Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 22, Issue 3, 2022
PRINT ISSN 2284-7995, E-ISSN 2285-3952

FORECAST MODELING OF FOREIGN TRADE IN AGRICULTURAL COMPLEX PRODUCTS BETWEEN UKRAINE AND ROMANIA

Olesia TOTSKA

Lesya Ukrainka Volyn National University, Department of Finance, 28 Vynnychenko Street, Lutsk, 43021, Ukraine, E-mail: Totska.Olesia@vnu.edu.ua

Corresponding author: Totska.Olesia@vnu.edu.ua

Abstract

The article presents forecast modeling of foreign trade between Ukraine and Romania by separate groups of agro-industrial goods. Indicators were forecast for three years (2022-2024) based on actual data for eleven years (2011-2021). Five trend models (exponential, linear, logarithmic, polynomial, and power) were constructed for each indicator and only one with the highest value of the reliability of the approximation R^2 was selected. The constructed trend models indicate a positive trend in 2022-2024 for preparations of grains, cocoa and cocoa preparations, sugar and sugar confectionery, animal or plant fats and oils; in 2023-2024 – for meat and meat preparations, alcoholic and non-alcoholic beverages, vinegar. At the same time, the forecast models indicate an increase in imports of tobacco and its industrial substitutes in 2023-2024, a decrease in imports of cereals over the same period, an increase in imports of other mixed foodstuffs in 2022-2024. Of the nine selected models, six are polynomial, one is power, one is logarithmic, and one is exponential. Two of them have a very high degree of reliability of the approximation R^2 (>0.9) and, accordingly, a high probability of forecast prediction.

Key words: *forecast modeling, foreign trade, products of the agro-industrial complex, Ukraine, Romania*

INTRODUCTION

Ukraine conducts foreign trade in goods and services with many countries around the world. One of Ukraine's trading partners is neighboring Romania. In 2021, Ukraine exported to Romania the products of the agro-industrial complex in the amount of 147,705.5 thn USD. The largest shares in its structure were occupied by groups of goods according to the following codes by Ukrainian Classification of Commodities in Foreign Trade: 19 Preparations of grains (38,145.7 thn USD; 25.8 %); 18 Cocoa and cocoa preparations (18,731.6 thn USD; 12.7 %); 17 Sugar and sugar confectionery (17,117.8 thn USD; 11.6 %); 15 Animal or plant fats and oils (14,562.6 thn USD; 9.9 %); 02 Meat and meat preparations (10,962.0 thn USD; 7.4 %); 22 Alcoholic and non-alcoholic beverages, vinegar (9,594.8 thn USD; 6.5 %) [9].

The amount of exports of these six groups of goods amounted to 109,114.5 thn USD or 73.9 % of the total exports of agricultural products of Ukraine to Romania.

At the same time, in 2021 Ukraine imported from Romania products of the agro-industrial complex in the amount of 61,746.6 thn USD. Thus, the balance of Ukraine's foreign trade with Romania in 2021 according to these indicators amounted to 85,958.9 thn USD. The largest shares in the structure of imports of agro-industrial products were occupied by the following groups of goods: 24 Tobacco and industrial substitutes of tobacco (29,378.2 thn USD; 47.6 %); 10 Cereals (11,168.4 thn USD; 18.1 %); 21 Other mixed foodstuffs (5,438.5 thn USD; 8.8 %) [9].

The amount of imports of these three groups of goods amounted to 45,985.1 thn USD or 74.5 % of the total imports of products of the Romanian agro-industrial complex to Ukraine.

Among the scientific works that analyzed the trade between Ukraine and Romania are: Cassidy K. L. (2013) – cross-border small trading in the Ukrainian-Romanian borderlands [1]; Chiappini R. (2011) – the dynamics of trade specialization and exportations in central and eastern European countries, including Ukraine and Romania [2]; Ignjatijević S. et al. (2013) – comparative

advantages and level of specialization in international trade in primary and industrial products of the Danube region [3]; Ignjatijević S. et al. (2015) – the level of competitiveness of the processed food sector in the countries of the Danube region [4]; Pidhirna V. N. (2011) – levels of openness of the economies of Ukraine and Romania for foreign trade and investment [7]; Stamule T. (2017) – Moldova's total exports and imports to the EU and the CIS, including Ukraine and Romania [8]; Wust A. and Zichner H. (2010) – small trade activities of small traders and entrepreneurs on the Romanian-Ukrainian border [12]. At the same time, there are scientific studies of exports of agro-industrial products of Ukraine: Koliadenko S. et al. (2020) – analysis and forecasting of Ukrainian agrarian exports to the EU countries [5]; Parkhomenko N. et al. (2022) – assessment of export opportunities and export potential of the agricultural sector of Ukraine [6]; Tkalenko S. et al. (2021) – empirical analysis of exports of organic agricultural food products of Ukraine [10]; Vasylieva N. (2020) – production and export components of Ukrainian cereals in global food security [11].
The purpose of this study is forecast modeling of trade between Ukraine and Romania by certain groups of goods, which had the largest shares in the structure of exports and imports of agro-industrial products in 2021.

MATERIALS AND METHODS

For the forecast modeling of indicators of export and import of goods of agro-industrial complex the method of extrapolation of trends which allows to extend past and present patterns for the future is used.
Forecasting of foreign trade indicators of Ukraine and Romania was carried out for three years (2022-2024) on the basis of actual data for eleven years (2011-2021). Five trend models were built for each indicator: exponential ($y = a_1 e^{a_0 x}$), linear ($y = a_1 x + a_0$), logarithmic ($y = a_1 \ln(x) + a_0$), polynomial ($y = a_2 x^2 + a_1 x + a_0$), degree ($y = a_1 x^{a_0}$), where a_0, a_1, a_2 – constants, x – time.
However, for each group of goods selected only one with the highest value of the reliability of the approximation R^2.

RESULTS AND DISCUSSIONS

Forecast models of agro-industrial products exports from Ukraine to Romania

The analysis of Ukraine's export trade operations with Romania will be conducted on the basis of Table 1. It will provide actual and forecast data for the three groups of agro-industrial products that had the largest exports in 2021.

Table 1. Exports of agro-industrial complex products from Ukraine to Romania 1 (thn USD)

Year	19 Preparations of grains	18 Cocoa and cocoa preparations	17 Sugar and sugar confectionery
2011	1,015.0	75.3	120.1
2012	2,422.0	260.6	251.8
2013	2,983.5	552.0	404.6
2014	3,225.2	1,328.4	806.8
2015	7,850.7	2,944.7	9,639.0
2016	9,685.0	3,991.0	19,362.1
2017	12,281.6	6,029.1	7,841.4
2018	13,231.0	10,560.3	12,102.4
2019	21,793.6	12,074.7	13,995.6
2020	30,866.6	14,501.5	15,978.0
2021	38,145.7	18,731.6	17,117.8
Forecast data			
2022	45,473.6	22,746.2	29,974.6
2023	54,773.1	27,137.9	36,439.5
2024	64,971.4	31,916.7	43,661.9

Source: Author's calculation based on data from the State Statistics Service of Ukraine [9].

As you can see, exports of preparations of grains ranged from 1,015.0 thn USD in 2011 to 38,145.7 thn USD in 2021. The dynamics of the indicators was positive annually. The average value of exports of preparations of grains for the analyzed period amounted to 13,045.4 thn USD.
In Fig. 1 for the indicators of exports of preparations of grains from Ukraine to Romania, a trend line is constructed, as well as its equation and the value of the reliability of the approximation R^2.
As can be seen from Fig. 1 and the forecast data in Table 1, the polynomial trend model assumes an increase in exports over the next three years. The value of R^2 is very high (>0.9), which indicates a high probability of prediction.

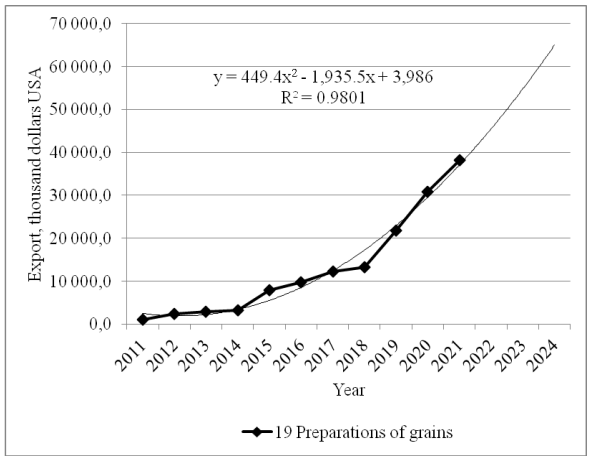

Fig. 1. Forecast model of exports of preparations of grains (thn USD)
Source: Author's calculation based on data from Table 1.

The third column of Table 1 shows that in the analyzed period, exports of cocoa and cocoa preparations ranged from 75.3 thn USD in 2011 to 18,731.6 thn USD in 2021. The dynamics of the indicators was also positive annually. The average value of exports of cocoa and cocoa preparations was 6,459.0 thn USD.
Figure 2 shows the forecast model of exports of cocoa and cocoa preparations from Ukraine to Romania.

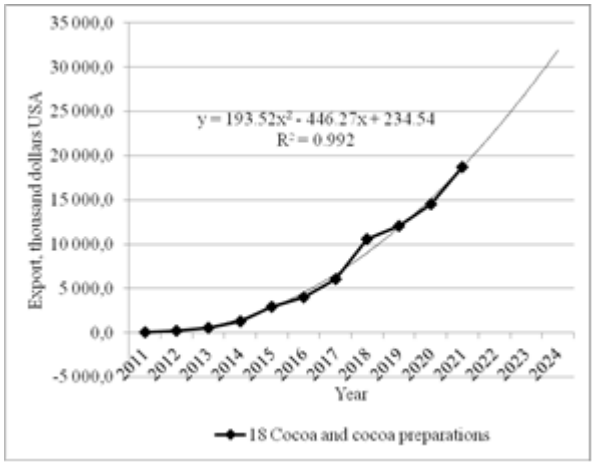

Fig. 2. Forecast model of exports of cocoa and cocoa preparations (thn USD)
Source: Author's calculation based on data from Table 1.

As can be seen from Fig. 2 and the forecast data in Table 1, the polynomial trend model assumes an increase in exports over the next three years. The value of R^2 is also very high (>0.9), which indicates a high probability of prediction.

The fourth column of Table 1 shows that in 2011-2021 exports of sugar and sugar confectionery ranged from 120.1 thn USD in 2011 to 19,362.1 thn USD in 2016.
The dynamics of the indicators was positive annually, except in 2017, when there was a decline in exports to 7,841.4 thn USD.
The average value of exports of sugar and sugar confectionery for the analyzed period amounted to 8,874.5 thn USD.
Figure 3 shows the forecast model of sugar and sugar confectionery exports from Ukraine to Romania.

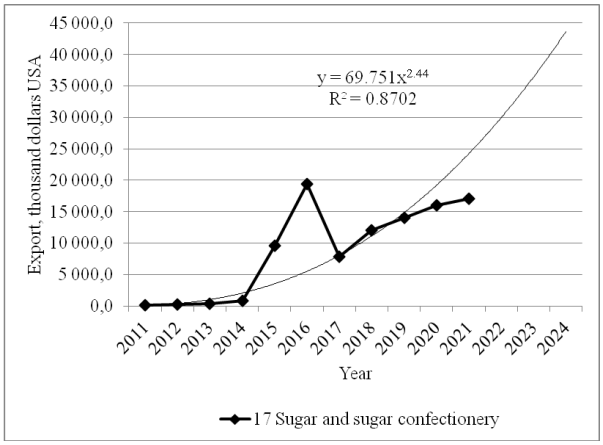

Fig. 3. Forecast model of exports of sugar and sugar confectionery (thn USD)
Source: Author's calculation based on data from Table 1.

As can be seen from Fig. 3 and the forecast data in Table 1, the power trend model assumes an increase in exports over the next three years.

Table 2 .Exports of agro-industrial complex products from Ukraine to Romania 2 (thn USD)

Year	15 Animal or plant fats and oils	02 Meat and meat preparations	22 Alcoholic and non-alcoholic beverages, vinegar
2011	1,146.7	-	234.8
2012	4,766.1	-	28.9
2013	1,418.4	-	80.7
2014	1,861.7	3,354.0	22.4
2015	7,311.5	2,088.1	39.7
2016	5,263.2	6,243.6	120.1
2017	7,167.0	8,998.2	575.3
2018	5,228.4	10,817.7	1,624.8
2019	2,236.1	1,964.3	401.4
2020	14,904.9	4,711.4	3,031.3
2021	14,562.6	10,962.0	9,594.8
Forecast data			
2022	16,125.4	8,290.7	9,401.9
2023	19,072.9	8,550.4	12,232.3
2024	22,310.7	8,785.3	15,409.3

Source: Author's calculation based on data from the State Statistics Service of Ukraine [9].

The value of R^2 is quite high (>0.8), which indicates a high probability of prediction.

We will continue the analysis and forecasting of Ukraine's export trade operations with Romania on the basis of Table 2.

In it we will present actual and forecast data for the other three groups of agro-industrial products, which had the largest exports in 2021.

As you can see, exports of animal or plant fats and oils ranged from 1,146.7 thn USD in 2011 to 14,904.9 thn USD in 2020. The dynamics of the indicators did not have a clear trend: growth has repeatedly alternated with declines. The average value of exports of animal or plant fats and oils for the analyzed period amounted to 5,987.9 thn USD.

In Fig. 4 shows the forecast model of exports from Ukraine to Romania of animal or plant fats and oils.

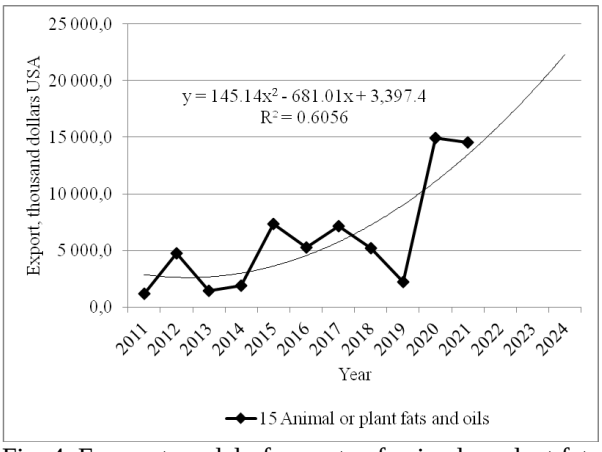

Fig. 4. Forecast model of exports of animal or plant fats and oils (thn USD)

Source: Author's calculation based on data from Table 2.

As can be seen from Fig. 4 and the forecast data in Table 2, the polynomial trend model assumes an increase in exports over the next three years. The value of R^2 is not high enough (>0.6), which indicates a low probability of forecast prediction.

The third column of Table 2 shows that in the analyzed period, exports of meat and meat preparations ranged from 1,964.3 thn USD in 2019 to 10,962 thn USD in 2021. The dynamics of indicators was positive in all years except 2015 and 2019. The average value of exports of meat and meat preparations for the analyzed period was 6,142.4 thn USD.

In Fig. 5 shows the forecast model of exports from Ukraine to Romania of meat and meat preparations.

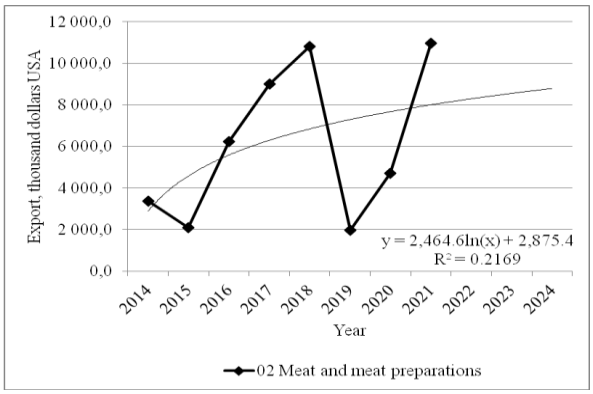

Fig. 5. Forecast model of exports of meat and meat preparations (thn USD)

Source: Author's calculation based on data from Table 2.

As can be seen from Fig. 5 and forecast data in Table 2, the logarithmic trend model assumes an increase in exports, but from a level below 2021. The value of R^2 is very low (>0.2), indicating a low probability of forecast fulfillment. The fourth column of Table 2 shows that in 2011-2021 exports of alcoholic and non-alcoholic beverages and vinegar ranged from 22.4 thn USD in 2014 to 9,594.8 thn USD in 2021. The dynamics of indicators was not clear, although the last two years have seen rapid growth. The average value of exports of alcoholic and non-alcoholic beverages and vinegar for the analyzed period amounted to 1,432.2 thn USD.

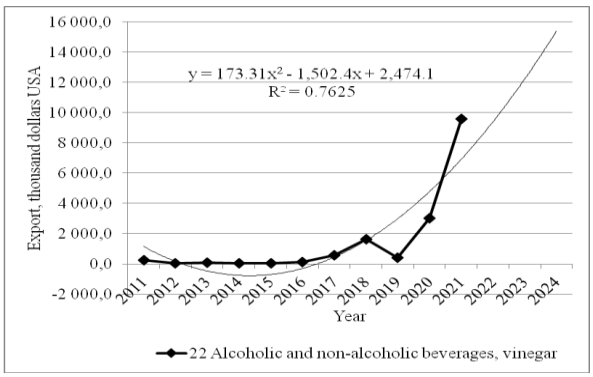

Fig. 6. Forecast model of exports of alcoholic and non-alcoholic beverages and vinegar (thn USD)

Source: Author's calculation based on data from Table 2.

In Fig. 6 shows the forecast model of exports from Ukraine to Romania of alcoholic and non-alcoholic beverages and vinegar.

As can be seen from Fig. 6 and forecast data in Table 2, the polynomial trend model assumes an increase in exports, but from a level below 2021. The value of R^2 is not high enough (>0.7), which indicates a low probability of forecast fulfillment.

Forecast models of import of agro-industrial complex products from Romania to Ukraine

The analysis of Ukraine's import trade operations with Romania will be conducted on the basis of Table 3. It will present actual and forecast data for the three groups of agro-industrial products that had the largest imports in 2021.

Table 3. Imports of agro-industrial complex products from Romania to Ukraine (thn USD)

Year	24 Tobacco and industrial substitutes of tobacco	10 Cereals	21 Other mixed foodstuffs
2011	551.6	52,843.3	3,019.4
2012	707.2	63,234.9	3,163.7
2013	977.3	63,148.9	4,740.6
2014	394.8	110,805.8	3,616.0
2015	200.7	38,858.8	2,132.0
2016	351.5	37,788.8	2,308.1
2017	1,148.5	42,456.0	1,845.7
2018	194.2	44,470.7	2,004.8
2019	421.8	41,366.3	3,997.7
2020	8,637.5	13,846.6	4,518.9
2021	29,378.2	11,168.4	5,438.5
Forecast data			
2022	28,116.3	15,976.2	6,156.9
2023	37,044.6	13,709.6	7,349.2
2024	47,102.1	11,764.6	8,708.4

Source: Author's calculation based on data from the State Statistics Service of Ukraine [9].

As you can see, imports of tobacco and industrial substitutes of tobacco ranged from 194.2 thn USD in 2018 to 29,378.2 thn USD in 2021. The dynamics of indicators was not clear, although in the last two years there has been rapid growth.

The average value of imports of tobacco and industrial substitutes of tobacco for the analyzed period amounted to 3,905.7 thn USD.

Figure 7 shows the forecast model of imports of tobacco and industrial substitutes of tobacco from Romania to Ukraine.

As can be seen from Fig. 7 and forecast data in Table 3, the polynomial trend model assumes an increase in imports, but from a level below 2021.

The value of R^2 is not high enough (>0.7), which indicates a low probability of forecast.

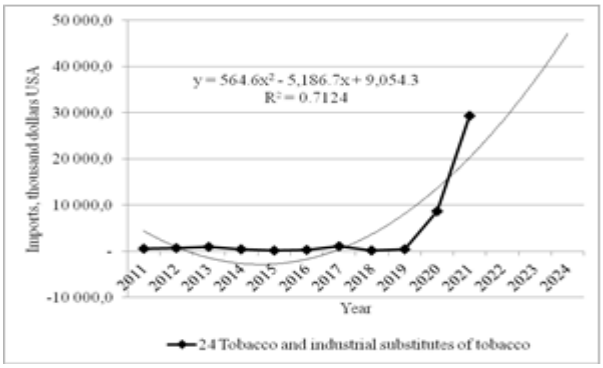

Fig.7. Forecast model of imports of tobacco and industrial substitutes of tobacco (thn USD)
Source: Author's calculation based on data from Table 3.

The third column of Table 3 shows that in the analyzed period, imports of cereals ranged from 11,168.4 thn USD in 2021 to 110,805.8 thn USD in 2014.

The dynamics of indicators was unstable, in the last three years there has been a trend to recession. The average value of imports of cereals for the analyzed period amounted to 47,271.7 thn USD.

In Fig. 8 shows the forecast model of imports of cereals from Romania to Ukraine.

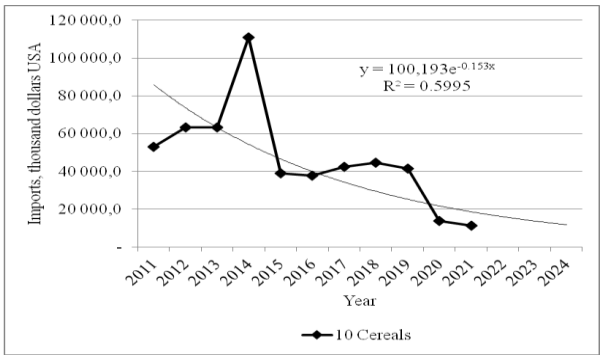

Fig. 8. Forecast model of imports of cereals (thn USD)
Source: Author's calculation based on data from Table 3.

As can be seen from Fig. 8 and forecast data in Table 3, the exponential trend model assumes a decrease in imports, but from a level higher than 2021. The value of R^2 is not high enough (>0.5), which indicates a low probability of forecast fulfillment.

The fourth column of Table 3 shows that in 2011-2021 imports of other mixed foodstuffs

ranged from 1,845.7 thn USD in 2017 to 5,438.5 thn USD in 2021. The dynamics of indicators was unstable, but in recent years the growth trend has been observed for four years. The average value of imports of other mixed foodstuffs for the analyzed period amounted to 3,344.1 thn USD.

In Fig. 9 shows the forecast model of imports of other mixed foodstuffs from Romania to Ukraine.

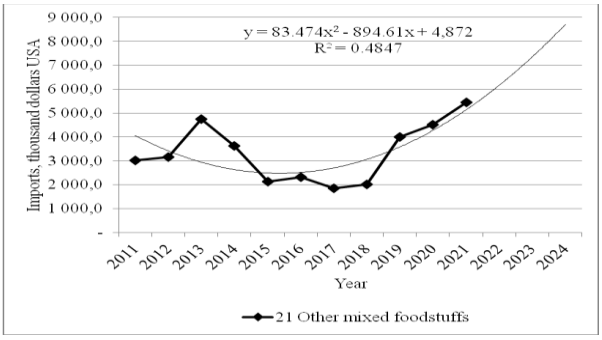

Fig. 9. Forecast model of imports of other mixed foodstuffs (thn USD)

Source: Author's calculation based on data from Table 3.

As can be seen from Fig. 9 and the forecast data in Table 3, the polynomial trend model predicts an increase in imports over the next three years. However, the value of R^2 is low (>0.4), which indicates a low probability of prediction.

CONCLUSIONS

In 2021, Ukraine exported to Romania the products of the agro-industrial complex in the amount of 147,705.5 thn USD. The largest shares in its structure were occupied by the following groups of goods: preparations of grains; cocoa and cocoa preparations; sugar and sugar confectionery; animal or plant fats and oils; meat and meat preparations; alcoholic and non-alcoholic beverages, vinegar. The trend models indicate a positive trend for the first four groups of goods in 2022-2024, for the last two – in 2023-2024.

At the same time, in 2021 Ukraine imported from Romania products of the agro-industrial complex in the amount of 61,746.6 thn USD. The largest shares in its structure were occupied by the following groups of goods: tobacco and its industrial substitutes; cereals; other mixed foodstuffs. Forecast models indicate an increase in imports of tobacco and its industrial substitutes in 2023-2024, a decrease in imports of cereals in 2023-2024, an increase in imports of other mixed foodstuffs in 2022-2024.

REFERENCES

[1]Cassidy, K. L., 2013, Gender relations and cross-border small trading in the Ukrainian-Romanian borderlands, European Urban and Regional Studies, 20(1):91-108.

[2]Chiappini, R., 2011, The dynamics of trade specialization and exportations in central and eastern European countries, Revue d'études comparatives Est-Ouest, 42(2):165-193.

[3]Ignjatijević, S., Ćirić, M., Carić, M., 2013, International trade structure of countries from the Danube region: Comparative advantage analysis of export, Ekonomicky casopis, 61(3):251-269.

[4]Ignjatijević, S., Milojević, I., Cvijanović, G., Jandrić, M., 2015, Balance of Comparative Advantages in the Processed Food Sector of the Danube Countries, Sustainability, 7(6):6976-6993.

[5]Koliadenko, S., Andreichenko, A., Galperina, L., Minenko, S., Kovylina, M., 2020, Analysis and forecasting of Ukrainian agrarian exports to the EU countries, Agricultural and resource economics-international scientific e-journal, 6(3):29-47.

[6]Parkhomenko, N., Otenko, I., Otenko, V., Chepeliuk, M., 2022, Development of export potential of Ukraine's agricultural sector. Scientific Papers. Series «Management, Economic Engineering in Agriculture and Rural Development», 22(1):485-492.

[7]Pidhirna, V. N., 2011, Expanding the level of openness of the economies of Ukraine and Romania for foreign trade and investment on the basis of national priorities, Bulletin of V. N. Karazin Kharkiv National University. Series: Economic, 970:300-304.

[8]Stamule, T., 2017, Trade comparative analysis: Republic of Moldova and other relevant countries, Proceedings of the International Conference on Business Excellence, 11(1):569-576.

[9]State Statistics Service of Ukraine, 2022, Countries by commodity structure of Ukraine's foreign trade for 2011-2021, http://www.ukrstat.gov.ua. Accessed on 12.05.2022.

[10]Tkalenko, S., Melnyk, T., Kudyrko, L., 2021, Empirical analysis of exports of organic agricultural food products of Ukraine, Baltic journal of economic studies, 7(3):177-185.

[11]Vasylieva, N., 2020, Ukrainian cereals in global food security: Production and export components, Montenegrin Journal of Economics, 16(2):143-153.

[12]Wust, A., Zichner, H., 2010, «Here is the wall!» – Is it? Transborder practices of small-scale economic actors at the Romanian-Ukrainian border, Revue d'études comparatives Est-Ouest, 41(4):171-193.