
Evaluating the Competitiveness of Poland's Egg Sector: Trends and Insights from 2019 to 2023

Submitted 06/03/25, 1st revision 23/03/25, 2nd revision 18/04/25, accepted 10/05/25

Dorota Pasińska¹, Marek Zieliński²

Abstract:

Purpose: The aim of this study is to assess the competitiveness of the Polish egg sector in 2019-2023.

Design/Methodology/Approach: The research used a descriptive analysis of statistical data, the import-export coverage index (trade coverage), the revealed comparative advantage index (RCA), Widodo matrix, correlation coefficient.

Findings: In 2019-2023, Poland had a comparative advantage in the export of table eggs on the world market. Having a comparative advantage in export does not guarantee its maintenance in the future. In the analysed period, in 2022, various statistical measures (mean, standard error, median, standard deviation, variance, kurtosis, skewness, range, sum, largest value, least value) characterizing the RCA for the European countries under review were the highest. This may indicate that this indicator is very price sensitive. At that time, there were increases in various egg prices in the EU, including export prices. The transformation from cage to cage-free systems of laying hens in many countries requires systematic multidisciplinary research.

Practical Implications: In the period under review, Poland's comparative advantage has improved periodically. This was probably related, among other things, to the outbreak of the war in Ukraine. In the long term, Poland may lose the comparative advantage. This may be related to Ukraine's accession to the European Union and improving its access to the single European market.

Originality/Value: Analysis of changes in the competitiveness of foreign trade is of great importance in the context of strategic decision-making by sector participants.

Keywords: Eggs, trade, war, comparative advantage, RCA.

JEL codes: Q11, Q13, Q17, Q18.

Paper type: Research article.

¹Dr., Institute of Agricultural and Food Economics—National Research Institute, Poland, e-mail: pasinska@ierigz.waw.pl;

²Institute of Agricultural and Food Economics—National Research Institute, Department of Economics of Agricultural and Horticultural Holdings, Poland.

1. Introduction

The aim of this study is to assess the competitiveness of the Polish egg sector in 2019-2023 against the background of European countries. The research hypothesis was formulated. In the period under review the greater comparative advantage in egg exports to the world market European countries surveyed, the greater the probability that the country is a net exporter of eggs. Are the European countries with comparative advantage examined net exporters and those without comparative advantage net importers?

The importance of the problem is related to Ukraine's possible accession to the EU. The research results are very important for those participants in the egg sector supply chain of those EU countries that export eggs or those that want to increase their export potential.

The inspiration for the study was the lack of studies assessing competitive position of the Polish egg on the global market for the last few years. The innovation of this study lies in the application of revealed comparative advantage in exports, trade coverage of imports with exports and Widodo matrix for egg market. There is no comprehensive approach to the issue of international trade relations of the egg sector in Poland and in European countries.

The study finds support primarily in the theoretical concepts of international trade. The views of these are evolving, one of the earlier ideas was by Smith (2007), the later ones are the conception of Ricardo (1929), Heckscher (1919), Ohlin (1933), Krugman (1994) and Porter (2006).

The egg industry is an important part of the agri-food sector in Europe, including in Poland too. Poland is one of the largest egg producers in Europe (European Commission, 2024). In 2023, the share of chicken eggs in agricultural production (market output) in Poland amounted to 6.3% (GUS Statistics Poland, 2024b), compared to 6.1% in 2019 (GUS Statistics Poland, 2021).

A significant portion of the Polish domestic egg production was exported, mainly to European Union countries (Łopaciuk, Pasińska, Szajner, Rosiak, Zaremba, Dzwonkowski, Hryszko, and Rola, 2023). Poland is one of the world's largest exporters of table eggs (UN Comtrade, 2024).

2. Literature Review

Competitiveness in the egg sector will become increasingly important due to changes in the policy on agricultural subsidies, which is characterized by a downward trend. Previous research studies have indicated certain basic conditions enabling a country to build its position on international markets, such as low

production costs (Aho, 2002; Harry, 2007), especially feed and labour, an appropriate business climate, vertical integration combined with the use of scale economies, and the possibility of using modern technologies (Aho, 2002; Haque 1995).

Some researchers study international competitiveness, although when it comes to research on eggs, this is not a popular research topic. Two key elements of the international dimension of competitiveness are competitiveness in foreign trade and investment competitiveness (Kowalski and Weresa, 2021). The literature review focused on the first mentioned dimension of international competitiveness.

Studies have shown that countries like India and Iran have had varying degrees of success in the international egg market, influenced by factors such as production costs, quality standards, and bargaining power in relation to competitors, occurrence of bird flu. For part of the period under study, India had a comparative advantage (measured by RCA) in the export of all egg products under review (chicken eggs, dried eggs and liquid eggs).

Towards the end of the period under review, it lost its comparative advantage in the export of liquid eggs. A probable reason for the loss of comparative advantage in the export of liquid eggs in 2005-2007 and 2008-2009 could have been the result of restrictions on imports related to the occurrence of bird flu. During this time, the RCA index increased for dried eggs, liquid eggs in export were probably replaced by dried eggs, hence this effect (Saran, Kumar, and Gangwar, 2013). It seems that in this case the deterioration of the competitive position in the export of liquid eggs should not be perceived as an unfavourable phenomenon. This may be an example of a solution that other countries could implement in the event of a bird flu outbreak.

This will not always be possible due to customer preferences and the technical possibilities of using dried eggs instead of liquid eggs by processors. A study on Iran was prepared by Mirzaei *et al.* (2012). In the years 1990-2005, the values of the international competitiveness indicators were highly volatile, and the price of eggs in export was lower than that of competitors in the region, which according to the researchers may be due to lower egg quality and an insufficient standardization process, as well as weaker bargaining power in relation to competitors.

The research results obtained by them are consistent with the earlier findings obtained by Salami *et al.* (2001). Sihang *et al.* (2021) examined the competitiveness of China. The research results they obtained indicate that China had a comparative advantage in egg production, although at the end of the analysed period the index of comparative advantage (RCA) was lower than at the beginning. The study also presents results for Poland (the study covers the earlier years 1998-2018 than presented in this study).

For most of the period under review Poland had a comparative advantage in egg

exports. Similar results were obtained for India for the years 2003, 2006, 2009 for bird eggs (coded HS 0407) (Jagdambe, 2016). The author of the study did not provide a broader comment on the results obtained regarding eggs. The study on the advantages of the Turkish agricultural sector relative to the EU was conducted by Şahinli (2013).

In 2008, Turkey and the European Union had a comparative advantage in the export of hen eggs in shell. The lack of comparative advantage was noted for dried eggs, liquid eggs and other bird eggs in shells. The study did not provide detailed explanations regarding the RCA value of zero or close to zero and the possibility of improving competitive position for these products. This is probably due to the large number of items examined (420 position).

However, the researcher explains that Turkey should strive to improve infrastructure, productivity, and support competitive projects. In the next study conducted, Şahinli (2014) received a result indicating improved competitiveness of the Turkish egg sector, as in 2000 Turkey had no comparative advantage, and in 2011 it did.

The need to support agricultural exports with subsidies was pointed out, although the article paid little attention to eggs. Ignjatijević *et al.* (2014) examined the competitive position of the egg sector in Serbia, which in 2005 and 2011 did not have a comparative advantage in the export of bird eggs, fresh and dried egg yolks and egg whites.

These products were included together in the study. The study indicates the need to conduct market research, support promotional activities for the export of agricultural products, and improves the financing possibilities of agricultural producers in Serbia. Ishchukova and Smutka (2013) attempted to assess Russia's competitiveness based on various measures, including the Balassa index.

In 1998, 2000, 2004 and 2006 Russia had a comparative advantage in egg exports, but in the subsequent years under study (2008-2010) it lost it. More substantial comparative advantages for this country were observed in trade with CIS and Asian countries, which, according to the researchers, may be related to geographic proximity and, as a result, lower transportation costs. The study did not indicate what type of eggs was the subject of the analysis. It emphasized that in the case of Russia, products with the highest comparative advantage should be supported (the article concerns various agricultural products).

The study on India covers the years 1995-2014. It is worth noting that for most of the study period India had a comparative advantage (before 2010). In the last years of the period under review (2010-2014), the Balassa index took values less than one, so India's competitive position deteriorated. It has been highlighted that consumption patterns are changing in both rural and urban areas, which may limit egg export

opportunities (Khorajiya, Shiyani, Ardeshtna, Swaminathan, and Meena, 2018).

The presented research results are not always directly comparable, because the studies used different research methods and sometimes different assumptions. It is not always possible to specify exactly which products are covered by the survey, table eggs, hatching eggs, albumen, yolks or other egg products.

3. Research Methodology

Ex-post measures were used to assess the competitive position of the egg sector in selected European countries. One of the measures used is the export-import coverage ratio, which can be presented using the following formula:

$$TC = \frac{E_{jk}}{I_{jk}}.$$

If the indicator has a value higher than 1, it means that the country has a surplus in trade in specific products (in this case hen eggs in shells). An indicator value lower than one means that there is a deficit in foreign trade in a specific product group, so the country has a weak competitive position in trade (Szczepaniak, 2021; Łukiewska, 2019).

Another measure used to assess the international competitiveness of the egg sector was the Revealed Comparative Advantage (RCA) indicator. Pawlak (2013) and Ferto and Hubbard (2003) note that the original version of this indicator was proposed by Balassa (1965). Fronczek (2018) and Pilarska (2017) emphasize that a simplified version of this measure was introduced earlier by Liesner (1958).

If the value of the indicator is greater than one, it means that the country has revealed comparative advantages in export to the world market, while less than one means there is no such advantage. The formula of the measure used is as follows:

$$RCA = \frac{E_{jk}}{E_{sk}} : \frac{E_{js}}{E_{sw}}$$

E_{sk} – value of total exports from country k ,

E_{js} – value of the industry's exports j to the global market,

E_{sw} – value of total world exports.

The common use of this type of measure is evidenced by many references in the literature (for example, Ambroziak 2009; Bąk-Filipek and Parlińska 2011; Şahinli, 2014). The measure proposed by Balassa (1965) as Pilarska (2017) points out was modified by other researchers, e.g., Vollrath (1991) who introduced the index of relative trade advantages, the index relative export advantages and the index of revealed competitiveness.

Some of these measures additionally take into account imports or avoid double counting of some items. Various statistical measures (mean, standard error, median, standard deviation, variance, kurtosis, skewness, range, sum, largest value, least value, correlation coefficient) were used to characterize the development of RCA.

In addition, the Widodo matrix was used (Widodo, 2009) (Figure 1). This is probably one of the first studies on the egg market where this method is used. In this study, instead of TBI (Trade Balance Index), TC was used, and instead of RSCA (Revealed Symmetric Comparative Advantage), RCA was used.

RCA is a commonly used measure of comparative advantage in the literature. According to Saleh and Widodo (Saleh and Widodo, 2010), RSCA is a better measure for econometric modelling. The matrix was adjusted to the indicators selected for this study:

- Group A: $RCA > 1$ i $TC > 1$,
- Group B: $RCA > 1$ i $TC < 1$,
- Group C: $RCA < 1$ i $TC > 1$,
- Group D: $RCA < 1$ i $TC < 1$.

Figure 1. Products Mapping

$RSCA > 0$	Group B: Comparative Advantage Net-importer ($RSCA > 0$ and $TBI < 0$)	Group A: Comparative Advantage Net-exporter ($RSCA > 0$ and $TBI > 0$)
$RSCA < 0$	Group D: Comparative disadvantage Net-importer ($RSCA < 0$ and $TBI < 0$)	Group C: Comparative disadvantage Net-exporter ($RSCA < 0$ and $TBI > 0$)
	$TBI < 0$	$TBI > 0$

Note: Trade Balance Index (TBI).

Source: Widodo (2009).

The study covers the years 2019-2023. The data comes from the UN Comtrade database (UN Comtrade, 2024), the Central Statistical Office in Poland (GUS Statistics Poland, 2020; GUS Statistics Poland, 2021; GUS Statistics Poland, 2024a; GUS Statistics Poland, 2024b; GUS Statistics Poland, 2024c), and the State Statistics Service of Ukraine (State Statistics Service of Ukraine, 2023). Some data on foreign trade are preliminary. Due to the small scale of production, Malta and Cyprus were excluded from the study. Not all countries provided data.

4. Research Results and Discussion

Poland is one of the largest exporters of eggs in the EU. In 2023, similarly to 2019, it ranked second after the Netherlands. For many years, the Netherlands has been the

leading exporter of eggs (Windhorst, 2017). Egg exports from EU countries are highly concentrated, as in 2023, as much as 82% of the value of egg exports from the EU were exports from five countries: the Netherlands, Poland, Germany, Belgium and Spain, and in 2019 it was about 85%, which means that the value of exports from other countries was low.

In 2023, compared to 2019, the value of egg exports from all EU countries, except Austria, increased. During this time, the value of exports from Ukraine decreased (approx. 46%) (UN Comtrade Database, 2024), which may be related to the war operations in Ukraine, which affect agricultural production by contributing to the decrease in the production of poultry, eggs and egg products (Kramskyi, 2022; Maksym, Chemerys, Dushka, and Nebozhenko, 2022; State Statistics Service of Ukraine, 2023; Pro Consulting, 2023).

The reduction in exports by Ukraine could have created opportunities for other exporters. Due to the large share of egg exports in egg production in Poland (Łopaciuk, Pasińska, Szajner, Rosiak, Zaremba, Dzwonkowski, Hryszko, and Rola, 2023), even a small increase in the supply of eggs (e.g., Ukrainian), especially much cheaper ones, on the main sales markets may worsen the conditions of egg trade.

This may also be reflected in the formation of egg prices in Poland. Eggs in Ukraine are one of the most important animal products exported (Maksym, Chemerys, Dushka, and Nebozhenko, 2022).

In 2023, the share of the value of egg exports from Ukraine was 13% of exports from Poland, compared to 45% in 2019. During this time, the value of exports from Poland increased significantly (by 87%). There was an increase in the volume of exports from Poland (by 4%) and a decrease from Ukraine (by 65%).

In 2023 compared to 2019, despite the increase in domestic production of table chicken eggs in Poland (by 6.6%) (GUS Statistics Poland 2024a; GUS Statistics Poland 2020), the volume of imports also increased (by 160%). The demand for eggs intended for export (UN Comtrade 2024) and for meeting the needs of the domestic market increased at that time (GUS Statistics Poland, 2024b).

In the years 2019-2023, the egg import coverage ratio fluctuated (Table 1). In all the years studied, the indicator reached values higher than one for: Ukraine, Finland, Poland, Spain, Bulgaria, Ireland and the Netherlands. During this time, values lower than one were recorded for: Italy, the Czech Republic, Slovakia, Austria, Belgium, Germany, France, Croatia, Estonia, the United Kingdom, Hungary, Greece and Luxembourg.

High values of the indicator may indicate Poland's specialization in egg production. In 2019, TC index values higher than for Poland were recorded for Ukraine, and in 2023 - for Finland and Ukraine. On the one hand, the higher level of coverage of

imports by exports of Ukraine and Finland than Poland may be disadvantageous, on the other hand it is worth noting that Finland is not a large producer of eggs (approx. 1/10 of Polish production), while Ukraine is quite large (FAO, 2024).

Moreover, due to the war operations, many Ukrainians have left the country (at the end of December 2022, there were about 1 million of them in Poland) (Duszczyk, Górny, Kaczmarczyk, and Kubisiak, 2023), which may result in lower global demand for eggs on the domestic market in Ukraine, although it may not fall due to the limited supply of egg substitutes.

In 2022, the year of the beginning of the war in Ukraine, the value of this indicator for Poland increased. Czyżewski and Danilczuk (2008) also obtained indicators higher than one for Poland (the study covered the years 2002-2007), which confirmed the coverage of imports with exports.

Table 1. *Development of the TC (trade coverage) index in 2019-2023 for selected European countries – table eggs in shells*

Specification	2019	2020	2021	2022	2023
Austria	0.22	0.32	0.36	0.21	0.25
Belgium	0.77	0.85	0.81	0.72	0.92
Bulgaria	3.87	8.79	7.65	6.03	3.75
Croatia	0.49	0.68	0.44	0.26	0.20
Czechia	0.36	0.54	0.44	0.71	0.52
Denmark	0.55	0.43	1.80	2.07	1.48
Estonia	0.09	0.10	0.13	0.17	0.15
Finland	18.19	12.24	17.94	23.80	22.92
France	0.40	0.54	0.82	0.22	0.22
Germany	0.27	0.24	0.24	0.24	0.24
Greece	0.11	0.15	0.17	0.13	0.08
Hungary	0.15	0.07	0.27	0.14	0.08
Ireland	4.76	1.93	3.78	3.07	1.60
Italy	0.35	0.22	0.22	0.13	0.58
Latvia	1.96	2.30	2.00	2.03	(.)
Lithuania	0.88	1.06	1.29	0.87	0.78
Luxembourg	0.05	0.08	0.08	0.09	0.06
Netherlands	1.80	1.81	2.03	1.56	1.58
Poland	32.25	29.36	8.02	18.22	11.71
Portugal	0.95	1.73	1.29	1.32	0.62
Romania	1.37	0.74	0.92	1.92	3.10
Slovakia	0.51	0.14	0.22	0.48	0.42
Slovenia	1.04	0.68	1.00	1.07	0.49
Spain	11.09	18.50	15.24	14.65	9.61

Sweden	2.96	14.30	0.70	12.99	1.40
Ukraine	2588.39	3328.31	64.46	127.29	91.14
United Kingdom	0.31	0.42	0.64	0.26	0.12

Note: (.) no data.

Source: Authors' calculation, (UN Comtrade Database 2024).

In the period under review, the indicators of revealed comparative advantages in the export of table eggs for chickens were varied (Table 3). In 2019-2023, the indicator values above one were recorded for Belgium, Bulgaria, Finland, Lithuania, Latvia, the Netherlands, Poland, Romania, Spain and Ukraine, but Poland, Belgium, Bulgaria, Finland, Lithuania, and Romania managed to improve their positions. Some countries had a comparative advantage in export to the world market at the beginning of the period under review (2019) and lost it in 2023 (Croatia, Portugal).

The Czech Republic had a comparative advantage only in 2022 and 2023. On the other hand, the indicator value was lower than one for the remaining countries, which means that they did not have a comparative advantage in trade in chicken eggs (Austria, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Slovakia, Slovenia, Sweden and the United Kingdom).

It is worth noting that in the year the war broke out, i.e., in 2022, compared to 2021, the largest increases in the indicators of revealed comparative advantage were recorded for Lithuania, Ukraine and Poland. When analysing the development of the RCA index for the years studied, it is worth noting that the highest levels of various statistical measures examined (mean, standard error, median, standard deviation, variance, kurtosis, skewness, range, sum, largest value, least value, confidence level) were recorded for 2022 (Table 4). It seems that this could have been related to the outbreak of the armed conflict in Ukraine, on this basis it can be stated that the situation on the egg market in the EU was characterized by great uncertainty at that time. It can be concluded that the applied RCA variant is sensitive to prices.

The price shocks that would have occurred at that time would have contributed to record increases in the prices of not only feed and grains, but also other components of production costs and eggs. Among other things, a significant increase in the prices of gas, energy and fertilizers was noted (Just and Echaust, 2023; Frankowski, 2023; Gorynia, 2023).

In 2023, compared to 2022, the level of the statistical measures examined decreased. In all the years studied, kurtosis was positive, as was skewness. The RCA distribution was slender, and its values were more distributed to the right of the mean. The correlation coefficient between RCA and TC was calculated for the years studied. The correlation was strong for years 2019, 2020 and 2023 and weak for years 2021 and 2022. The obtained research results provide partial support for the theory of comparative advantage.

Table 2. RCA indicator development in 2019-2023 for selected European countries – hen eggs in shells*

Specification	2019	2020	2021	2022	2023
Austria	0.42	0.52	0.42	0.29	0.26
Belgium	1.45	1.82	1.86	1.54	2.23
Bulgaria	3.66	4.46	5.29	5.16	5.61
Croatia	1.30	1.69	1.31	0.89	0.76
Czechia	0.35	0.50	0.70	1.19	1.00
Denmark	0.30	0.30	0.75	0.68	0.40
Estonia	0.46	0.49	0.64	0.89	0.79
Finland	1.53	1.32	2.26	2.71	1.90
France	0.32	0.47	0.65	0.36	0.28
Germany	0.86	0.81	0.93	0.79	0.71
Greece	0.18	0.25	0.28	0.29	0.21
Hungary	0.09	0.06	0.36	0.27	0.15
Ireland	0.58	0.53	0.60	0.58	0.56
Italy	0.22	0.17	0.17	0.15	0.39
Latvia	16.64	15.70	18.95	26.20	(.)
Lithuania	3.97	3.68	5.03	4.24	4.30
Luxembourg	0.30	0.60	0.61	0.68	0.40
Netherlands	7.00	7.20	8.75	6.18	5.50
Poland	8.58	7.70	7.09	10.43	8.73
Portugal	1.23	1.60	1.85	1.65	0.91
Romania	1.82	1.51	2.09	3.15	3.32
Slovakia	0.33	0.17	0.36	0.57	0.50
Slovenia	0.20	0.13	0.28	0.22	0.10
Spain	2.13	2.74	3.01	2.11	2.05
Sweden	0.17	0.72	0.10	0.87	0.33
Ukraine	19.48	16.88	4.27	8.59	11.08
United Kingdom	0.14	0.27	0.19	0.20	0.17

Note: (.) no data.

* RCA - when the value of the indicator is equal to or greater than one, it can be stated that the country has a comparative advantage in trade in the examined product group (Olczyk, 2008). On the other hand, when its value is lower than one - the country does not have a revealed comparative advantage in exporting a given product to a specific market (Ambroziak, 2009).

Source: Authors' calculation, (UN Comtrade Database 2024).

Table 3. RCA descriptive statistics from 2019 to 2023 for surveyed European countries

Specification	2019	2020	2021	2022	2023
Mean	2.73	2.68	2.55	3.00	2.02
Standard error	0.94	0.85	0.77	1.03	0.56
Median	0.58	0.72	0.75	0.89	0.74

Standard deviation	4.90	4.41	3.99	5.34	2.84
Sample variance	24.01	19.45	15.89	28.57	8.05
Kurtosis	6.55	5.70	10.93	14.12	3.82
Skewness	2.63	2.47	3.04	3.50	2.04
Range	19.39	16.81	18.85	26.05	10.97
Sum	73.71	72.30	68.83	80.90	52.65
Number	27	27	27	27	26
Largest value	19.48	16.88	18.95	26.20	11.08
Least value	0.09	0.06	0.10	0.15	0.10
Confidence level (95.0%)	1.94	1.74	1.58	2.11	1.15

Source: Authors' calculation, (UN Comtrade Database 2024).

Summarizing the results of the received studies, a Widodo matrix (Widodo, 2009) was prepared. Throughout the study period, Bulgaria, Finland, Latvia (2023 data not available), the Netherlands, Poland, Spain and Ukraine were net exporters of chicken eggs and had a revealed comparative advantage in eggs (group A) (Figures 2-6).

The obtained research results may provide support for the theory of comparative advantage, there is a greater probability that a country will be a net exporter if it has a comparative advantage. Romania was in this part of the matrix in 2019 and 2022-2023. Belgium had a revealed comparative advantage and was a net importer of chicken eggs in 2019-2023.

Croatia, Lithuania, Portugal, Romania and the Czech Republic appeared in quadrant B of the matrix in some years of the study period. Throughout the entire period studied, Ireland had no comparative advantage and was a net exporter of eggs (group C). In all years except 2020, Sweden was also included in this quarter of the matrix.

When analysing quarter D, it is worth noting that in 2019-2023 the following countries did not have a comparative advantage in the case of eggs and were net importers: Austria, Estonia, France, Germany, Greece, Hungary, Italy, Luxembourg, Slovakia, United Kingdom. In all years of the study period, except 2022, the Czech Republic was in quadrant D. In some years, the following countries appeared in group D: Denmark (2019, 2020), Slovenia (2020, 2021, 2022), Sweden (2021), Croatia (2022, 2023) and Portugal (2023).

Figure 2. Egg Mapping in 2019

RCA>1	Group B: Comparative Advantage Net-importer (RCA > 1 and TC <1)	Group A: Comparative Advantage Net-exporter (RCA > 1 and TC >1)
	Belgium, Croatia, Lithuania, Portugal	Bulgaria, Finland, Latvia, Netherlands, Poland, Romania, Spain, Ukraine

RCA < 1	Group D: Comparative disadvantage Net-importer (RCA < 1 and TC < 1)	Group C: Comparative disadvantage Net-exporter (RCA < 1 and TC > 1)
	Austria, Czechia, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Luxembourg, Slovakia, United Kingdom	Ireland, Slovenia, Sweden
	TC < 1	TC > 1

Source: Authors' calculations, (UN Comtrade Database, 2024) (Widodo, 2009).

Figure 3. Egg Mapping in 2020

RCA > 1	Group B: Comparative Advantage Net-importer (RCA > 1 and TC < 1)	Group A: Comparative Advantage Net-exporter (RCA > 1 and TC > 1)
	Belgium, Croatia, Romania	Bulgaria, Finland, Latvia, Lithuania, Netherlands, Poland, Portugal, Spain, Ukraine
RCA < 1	Group D: Comparative disadvantage Net-importer (RCA < 1 and TC < 1)	Group C: Comparative disadvantage Net-exporter (RCA < 1 and TC > 1)
	Austria, Czechia, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Luxembourg, Slovakia, Slovenia, United Kingdom	Ireland, Sweden
	TC < 1	TC > 1

Source: Authors' calculations, (UN Comtrade Database, 2024) (Widodo, 2009).

Figure 4. Egg Mapping in 2021

RCA > 1	Group B: Comparative Advantage Net-importer (RCA > 1 and TC < 1)	Group A: Comparative Advantage Net-exporter (RCA > 1 and TC > 1)
	Belgium, Croatia, Romania	Bulgaria, Finland, Latvia, Lithuania, Netherlands, Poland, Portugal, Spain, Ukraine
RCA < 1	Group D: Comparative disadvantage Net-importer (RCA < 1 and TC < 1)	Group C: Comparative disadvantage Net-exporter (RCA < 1 and TC > 1)
	Austria, Czechia, Estonia, France, Germany, Greece, Hungary, Italy, Luxembourg, Slovakia, Slovenia, Sweden, United Kingdom	Denmark, Ireland
	TC < 1	TC > 1

Source: Authors' calculations, (UN Comtrade Database, 2024) (Widodo, 2009).

Figure 5. Egg Mapping in 2022

RCA>1	Group B: Comparative Advantage Net-importer (RCA > 1 and TC <1)	Group A: Comparative Advantage Net-exporter (RCA > 1 and TC >1)
	Belgium, Czechia, Lithuania	Bulgaria, Finland, Latvia, Netherlands, Poland, Portugal, Romania, Spain, Ukraine
RCA<1	Group D: Comparative disadvantage Net-importer (RCA < 1 and TC < 1)	Group C: Comparative disadvantage Net-exporter (RCA < 1 and TC >1)
	Austria, Croatia, Estonia, France, Germany, Greece, Hungary, Italy, Luxembourg, Slovakia, United Kingdom	Denmark, Ireland, Slovenia, Sweden
	TC <1	TC>1

Source: Authors' calculations, (UN Comtrade Database, 2024) (Widodo, 2009).

Figure 6. Egg Mapping in 2023

RCA>1	Group B: Comparative Advantage Net-importer (RCA > 1 and TC <1)	Group A: Comparative Advantage Net-exporter (RCA > 1 and TC >1)
	Belgium, Lithuania	Bulgaria, Finland, Netherlands, Poland, Romania, Spain, Ukraine
RCA<1	Group D: Comparative disadvantage Net-importer (RCA < 1 and TC < 1)	Group C: Comparative disadvantage Net-exporter (RCA < 1 and TC >1)
	Austria, Croatia, Czechia, Estonia, France, Germany, Greece, Hungary, Italy, Luxembourg, Portugal, Slovakia, Slovenia, United Kingdom	Denmark, Ireland, Sweden
	TC <1	TC>1

Source: Authors' calculations, (UN Comtrade Database, 2024) (Widodo, 2009).

The conducted study confirms the high competitiveness as measured by the index of comparative advantage of Polish and Ukrainian eggs on international markets. Despite the war, competitive indicators are favourable for Ukraine. Zosymenko and Rybchak (2018) classified bird eggs and egg yolks as well as egg albumin as products with high competitive potential between EU and Ukrainian producers. The armed conflict in Ukraine resulted in an increase in production costs in many countries.

A significant advantage of Polish exporters may be the possibility of selling large batches of eggs, this may be related to the growing role of retail chains in retail trade. Subsequent research work should be devoted to investigating this problem.

The wide range of eggs from some EU countries constitutes their significant source of competitive advantage.

5. Conclusions, Proposals, Recommendations

In the years 2019-2023, Bulgaria, Finland, Latvia (2023 data not available), the Netherlands, Poland, Spain and Ukraine were net exporters of chicken eggs and had a revealed comparative advantage in eggs (group A, Widodo matrix) (Widodo, 2009). The competitive battle in the egg market is basically between these countries.

The Netherlands benefits from the so-called Rotterdam effect, which is related to access to the sea and port infrastructure. The value of trade with the Netherlands may be artificially overstated due to the fact that the destination of some goods is not the Netherlands, similarly to the original place of shipment (Balić, Del Prete, Magrini, Montalbano, and Nenci, 2019). These results may provide support for the theory of comparative advantage.

On the other hand, throughout the period under review only Belgium had a comparative advantage and was a net importer of eggs (group B). At that time Ireland did not have a comparative advantage and its exports were greater than its imports of eggs (group C), and these countries did not have a comparative advantage and were net importers of eggs: Austria, Estonia, France, Germany, Greece, Hungary, Italy, Luxembourg, Slovakia, Great Britain (group D). For some years for surveyed countries a strong positive correlation was obtained between the RCA index and TC, while for others a weak one.

Having a comparative advantage in export does not guarantee its maintenance in the future. Studies on different periods, sometimes with other research assumptions and different countries indicate that some countries had, similarly to Poland, a comparative advantage (some for the entire period under review and some for part of the period under review): China (Sihang, Xingshuo, and Yu, 2021), India (Jagdambe, 2016; Saran, Kumar, and Gangwar, 2013), Turkey (Şahinli, 2014), and some did not have it (Serbia (Ignjatijević, Čavlin, and Đorđević, 2014)).

Due to the fact that Ukraine has large areas of agricultural land (of which a significant part is chernozem), three times larger than in Poland (Zolotnytska and Kowalczyk, 2022), a large potential for the development of the egg sector and in connection with the possibility of producing cheaper feed, in the long term the situation of the Polish producers and exporters may be different.

Egg replacers (vegan) are appearing in many countries of the world, perhaps for consumers these products will be more sustainable, alleviating their ethical, animal and human health, environmental (exploitation of natural resources), social, political concerns about animal products (Bedin, Torricelli, Gigliano, De Leo, and Pulvirenti, 2018).

Further research should concern the application of various econometric models, in which various factors influencing the competitive position of these countries will be examined. The study presented here has some limitations, as Cieřlik (2017) notes, this type of analysis is primarily an ex-post analysis and, in such assessments, Pilarska (2017) also emphasizes limitations of the measures used.

Due to the limitations of the study, only selected methods were presented, e.g. various modifications of the RCA index (for example Vollrath version (Vollrath, 1991) were proposed in the literature, which can be used in further studies. Subsequent analyses should focus on the international competitiveness of the egg sector, taking into consideration rearing systems, poultry species, or various functional features of eggs, as well as their competitiveness in export those products from the point of view of product emissions.

For the EU countries surveyed, the possible accession of Ukraine to the European Union is very important information, because its access to the single European market will improve. It is assumed that after accession the polish indicator of revealed comparative advantages may deteriorate. This is very important information for agricultural producers indicating a higher risk of long-term investments. If the prediction proves correct, it may also have a negative impact on related sectors.

This prediction may not come true if avian influenza develops very dynamically in the region. Another important challenge for producers is to meet the farm-to-fork strategy (European Commission, 2020), and for exporters to find customers for products produced with sustainable production goals. Due to the highly variable conditions and the transformation from cage systems to cage-free systems in many countries (Majewski, Potori, Sulewski, Wąs, Mórawska, Gębska, Malak-Rawlikowska, Grontkowska, Szili, and Erdős, 2024), multidisciplinary research of the sector is necessary.

Integration in the sector can also be examined in relation to the competitive position of individual countries. Perhaps a so-called pull account can be used. The degree of integration of the sector varies greatly in the countries studied. In a sequential account of production costs in each country, one could try to include separately farms that produce feed themselves, those that buy it exclusively from the market and those that follow a mixed strategy in this regard. Such studies could provide tremendous support for shaping agricultural policy toward the sector in individual countries.

Another research proposal is to investigate level of sustainability of production, consumption and trade. These issues may be increasingly important for different stakeholder groups, e.g., the banking sector can only support sustainable production, and will consumers be interested in purchasing such products and are they willing to

pay more for it? There is a research gap in this area. It should be the subject of interest of further studies.

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