

*Marta GUTH*

## **ECONOMIC DETERMINANTS OF MILK PRODUCTION IN THE MACRO-REGIONS OF THE EUROPEAN UNION IN 2011 COMPARED TO 2004 IN THE CONTEXT OF MILK QUOTA ABOLITION**

## **EKONOMICZNE DETERMINANTY PRODUKCJI MLEKA W MAKROREGIONACH UNII EUROPEJSKIEJ W 2011 ROKU, W PORÓWNANIU Z ROKIEM 2004, PO LIKWIDACJI KWOT MLECZNYCH**

Department of Macroeconomics and Agricultural Economics, Poznan University of Economics and Business, Niepodległości 10, 61-875 Poznań, Poland, e-mail: marta.guth@ue.poznan.pl

**Streszczenie.** Określono ekonomiczne determinanty produkcji mleka w makroregionach Unii Europejskiej w 2011 roku, w porównaniu z rokiem 2004. Celem było zbadanie, czy i w jaki sposób czynniki decydujące o zróżnicowaniu rynku mleka w 2011 roku uległy zmianie, w odniesieniu do 2004 roku; wykorzystano analizę czynnikową, w ramach której wyróżniono po trzy czynniki dla każdego roku, które wpływały na produkcję mleka w gospodarstwach mlecznych FADN w makroregionach Unii Europejskiej. Na potrzeby realizacji wyżej wymienionego celu dokonano analizy porównawczej wpływu poszczególnych cech na wyróżnione czynniki, tj. relacje rynkowe (cenowo-kosztowe), zasoby czynników wytwórczych i sytuację finansową gospodarstw mlecznych FADN w makroregionach Unii Europejskiej. Ponadto stwierdzono, czy polskie makroregiony są konkurencyjne wobec innych makroregionów Unii Europejskiej pod względem produkcji mleka oraz czy poprawiły swoją pozycję w 2011 roku, w odniesieniu do 2004 roku, pod względem szans i zagrożeń funkcjonowania na jednolitym rynku europejskim po likwidacji kwot mlecznych.

**Key words:** milk production, macro-regions of the European Union, factor analysis.

**Słowa kluczowe:** produkcja mleka, makroregiony Unii Europejskiej, analiza czynnikowa.

## **INTRODUCTION**

The European Union is characterized by diversity on many levels among which agriculture is mentioned as a sector showing most variation (Matuszczak 2012). Besides factors independent of human actions, such as the soil, climate and natural environment, there are also differences in production levels and economic indicators of farms (Grontkowska 2012). To check what factors determine milk production in the macro-regions of the European Union in 2011, and thus are the determinants of the development of dairy farms, it was necessary to examine the impact of a range of factors and explain the resource variability of joint matrix of observation. It significantly hinders versatile and comprehensive synthesis of data (Czyżewski 1976). Okóń (1964) says that phenomena in a particular area, despite their diversity and variation, are related in some way, and are at least in part determined by a relatively small number of functional units, parameters or factors. In multivariate analysis (MVA), finding similarities in the breaking of each variable, hence the existence of a correlation,

leads to the finding that some of them overlap, and thus differentiate the cases in the same way (Stanisz 2007). In view of the foregoing considerations and the difficulty of interpretation of too many pending attributes it was decided to use factor analysis, in which new variables, called factors, retain a relatively large part of the information contained in the original variables and each of them is a carrier of the other substantive content (Czopek 2013).

The issue of determinants of the diversity of milk production in the European Union, particularly across regions, is rarely raised in scientific studies. While statistics on production, prices of milk, the amount of dairy cows and their milk yield in individual countries are generally available, the complete interpretation requires fine-tuning. The results of the research will help answer the question of which factors and to what extent influenced the production of dairy farms in the macro-regions of the European Union in 2011 and 2004. This is especially interesting in the light of new, more liberal regulations regarding the milk sector, represented by the elimination of milk quotas in April 2015 and its consequences.

## METHODOLOGY

For the purpose of this analysis regional data for the type of farming (TF8) dairy cows for two periods – 2004 and 2011 were used (Czyżewski and Guth 2016). The year 2004 was selected for the study since the 2004 enlargement of the EU by 10 new Member States was the largest single expansion of the EU, resulting also in improved data availability. On the other hand, 2011, due to reporting delays, provides the latest published data. From among 129 European macro-regions existing in 2011, 108 regions were selected that met the criterion of having the required number (15) of farms of economic size, allowing for their inclusion in FADN. In order to show changes in the factors affecting the dairy farms production in the EU macro-regions, dynamic factor analysis for the two periods – 2004 and 2011 was conducted. The starting point was to create a matrix of observations, which was built from a set of 49 indicators capturing various features of the dairy farms in the EU macro-regions in 2004 and 2011, retrieved from FADN. The analysis of linear correlation of variables showed that there are significant correlations between them, characterized by high complexity. In the case of the surveyed population of dairy farms in the Euro-regions the critical value at  $\alpha = 0.01$  was 0.245757 for the year 2011 ( $N = 108$ ), and for 2004 it amounted to 0.273245 ( $N = 87$ ), so all  $-0.245757 \leq r \leq 0.245757$  for 2011 and  $-0.273245 \leq r \leq 0.273245$  for 2004 can be regarded as irrelevant for the purposes of the research. To extract the basic systems of interdependent features, the method of grouping based on the criterion of maximum correlation was applied. In terms of factor analysis the determinants of milk production in the EU macro-regions in 2011 were determined by 44, and in 2004 by 42 features selected from the 49 analyzed indicators.

## RESULTS

In the case of the surveyed population of dairy farms in the Euro-regions on the basis of the criteria of sufficient proportions and screen plots for both 2004 and 2011, 3 independent factors were selected which explain more than 75% of the volatility of the common stock for each of the analyses. It was considered that such a high percentage of share in the use of

accumulated variation allows the author to base the analysis on just these 3 factors (see Table 1). To narrow the scope of the factors and standardize them, the solution was subjected to the procedure of rotation, i.e. the Varimax rotation (raw version) was used for further analysis.

Table 1. Factor solution 2004 and 2011

Factor	Self-value of correlation matrix		Share in the use of variation [%]			
			common		accumulated	
	2004	2011	2004	2011	2004	2011
F <sub>1</sub>	18.66612	23.23651	37.33	45.56	37.33	45.56
F <sub>2</sub>	13.26480	12.67386	26.53	24.85	63.86	70.41
F <sub>3</sub>	6.701008	7.96607	13.40	15.62	77.26	86.03

Source: own elaboration based on results of research using FADN data for the type of production (TF8) dairy cows by region for 2004 and 2011.

In 2011, in comparison to 2004, one can observe an increase in the share of the first and the third factor in the overall resource variability (increase in the common value of individual factors relative to 2004) and a slight decrease in the share of the second factor. The increase in the share of a given factor in the use of variation is equivalent to increasing its weight and homogeneity (Czyżewski 1976). Turning to detailed characteristics as the leading factor can be considered the first factor (F<sub>1</sub>) because it explains the largest resource of common variation (37.33% for 2004 and 45.56% in 2011).

### Market (price-cost) relations in FADN dairy farms and its diversity in the Euro-regions in 2011 relative to 2004

Presented in terms of the significance of features, construction of F<sub>1</sub> factor is made up of basic data, determining market (price-cost) relations of dairy farms in the FADN regions in 2004 and 2011 (see Table 2)<sup>1</sup>. The structure of features forming F<sub>1</sub> factor and their assigned weights indicate that the price-cost relations of dairy farms in the Euro-regions in 2011 were conditioned mostly by subsidies for intermediate consumption and costs of external factors (depreciation, services, wages and rents), maintenance costs, and short-term loans, as evidenced by the highest factor loadings for these features.

It is worth noting that in 2011 the importance of subsidies on livestock and VAT on investment fell, while these features significantly determined the price-cost relations in 2004. Wages paid, short-term loans and decoupled payments (single farm payment (EU15) and the single area payments (EU12)), in turn, gained in importance compared to 2004. These changes can be associated with the consolidation of production and investment being made after 2004, which streamlined the production process in the view of the elimination of

<sup>1</sup> It should be explained that although the structure of the characteristics forming F<sub>1</sub> factor significantly outweigh the factors related to costs (14 out of 24 attributes), the author concluded that prices indirectly affect both the costs and resources in the surveyed farms, because their height and relation to the total costs of farms affect decisions on the scale and type of production. Therefore, the limitation of the factor name, understood as a kind of grouping criterion comprising factor variables to only cost determinants seemed to be too simplistic. It was therefore concluded that this relationship of prices to costs creates conditions in the market (hence the market relations), hence affects the production decisions of FADN dairy farms to the biggest extent of all the studied factors (in connection with the most use of the common variation by F<sub>1</sub> factor).

production limitations. It should be also noted that the importance of subsidies (after adding the factor loads corresponding to all features floating on subsidies) remained relatively stable (or even slightly increasing) in 2011 compared to 2004. It can therefore be concluded that in the later period dairy farms still based their price-cost relationship and resulting production decisions on the subsidies. Nevertheless, the decline in the influence of long-term liabilities can be the basis for claims about improved situation of dairy farms in 2011 compared to 2004. The impact of the economic size and the number of dairy cows to market relations in dairy farms in the EU regions remained relatively stable in 2011 compared to 2004. This reflects the progressive processes of concentration and an increase in economic size necessary to ensure production efficiency. In 2011 compared to 2004 the importance of the value of crop production in dairy farms in the Euro-regions, which helps limit the risk of fluctuations in feed prices and their impact on production efficiency, increased. In addition, the significance of the beef sold in the dairy farms to market relations in dairy farms in the EU regions increased in 2011 compared to 2004. This may mean that dairy farms, in the face of declining prices in 2007–2009, were more likely to diversify their production.

Table 2. Market (price-cost) relations in FADN milk farms in 2004 and 2011(F<sub>1</sub> factor construction)

No.	Name of characteristics	Factorial load	
		2004	2011
1	Economic size	0.82155	0.83060
2	Milk cows	0.64424	0.73602
3	Other cattle	0.60732	0.72798
4	Total output crops and crop production	–	0.71875
5	Change in value of livestock	0.59127	0.74368
6	Total specific costs	0.73939	0.74947
7	Machinery and building current costs	0.87931	0.86501
8	Energy	0.63428	0.77558
9	Contract work	0.83168	0.71200
10	Other direct inputs	0.77896	0.79576
11	Depreciation	0.64397	0.72816
12	Wages paid	–	0.80432
13	Rent paid	0.81106	0.90900
14	Interest paid	0.76517	0.67006
15	VAT on investments	0.74994	–
16	Farm Net Value Added	0.72556	0.80420
17	Long& medium-term loans	0.75482	0.59483
18	Short-term loans	0.84626	0.87838
19	Gross investment	0.81745	0.81395
20	Total subsidies on livestock	0.80461	0.71141
21	Share of dairying subsidies in total subsidies on livestock	0.64026	0.71819
22	Subsidies on intermediate consumption	0.74885	0.91604
23	Subsidies on external factors	0.67698	0.86492
24	Decoupled Payments	–	0.84932

Source: own elaboration based on results of research using FADN data for the type of production (TF8) dairy cows by region for 2004 and 2011.

In order to limit the subjectivity of the evaluation, a comparative scale for dynamic spatial factor presentation was constructed. First, a set of 108 EU macro-regions in 2011 was distributed into 4 typological classes according to the criterion of factor value. It is assumed that the groups of dairy farms from the Euro-regions formed in this way have similar market

relations. The first typological group containing macro-regions with the highest factorial values consisted of dairy farms located in the macro-regions of northern and central Germany (Brandenburg, Sachsen-Anhalt, Mecklenburg-Vorpommern, Thuringen, Sachsen, Schleswig-Holstein) and Slovakia. These are relatively wealthy regions dominated by intensive dairy farming, high marks for herds with an average of more than 200 dairy cows (209.89 cows/farm) and average farms of nearly 800 ESU (795.5 ESU – Economic Size Unit). These features result also from transformations of ownership after world war two. Regions with values above the average formed the second typological group, which included macro-regions from north-eastern Germany, southern Sweden, northern and central France, southern Belgium, the Netherlands, the Czech Republic, two Bulgarian regions (Severozapaden and Yuzhentsentralen) and one Hungarian region (Nyugat-Dunántúl). In total, 35 out of 108 regions analyzed ranked above the average, among which macro-regions of the richer EU15 countries predominated, which is mainly due to the high concentration of production. The fact that only one third of the regions was above the average may contribute to the finding that in 2011 there was a relatively large disparity in the price and cost relationship in the macro-regions of surveyed member countries.

Among the regions belonging to the most numerous, containing 50 out of 108 tested macro-regions, III typological group the regions from the EU-12 dominated (all Polish regions – Pomorze and Mazury, Wielkopolska and Slask, Mazowsze and Podlasie, Małopolska and Pogorze, as well as Lithuania, Latvia, Estonia, Slovenia and Hungarian and Romanian regions), which confirms their backwardness and poor competitive position in relation to the leading regions. Among the regions of the EU-15 in III typological group there were regions from England, Spain, Portugal, Italy, Ireland and Luxembourg. Moreover, there were also regions of southern Germany (Baden-Württemberg and Bavaria), southern France, Austria and Swedish Norrland, where mountainous terrain severely limits the possibility of concentration of production, and triggers a less favorable price-cost relationship. IV typological group of relatively worst price-cost relations consisted of most of the Italian and Spanish macro-regions, all Finnish regions, Malta and Slovakia. All these macro-regions apart from Slovakia have difficult conditions for milk production due to water shortages and lack of natural meadows and pastures. Dependence on external feed and low concentration of production especially in the southern regions lead to high production costs and reduced efficiency.

The analysis was conducted in a dynamic form for two periods in order to show relative changes in variance across the macro-regions in 2011 in relation to 2004. Among the regions whose position deteriorated there were regions with relatively most favorable price-cost relations, Finnish regions Pohjois-Suomi and Pohjanmaa Etela-Suomi, which dropped to the fourth group with the lowest relative price-cost relationships, Scotland, Wales and Luxembourg, where there was a decline to III typological group below the average, the German Saarland and the French Champagne-Ardenne and Nord-Pas-de-Calais, which fell to the second typological group in 2011. A positive phenomenon seems to be the promotion of eighteen regions of the European Union from IV typological group to III, which included all the Polish macro-regions. It should be noted that half of the regions that recorded an increase were the regions of the EU-12. This fact can suggest the blurring of differences in price-cost relations between the regions of the EU-15 and EU-12. It should be, however, noted that the

presented scale is only a tangible approximation of the issues discussed herein, informative of dynamic changes taking place in various regions of the European Union. It should be remembered that factorial values are relative and must not be absolutized, and the general trends are more important than the position occupied by individual regions or countries.

### Resources of production factors in FADN dairy farms and their diversity in the Euro-regions in 2011 relative to 2004

The second factor accounted for 26.53% of the common resource variability in 2004. In 2011, this share decreased slightly and amounted to 24.85%. After a thorough analysis of the characteristics of its scope, it was concluded that it represents variables of the resources of production factors in dairy farms in the Euro-regions, as all concern all three factors of production – labor, land and capital. Among the variables that create the second factor the biggest impact in 2004 had unpaid and paid labour input, total utilized agricultural area and share of rented agricultural area in total utilized agricultural area, share of feed for grazing livestock in direct costs, as well as share of home grown feed for grazing livestock in total amount of feed for grazing livestock. In 2011 subsidies on investment, payments for rural development and share of environmental subsidies in payments for rural development became more important (Table 3). The influence of share of feed for grazing livestock in direct costs and share of feed produced on the farm remained at a stable level, which supports the thesis about the significance of feed production in leveling the risk of fluctuations in feed prices. It should be noted that in 2011 compared to 2004, institutional factors represented by EU subsidies became increasingly important. This suggests that, although farms were modernized and upgraded in the Accession period, their production and resources of production factors significantly depended on intervention in the EU milk market. Agri business economists (Sass 2007; Ziętara 2010; Seremak-Bulge 2011; Wójcik 2012; Parzonko 2013) underline the need to increase the herd in order to improve production efficiency (hence the growing importance of subsidies on investments shown in the construction of  $F_2$ ).

Table 3. Resources of production factors in FADN dairy farms a in the Euro-regions in 2004 and 2011 ( $F_2$  factor construction)

No.	Name of characteristics	Factorial load	
		2004	2011
1	Unpaid labour input	0.94354	0.82268
2	Paid labour input	0.94151	0.82181
3	Total utilised agricultural area	0.86898	0.70162
4	Share of rented agricultural area in total utilised agricultural area	0.90110	0.75900
5	Share of feed for grazing livestock in direct costs	0.72134	0.75641
6	Share of home grown feed for grazing livestock in total amount of feed for grazing livestock	0.73842	0.75547
7	Subsidies on investments	–	0.75946
8	Average farm capital	0.79619	0.40672
9	Payments for rural development	0.52205	0.94585
10	Total subsidies on livestock	0.53370	0.78008
11	Share of environmental subsidies in payments for rural development	0.40924	0.73928

Source: own elaboration based on results of research using FADN data for the type of production (TF8) dairy cows by region for 2004 and 2011.

Analogously to the procedure used for the  $F_1$  factor, a comparative scale was prepared to enable dynamic, spatial presentation of the resource factors for the  $F_2$  factor. In the group of dairy farms with the highest factorial values of resources of production factors following regions were included: north-eastern Germany regions – Sachsen, Thuringen and Brandenburg, Scandinavian regions – Finnish Ostrobothnia, Swedish Norrland, Slovakia, the Czech Republic, Estonia, Luxembourg, Spanish Navarra and Hungarian Észak-Alföld.

The II typological group containing regions with a predominance of dairy farms with larger resources of production factors than the average consisted of Finnish, French, Italian, Hungarian, Spanish macro-regions and German Sachsen-Anhalt, Swedish Skogs-ohmellanbygdsland and Scotland. In total, only 28 out of 108 tested regions scored above the average. As in the case of price-cost relationship, regions of the richer EU-15 states prevailed in this group, that is the ones that had invested earlier on in the past, which allowed them for a more efficient use of production factors. The third, most numerous (73 out of 108 regions) group comprised of all Polish regions (with the highest ranking Mazowsze and Podlasie, followed by Wielkopolska and Slask, and finally close to each other in terms of factor value Pomorze and Mazury, Malopolska and Pogórze), Bulgarian and Romanian regions, Latvia, Lithuania, Austria, the regions of central and southern Germany, French, Spanish, Italian and English regions. This reflects relatively similar conditions for milk production, and thus the resources of production factors in most European regions. The fourth group, with the lowest factor values for resources of production factors contained the regions of Northern Germany – Nordrhein-Wesfalen, Mecklenburg-Vorpommern, Niedersachsen and Schleswig-Holstein, Belgian Flanders, Denmark and the Netherlands.

When analyzing changes in the competitive positions of Euro-regions in terms of resources of production factors in 2011 relative to 2004, it is clear that a certain mobility between II and III typological group was recorded. It is worth noting, however, that the regions upgraded and downgraded in the ranking were predominantly the ones located in the "old" member states. This may point to more funding and higher investment activity of dairy farms in these regions, which largely conditioned their resources of production factors. The largest decrease was recorded in German Mecklenburg-Vorpommern and the Italian Piemonte, which went down by two typological groups. The regions demonstrating the biggest improvement were the Finnish regions – Pohjanmaa, moving from group IV to I, Pohjois-Suomi and Sisa-Suomi, which jumped two groups. Also, Luxembourg, Spanish Balearic Islands and Navarra and Hungarian Észak-Alföldim proved their competitive position enough to move up 2 groups.

### **Assets and financial situation of FADN dairy farms and their diversity in macro-regions of the European Union in 2011 relative to 2004**

The third factor, in turn, explains respectively 13.40 of common variation for 2004 and 15.62% for 2011. After the analysis of factor  $F_3$  it was decided that it contains features that can be described as components of financial and assets situation of FADN dairy farms in EU macro-regions. When selecting the features of the study, the author wondered about the legitimacy of the use of outcome variables which are rather effects of production. It was, however, recognized that these variables can have a significant impact on the production decisions of dairy farms, so it was decided to include them in the study. In 2004, the financial and assets situation of dairy farms was most affected by family farm income and cash flow 1,

whereby these variables turned out to be less significant in 2011, which may indicate an improvement in the economic situation of the surveyed entities (see Table 4). The thesis about improved economic situation is also supported by the growing importance of average farm capital and total assets (the sum of the fixed and current assets), including a substantial increase in fixed assets. An interesting phenomenon is the large increase in the importance of performance indicators of production – milk yield of cows and the value of animal production per animal unit. The growing importance of these variables may be dictated by fierce competition on the EU internal market and limited options to expand the scale of production due to high investment costs and environmental constraints. Therefore the financial situation of dairy farms in EU macro-regions in 2011 largely depended on the efficiency of the use of factors of production.

Table 4. Assets and financial situation of FADN dairy farms in 2011 relative to 2004 (F<sub>3</sub> factor construction)

No.	Name of characteristics	Factorial load	
		2004	2011
1	Milk yield	0.199005	0.703114
2	Total livestock output / LU	–	0.797296
3	Total fixed assets	0.640984	0.795313
4	Total current assets	0.618336	0.750268
5	Net worth	0.654045	0.747501
6	Cash flow I	0.743162	0.736540
7	Gross Farm Income	0.780462	0.488540

Source: own elaboration based on results of research using FADN data for the type of production (TF8) dairy cows by region for 2004 and 2011.

As in previous cases, a comparative scale was designed that arranged regions starting with those with the best financial and assets situation, ending with the "worst" in terms of factor value for 2011. The ranking was divided into 4 typological groups to enable dynamic, spatial presentation of the financial position of dairy farms in regions and reduce the researcher's subjectivity. This made it possible to determine in which regions of the EU dairy farms have a better financial situation and where it is less favorable, which could be inferred that they need more support. The group of dairy farms with the best financial situation in 2011 included English regions – England-West, England-East, England-North and Scotland, the Netherlands, Denmark, the regions of northern Italy – Lombardia, Emilia-Romagna, Umbria, Veneto and Sardinia, and two Spanish regions – Cataluna and Navarra. The second typological group with regions ranking above the average contained all Scandinavian regions, regions of north-central Germany, Ireland, Wales and Northern Ireland and Belgian Flanders, Luxembourg, regions of central France, northern and central Italy, and Spanish Andalucia, Castilla-Leon and Pais Vasco. In total, 49 out of 108 regions ranked above the average. It should be noted that these groups did not contain even a single region of the EU-12. This demonstrates continuing disparities in income of dairy farms located in the EU-15 and EU-12. III typological group accounted for most French regions, Polish Pomorze and Mazury and Wielkopolska and Slask, southern regions of Germany, Austria, and southern regions of Italy and Portugal, eastern Hungary and Estonia, Czech Republic, Slovakia and Slovenia. In contrast, the IV group, the one with the worst financial situation,



consisted of Latvia, Lithuania, Polish regions – Mazowsze and Podlasie, Małopolska and Pogorze, as well as all Bulgarian and Romanian regions, which confirms the backwardness of these regions relative to other regions of the European Union.

Turning to the dynamic analysis, it should be noted that seven regions lost their positions in the first typological group of regions with the best financial situation. These were regions located in northern Germany, southern Italy and southern Spain. Among them, the largest relative decreases (up to 2 typological groups) were recorded in the Italian Campania, Sicily and the Spanish Balearic Islands. Four regions from group II – Denmark, England-North, England-East and the Italian Veneto- were promoted to the first group. In 18 regions the farms' financial situation in 2011 improved sufficiently to jump to the second typological group. It should be, however, noted that all these regions were located in the EU-15 countries, what confirms disparities in the development of dairy farms in the EU-15 and EU-12 countries. Scandinavian regions (all Finnish regions and one Swedish region) moved up from the fourth to second group, showing the biggest improvement among all the regions analyzed. Only in two macro-regions (Slovakia and Basilicata) the financial situation deteriorated so much that they lost their above the average position and were downgraded. As many as 10 regions from the IV typological group of relatively the worst financial situation managed to improve their competitive position enough to advance to higher groups in 2004. Among these were two Polish regions – Pomorze and Mazury, Wielkopolska and Slask, where due to relatively fast processes of concentration and improvement in production efficiency, dairy farms achieved better financial results than in Malopolska and Pogorze, Mazowsze and Podlasie, where extensive farming with high seasonality is prevalent. The ranking was made using relative values, and large variation in regions' position of regions led to the inclusion of Bulgarian and Romanian regions, although only recently have they met the EU standards and started benefiting from subsidies, so their competitive position is relatively low (most classified in the fourth typological group).

## **CONCLUSIONS**

Having presented theoretical assumptions and procedure of factor analysis, three factors were extracted which explain more than 75% of the common variation to both study years, and considered sufficient to carry out the research on their basis. The most difficult task proved to be the identification and interpretation of factors. It is part of the analysis fraught with relatively greatest subjectivity of evaluation. To limit the above problems a comparative scale was used, dividing a set of 108 macro-regions of the European Union into four typological classes according to the factor value criterion. The research gives ground to the following basic conclusions:

- there still exists a significant discrepancy in the development of dairy farms in the regions of the "old" and "new" member states. Dairy farms from the old EU countries produce milk at favorable price and cost relations, having at their disposal relatively more resources of production factors and better financial situation, which was expressed in above average position in the ranking of all EU regions for all distinguished factors;

- the first ( $F_1$ ) showing the price and cost relationship of dairy farms in the EU macro-regions should be considered the leading factor, since it explains the largest share of common variation (37.33% for 2004 and 45.56% in 2011). In 2011 price-cost relations were conditioned mainly by subsidies on intermediate consumption and costs of external factors (depreciation, services, wages and rents), maintenance costs, , and short-term loans. On the other hand, in 2011 compared to 2004 the importance of subsidies on livestock production and VAT on investments decreased, which significantly determined the price-cost relations in 2004. Wages, short-term loans and net investment, as well as decoupled payments, which were insignificant in 2004 became, in turn, more important. These changes can be attributed to the consolidation of manufacturing and investments made after 2004 to streamline production processes in view of abolition of production limitations. The growing importance of crop production, limiting the risk of fluctuations in feed prices and their impact on production efficiency, and the beef and veal values on price-cost relations in dairy farms in EU regions in 2011 may mean that dairy farms, faced with declining prices over the 2007–2009 period and further price declines after milk quota abolition were more likely to diversify their production;
- it should be also noted that the importance of subsidies in 2011 compared to 2004 was relatively stable (or even slightly increasing). It can therefore be concluded that in the later period dairy farms still based their production decisions on the subsidies obtained. Nevertheless, the decline in the influence of long-term liabilities might prove that the financial situation of dairy farms improved in 2011 compared to 2004;
- resources of production factors in dairy farms in the Euro-regions in 2004 were conditioned by capital, and labour input (paid and unpaid), total area of utilized agricultural land and share of leased agricultural land in that total area, as well as the share of feed for the grazing stock produced on the farm in feed for grazing stock. In 2011 payments on investment, agri-environment and rural development became more important. This suggests that despite investment and modernization that took place after the EU accession, dairy farms and their resources of production factors significantly depended on intervention in the EU milk market;
- in 2004, the financial situation of milk farms was most affected by farm income and cash flow. These variables were found to be insignificant in 2011, which may indicate an improvement in the economic situation. This hypothesis is also supported by the growing importance of average farm capital and total assets (the sum of fixed and current assets), including a substantial increase in fixed assets. It seems that an important factor was the growing importance of production performance indicators – milk yield of cows and the value of livestock production per animal unit. The growing importance of these variables may be dictated by fierce competition on the EU internal market and limited possibilities to increase the scale of production due to high investment costs and environmental constraints especially after milk quota system abolition;
- all Polish regions moved from IV to III typological group in terms of price-cost relations in 2011 compared to 2004. In terms of resources of production factors Polish regions (among which Mazowsze and Podlasie came first in the ranking, followed by Wielkopolska and Slask, and further by Pomorze and Mazury, and Malopolska and Pogorze) were

classified in the third most numerous (73 out of the 108 regions analyzed) group below the average for the whole set. They operated in similar milk production conditions as most of the macro-regions of the European Union. A positive phenomenon observed in Poland, which resulted in its promotion from the fourth to the third typological group, was improved financial situation of Pomorze and Mazury, Wielkopolska and Slask regions, mainly due to rapid concentration processes and enhanced production efficiency. It should be noted, however, that Mazowsze and Podlasie, Małopolska and Pogorze regions were classified in 2011 in the IV group of EU macro-regions having the most difficult financial situation for milk producers.

## REFERENCES

- Czopek A.** 2013. Analiza porównawcza efektywności metod redukcji zmiennych – analiza składowych głównych i analiza czynnikowa [The application of mathematical methods in economics and management]. Zesz. Nauk. Wydz. UE Katow. 7, 7–11. [in Polish]
- Czyżewski A.** 1976. Miasta wielkopolski w Polsce Ludowej. Ekonomiczno-demograficzne podstawy rozwoju w okresie 1946–1970. Warszawa, PWN, 27, 44. [in Polish]
- Czyżewski A., Guth M.** 2016. Zróżnicowanie produkcji mleka w makroregionach Unii Europejskiej z wyróżnieniem Polski. Warszawa, PWN. [in Polish]
- Grontkowska A.** 2012. Zmiany w wynikach produkcyjnych i ekonomicznych gospodarstw mlecznych najsilniejszych ekonomicznie w latach 2004–2009 w krajach Unii Europejskiej [Changes in production and economic results of the largest dairy farms in the EU countries in the years 2004–2009]. Rocz. Nauk Rol., Ser. G 99(1), 58–69. [in Polish]
- Matuszczak A.** 2012. Podobieństwa i różnice w rozwoju regionów rolnych UE-25 – próba określenia czynników pro wzrostowych, in: Determinanty rozwoju regionów w Europie. Społeczeństwo, gospodarka, turystyka. Red. K. Pajak, T. Różanski. Piła, PoliDruk Poznań, 156–174. [in Polish]
- Okóń J.** 1964. Analiza czynnikowa w psychologii. Warszawa, PWN, 18. [in Polish]
- Parzonko A.** 2013. Globalne i lokalne uwarunkowania rozwoju produkcji mleka. Warszawa, Wydaw. SGGW. [in Polish]
- Sass R.** 2007. Wielkość stada a dochód z zarządzania w gospodarstwach wyspecjalizowanych w chowie bydła mlecznego [The size of herd and the income from the management of farms specializing in milk cattle breeding]. Rocz. Nauk Rol., Ser. G 93(2), 71–79. [in Polish]
- Seremak-Bulge J.** 2011. Rynek mleka na prognozę 2011 r. Białystok, Polska Izba Mleka. [in Polish]
- Stanisz A.** 2007. Przystępny kurs statystyki z zastosowaniem STATISTICA PL na przykładach z medycyny. Tom 3. Analizy wielowymiarowe. Kraków, StatSoft. [in Polish]
- Wójcik A.** 2012. Koszty i dochodowość produkcji mleka w europejskich gospodarstwach utrzymujących do 50 krów [Costs and profitability of milk production in European milk farms holding up to 50 cows]. Rocz. Nauk Rol., Ser. G 99(1), 100–107. [in Polish]
- Ziętara W.** 2010. Koszty i dochodowość produkcji mleka w polskich gospodarstwach w latach 2006–2008 [Costs and profitability of milk production in Polish households in 2006–2008]. Rocz. Nauk Rol., Ser. G 97(1), 53–66. [in Polish]

**Summary.** The aim of the paper was to identify economic determinants of milk production in the macro-regions of the European Union in 2011 compared to 2004. The focus was to investigate whether and how the factors of differentiation of the milk production in 2011 changed in relation to 2004. The research was conducted with the use of factor analysis which distinguished three factors that affected milk production of FADN dairy farms in the EU macro-regions for each year. The results were analyzed comparatively, with focus on the impact of individual characteristics on selected factors, i.e. market relations (price-cost), resources of production

and the financial situation of FADN dairy farms in the EU macro-regions. Moreover, an attempt was made to determine whether Polish macro-regions can compete in milk production and whether their position improved relative to other regions in 2011 compared to 2004 in the context of opportunities and threats to the functioning of single European market after the abolition of the milk quota regime.

*The project was funded by the National Science Centre on the basis of decision No. DEC-2013/11/N/HS4/03191*