https://doi.org/10.17221/322/2022-AGRICECON

Changes in the comparative advantage of Polish dairy products

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Citation: Bórawski P., Bełdycka-Bórawska A., Parzonko A., Rokicki T., Holden L. (2022): Changes in the comparative advantage of Polish dairy products. Agric. Econ. – Czech., 68: 464–475.

Abstract: Competitiveness is one of the key concepts in economic sciences, andit is defined as the ability of businesses to compete in the market. The aim of this study was to assess the competitiveness of dairy products in Poland. The competitiveness was evaluated in a macroeconomic approach by analysing the exports, imports, and the trade balance. The results were processed and presented with the use of tabular, graphic, and descriptive methods. After Poland joined the European Union (EU) in 2004, one of the key goals was to improve the quality, storage, and applicability of dairy products, and to promote trade in milk and dairy products. The Polish dairy industry reported a positive balance in the foreign trade of milk and dairy products, which contributed to positive values in the competitiveness indicators of dairy products. The values of the export specialisation index (*SI*), export revealed comparative advantage (*XRCA*), relative import penetration index (*MRCA*), foreign trade coverage ratio (*CRK*), and the Grubel-Lloyd intra-industry trade index (*IITk*) were positive, which attests to the competitiveness of Polish dairy products. We proved that the COVID-19 pandemic had an impact on the competitiveness of dairy enterprises in Poland.

Keywords: competitiveness; COVID-19; export; import; market economy; trade balance

In a market economy, competitiveness is often defined as the ability of a business to compete in the market. Competitiveness is one of the key concepts in economic sciences. It generally applies to businesses operating on a given market, but it can also relate to products (Aiginger et al. 2013). A product's competitiveness is assessed based on its attributes, use characteristics, applicability, and the ability to provide specific benefits for consumers. Competitiveness is related to the comparative advantage theory

Supported by the University of Warmia and Mazury in Olsztyn, Faculty of Agriculture and Forestry, Department of Agrotechnology and Agribusiness (Project No. 30.610.012–110) and project funded by the National Science Centre in Poland allocated on the project OPUS 15 (Project No. 2018/29/B/HS4/00392). The publication was writtenas a result of the author's internship at Pennsylvania State University, co-financed by the European Union under the European Social Fund (Operational Program Knowledge Education Development), carried out in the project Development Program at the University of Warmia and Mazury in Olsztyn (Project No. POWR.03.05. 00–00-Z310/17).

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developed by David Ricardo in 1817 in his seminal work entitled On the Principles of Political Economy and Taxation (Ricardo 1817). Comparative advantage is measured in terms of opportunity costs, namely the value of goods that could be produced with the same resources. The cost of various goods can be calculated. A product has a comparative advantage when it can be produced at a lower opportunity cost than the same product manufactured by the competition. Based on this principle, countries produce and export goods whose opportunity costs are lower than in other countries. The competitiveness of businesses operating in a given market is determined by numerous factors, including the demand, state aid, strategy, and structure of the competition (Davies and Ellis 2000). These factors also include the international market, economic policy, market size and market structure (Czyżewski and Czakowski 2016).

Competitiveness can be analysed at the micro, meso, or macro level. In the microeconomic approach, a business is competitiveif it produces goods and offers services more effectively than other market participants (Bojnec and Fertő 2013; Nagy and Jámbor 2019). In the mesoeconomic approach, competitiveness is analysed at the regional level. In the macroeconomic approach, competitiveness is the abilityof an economy to promote development, welfare, and sustainable production (Chikán 2008).

Competitiveness plays a special role in the dairy market as this sector involves numerous producers, and dairy processingis an important part of the food industry. In the European Union (EU), the Common Agricultural Policy (CAP) as well as numerous programmes and subsidies promote the competitiveness of dairy producers. These funds improve the productivity and production technologies in the dairy sector (Zhu et al. 2008).

Poland abounds in meadows and pastures which are important sources of feed. The abolishment of dairy quotas in 2015 improved the performance and openness of the Polish dairy market (Bełdycka-Bórawska et al. 2021). Investment projects relating to the horizontal and vertical integration of market participants, supply chains, and the quality of dairy products improved the competitiveness of dairy farms and processing companies (Bórawski et al. 2021).

Competitiveness applies to the dairy industry and dairy products. Dairy products are staple foods. The price, suitability, quality, physical attributes, and packaging of dairy products determine their market status relative to similar products supplied by competitors (Gospodarowicz et al. 2013). Milk and dairy products are rich sources of biologically active compounds, calcium, phosphorus, vitamins, and minerals, and they should be consumed daily. Flavoured dairy products have been introduced to meet the growing consumer expectations (Mossaz et al. 2010). Dairy producers should analyse consumer preferences and perceptions. By purchasing a product, consumers can confront their needs with the benefits resulting from their consumption (Kowalska et al. 2020).

According to the literature, the world's leading milk and dairy producers are New Zealand (around 38% share of the global market), the EU (around 32%), and the USA (around 14%) (Dairy Australia 2015; Blayney et al. 2016). In the EU, agriculture, including the dairy sector, receives considerable financial support, including direct payments which provide farmers with a stable source of income and minimise the adverse effects of fluctuations in the prices, income, crop, and milk yields. The dairy sector can receive support under the CAP, however, in most cases, these payments are complemented by national support. The MacSharry reform of 1992 decreased the intervention prices of butter (by 9%) and dairy products (by 7.5%) (Folmer et al. 1995). In 2013, attempts were made to liberalise the milk market, which significantly influenced the competitiveness of European dairy producers in the global market. Milk quotas, which limited production levels and kept milk prices high, were lifted in 2015 (Parzono and Bórawski 2020). After an initial decrease, milk prices increased because the European dairy sector opened to the global market where prices were higher.

Michaličková et al. (2014) analysed the competitiveness of Slovakian dairy farms by comparing the value of the production inputs and milk yields. Milk prices should be determined not only by supply and demand, but also by the farmers' ability to create organisations of agricultural producers and negotiate fair prices. Parzonko and Bórawski (2020) found that the competitiveness of Polish dairy farms was determined by the raw material resources and low labour costs.

COVID-19 pandemic had an impact on the milk market. It affected both the supply and demand at a local and regional level. However, world milk production was resilient (FAO 2020; Ruiz-Roso et al. 2020; Brumă et al. 2021). The COVID-19 pandemic posed an unprecedented threat to people and markets (Acosta et al. 2021). Moreover, the COVID-19 pandemic had a negative impact on the animals' health and well-being and disrupted the livestock supply chain and decreased efficiency (Hashem et al. 2020). So, as the effect of COVID-19 pandemic, a bigger au-

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tomatization of processes to replace human workforce has been seen (Weersink et al. 2020). The COVID-19 pandemic affected, to a small degree, smaller farms which rely on their own fodder, but it disrupted the supply chains more (Perrin and Martin 2021). Bigger farms were affected more because they could not sell their milk and had to reduce the production, which led to a drop in the number of dairy cows (Quingbin et al. 2020). Polish dairy farms are rather small, and the impact of COVID-19 was rather small. Poland's accession to the EU in 2004 created good prospects for dairy farms (Pisiulewski and Marzec 2022). So, summing up, the COVID-19 pandemic had a tremendous impact on dairy supply chains because they are vulnerable to shock (Karwasra et al. 2021).

The main assumptions of the comparative advantage theory were described by David Ricardo (1817). According to Ricardo, two countries can benefit from trade in two products. One country will manufacture and export goods that are cheaper to produce, and the other will import goods that are more expensive to manufacture in that country (Brumă et al. 2021). The country with lower prices (lower production costs) will achieve a comparative advantage.

Another theory of comparative advantage was formulated in 1919 by Heckscher-Ohlin (Heckscher et al. 1991). This theory posits that countries export goods that they can more efficiently produce with the use of cheap and plentiful resources. In turn, they will import products that cannot be produced as efficiently because the required resources are scarce and expensive (Gunawardana and Khorchurklang 2007).

Competitiveness relates to foreign trade. Competitive products enjoy a stable position on the market, and their market standing is improved at the expense of other goods. In the EU, competitiveness has largely been determined by the dairy market regulations under the CAP. Before 2015, milk quotas kept dairy prices at a high level, but the single market was closed to global trade, and large amounts of surplus goods were not manufactured (Havrilla and Gunawardana 2003; Bórawski et al. 2019). The successful export of Polish dairy products is determined by their high comparative advantage in the European single market (Pawlak 2022). The above implies that the opportunity cost of milk and dairy production is lower in Poland than in other countries (Szczepaniak 2019). An absolute advantage is not required to achieve success in the dairy market.

There is a general scarcity of published studies examining the competitiveness of dairy products. The export specialisation index (*SI*), relative import penetration index (*MRCA*), relative trade advantage (*RTA*), foreign trade coverage ratio (*CRK*) and Grubel-Lloyd intra-industry trade index (*IITk*) are not deeply analysed in the literature in relation to the Polish dairy sector. In addition, the comparative advantage of dairy products has not been sufficiently analysed in the literature. The present study was undertaken to fill in this knowledge gap.

The main aim of this study was to evaluate the competitiveness of Polish dairy products at the macroeconomic level, with special emphasis on the comparative advantage of the supplied products related to the COVID-19 pandemic. The following specific objectives were formulated to achieve the main research goals: to evaluate the foreign trade of Polish dairy products and to analyse the comparative advantage of Polish dairy products.

The aims were achieved by using different sources of data and literature as well as using different methods.

MATERIAL AND METHODS

In this study, the competitiveness was evaluated via a macroeconomic approach. The competitiveness was evaluated by analysing the dairy exports, imports, and trade balance. Competitiveness indices can also be used to evaluate the competitiveness and comparative advantage (Frohberg and Hartmann 2000; Gorton et al. 2001). The data for the study were obtained from Polish dairy market databases (Szajner 2022), Eurostat, FAOStat, and other sources. The macroeconomic level was analysed based on secondary data describing the trade of milk and dairy products. We calculated the main indicators describing the comparative advantage of the dairy products. The data period under study covered 2005–2021.

The competitiveness of Polish dairy products was evaluated with the use of export indicators (fixed-base indicators). The analysis covered the period after Poland's accession to the EU to identify any long-term changes (2005–2021). Indicators for assessing the competitiveness of the Polish dairy market were used in the study in the macroeconomic approach. These indicators have different definitions in the literature (Kawecka-Wyrzykowska 2010; Firlej et al. 2017; Pawlak et al. 2019; Kiryluk-Dryjska and Baer-Nawrocka 2021; Pawlak 2022).

i) Export specialisation index (*SI*) is the ratio of a product's share in the exports of country *k* to that product's share in the global or regional exports [Equation (1)]. High values of *SI* are desirable.

$$SI = \frac{Xik}{Xiw} \quad (1)$$

where: *SI* – export specialisation index; *Xik* – the share

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of product *i* in the exports of country *k*; *Xiw* – the share of product *i* in the exports on the European single market

ii) Export revealed comparative advantage (*XRCA*) is a ratio of two ratios. The first ratio denotes the share of product *i* in the exports of country *k* to the share of product *i* in the exports of country *m*. The second ratio denotes the share of the total exports in country *k* to the total exports in country *m* (excluding the analysed product) [Equation (2)]. This index was developed by Balassa (Balasa 1979, 1989, 1996; Havrilla and Gunawardana 2003; Pawlak and Poczta 2020). *XRCA* is less than 1 when a product's share in a country's exports is lower than its share in the global exports – in this case, the trade in the European single market.

$$XRCA = \frac{\frac{Exik}{Exim}}{\frac{Exk}{Exm}} \quad (2)$$

where: *Ex* – exports; *i* – product category; *k*, *m* – countries

iii) Relative import penetration index (*MRCA*) has a similar structure to *XRCA*. The only difference is that *XRCA* denotes a given product's share in a country's imports, rather than exports [Equation (3)].

$$MRCA = \frac{\frac{Mik}{Mjk}}{\frac{Mim}{Mjm}} \quad (3)$$

where: *MRCA* – relative import penetration; *Mik* – the share of product *i* in the imports of country *k; Mjk* – imports of agri-food products in country *k; Mim* – the share of product *i* in imports on the European single market; *Mjm* – imports of agri-food products on the European single market

MRCA is interpreted inversely to *XRCA*. Values higher than 1 indicate that a given country does not have a comparative advantage.

iv) Relative trade advantage (RTA) is the difference between *XRCA* and *MRCA*, where a positive value denotes a comparative advantage, and a negative value denotes the absence of a comparative advantage [Equation (4)].

$$RTAik = XRCAik - MRCAik \quad (4)$$

where: *RTAik* – relative trade advantage; *XRCAik* – export revealed comparative advantage; *MRCAik* – relative import penetration

v) Foreign trade coverage ratio (*CRK*) measures the ratio of exports to imports [Equation (5)]. Values higher than 100 indicate that a country specializes in a given product and has a relative advantage over its trade partners. Values below 100 indicate that imports exceed exports; therefore, a country does not specialise in a given product (Czyżewski and Czakowski 2016).

$$CRK = \frac{Xk}{Mk} \quad (5)$$

where: *CRK* – foreign trade coverage ratio; *Xk* – exports of country *k*; *Mk* – imports of country *k*

vi) Grubel-Lloyd intra-industry trade index (*IITk*) measures intra-industry trade. High values of *IITk* (approximating 100) point to intra-industry trade, i.e. a country exports as much of a given productas it imports. The *IITk* denotes an exporting country's ability to cater to a foreign partner's demand, and it represents the adaptability and competitiveness of a given economy. Changes in the *IITk* were also analysed by the Grubel-Lloyd index (Pawlak and Lukasiewicz 2022). This parameter was determined within the range of the values proposed in the literature (0–1 point or 0–100%). High values of *IITk* indicate that most trade takes place within the same industrial branch (Pawlak and Lukasiewicz 2022) [Equation (6)].

$$IITk = \frac{(EXik + IMik) - (EXik - IMik)}{(EXik + IMik)} \quad (6)$$

where: *IITk* – Grubel-Lloyd intra-industry trade index of country *k*; *EXik* – export of product *i* in country *k*; *IMik* – import of product *i* in country *k*

RESULTS AND DISCUSSION

Between 2005 and 2021, the value of the dairy exports increased from EUR 899.6 million to EUR 2 553 million (by 184%). In the corresponding period, the value of the dairy imports increased from EUR 146.9 million to EUR 1 170 million (by 696%), and the trade balance increased from EUR 752.7 million to EUR 1 383 million (by 83.7%).

In 2021, dairy products with the highest export value were cheese and tvorog (EUR 905 million), liquid milk and cream (EUR 500 million), and condensed milk powder (EUR 320 million). In the same year, dairy products with the highest import value were cheese and tvorog (EUR 405 million), condensed milk powder (EUR 195 million), liquid milk and cream (EUR 150 million), and butter and milk fat (EUR 110 million). The dairy products were mainly exported to Germany, the Czech Republic, Italy, and the

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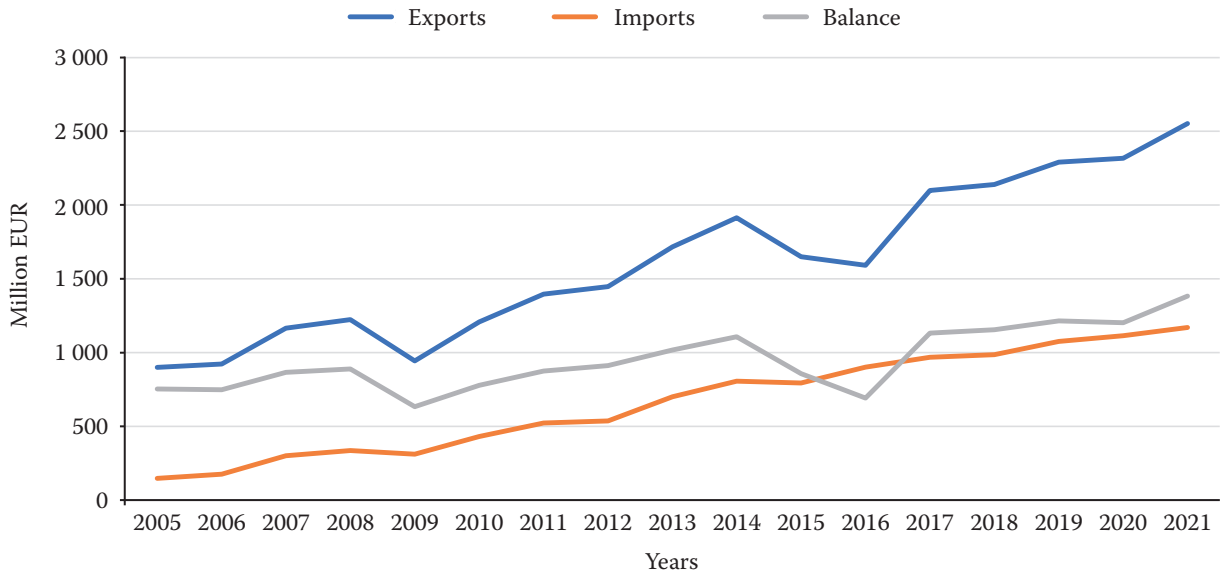

Figure 1. Foreign trade in milk and dairy products

Source: Own elaboration based on Szajner (2022)

Netherlands. The dairy products were mainly imported from the EU countries. The main import partners were: Germany, Lithuania, the Netherlands, the Czech Republic, France and Italy. In 2019, the import of cheese and tvorog increased by more than 10% compared to 2018 (Szajner 2022). The data presented in Figure 1 did not confirm the negative impact of COVID-19 on the dairy trade in Poland.

The analysis revealed that the greatest changes in the competitiveness occurred in the ice cream segment, where exports increased nearly 12 fold between 2005 and 2021 (Table 1). An equally high increase in exports was noted for whey, liquid milk and cream, and cheese and tvorog. In turn, the smallest increase in exports was observed for casein and condensed milk powder. In 2021, the greatest increase in exports relative to the

Table 1. Polish dairy exports (indices)

Years	Cheese and tvorog	Condensed milk powder	Liquid milk and cream	Whey	Yogurt and fermented milks	Butter and milk fat	Ice cream	Casein
2005	1	1	1	1	1	1	1	1
2006	1.165	0.763	1.252	1.766	1.318	0.499	1.581	0.337
2007	1.317	1.252	1.320	3.589	1.606	1.351	2.074	0.342
2008	1.747	1.003	1.401	1.452	1.650	0.880	2.212	0.399
2009	1.354	0.620	1.140	1.471	1.508	0.486	2.000	0.367
2010	1.619	0.608	1.497	1.435	1.533	0.507	2.074	0.342
2011	1.785	0.789	1.761	2.419	1.828	0.967	2.304	0.528
2012	2.033	0.842	1.700	4.199	1.702	1.044	2.903	0.642
2013	2.542	0.940	2.120	4.866	1.746	1.378	3.152	0.467
2014	2.415	1.564	2.476	4.665	1.927	1.367	3.535	0.405
2015	2.462	1.502	2.597	4.785	1.898	1.351	3.917	0.410
2016	2.298	0.677	2.597	3.591	1.499	1.476	4.521	0.367
2017	2.745	0.903	3.811	5.206	1.746	3.215	5.783	0.476
2018	2.867	0.769	3.618	4.426	1.898	3.547	8.065	0.364
2019	2.924	1.084	4.024	4.663	1.927	2.660	8.290	0.346
2020	3.024	1.161	3.865	4.687	1.803	2.311	9.756	0.374
2021	3.326	1.144	4.638	4.904	2.117	2.140	12.442	0.410

Source: Own elaboration based on Szajner (2022)

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2005 data was noted for ice cream (1 144%), liquid milk and cream (364%), whey (390%), cheese and tvorog (233%), butter and milk fat (114%), yogurt and fermented milk (112%), and condensed milk powder (14%). In the studied period, dairy exports increased by 155% on average. Casein was the only dairy product whose exports decreased from EUR 43.9 million to EUR 28 million (–59%).

The observed increase in Polish dairy exports resulted from access to the single market after Poland joined the EU. The other reason was a high level of self-sufficiency in milk which reached 118.3–123.9% in 2020–2021 and enabled Polish dairy companies to export the surplus production (Kita and Adenauer 2015). In addition, Polish dairy products were cheaper than those manufactured in the EU-15 countries. The weakening of the Polish zloty and lower production costs in Poland also ledto an increase in exports (Kita and Adenauer 2015). After Poland joined the EU, other contributing factors included the higher prices on the global market and the weakening of the Polish currency relative to the Euro (Kowalska et al. 2020).

The exports of dairy products are dependent on the milk supply. In 2021, dairy exports were the highest (EUR 249.1 million) in June when the milk production was the highest, and they were the lowest (EUR 182.5 million) in January when the milk supply was the lowest (Bórawski and Dunn 2015).

Between 2005 and 2021, the greatest increase in dairy imports (nearly 25-fold) was noted for liquid milk and cream. A considerable increase was also observed in the imports of yogurt and fermented milk (more than 15-fold). The smallest increase was noted in the casein and whey imports. In 2021, the greatest increase in dairy imports relative to 2005 was noted for liquid milk and cream (2 359%), ice cream (1 686%), yogurt and fermented milk (1 574%), condensed milk powder (1 158%), butter and milk fat (968%), cheese and tvorog (798%), whey (519%), and casein (9.9%). The total dairy imports increased by 701% in the analysed period.

The structure of the dairy imports was similar in the global market. The top dairy imports were cheese, condensed milk powder, whey, and butter (Davis and Hahn 2016).

As we can see from Table 2, the COVID-19 pandemic impacted the imports of dairy products. It can particularly be seen in liquid milk and cream, condensed milk powder and casein. This was the effect of disrupted supply chains. Bearing in mind that most of the Polish imports and exports of milk and dairy products are in the EU, the negative effect is seen, but its strengths were not so large. The COVID-19 pan-

Table 2. Polish dairy imports (indices)

Years	Cheese and tvorog	Condensed milk powder	Liquid milk and cream	Whey	Yogurt and fermented milks	Butter and milk fat	Ice cream	Casein
2005	1	1	1	1	1	1	1	1
2006	1.244	0.910	2.639	1.762	2.407	1.301	1.571	0.619
2007	1.809	2.394	5.656	3.048	6.111	2.097	2.107	0.768
2008	2.220	3.239	5.705	1.914	6.204	2.068	2.929	1.035
2009	2.364	3.006	4.574	1.571	4.463	2.485	2.500	0.652
2010	3.124	5.103	7.164	2.095	5.944	4.971	2.929	0.796
2011	3.761	6.265	10.607	2.257	7.833	6.000	3.411	0.796
2012	3.769	6.329	11.475	2.390	7.463	4.553	4.750	1.041
2013	4.902	9.987	17.328	4.629	7.907	5.806	5.089	0.686
2014	5.490	13.110	15.148	5.086	9.796	5.592	5.518	0.816
2015	5.432	12.258	14.754	4.762	9.259	5.243	5.000	0.638
2016	6.375	14.981	20.984	2.857	13.463	6.000	7.179	0.860
2017	7.395	10.400	26.557	4.686	15.463	10.738	9.089	0.755
2018	7.539	9.355	26.230	4.762	17.593	10.194	12.500	0.709
2019	8.461	12.258	27.803	4.590	14.370	8.398	12.018	0.984
2020	8.386	13.387	26.311	6.057	13.463	8.184	14.714	1.144
2021	8.980	12.581	24.590	6.190	15.741	10.680	17.857	1.064

Source: Own elaboration based on Szajner (2022)

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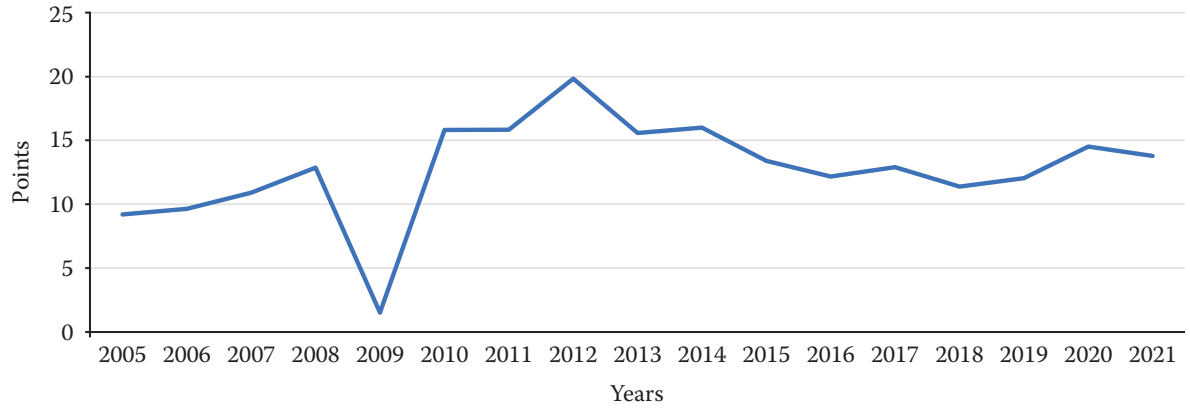

Figure 2. Export specialization index (*SI*) for dairy product

Source: Own elaboration based on Szajner (2022)

demic impacted the milk market structure, per capita income, and limited consumer purchases (Acosta et al. 2021).

The *SI* is presented in Figure 2. The *SI* remained stable (around 14 points) in the analysed period. This parameter was lowest in 2009, which indicates that milk and dairy exports decreased in response to the global financial crisis. The data suggest that dairy exports are influenced by the market performance. The *SI* peaked in 2012, which suggests that Polish dairy products were characterised by the greatest comparative advantage and that the demand for dairy products in the EU and other countries was highest in that year.

The values of *XRCA*, *MRCA*, and *RTA* are presented in Figure 3. *XRCA* values point to the competitiveness of the Polish dairy sector. This index is expressed in points as the ratio of two ratios. The first ratio denotes the share of a specific dairy product in Polish exports to the share of the same dairy product in EU exports, whereas the second ratio is the share of Poland's total dairy exports to total dairy exports in the EU. The value of *XRCA* was highest in the first years after Poland's accession to the EU.

MRCA is also calculated as a ratio of two ratios, but for imports rather than exports. The first ratio denotes the share of a specific dairy product in the Polish imports to the share of the same dairy product in the EU imports, whereas the second is the ratio of Poland's total dairy imports to the total dairy imports in the EU. The values of *MRCA* exceeded *XRCA*, which in-

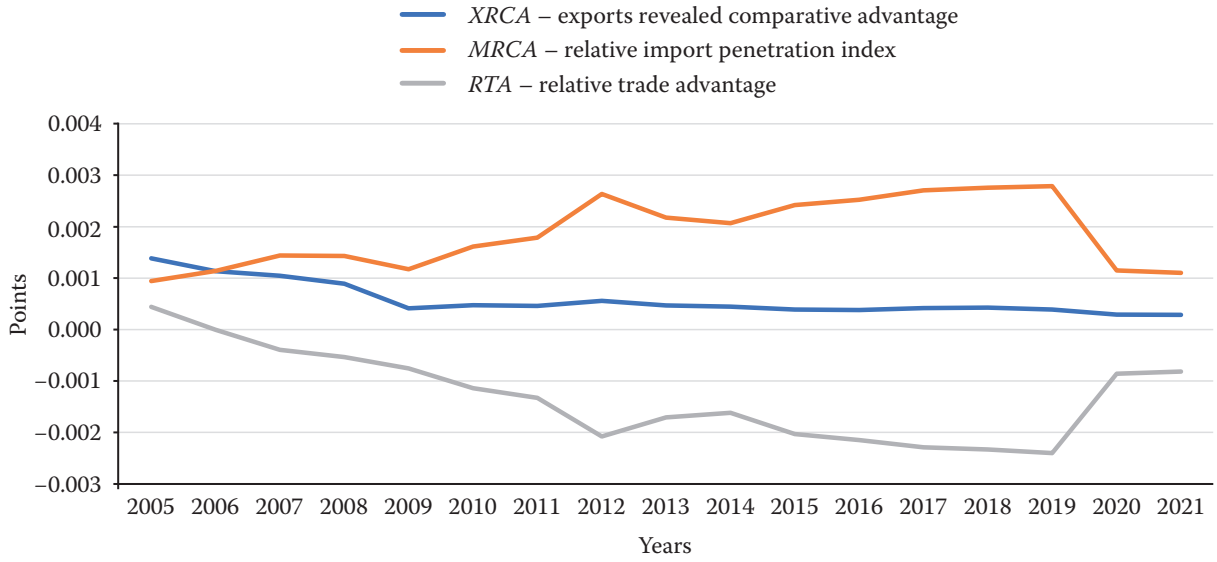

Figure 3. *XRCA*, *MRCA* and *RTA* for dairy products

MRCA – relative import penetration index; *RTA* – relative trade advantage; *XRCA* – export revealed comparative advantage

Source: Own elaboration

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Table 3. Foreign trade coverage ratio (*CRK*) for dairy products (points)

Years	Dairy products	Cheese and tvorog	Condensed milk powder	Liquid milk and cream	Whey	Yogurt and fermented milks	Butter and milk fat	Ice cream	Casein
2005	612.389	603.326	1 803.871	1 767.213	398.095	1 268.519	862.136	387.500	77.837
2006	527.429	565.062	1 513.475	838.509	398.919	694.615	330.597	389.773	42.407
2007	388.993	439.216	943.396	412.464	468.750	333.333	555.556	381.356	34.642
2008	365.452	474.925	558.765	433.908	301.990	337.313	366.667	292.683	29.966
2009	304.062	345.685	371.888	440.502	372.727	428.631	168.750	310.000	43.750
2010	280.758	312.704	214.918	369.336	272.727	327.103	87.891	274.390	33.408
2011	267.349	286.439	227.291	293.354	426.582	295.981	138.997	261.780	51.670
2012	270.138	325.471	239.857	261.857	699.203	289.330	197.655	236.842	48.041
2013	245.378	312.890	169.767	216.178	418.519	280.094	204.682	240.000	52.972
2014	237.533	265.347	215.157	288.853	365.169	249.527	210.764	248.220	38.696
2015	207.885	273.469	221.053	311.111	400.000	260.000	222.222	303.571	50.000
2016	176.779	217.461	81.481	218.750	500.333	141.265	212.136	244.030	33.196
2017	216.963	223.988	156.576	253.580	442.276	143.234	258.137	246.562	49.061
2018	217.259	229.412	148.276	243.750	370.000	136.842	300.000	250.000	40.000
2019	212.812	208.464	159.474	255.778	404.357	170.103	273.064	267.311	27.387
2020	208.036	217.557	156.434	259.626	308.019	169.876	243.416	256.917	25.426
2021	218.205	223.457	164.103	333.333	315.385	170.588	172.727	270.000	0.300

Source: Own elaboration based on Szajner (2022)

dicates that imports grew at a faster rate than exports. As a result, RTA was negative from 2007. *MRCA* was positive and exceeded the *XRCA* values from 2007, which points to a growing demand for imported dairy products in Poland.

As we can see from Figure 3, the COVID-19 pandemic impacted the trade indicators. These changes may be due to the decrease in the demand for dairy and the process of automatization (Weersink et al. 2020).

Table 4. Grubel-Lloyd intra-industry trade index (*IITk*) (points)

Years	Dairy products	Cheese and tvorog	Condensed milk powder	Liquid milk and cream	Whey	Yogurt and fermented milks	Butter and milk fat	Ice cream	Casein
2005	0.281	0.284	0.105	0.107	0.402	0.146	0.208	0.410	0.875
2006	0.319	0.301	0.124	0.213	0.401	0.252	0.464	0.408	0.596
2007	0.409	0.371	0.192	0.390	0.352	0.462	0.305	0.415	0.515
2008	0.430	0.348	0.304	0.375	0.498	0.457	0.429	0.509	0.461
2009	0.495	0.449	0.424	0.370	0.423	0.378	0.744	0.488	0.609
2010	0.525	0.485	0.635	0.426	0.537	0.468	0.936	0.534	0.501
2011	0.544	0.518	0.611	0.508	0.380	0.505	0.837	0.553	0.681
2012	0.540	0.470	0.588	0.553	0.250	0.514	0.672	0.594	0.649
2013	0.579	0.484	0.741	0.633	0.386	0.526	0.656	0.588	0.693
2014	0.593	0.547	0.635	0.514	0.430	0.572	0.644	0.574	0.558
2015	0.650	0.536	0.623	0.486	0.400	0.556	0.621	0.496	0.667
2016	0.723	0.630	0.898	0.627	0.333	0.829	0.641	0.581	0.498
2017	0.631	0.617	0.779	0.566	0.369	0.822	0.558	0.577	0.658
2018	0.630	0.607	0.806	0.582	0.426	0.844	0.500	0.571	0.571
2019	0.639	0.648	0.771	0.562	0.397	0.740	0.536	0.544	0.430
2020	0.649	0.630	0.780	0.556	0.490	0.741	0.582	0.560	0.405
2021	0.629	0.618	0.757	0.462	0.481	0.739	0.733	0.541	0.462

Source: Own elaboration based on Szajner (2022)

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CRK is the ratio of exports to imports. This parameter was calculated by dividing the dairy exports by dairy imports in each year of the analysed period. The *CRK* value was highest in 2005. This parameter decreased gradually in the successive years, and its value stabilised in the last years of the studied period (Table 3). The *CRK* value for most dairy products was below 100%. Similar trends were observed in the agri-food market: the *CRK* value was below 100% before Poland joined the EU and exceeded 100% after the accession. This parameter changed dynamically in the studied period (Pawlak and Lukasiewicz 2022). The *CRK* value was below 100% only for casein, which indicates that surplus casein could not be exported. Casein production is relatively low in the Polish dairy sector.

The COVID-19 pandemic did not have a negative impact on the foreign trade coverage ratio (*CRK*) for dairy products. This was the effect of the process of polish dairy products which are cheaper compared to other European Union (EU) countries.

The highest values of *IITk* were noted for butter and milk fat, yogurt and fermented milk, condensed milk powder, and cheese and tvorog. The time series analysis revealed a minor increase in the *IITk* values between 2005 and 2021, which could be attributed to a general improvement in the performance of the dairy market, as wellas to an increase in the competitiveness of Polish dairy products (Table 4).

The Grubel-Lloyd intra-industry trade index (*IITk*) was not affected much by the COVID-19 pandemic. The value of the indicators decreased more in liquid milk and cream, cheese and tvorog and condensed milk powder in 2019–2021. However, butter and milk fat and casein increased in the analysed indicator.

CONCLUSION

This study was undertaken to assess the competitiveness of Polish dairy products. The competitiveness was evaluated by analysing the dairy exports, imports, and the trade balance on international markets. The results of the analysis indicate that the competitiveness of Polish dairy products improved significantly after Poland joined the EU and gained access to the single market.

In the EU, the competitiveness of dairy products is influenced by the CAP (Bojnec and Fertő 2013) which directly contributes to the sustainable development. In the dairy market, the achievement of sustainable development goals in the economic, social, and environmental dimensions are determined by the comparative advantage, product diversification, and supply chain continuity in the global market.

The trade balance for dairy products has been positive ever since Poland joined the EU market, and it continues to increase. Production costs are lower in Poland, which increases the comparative advantage of Polish dairy products. Dairy imports grew at a higher rate than dairy exports between 2005 and 2021. However, the weakening of the Polish zloty increased the proceeds from Polish dairy exports.

The *SI* for dairy products remained high in the analysed period, and its lowest value was noted in 2009, which indicates that the dairy market was affected by the global financial crisis. Beginning in 2006, the values of *MRCA* exceeded the values of *XRCA*, which suggests that the Polish market was susceptible to dairy imports. However, the volume of dairy products sold on the retail market is determined by the lower production and sales costs in Poland. These results indicate that Polish dairy products have a comparative advantage in the European single market. The *CRK* value was highest in the first years after Poland's accession to the EU. An analysis of the *CRK* values indicates that dairy exports exceeded imports several-fold, in particular in the segment of butter, milk fat, yogurt, and fermented milk.

The imports of dairy products were affected by the COVID-19, which was the effect of broken supply chains. The dairy products imported to Poland come from countries having big farms. Such farms were affected the most. The export of dairy products was affected less because it relied on domestic products. Polish dairy farms are smaller compared to western European Union (EU) countries and they were affected less by the COVID-19 pandemic.

The analysis revealed that Polish dairy products are competitive. The *SI* value was high in the analysed period, and its lowest value was noted in 2009, which suggests that the dairy market is highly susceptible to global financial crises.

The values of *XRCA* were positive, but low between 2005 and 2021, which indicates that Polish dairy products performed well in foreign markets. Changes in the *XRCA* values can also be attributed to macroeconomic processes, including the global financial crisis, COVID-19 pandemic, and the Russian invasion of Ukraine.

The values of *MRCA* were positive in the studied period (2005–2021), which indicates that the demand for imported products was high in Poland. The volume and value of the dairy imports increased at a faster rate than the value of the dairy exports. In the analysed period, the value of dairy exports increased by 184%; the

https://doi.org/10.17221/322/2022-AGRICECON

value of dairy imports increased by 696%, and the trade balance increased by 84%.

The *CRK* value exceeded 100% for most dairy products. The only exception was casein, for which the *CRK* value was below 100%. Casein production is low in Poland, and, thus, this item must be imported.

The *IITk* value was positive between 2005 and 2021. The highest values of *IITk* were noted for the most competitive Polish dairy products, including butter and milk fat, yogurt and fermented milk, condensed milk powder, and cheese and tvorog. These observations suggest that the competitiveness of Polish dairy products remained high and continued to increase in the studied period.

The milk market in Poland was affected by the COVID-19 pandemic. However, the effects were not equal for all the market participants. Small dairy farmers did not feel the negative impact much because they did not rely on purchasing fodder. Dairy enterprises and bigger farms were affected to a larger extent because they rely on supply chains.

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Received: October 18, 2022
Accepted: December 1, 2022