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Return on Equity in Dairy Farms from Selected EU Countries: Assessment Based on the DuPont Model in Years 2004–2020

Andrzej Parzonko [1], Anna Justyna Parzonko [2,*], Piotr Bórawski [3] and Ludwik Wicki [1]

[1] Department of Economics and Organization of Enterprises, Faculty of Economics, Institute of Economics and Finance, Warsaw University of Life Science SGGW-Warsaw, 02-787 Warszawa, Poland; andrzej_parzonko@sggw.edu.pl (A.P.); ludwik_wicki@sggw.edu.pl (L.W.)
[2] Department of Tourism, Social Communication and Consulting, Faculty of Economics, Institute of Economics and Finance, Warsaw University of Life Science SGGW-Warsaw, 02-787 Warszawa, Poland
[3] Department of Agrotechnology and Agribusiness, Faculty Agriculture and Forestry, University of Warmia and Mazury in Olsztyn, 10-719 Olsztyn, Poland; pboraw@uwm.edu.pl
* Correspondence: anna_parzonko@sggw.edu.pl; Tel.: +48-22-59-34-162

Abstract: The European Union dairy sector plays a significant role in supplying dairy products to consumers all over the world. The aim of this study was to examine changes in the return on equity as one of the main financial indicators determining the economic viability of EU dairy farms in the years 2004–2020. The analysis based on the DuPont model was used to determine the main drivers of return on equity in dairy farms from the five studied EU countries. The research results show that (1) the lowest return on equity in the years 2004–2020 was calculated for average farms from the Netherlands, and the reason for this phenomenon was the use of significant assets in the production, mainly resources that are very expensive in the Netherlands—land and human labor; (2) the highest return on equity was characteristic of dairy farms from France, and the factor strongly determining the favorable value of this ratio was the high degree of financing assets with low-interest loans and credits; (3) despite the lowest production potential and small scale of milk production, average Polish farms in the years 2004–2020 were characterized by a relatively high return on equity, which ranged from 4.97% to 14.9%.

Keywords: EU countries; dairy farms; return on equity; DuPont model

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1. Introduction

The European Union member states play a significant role in the global production and processing of milk [1]. In the years 2004–2022, milk production in the EU increased from 134.45 to 154.13 million tons. These figures accounted, respectively, for 21.4% and 17.1% of global milk production. A significant part of dairy products produced in EU countries was exported to third countries. In 2022, exports of butter, cheese, skimmed milk powder and whole milk powder amounted to 257.13; 1455.66; 813.63; 285.44 thousand tons, respectively. Moreover, 40.4% of exported cheese came from the EU, while skimmed milk powder and butter accounted for 29.4% and 25.9% of global exports, respectively [2]. The cited data prove that EU countries are among the leading global suppliers of dairy products.

The World Bank data show that the world population will increase to 8.522 billion in 2030, and in 2050 it will reach 9.870 billion [3]. Population growth will inevitably generate an increased demand for food, including dairy products. Furthermore, the rising standard of living in many developing countries is driving the demand for higher-quality food, in particular for products of animal origin. For example, the daily per capita protein consumption from animal products in China between the 1960s and 2021 increased by about 10 times, from 4 to over 40 g. However, it is still significantly lower than in Europe, where it is almost 60 g, or in North America, where it exceeds 70 g. In turn, in Africa, it is barely 15 g, while in Asia, despite the dynamic growth in many countries of this

continent, including primarily China, it still does not exceed 30 g daily per capita. To cater for the demand for animal-based protein, it is rational to promote the breeding of ruminant animals (cattle, sheep, goats, etc.), which process plants that are not directly used as food by humans, e.g., grass from pastures [4].

The downside of increasing the number of ruminants, especially cattle, is the high environmental impact of this type of farming. These animals emit greenhouse gases into the atmosphere (methane, carbon dioxide, and nitrogen oxide), which contribute to climate change, while climate change mitigation and keeping high environmental standards is one of key objectives of EU policy [5,6]. In addition, the high labor and capital intensity of this direction of agricultural production discourages especially young farmers from its continuation and development [7].

The development of the dairy sector, especially farms specialized in cattle breeding and milk production in EU countries, depends on a variety of factors related to market and environmental conditions, politics, and history [8,9].

One of the basic parameters determining the operations and development of dairy farms in the free market economy is the profitability of production. It can be analyzed differently. The financial results obtained from dairy farms can be related to the used factors of production, such as labor and capital. Therefore, the economic efficiency of labor (labor profitability), already raised by the classics of economics, e.g., by A. Smith in 1776 in his work The Wealth of Nations [10], still determines the behavior of entrepreneurs, including farmers. Most often, they do not accept income from work below the average in a given society (usually, due to differences in the level of economic development; the reference point are salaries in national economies) and take actions.

An indicator that is no less important in determining decisions to continue and develop business activity is the return on equity [11]. Entrepreneurs, including farmers, are looking for activities that are characterized by a high return on employed capital. The problem is quite complex since agricultural activity, especially involving animal husbandry, is capital-intensive, and the profitability of the invested capital is relatively low. Therefore, farmers, especially young farmers and operators of farms characterized by not the best production potential consider if it would be better to manage the capital invested in the assets (resources) of a farm in a different way. The alternatives include (1) changing the direction of production to a less labor-intensive one and taking up work outside the farm, (2) selling assets and investing in certain securities (e.g., bonds) and (3) abandoning production on the farm and taking up work outside farming. Undoubtedly, such actions may contribute to reducing milk production in the EU in the future.

Therefore, the main purpose of this study is to present changes in return on equity (ROE) as one of the main financial indicators determining the economic rationality of dairy farms from selected EU countries in the years 2004–2020. The study will address the following research questions: (1) How was the return on equity change in the years 2004–2020 on dairy farms in EU countries who were the largest milk producers in 2020 (Germany, France, Poland, the Netherlands, Italy)? (2) What factors determined changes in return on equity? (3) What changes occurred in the number of dairy farms and the scale of production in the years 2004–2020 in individual EU countries, e.g., influenced by economic factors? The research includes an analysis based on the DuPont model used to determine the main drivers of return on equity in dairy farms from five studied EU countries.

2. Changes in Milk Production and Economic Strength of Dairy Farms in EU Countries in 2004–2020

In 2022, the number of the EU member states was 27 and the last change to this number was caused by Brexit in January 2020, when the UK left the organization. One of the basic policies of the EU is the common agricultural policy (CAP), which defines the basic framework and directions for the development of the food sector, including agricultural holdings. The idea of a CAP was born in the European Community in the 1950s and was a response to the problems of food shortages emerging after World War II [12,13]. Therefore,

this policy primarily promoted the increase in food production to ensure supplies of food at affordable prices, while guaranteeing the viability of the agricultural sector. Currently, 10 basic objectives have been defined under the EU CAP for the years 2023–2027: (1) ensuring viable farm income, (2) increasing competitiveness, (3) improving farmers' position in value chains, (4) mitigating climate change, (5) efficient natural resource management, (6) halting and reversing biodiversity loss, (7) fostering structural change and generational renewal, (8) ensuring jobs and growth in rural areas, (9) responding to societal demands on food quality and health, and (10) fostering knowledge and innovation [14]. The presented objectives are in line with the EU climate policy and impose certain restrictions on the intensity of agricultural production, which causes controversies in individual EU countries [15].

These objectives are consistent with the concept of the sustainable development of agriculture, which attempts to balance economic, environmental and social goals. Despite the importance of social and environmental goals, especially in the macroeconomic perspective, the financial results achieved by a single farm are the basis for taking decisions regarding the directions of farm development or leaving agriculture. Therefore, studies on the profitability of agricultural activity and the profitability of employed capital provide the basis for assessing the effectiveness of the mechanisms of the Common Agricultural Policy of the EU.

Despite their geographical proximity, the cultural, natural, and economic resources of individual EU countries are quite diverse. Similarly, diversity concerns the development of the dairy sector and is manifested by the scale of milk production and processing, the economic strength of dairy farms, milk processing advancement, and the degree of self-sufficiency regarding dairy products [16]. The largest milk producer in the EU is Germany (Table 1). In 2021, milk production in Germany amounted to 32.092 million tons which represented an increase of 4.26 million tons compared to that in 2004. Other leading milk producers in the EU include France, Poland, the Netherlands and Italy. In 2021, these five EU countries produced 64.7% of milk from the entire EU. The largest quantity increases in milk production from 2004 to the end of 2021 were recorded by the following states: Germany (4.26 million tons), Ireland (3.71 million tons), the Netherlands (3.31 million tons), Poland (3.06 million tons), and Italy (2.47 million tons) (Table 1).

Dairy farms in EU countries are quite diverse in terms of the scale and intensity of milk production (Table 2). In 2020, there were over 467,000 dairy farms in the EU. The largest number of them was in Romania (134,070) and they were holdings with the lowest volume of milk production. On average, in 2020, milk production from a Romanian farm was only 27.45 thousand kg, which, considering the average milk yield per cow, gives only about five animals [17]. The farm structure of farms in countries such as Bulgaria, Poland, Lithuania, Latvia and Slovenia is characterized by a significant number of holdings with a relatively small production scale. At the other end of dairy farm spectrum based on the scale of milk production were holdings from the following countries: Czechia, Denmark, Estonia, and the Netherlands. Countries with the biggest share of the largest farms, characterized by an average annual production exceeding EUR 500,000 in 2020, included Denmark and Cyprus, at 76% and 74%, respectively (Table 2).

The large diversity of dairy farms in individual EU countries results from historical conditions and political decisions. After World War II, Eastern and Central European countries were in the sphere of influence of the USSR where socialist concepts were implemented, while other countries constituting so-called Western Europe were in the sphere of influence of the US and developed market economies. In 1991, after the collapse of the USSR, most Central and Eastern European countries transitioned towards a market economy. In 2004, Cyprus and Malta joined the EU along with eight Central and Eastern European countries—Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia. In 2007, two more countries—Bulgaria and Romania—joined the EU. The expansion of the EU has brought benefits for the entire European Community [18]. However, different models of farming in the countries of Central and Eastern Europe during the

period of real socialism and diverse models of systemic transformation adopted after 1991 have caused significant differences in the organizational and legal form of farms as well as the scale and intensity of production in this region [19]. Dairy farms in Czechia are the biggest regarding milk production, land size and capital resources [20]. This resulted from the fact that after 1991, most large state-owned agricultural enterprises that dominated Czech agriculture were fully privatized and transformed into business partnerships. In Poland, the rural community strongly resisted the creation of state-owned farms in the period 1945–1991 and small family farms survived even though the state authorities in the period 1945–1989 attempted to impede their development [21]. The changes implemented after 1991 and the further transformation that took place after Poland's accession to the EU did not fundamentally change the existing farm structure. Polish farms, including those specializing in breeding cattle and milk production, are still among the smallest in the EU [22]. Considering the significant diversification of dairy farms in EU countries, operating on the single market after 2004, this study aims to examine changes in the level of the profitability of production and return on equity in this group of business entities and the prospects of their further operations.

Table 1. Production of milk in EU in years 2004–2021.

No.	Countries	Year					Increase in Milk Production in 2021 Compared to 2004	
		2004	2010	2015	2021			
		(M ton)	(M ton)	(M ton)	(M ton)	Per capita (kg)	(M ton)	%
1	Germany	28.24	29.63	32.67	32.51	390.92	4.26	15.09
2	France	24.33	24.03	25.82	24.78	366.24	0.44	1.83
3	Poland	11.82	12.28	13.24	14.88	393.26	3.06	25.88
4	Netherlands	10.91	11.63	13.52	14.22	813.54	3.31	30.37
5	Italy	10.73	11.40	11.43	13.20	222.88	2.47	23.07
6	Ireland	5.31	5.35	6.60	9.02	1801.93	3.71	69.98
7	Spain	6.64	6.36	7.03	7.62	160.83	0.99	14.89
8	Denmark	4.57	4.83	5.28	5.64	966.43	1.08	23.54
9	Belgium	3.41	3.87	3.83	4.43	383.76	1.02	29.85
10	Austria	3.14	3.26	3.54	3.83	428.78	0.69	22.08
11	Romania	5.02	3.94	3.98	3.64	189.41	−1.39	−27.61
12	Czechia	2.60	2.68	3.03	3.31	315.38	0.71	27.19
13	Sweden	3.28	2.86	2.93	2.78	268.05	−0.49	−15.05
14	Finland	2.45	2.34	2.44	2.31	418.31	−0.13	−5.47
15	Hungary	1.89	1.68	1.94	2.08	213.78	0.19	9.80
16	Portugal	2.01	1.92	2.01	2.00	193.78	−0.01	−0.72
17	Lithuania	1.84	1.73	1.73	1.47	526.98	−0.37	−20.00
18	Latvia	0.78	0.83	0.98	0.99	523.08	0.21	26.32
19	Slovakia	1.08	0.92	0.93	0.90	165.33	−0.18	−16.34
20	Estonia	0.65	0.68	0.78	0.84	630.57	0.19	28.65
21	Bulgaria	1.35	10.95	1.03	0.84	120.87	−0.51	−37.84
22	Greece	0.77	0.67	0.76	0.71	66.58	−0.06	−7.43
23	Slovenia	0.65	0.60	0.63	0.64	303.43	−0.01	−1.61
24	Croatia	0.68	0.79	0.69	0.56	138.00	−0.13	−18.45
25	Luxembourg	0.27	0.30	0.35	0.44	698.38	0.17	65.07
26	Cyprus	0.15	0.15	0.17	0.30	332.74	0.15	97.16
27	Malta	0.04	0.04	0.04	0.04	76.61	0.00	−5.83
Total		134.62	145.73	147.38	153.99	344.49	19.37	14.39

Source: Eurostat data.

Table 2. Number of dairy farms in EU countries in 2020 by economic size class.

No.	Countries	Number of Farms in 2020 by Economic Size							Average Annual Milk Production in 2020 per Farm [Thousand kg]
		From over 0 to 15,000 EUR	From 15,000 to 49,999 EUR	From 50,000 to 99,999 EUR	From 100,000 to 249,999 EUR	From 250,000 to 499,999 EUR	500,000 EUR or over	Total	
1	Germany	260	3820	7730	16,880	11,260	4770	44,720	741.61
2	France	350	1010	3330	16,930	11,610	2070	35,300	714.87
3	Poland	18,910	36,590	24,800	9110	860	220	90,490	160.27
4	Netherlands	20	80	240	2630	7330	4170	14,470	1003.59
5	Italy	2220	5670	4410	5800	3490	2850	24,440	520.15
6	Ireland	0	620	2350	8150	3430	760	15,310	557.92
7	Spain	910	2150	3050	4070	1590	770	12,540	606.54
8	Denmark	0	20	20	180	380	1890	2490	2275.50
9	Belgium	40	70	150	1390	1790	680	4120	1079.89
10	Austria	1130	8190	8570	5940	450	30	24,310	156.95
11	Romania	116,490	14,350	2280	750	120	80	134,070	27.45
12	Czechia	120	100	130	190	100	260	900	3630.81
13	Sweden	0	20	110	690	1080	1120	3020	918.13
14	Finland	40	330	1250	2420	1040	310	5390	446.48
15	Hungary	1100	860	300	210	80	180	2730	737.85
16	Portugal	240	550	1040	1630	620	220	4300	464.43
17	Lithuania	9410	2780	910	530	120	50	13,800	107.83
18	Latvia	4400	1990	520	390	110	80	7490	131.94
19	Slovakia	1080	240	50	40	30	130	1570	584.52
20	Estonia	170	110	80	90	70	140	660	1285.30
21	Bulgaria	10,460	2090	1160	590	80	50	14,430	61.12
22	Greece	110	300	260	370	90	30	1160	589.19
23	Slovenia	250	2210	1290	630	60	10	4450	141.72
24	Croatia	1,710	1580	580	260	30	30	4190	142.24
25	Luxembourg	0	0	20	180	250	70	520	860.27
26	Cyprus	0	0		10	40	140	190	1448.21
27	Malta	0	0	10	30	20	10	70	601.57
Total		169,420	85,730	64,640	80,090	46,130	21,120	467,130	330.00

Source: based on Eurostat data.

3. Materials and Methods

To fulfil the research objective, we used data from EU Farm Accountancy Data Network (FADN). This is a European system for collecting accountancy data from agricultural holdings. It was formally established in 1965. The network expanded its reach alongside the expansion of the European structures. FADN is one of the tools used in the programming and implementation of the tasks of the Common Agricultural Policy [23]. The data collected by this network are used primarily for the annual determination of the income of farms operating in the EU and the assessment of measures taken under the common agricultural policy.

The European FADN covers commercial agricultural holdings that produce about 90% of the value of standard output in a given region or country. A certain weakness of the system is that its field of observation does not include semi-subsistence farms. One can also have minor reservations about the way source information is obtained from agricultural holdings. The way economic events are recorded differs from one EU country to another. Nevertheless, the FADN system is the only one in the EU that allows a comparison of economic parameters from farms in different EU countries.

Farms are grouped according to the type of farming, which is determined based on the share of revenues from a given activity in the structure of total revenues. This analysis focuses on farms specializing in milk production (dairy farms) and, according to the FADN methodology, these are entities that have a minimum share of milk sales of 60% in the structure of the farm's total income. Due to the need for transparency and relevance in this study, the research sample was limited to dairy farms from five countries with the highest milk production in 2020 in the EU: Germany, France, Poland, the Netherlands and Italy (Table 1).

The analysis involved the use of the parameters of an average dairy farm from the selected EU countries in the years 2004–2020 based on data from FADN. The parameters of an average dairy farm were determined in accordance with the FADN methodology. When determining them, the sum of individual measures (e.g., SE026—arable land (ha)) of all dairy farms constituting the sample of farms was divided by the number of farms in the sample (arithmetic mean). The number of dairy farms in the sample and the basic parameters of an average dairy farm from the countries included in the analysis are presented in Table 3.

Table 3. Number and production potential of dairy farms from EU countries in 2020 covered by the FADN.

No.	Countries	Number of Monitored Agricultural Holdings	Average Number of Cows per Farm (LSU)	Average Arable Land Size [ha]	Average Value of Sales of Milk (EUR)	Average Value of Farm Assets (EUR)
1	Germany	51,236	70.7	81.8	206,426	1,025,860
2	France	39,683	66.6	99.7	180,439	530,750
3	Poland	94,137	17.6	21.3	31,644	243,695
4	Netherlands	16,426	102.5	59.7	339,562	3,998,026
5	Italy	29,727	58.9	35.1	179,286	934,583

Source: data from the EU FADN (2023).

To assess changes in the economic efficiency of the studied EU dairy farms, this research applies the DuPont model. It enables the identification of key areas of activity of an economic entity (including a farm) that impact the return on equity (ROE) [24]. The DuPont analysis is used to decompose the different drivers of return on equity (Figure 1). The model, based on selected items from the profit and loss account and the balance sheet, shows a cause and effect relationships between general indicators (ROE, ROA, and ROS) and more detailed indicators at the lower levels of the pyramid. The analysis identifies the causes of good or poor use of capital and enables the prediction of future results.

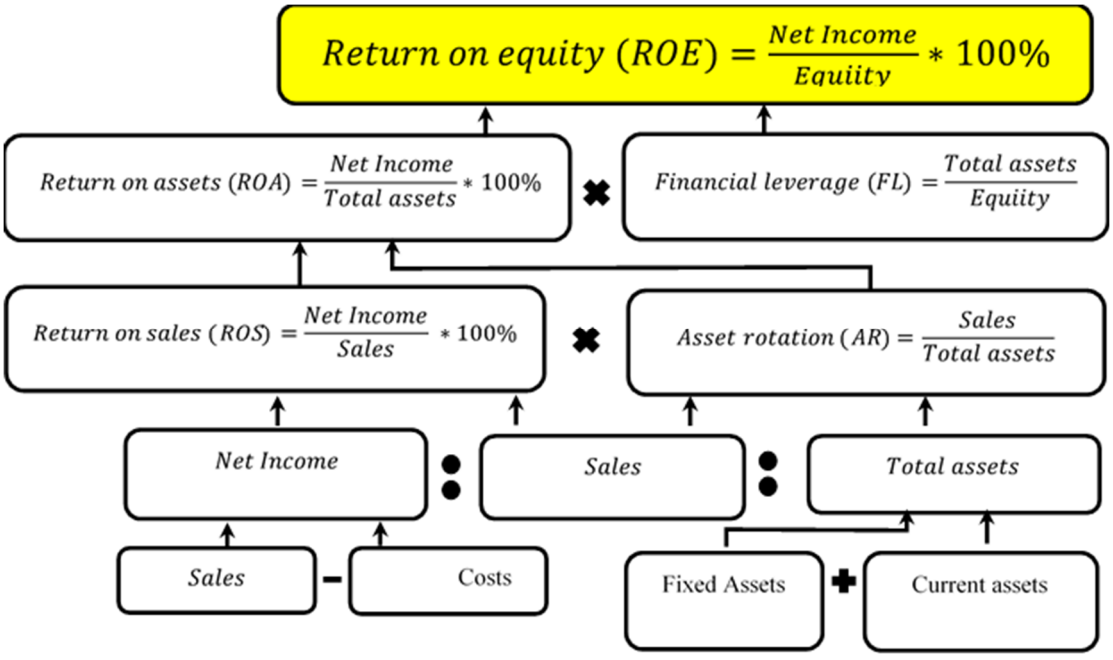

Figure 1. DuPont model; Source: [25].

ROE is a measure of the benefits derived by owners from employed capital. This indicator determines what profit the enterprise (farm) obtains from 1 EUR of equity. The higher the ROE value, the faster the time to recover the invested capital. The ROE value is one of the main criteria for the selection of investments by investors.

The financial leverage effect (FL) is an increase in the return on equity due to an increase in debt. Financial leverage shows what part of assets is financed by equity. The leverage enables the increase in the value of assets without the need to invest one's own cash, enabling an increase in the return on equity. Positive leverage occurs only when the return on assets exceeds the interest on debt.

ROA informs about the ability of an enterprise (farm) to generate profits using its own assets and the effectiveness of its management of them. ROA indicates how much profit each 1 EUR generates per asset unit.

The logarithmic method was used to calculate the impact of factors having a significant impact on the decrease or the increase in return on equity (ROE). This tool makes it possible to determine deviations between comparable quantities.

$$\Delta Z_{(ROS)} = (ROE_1 - ROE_0) * \frac{\log \frac{ROS_1}{ROS_0}}{\log \frac{ROE_1}{ROE_0}}$$

$$\Delta Z_{(AR)} = (ROE_1 - ROE_0) * \frac{\log \frac{AR_1}{AR_0}}{\log \frac{ROE_1}{ROE_0}}$$

$$\Delta Z_{(FL)} = (ROE_1 - ROE_0) * \frac{\log \frac{FL_1}{FL_0}}{\log \frac{ROE_1}{ROE_0}}$$

where ROS_1; AR_1; FL_1 are variables for the current period, ROS_0; AR_0; FL_0 are variables for the base period (2004), $\Delta Z_{(ROS)}$ is the impact of return on sales (ROS) on return on equity (ROE), $\Delta Z_{(AR)}$ is the impact of asset rotation (AR) on return on equity (ROE) $\Delta Z_{(FL)}$ is the impact of financial leverage (FL) on return on equity (ROE).

4. Results

4.1. Return on Equity in Average Dairy Farms from Selected EU Countries

Dairy farms from the studied EU countries successively increased milk production, which on the one hand generated higher revenues and income, and on the other hand caused a need to engage more assets, especially fixed ones, in the production potential.

Among the factors stimulating an increase in the scale of production on dairy farms from EU countries is the successive change since 2003 in EU agricultural policy towards the greater liberalization of the milk market [26]. As a consequence, the milk production quota mechanism, which had been in place in EU countries since 1984, was abandoned in 2015. Farmers after 2015, without the threat of paying a penalty for not having a milk quota, were able to increase their milk production. Dairy farms that had sufficient land resources necessary for roughage production increased the scale of milk production quite rapidly [27,28].

In the years 2004–2020, the largest increase in total assets was recorded in dairy farms from the Netherlands. On an average Dutch farm, total assets increased from EUR 2,114,376 to EUR 3,998,026 (Table 4). Such a significant growth in production potential generated an increase in income from a dairy farm by merely EUR 16,663, while the average annual revenue rose by EUR 226,852. These figures show that generating income from a dairy farm in the Netherlands comes with the burden of excessive costs. Among the presented average EU dairy farms, farms from Poland visibly stood out in terms of involved assets and earned income. Despite a significant increase in assets in 2004–2020 from EUR 71,066 to EUR 243,695 (almost 3.5 times), their value was almost twice smaller compared to that of holdings from France (the following country in this category). Income earned from an average Polish dairy farm in 2020 amounted to EUR 19,251 and increased by over 2.6 times

compared to that in 2004 but was over twice lower than that of an average dairy farm in France (Table 4).

Table 4. Selected measures presenting the economic results of average dairy farms from selected EU countries in 2004 and 2020.

No.	Countries	Average Revenue from Dairy Farm (EUR)		Average Income from Dairy Farm (EUR)		Average Assets Value (EUR)	
		2004	2020	2004	2020	2004	2020
1	Germany	125,617	289,361	28,423	44,188	631,747	1,025,860
2	France	116,627	238,261	27,090	42,550	292,899	530,750
3	Poland	17,806	42,663	7250	19,251	71,066	243,695
4	Netherlands	186,209	413,061	37,911	54,574	2,114,376	3,998,026
5	Italy	153,821	245,028	55,274	102,708	779,671	934,583

Source: data from the EU FADN (2023).

When considering changes in the economic effects and production potential of average dairy farms from selected EU countries, it is worth noting that the profitability of production measured according to farm income per kg of produced milk in the analyzed 16 years practically did not change (Figure 2). A slight increase was recorded only in Italy and Poland (of 0.08 and 0.05 EUR/kg of milk produced, respectively). These figures confirm the phenomenon referred to as market treadmill. It assumes that despite farmers' continuous efforts to increase the productivity of factors of production, the market mechanism 'washes out' the benefits of this effort. The essence of the treadmill in the agricultural sector boils down to the fact that agricultural income does not progress with the increase in farm productivity. The direct cause of the phenomenon is the drainage of the surplus due to productivity growth through flexible agricultural prices (effect of agricultural prices on changes in agricultural production) [29].

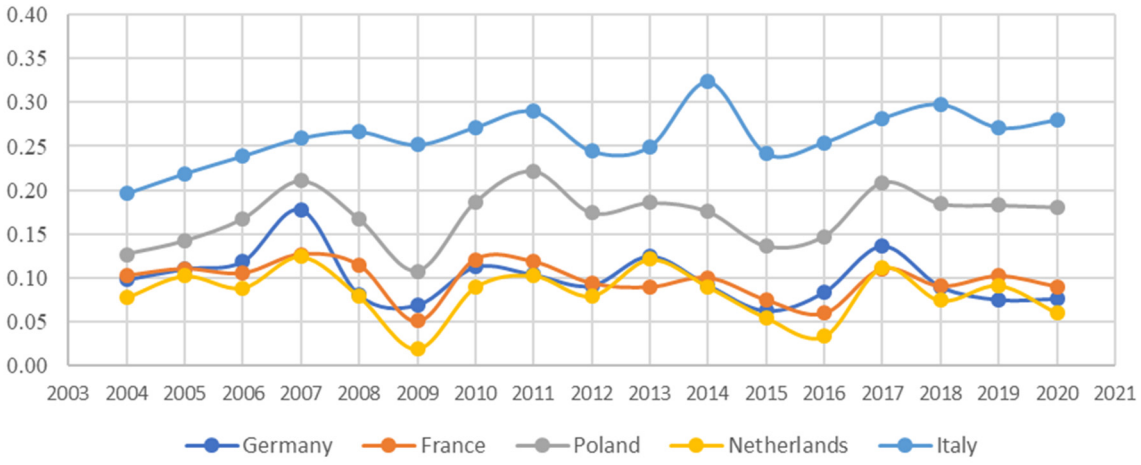

Figure 2. Profitability of milk production in an average dairy farm in selected EU countries (EUR/kg of milk).

One of the most important financial indicators informing about the economic viability of the conducted business activity is the return on equity [30]. In average farms from the studied countries, the return on equity in 2020 ranged from 1.87% in the Netherlands to 16.34% in France. The presented values compared to the parameters from 2004 show that returns on equity in average dairy farms from Italy, France and Germany increased by 53.4%, 8.2% and 8.1%, respectively. Decreases in this ratio were recorded in the Netherlands and Poland, of 22.1% and 27.4%, respectively (Figure 3). In the analyzed period (2004–2020), returns on equity fluctuated, and the least favorable period was 2009, in which it ranged

from 0.68% on Dutch farms to 9.83% on Italian farms. In contrast, year 2017 can be described as favorable for milk producers. At that time, returns on equity ranged from 4.85% in the Netherlands to 19.46% on farms in France. The analysis of return on the equity ratio in average dairy farms from the studied EU countries showed that (1) in the period under study, the Netherlands had the lowest ROE in dairy farms, (2) dairy farms in France had the highest value of equity, and (3) there were clear correlations between the financial situation of dairy farms from the studied EU countries and the situation on global markets.

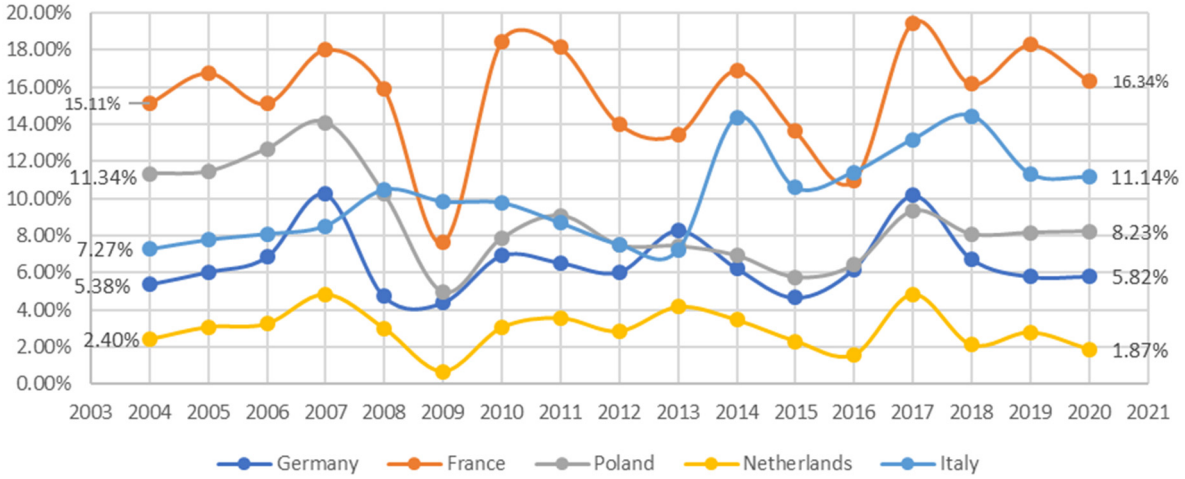

Figure 3. Return on equity in average dairy farms from selected EU countries in 2004–2020.

4.2. Factors Determining Return on Equity in Average Dairy Farms from the Selected EU Countries

The analysis based on the Du Pont model to identify the main factors impacting the achieved return on equity in average dairy farms from the studied EU countries required the following indicators: return on sales, asset turnover and financial leverage. Then, using the logarithmic method, their impact on the return on equity was worked out. Particular attention was paid to examining the relationships in the years 2015–2020 compared to those in 2004.

The data presented in Table 5 show that in 2015 the return on equity compared to that in 2004 increased only in Italian dairy farms. The main reason for the increase was the favorable rotation of assets and a slight increase in return on sales. The value of assets in an average Italian dairy farm in 2020 increased by 19.9% compared to that in 2004, while revenues during this period grew by as much as 59.3%. This also resulted in an increase in farm income by 85.8%. A decrease in the return on equity in 2015 compared to that in 2004 was recorded for average dairy farms in Poland. The decreasing asset turnover had the greatest impact on this situation. The value of assets in average Polish dairy farms in 2020 was almost 3.5 times higher than that in 2004, while revenues increased only by 2.4 times. Large investments made in the analyzed period turned out to be less productive.

In 2016, the situation was similar to that in 2015, but changes took place in 2017 (Table 5). Out of the five selected countries, average dairy farms from Germany, France, the Netherlands and Italy recorded an increase in return on equity compared to that in 2004. Only Polish dairy farms recorded a slight decrease in this measure. The main reason for these advantageous changes in the majority of dairy farms was the favorable relation of revenues to the used assets and the improvement of production profitability. This situation resulted from the favorable economic situation on the world markets and the rise in the prices of dairy products, which resulted in an increase in the purchase price of milk. Notably, average dairy farms from France improved the financial leverage ratio in the analyzed year—the ratio of assets to equity was 191%.

Table 5. Results of causal analysis of return on equity in average dairy farms from selected EU countries.

Countries	Deviation of the Return on Equity Ratio Compared to 2004	Return on Sales	Financial Leverage	Asset Turnover
		Year 2015		
Germany	−0.008	−0.024	0.005	0.011
France	−0.015	−0.058	0.026	0.017
Poland	−0.055	−0.007	−0.004	**−0.044**
Netherlands	−0.002	−0.012	0.003	0.007
Italy	0.034	0.005	0.000	0.029
		Year 2016		
Germany	0.008	−0.013	0.007	0.014
France	−0.042	−0.073	0.026	0.005
Poland	−0.050	0.001	−0.005	**−0.046**
Netherlands	−0.009	−0.018	0.003	0.006
Italy	0.042	0.012	−0.001	**0.031**
		Year 2017		
Germany	0.048	0.011	0.008	**0.029**
France	0.044	−0.007	**0.028**	0.023
Poland	−0.020	0.019	−0.005	**−0.034**
Netherlands	0.024	0.003	0.004	**0.017**
Italy	0.059	0.020	−0.001	**0.040**
		Year 2018		
Germany	0.014	−0.015	0.007	0.022
France	0.011	−0.038	0.028	0.021
Poland	−0.032	0.008	−0.005	−0.035
Netherlands	−0.002	−0.005	0.000	0.003
Italy	0.073	0.022	0.000	0.051
		Year 2019		
Germany	0.004	−0.022	0.007	0.019
France	0.031	−0.026	**0.031**	0.026
Poland	−0.032	0.007	−0.006	**−0.033**
Netherlands	0.004	−0.002	0.001	0.005
Italy	0.040	0.013	−0.001	0.028
		Year 2020		
Germany	0.005	−0.022	0.007	0.020
France	0.013	−0.041	0.035	0.019
Poland	−0.031	0.010	−0.006	−0.035
Netherlands	−0.006	−0.009	0.000	0.003
Italy	0.039	0.014	−0.001	0.026

The following years brought slight changes in the return on equity in average dairy farms from the studied EU countries compared to that in 2004 (Table 5). Interestingly, average dairy farms in Poland achieved a return on equity ratio ranging from 4.97% in 2009 to 14.09% in 2007. Compared to the ROE ratios of other dairy farms from the studied countries, it was at an average level, close to the ROE recorded for dairy farms from Germany. Nevertheless, the ROE in 2015–2020 in Polish farms was significantly lower than that in 2004 (Table 5). There is a historical explanation of this difference. Until 2004, Poland was outside the structures of the European Community, which translated into significantly lower prices of both products and means of production. Accession to the EU immediately opened the possibility of exporting dairy products, which resulted in a very rapid increase in milk purchase prices. In 2004, milk purchase prices increased by 30% compared to those of the previous year [31]. Still, low production costs and the lower value of fixed assets

used in the operations in 2004 resulted in a remarkably high return on equity. How the return on equity and the indicators affecting it evolved between 2004 and 2020 are shown in Figures 4–8.

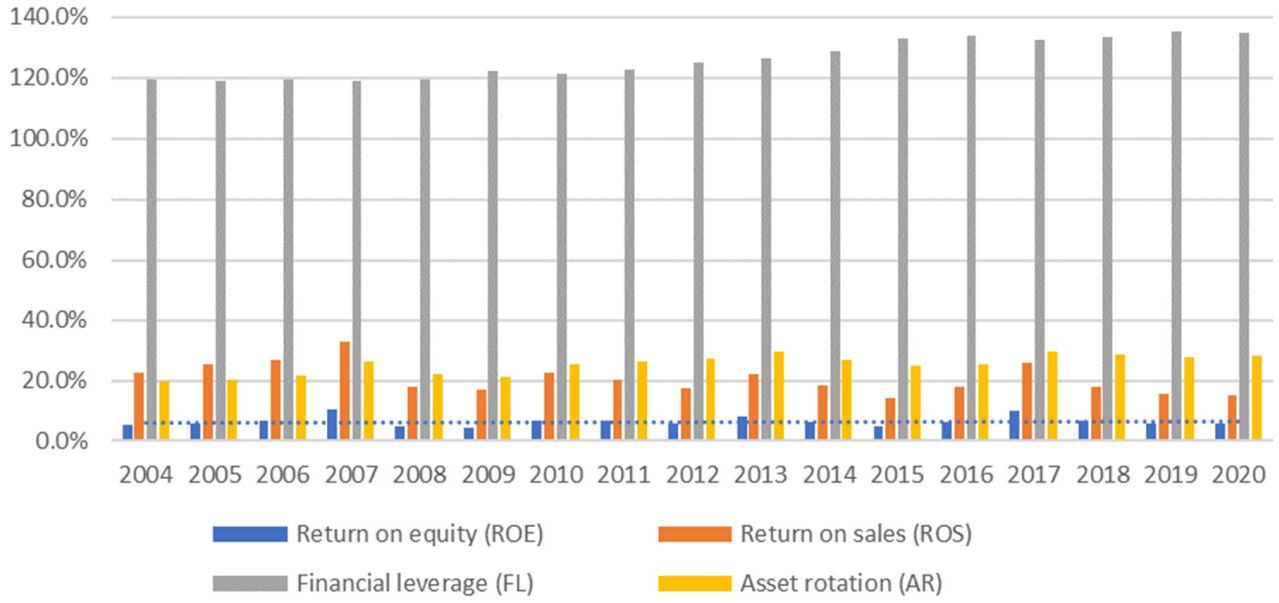

Figure 4. Return on equity, return on sales, financial leverage, and asset turnover in average dairy farms from Germany in 2004–2020.

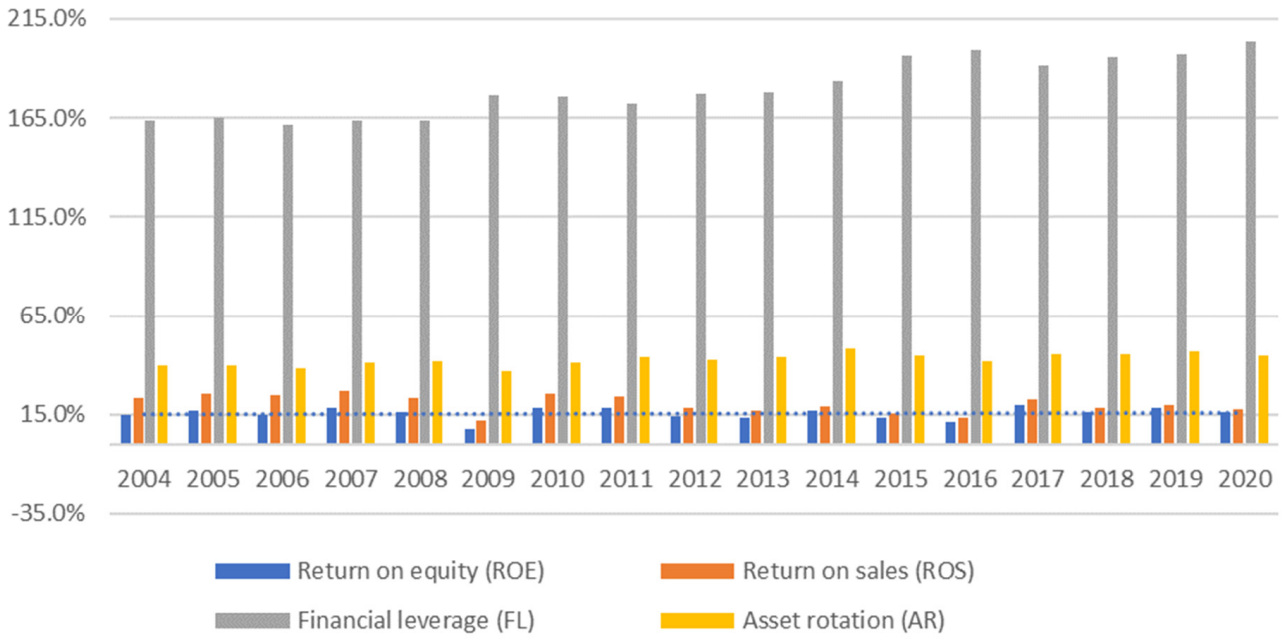

Figure 5. Return on equity, return on sales, financial leverage, and asset turnover in average French dairy farms in 2004–2020.

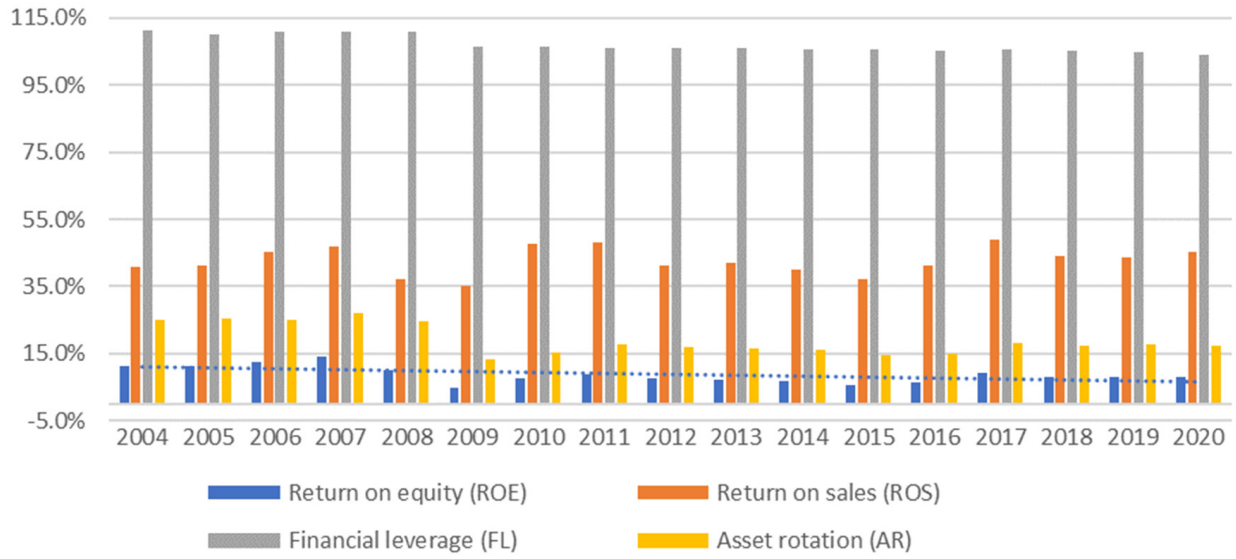

Figure 6. Return on equity, return on sales, financial leverage, and asset turnover in average Polish dairy farms in 2004–2020.

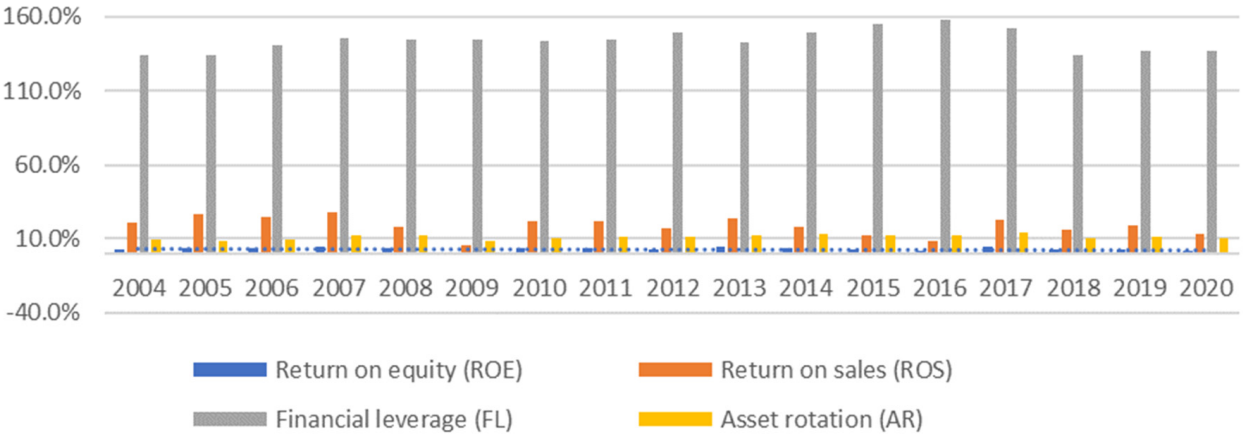

Figure 7. Return on equity, return on sales, financial leverage, and asset turnover in average dairy farms from the Netherlands in 2004–2020.

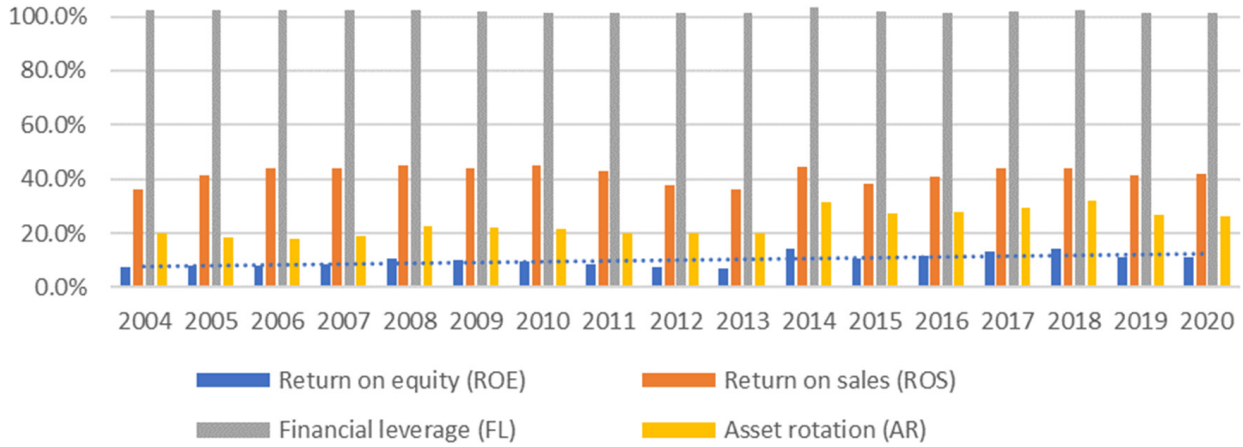

Figure 8. Return on equity, return on sales, financial leverage, and asset turnover in average Italian dairy farms in 2004–2020.

5. Discussion

This study, focusing on dairy farms from five EU countries, the largest milk producers in 2020, confirms the diversity of holdings across the EU member states in terms of the scale and efficiency of milk production, as highlighted in the earlier literature on the subject [32]. This diversity results from historical conditions and the level of economic development of the country. Most of the contemporary studies [33–39] focus on the broader economic dimension of the functioning of dairy farms, rather than solely on the return on equity. This approach has its advantages but also limitations. The main weakness is that it fails to identify the determinants of changes in the profitability of production on dairy farms in a precise way. Statements such as "the volatility of milk production profitability was most strongly affected by the size of forage area, size of herds, milk yield of cows, milk prices, energy costs and wage costs" [33] are evident. It is hard to disagree with some authors [36] that the scale of milk production is a very important factor determining the efficiency of dairy farms. These are quite obvious conclusions.

The current study supplements these general statements with specific indicators presenting the return on equity and the main reasons for its changes in dairy farms over a relatively long period (2004–2020). It is worth noting that the conducted analyses show that the return on equity compared to that in 2004 only increased in Italian dairy farms. The main reason for the increase was the favorable rotation of assets and a slight increase in return on sales. The dairy farms in the other analyzed countries recorded a decrease in ROE, especially the dairy farms in Poland. These data explain the reduction in the number of dairy farms in the EU, especially those characterized by a relatively small scale of production. On the other hand, farms which have above-average production compared to that of other farms in the same country increase the scale of milk production.

The analysis of changes in the return on equity on dairy farms from the selected EU countries in the years 2004–2020 raises the question about the directions of changes both in the production potential, as well as in the organization and economic results in this group of entities in the future. The situation is quite complex due to uncertain geopolitical conditions, as well as the consequences of the EU's Common Agricultural Policy for 2023–2027. Considering only the solutions outlined by the EU agricultural policy, we hypothesize that dairy farms conducting intensive milk production will be forced to limit it because of administrative procedures. Especially, farms characterized by high livestock density and simplified cultivation systems (cultivation of one or possibly two types of crops) to comply with the new requirements will have to use crop rotation and introduce more crops. Undoubtedly, this will contribute to an increase in the cost of milk production. Additional requirements imposed on milk producers by the Green New Deal will also add to milk production costs. This raises the question about the future purchase prices of milk, and increase in which may compensate for higher costs and determine the profitability of production and return on equity. To a large extent, the purchase prices of milk will depend on the prices of dairy products which, in turn, will depend on demand. It is highly probable that the internal demand for dairy products in the EU in the coming years will not grow; therefore, the profitability of production and return on equity of European dairy farms will depend on the possibility of exporting dairy products to Asia (mainly China) and Africa. In addition, it should be emphasized that the demand for organic and ecological products is successively growing in the EU, and the administrative mechanisms of the implemented Common Agricultural Policy positively stimulate this form of activity. This may create new opportunities for some dairy farms from EU countries, but not for all. Therefore, we should expect a further reduction in the number of dairy farms and the number of cows in EU countries in the years 2023–2027. The pace of this process will depend on future cooperation with countries that are net importers of dairy products, mainly China.

6. Summary and Conclusions

European Union dairy farms play a significant role in supplying dairy products to consumers all over the world. Favorable environmental and historical conditions contributed

to the fact that milk production in 2022 from the 27 countries forming the EU accounted for 17.1% of the world's milk production. Such a production scale exceeded the internal needs of the European community which resulted in strong export performance. In 2022, as much as 40.4% of exported cheese in the world came from the EU, while skimmed milk powder and butter accounted for 29.4% and 25.9% of global exports, respectively. The leading milk producers in the EU in 2022 included Germany, France, Poland, the Netherlands and Italy. EU dairy farms, supplying raw material necessary to produce high-quality dairy products in 2004–2020 were quite diverse in terms of production potential and scale. Among the average dairy farms from the five selected EU countries, farms from the Netherlands had the greatest potential and scale of production while farms from Poland represented the polar opposite. The average dairy farm in the Netherlands in 2020 had about 100 cows, and the value of the assets was EUR 3,998,026. The average farm in Poland had only 18 cows and the value of assets amounted to EUR 243,695. Despite the diversity of the studied dairy farms, the return on equity, which is one of the most important financial indicators assessing business viability, was not so diverse.

The analysis of return of equity on average dairy farms from five EU countries characterized by the largest milk production and processing in 2022 showed the following:

1. The lowest return on equity in the years 2004–2020 was recorded for farms from the Netherlands. This ratio ranged from 0.68% in 2009 to 4.86% in 2017. The reasons for the relatively low ROE in dairy farms in the Netherlands should be sought in context of the need to engage significant assets in production, mainly a very expensive resource such as land and costly human labor.
2. The highest return on equity was calculated for dairy farms from France. The value of this ratio ranged from 7.64% in 2009 to 19.46% in 2017. The factor strongly determining the favorable value of this ratio was the high degree of financing assets with low-interest loans and credits. The ratio of the total value of farm assets to the value of equity in average French dairy farms ranged from 163.4% in 2004 to 203.9% in 2020. Undoubtedly, the need to repay credits and loans in the future (if they are not canceled) will have a negative impact on the financial liquidity of French dairy farms.
3. Despite the fact that they had the lowest production potential and a small scale of milk production, average Polish dairy farms in 2004–2020 had quite a high return on equity. This ratio ranged from 4.97% in 2009 to 14.9% in 2007. In the years 2015–2020, in average Polish dairy farms, the return on equity was clearly lower than that in 2004 and ranged from 5.77% to 9.31%. The main reason for the deterioration of the situation was the large investments in fixed assets, which resulted in an increase in farm assets, while the increase in revenues was not commensurate. In addition, the main reason for the high return on equity in 2004 was Poland's accession to the EU, which generated a significant increase in the prices of both dairy products and milk.
4. Global conditions and administrative regulations at the EU level affect the return on equity in dairy farms. High prices of dairy products on the world markets in 2007 resulted in a relatively high return on equity in average dairy farms in the analyzed countries. This also translated into regulations in the field of agricultural policy, which included the abolition of subsidies for dairy products exported outside the EU. The consequences of these changes in regulations could be seen in 2009, when the drop in prices for dairy products on the world markets left its mark on the return on equity in dairy farms in the studied EU countries.
5. The conducted research requires more in-depth analysis. Further work should examine the evolution of return on equity in dairy farms diversified by the scale of milk production. What is the difference between farms with a similar scale of milk production but with different affiliations to a particular country? How do macroeconomic conditions determine the economic efficiency of milk production?

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