line is also upward through the whole timeframe under research, the upward slope is not so steep as in the case with the Ukrainian agro – exports. Another interesting matter to pay one’s attention to – despite the upward trend line of the agro – exports of Canada to the EU, the projection for the following two years are supposed to be lower than the value of the year 2020,
under the circumstances unchanged. Having conducted the multi-level comparative analysis, the main purpose of the article is to be fulfilled, that is – it’s time to assess whether the agricultural products exports of Ukraine to the EU are correlated with the said exports of Canada to the EU, and if they are, how strong the correlation is. The first step in the assessment mentioned above is the calculation of the Pearson correlation coefficients and their corresponding \( p \)-values. The results of the mentioned calculations are presented in Table 2.

Let’s, first of all, analyse the very values of the Pearson correlation coefficients of the agricultural products exports of Ukraine and Canada to the EU. The value of the Pearson correlation coefficient of the agricultural products exports of Ukraine to the EU and Canada to the EU points to a positive moderate correlation between the analysed subjects. With the 95% of confidence intervals, that is with \( \alpha=0.05 \), the corresponding \( p \)-values indicate the obtained results not to be statistically significant and don’t allow us to reject the \( H_0 \). As the Pearson correlation test needs the data analysed to be normally distributed, the tests for normality were conducted with the data under research. To cut the long story short, the agro – exports of Ukraine to the EU data appeared to be a little bit rightly skewed and leptokurtic, while the said exports of Canada to the EU data – were a little bit negatively skewed and platykurtic. Though the deviations from normality are rather small, they still exist and should not be allowed to influence the conducted research about the presence/absence of the correlation between the analysed subjects. That’s why the Spearman correlation coefficients and their corresponding \( p \)-values were calculated and presented in Table 3.

![Figure 3. Agricultural Products Exports of Canada to the EU, mln EUR](image)

**Source:** author’s own elaboration on the basis of the data from (Eurostat, 2022).

<table>
<thead>
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<th>Table 2. Pearson Correlation Coefficients of the Agricultural Products Exports of Ukraine and Canada to the EU</th>
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<td>Agricultural Products Exports of Ukraine to the EU, mln EUR</td>
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</table>

Pearson Correlation Coefficients, \( N = 10 \) \( \text{Prob} > |r| \) under \( H_0: \text{Rho}=0 \)

**Source:** author’s own elaboration on the basis of the data from (Eurostat, 2022).

As Spearman correlation is a non-parametric test, having no dependence on whether the data are normally distributed, the Spearman correlation coefficients are considered to be more robust for the data with deviations from normality. First of all, let’s take a look at the value of the
Spearman correlation coefficient between the agricultural products exports of Ukraine to the EU and Canada to the EU. Its value points to the presence of a positive moderate correlation between the subjects under analysis. But, when we cast a look at its corresponding p-value, we see, that its value points to the fact, that the said coefficient result can’t be considered statistically significant, not allowing us to reject the H0 hypothesis.

**Table 3. Spearman Correlation Coefficients of the Agricultural Products Exports of Ukraine and Canada to the EU**

<table>
<thead>
<tr>
<th>Agricultural Products Exports of Canada to the EU, mln EUR</th>
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</thead>
<tbody>
<tr>
<td>1.00000</td>
<td>0.53939 0.1076</td>
</tr>
<tr>
<td>0.53939 0.1076</td>
<td>1.00000</td>
</tr>
</tbody>
</table>

Spearman Correlation Coefficients, N = 10 Prob > |r| under H0: Rho=0

**Source:** author’s own elaboration on the basis of the data from (Eurostat, 2022).

4. CONCLUSION

Humanity is facing many challenges nowadays. They seem to be more or less seriously dependent on their nature, causes and consequences. But all of them have a common thing – they all threaten food security directly or indirectly. But, when the impact of such challenges as climate changes seem to be obvious because of their direct influence on the food security through their impact on the agricultural production, many don’t consider the turbulences on the political scenes, especially those in the small countries, to seriously impact the global food security directly. The horrible events happening in Ukraine showed everybody, that, even if a country is relatively small, it can still be an important player on the global agricultural market and any political turbulences on its scene can impact its agricultural production and, therefore, its agricultural exports, impacting then directly the food security either of its trading partners or the whole world as well.

To make conclusions from the conducted research, it should be reminded, that the EU is the first trader in agricultural products of the world, both in terms of exports and imports (European Commission, n.d.). So, the trade relations with such a powerful player in the global market are interesting and useful to be researched. Though Canada is approximately 16.5 times bigger than Ukraine, the agricultural products export amount of each of the countries was very much alike in 2011, with the difference between the said amounts having been doubled in 2012 in favour of Ukraine. In general, the agro – exports dynamics of Ukraine to the EU are more changeable than that of Canada. What is worth paying special attention to, is the change in the agricultural products exports of Ukraine and Canada to the EU in 2020 – in the case of Ukraine the said exports decreased by 1049.5 mln EUR, while the analysed exports of Canada to the EU increased by 221.5 mln EUR.

The simple statistics of the Ukrainian agro–exports to the EU for the timeframe under analysis, except for standard deviation, are approximately two times bigger than those of Canada.

The difference between the standard deviations of the analysed data sets is 3.4 times in favour of the Ukrainian exports, proving once more the higher dispersion of the Ukrainian agro – exports data values if compared to those of Canada. Though, the general dynamics of the agricultural
products exports of Ukraine and Canada to the EU differ, the trend lines for both agro - exports data under research were built using the same function type, that is the power one. In both cases, the power functions for the building of the trend lines and projection making were chosen from the exponential, linear, logarithmic, polynomial and power functions. The criterion for the appropriate function choice was the values of the R² coefficients. The trend lines are upward in both cases, though the one of the Ukrainian exports is steeper than that of the Canadian one. According to the projections, the agricultural products exports amount of Ukraine to the EU is to be higher, than that of 2020, though lower, than that of 2019, under the circumstances unchanged. The projected agricultural product exports of Canada to the EU are to be lower than that of 2020, under the circumstances unchanged. The value of the Pearson correlation coefficient of the agricultural products exports of Ukraine to the EU and Canada to the EU points to the positive moderate correlation between the analysed subjects. With the 95% of confidence intervals, that is with α=0.05, the corresponding p-values indicate the obtained results not to be statistically significant and don’t allow us to reject the H₀. Similar results were obtained after the Spearman correlation coefficients and their corresponding p-values were calculated.

So, in order to keep pace with demographics and the growing demand for affordable, safe and nutritious food, policymakers will need to develop strategies that promote economically, socially and environmentally sustainable agriculture and agri-food systems (WTO, 2019). Talking about strategies, not only economical ones should be developed and implemented, but the ones promoting stabilization of the overall political situation in the world as well as in single countries are to be paid the special attention to as the slightest turbulences even in the smallest country can appear to threaten the food security of either its trading partners or the whole world.

REFERENCES


