

Concentration and productivity of livestock and mixed farms in new and old EU member states. A regional level approach

Koncentracja i produktywność gospodarstw specjalizujących się w produkcji zwierzęcej i wielokierunkowych w nowych i starych państwach członkowskich UE. Podejście regionalne

Lucyna BŁAŻEJCZYK-MAJKA*, Radosław KALA

¹ Adam Mickiewicz University in Poznań, Poland, majkal@amu.edu.pl *correspondence

Abstract

The research was based on the data contained in the Farm Accounting Data Network and covers the period of the first six years following the extension of the European Union in 2004. The research units were averaged farms representing 80 regions belonging to fifteen countries of the EU-15 and the ten new member states. The total number of units representing these regions was 333, of which 226 and 107 were livestock farms and mixed farms, respectively.

The aim of this paper was to indicate (i) whether the concentration of mixed farms is faster than the specialist livestock farms and whether it is more intensive in the regions of the new UE states than in the old ones, and (ii) whether farms from the new regions improve productivity faster than the farms of the old regions irrespective of their production profile. The analysis was based on the regression and data envelopment method with estimation of the Malmquist total factor productivity (TFP) index and its components.

As to the first question, the main findings indicate, on average, a decrease of the total labor input, but only in the new regions, an increase in the utilized agricultural area of farms both in the old and new regions, although larger in the new member countries, and the increase of stocking density in livestock farms of the old regions and only in mixed farms of the new regions.

The answer to the second question is less optimistic, because in the analyzed period, especially after 2007, pure technical efficiency decreased in both types of farms both in the old and new regions. In turn, the indexes of scale and technical efficiency change indicated some improvements. However, they concern technical efficiency of both types of farms from the old regions and only scale efficiency of mixed farms from the new regions.

Varied changes in individual TFP components resulted in differences of the Malmquist indexes. Their values indicate a decrease by 3% for farms from the new regions and by 1% for mixed farms from the old regions. This confirms the conclusion that farms from the old regions better endure a generally difficult period of stagnation.

We observed that, the financial standing of all farms, except for livestock farms from the old regions, deteriorated, but those from the new regions suffered greater losses.

Keywords: animal production, data envelopment analysis, Malmquist index, mixed production, technical efficiency change, scale efficiency change

Streszczenie

Badania zostały przeprowadzone w oparciu o dane uzyskane z agendy FADN (Farm Accounting Data Network). Dotyczą one sześcioletniego okresu po poszerzeniu Unii Europejskiej w 2004r. Jednostką badawczą były średnie gospodarstwa reprezentujące 80 regionów przynależnych piętnastu państw EU-15 oraz dziesięciu nowych państw członkowskich. Ogólna liczba jednostek reprezentujących te regiony wynosiła 333, z czego 226 dotyczyło gospodarstw specjalizujących się w produkcji zwierzęcej, a 107 jednostek odnosiło się do gospodarstw wielokierunkowych.

Celem badania była odpowiedź na dwa pytania. Po pierwsze, czy w badanym okresie procesy koncentracji przebiegały szybciej w przypadku gospodarstw wielokierunkowych czy też w gospodarstwach specjalizujących się w produkcji zwierzęcej oraz czy procesy te przebiegały bardziej intensywnie w regionach należących do nowych członków UE, czy też w regionach reprezentujących stare państwa unijne. Po drugie, czy gospodarstwa prowadzące swoją działalność na terenie nowych państw członkowskich szybciej poprawiały w badanym okresie produktywność niż gospodarstwa ze starej UE z uwzględnieniem ich profilu produkcji. Przeprowadzone badania bazowały na analizie regresji i zastosowaniu metod DEA (data envelopment analysis) do estymacji indeksu produktywności ogólnej Malmquista i jego komponentów.

Wyniki przeprowadzonych badań w odniesieniu do pierwszego pytania wskazują, że średnio nastąpił spadek zużycia nakładów siły roboczej, ale tylko w nowych regionach. Odnotowano również wzrost w powierzchni użytków rolniczych wykorzystywanych przez gospodarstwa zarówno w nowych jak i starych krajach członkowskich, ale większy w nowych krajach oraz wzrost przeciętnego pogłowia zwierząt utrzymywanych w gospodarstwach starej UE specjalizujących się w produkcji zwierzęcej i w gospodarstwach wielokierunkowych nowych państw członkowskich.

Odpowiedź na drugie pytanie jest mniej optymistyczna. Wynika to z faktu, że w analizowanym okresie, szczególnie po roku 2007, czysta efektywność techniczna spadała w obu typach gospodarstw reprezentujących zarówno stare jak i nowe regiony. Z kolei indeksy skali i technicznej efektywności wykazywały wzrost. Jednak wzrost efektywności technicznej odnotowano w obu typach gospodarstw prowadzących swoją działalność jedynie na terenie starej UE. Z kolei wzrost indeksu skali dotyczył tylko mieszanych gospodarstw z nowych regionów UE.

Analiza indeksów produktywności ogólnej Malmquista wskazywała z kolei na duże ich zróżnicowanie. Ich wartość spadała ok 3% w przypadku gospodarstw z nowych regionów i o 1% w przypadku gospodarstw mieszanych ze starych regionów. To prowadzi do wniosku, że gospodarstwa ze starych regionów lepiej znoszą trudności związane z okresem stagnacji gospodarczej. Zaobserwowaliśmy także, że kondycja finansowa wszystkich gospodarstw, z wyjątkiem gospodarstw hodowlanych ze starych regionów, pogorszyła się, ale te z nowych regionów poniosły większe straty.

Keywords: indeks produktywności ogólnej Malmquista, produkcja wielokierunkowa, produkcja zwierzęca, zmiana efektywności technicznej, zmiana efektywności skali

Introduction

Due to the nature-related character of production processes in agriculture the problem of productivity is particularly complex in this type of economic activity. Multiple factors affecting efficiency of agricultural production were grouped by Hayami and Ruttan (1985) into three categories, (a) resource endowment, (b) technology, as embodied in fixed or working capital, and (c) human capital, broadly conceived to include the education, skills, knowledge and capacity embodied in a country's population. Such a division of production factors has been followed in numerous studies. According to Gutierrez (2002), the primary factor determining efficiency of agricultural production is connected with natural conditions. A similar opinion was expressed by Gallup, Sachs and Mellinger (1999) who stated that geographical constraints, such as soil quality and climate or the location of the country, can influence productivity heterogeneously across countries. Other factors influencing efficiency of farms include the accumulation of physical capital (Gutierrez, 2002), biological yield capacity, share of owned land, share of hired labor (Bojnec and Latruffe, 2007), farmer's age and quantity of human capital per person (Gasson et al., 1988; Gutierrez, 2002), as well as political situation (McMillan et al., 1989; Pingali and Xuan, 1992).

In 2004 the European Union was enlarged to incorporate ten new states. These ten new member countries, undergoing political and economic transformations, in their farming sectors experienced significant changes in the allocation of labor caused by price liberalization, subsidizing cuts, land reforms and farm restructuring (Macours and Swinnen, 2005). Moreover, variations in adjustment were caused by interactions of differences in reforms and in initial conditions, both between countries and between regions (Swinnen, Dries and Macours, 2005; Dries and Swinnen, 2002). A certain role was played here by differences in human capital and rural market imperfections (Gorton and Davidova, 2004; Rizov and Swinnen, 2004). Finally, this extension has had an impact on agriculture not only in the new member states, but also in the old ones. On the one hand, it brought subsidies, new potential sale markets for goods and new possibilities to purchase means of production, while on the other hand, the pressure of competition increased, leading to the necessity to improve efficiency (Larsén, 2010).

In this situation the EU faced a difficult task to reduce differences between regions, either supporting economically weaker regions or strengthening specific sectors of economy. The proposed the Common Agricultural Policy and the cohesion policy were to lead to the convergence of regions from the old and new EU. In the opinion of Gutierrez (2002), a higher degree of openness will allow smaller countries to absorb technology, developed by the advanced nations, at a faster rate and thus they will grow more rapidly. In turn, Davidova (2011) pointed to a considerable share of semi-subsistence farming in Central and Eastern Europe, which is another aspect strengthening the need to improve farm efficiency in the new member countries in accordance with the definite aim of EU regional policy to reduce the significant economic, social and territorial disparities that still exist between Europe's regions.

So the greater part of structural fund resources are concentrated on the poorest regions and countries (EU, 2014).

Improvement of farm efficiency and thus also competitiveness may be ensured using different methods. One of them is to increase the degree of specialisation. In the next few years this may lead to structural changes in agriculture of a given country, since the share of mixed farms decreases to the advantage of specialised farms (e.g. Mathijs and Swinnen, 1998). The effect of specialization on technical efficiency was repeatedly investigated in literature concerning Central and Eastern Europe. Mathijs and Vranken (2000) for Hungary and Bulgaria, Curtiss (2000) for Czech Republic and Brümmer (2001) for Slovenia found that highly specialized farms are more technically efficient.

Specialisation typically leads to changes in the scale of production. Johnson and Ruttan (1994) suggested – based on research on developing countries that smaller farms are more productive because land is used more intensively. Moreover, according to this theory, households are believed to force lower opportunity costs of labor than large, commercial farms. This approach has been criticized on both empirical and conceptual grounds (Kislev and Peterson, 1996). The latter authors argued that scale economies are temporary disequilibrium phenomena that persist only under specific circumstances. Similarly, Kanchev (2000), and Latruffe et al. (2004) in their research found that large and intensive holdings are generally more efficient. What is more, Gorton and Davidova (2004) claimed, what is revealed in practice, that mean farm size increases and that larger farms are more profitable and efficient. These observations are also supported by our earlier paper (Błażejczyk-Majka, Kala, Maciejewski, 2011), which confirms that the highest efficiency is achieved by the biggest farms and that a longer period of farming under stable conditions promotes a higher efficiency. At the same time, Kleinhanß et al. (2007) observed that enlargement of farms focused on animal production is limited by EU requirements connected with environmental protection and that environmental adaptation and efficiency have become key issues in the new European agricultural policy.

The new economic situation, after the greatest to date enlargement of the EU, should thus bring about improved efficiency of both farms operating in the old member states and those in the new EU countries. However, convergence processes taking place in the EU countries should lead to more profound changes in the new member countries. What is more, free transfer of goods and a significant extension of the common market for agri-food produce as well as increased competitiveness on this market should enforce improvement of efficiency, which for specialised farms should be at least as high as in mixed farms.

Expectations presented above provided a starting point for the formulation of the main aims of the investigations. They can be formulated in the form of two questions, i.e. (i) whether the concentration of mixed farms is faster than that of the specialist livestock farms and whether it is more intensive in the regions of new UE states than in the old ones, and (ii) whether farms from the new regions improve productivity faster than the farms of the old regions irrespective of their production profile. The second supposition was analyzed in our earlier paper (Błażejczyk-Majka, Kala, Maciejewski, 2013) with respect to crop field farms and mixed farms. Since the conclusion was negative, it is interesting to establish if it is so also in the case of livestock farms. These hypotheses were analyzed at the regional level and with

respect to the period of 2004-2009, i.e. the first six years after EU enlargement. Economic and statistical data were gathered from the Farm Accounting Data Network (FADN), while changes of efficiency were measured with the use of the Malmquist Total Factor Productivity (TPF) index and its components evaluated by the Data Envelopment Analysis.

Materials and methods

Two types of analyses were employed in this study. In order to evaluate the rate of concentration we use the standard log-linear regression model of the form:

$$\log y = a + rt + \varepsilon,$$

where $y = y(t)$ is a selected variable dependent on time t , ε is the random error, while a and r are fixed parameters. If the logarithm is natural and time is expressed in years, then the estimated r provides the yearly change of dependent variable y .

To estimate efficiency and productivity growth we use the nonparametric approach known as data envelopment analysis (DEA). This method of evaluation of technical efficiency was initiated by Farrell (1957) and fully elaborated by Charnes, Cooper and Rhodes (1978), who used a linear programming approach. Many historical details concerning this approach may be found in a study by Førsund and Sarafoglou (2002).

The only assumptions of DEA concern the type of technology, which can be constant return to scale (CRS) or variable return to scale (VRS), and the type of orientation, which can be focused on outputs maximization given the values of inputs, or on inputs minimization given the values of outputs. In this study we used output-oriented DEA with a multi-input and two-output model.

In the case of panel data it is also possible to estimate technical efficiency change, ΔTEC , and pure technical efficiency change, ΔTEV , which are based on CRS and VRS assumptions, respectively. Moreover, the ratio $\Delta\text{TEC}/\Delta\text{TEV}$ provides a measure of scale efficiency change ΔSE . The next index, measuring the change in technology and denoted by ΔT is composed of two ratios of technical efficiency, corresponding to the technology of two successive periods. Finally, the product of ΔTEC and ΔT forms the so-called Malmquist total factor productivity index, MC . Its alternative decomposition is delivered by the product

$$\text{MC} = \Delta\text{TEV} \times \Delta\text{SE} \times \Delta\text{T},$$

where the first term expresses technical efficiency change with respect to the best practice technology (for details see e.g. Färe, Grosskopf and Margaritis, 2008).

All the above indexes, when greater than one, indicate some improvement in pure technical efficiency, in scale or in technology, respectively.

Results

Data

In this study we used the economic data published annually by the Farm Accounting Data Network (FADN). The system delivers data with different levels of aggregation focusing on the biggest commercial farms, which jointly in a given region or member state generate at least 90% standard gross margin (SGM). The total value of SGM for each farm makes it possible to determine its economical size, which is expressed in European size units (ESU). The system distinguishes six classes: very small farms (0 - 4 ESU), small (4 - 8), medium-sized (8 - 16), large (16 - 40), very large (40 - 100) and the biggest farms (at least 100 ESU).

On the other hand, each farm is classified to one of the eight types taking into account the share of individual types of production in the total value of ESU. As a result, each region is represented by a certain set of average farms, of which each is determined on the basis of a set of farms classified to a specific combination of type and economic size.

Investigations were conducted for all regions of states, which operated within the EU in the years 2004-2009. Due to the enlargement of the Union in 2004 these regions are divided into two groups, i.e. the old and the new EU members. As the basic research units we used in each region the average farms in individual classes of economic size and representing two joint types of production, i.e. those generally specializing in livestock production (in FADN classification the types 41, 44, 45, 50) and those generally conducting mixed production (types 70, 80). These average farms representing individual regions will simply be referred to as farms.

After enlargement of the EU in 2004, the total number of regions was 122, of which only 111 were represented by farms of various economic size and specializing in livestock production or running mixed-type production. The total number of average farms representing these regions was 333, of which 226 and 107 were livestock farms and mixed farms, respectively. Among these two groups only 83 and 24 farms were from the new regions and the others from the old ones. State affiliation of considered regions is presented in Table 1.

Such a selection of research units belonging to two directions of production and representing the old and new EU members was dictated by a desire to verify two conjectures: (i) that the concentration of mixed farms is faster than the specialist farms and is more intensive in the regions of the new UE states than in the old ones, and (ii) whether farms from the new regions improve productivity faster than the farms of the old regions irrespective of their production profile. The second supposition was analyzed in our earlier paper (Błażejczyk-Majka, Kala, Maciejewski, 2013) with respect to crop field farms and mixed farms. Since the conclusion was negative, it is interesting to establish, if it is so also in the case of livestock farms.

Indexes of efficiency change were estimated using output-oriented, two-output, and multi-input DEA. As the first output variable we used the variable which in the FADN nomenclature is referred to as total output (denoted as SE131). It is the sum of values of plant and animal production resulting from various agricultural activities, except for income from any type of subsidies. As the second output variable we used animal production (SE126). As inputs we used labor (SE011), expressed in the number of man-hours, land (SE025), i.e. total utilized agricultural area (UAA), expressed in hectares, and the consumption of fixed assets, referred to as

depreciation (SE360). Such a view of fixed capital does not allow for detailed and qualitative comparisons; however, it is often used because of limited availability of data (e.g. Bokusheva and Hockmann, 2006; Davidowa and Latruffe, 2007; Larsén, 2010). The last input is working capital, determined as the difference between the total value of inputs (SE270) and total wages (SE370) and fixed capital costs (SE360).

Table 1. Regions represented by livestock and mixed farms

State	Old regions
Austria (1)	Austria
Denmark (1)	Denmark
Belgium (2)	Vlaanderen, Wallonie
France (21)	Champagne-Ardenne, Picardie, Haute-Normandie, Centre, Basse-Normandie, Bourgogne, Nord-Pas-de-Calais, Lorraine, Alsace, Franche-Comté, Pays de la Loire, Bretagne, Poitou-Charentes, Aquitaine, Midi-Pyrénées, Limousin ^(L) , Rhône-Alpes, Auvergne, Languedoc-Roussillon ^(L) , Provence-Alpes-Côte ^(L) , Corse ^(L)
Finland (4)	Etela-Suomi, Etela-Suomi ^(L) , Etela-Suomi ^(L) , Etela-Suomi ^(L)
Germany (13)	Schleswig-Holstein, Niedersachsen, Nordrhein-Westfalen, Hessen, Rheinland-Pfalz, Baden-Württemberg, Bayern, Saarland, Brandenburg, Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt, Thuringen
Greece (4)	Makedonia-Thraki, Ipiros-Peloponissos-Nissi Ioniou, Thessalia ^(L) , Sterea Ellas-Nissi Egaeou-Kriti
Italy (18)	Aosta ^(L) , Piemonte, Lombardia ^(L) , Alto-Adige ^(L) , Veneto, Friuli-Venezia, Emilia-Romagna, Toscana, Marche, Umbria, Lazio ^(L) , Abruzzo, Molise, Campania, Puglia, Basilicata, Sicilia, Sardegna ^(L)
Ireland (1)	Ireland
Luxembourg (1)	Luxembourg
Netherlands (1)	The Netherlands
Portugal (2)	Alentejo e do Algarve, Açores ^(L)
Spain (15)	Galicia ^(L) , Asturias ^(L) , Cantabria ^(L) , Pais Vasco ^(L) , Navarra ^(L) , Aragón, Cataluna ^(L) , Baleares, Castilla-León, Madrid ^(L) , Castilla-La Mancha, Comunidad Valenciana ^(L) , Murcia, Extremadura, Andalucia
Sweden (3)	SlattbygdsIan, Skogs-och mellanbygdsIan, Lan i norra ^(L)
United Kingdom (6)	England-North, England-East, England-West, Wales ^(L) , Scotland, Northern Ireland ^(L)
	New regions
Cyprus (1)	Cyprus ^(L)
Czech Republic (1)	Czech Republic
Estonia (1)	Estonia
Hungary (6)	Közép-Dunántúl, Nyugat-Dunántúl, Dél-Dunántúl, Észak-Magyarország ^(M) , Észak-Alföld, Dél-Alföld
Lithuania (1)	Lithuania
Latvia (1)	Latvia
Malta (1)	Malta ^(L)
Poland (4)	Pomorze and Mazury, Wielkopolska and Śląsk, Mazowsze and Podlasie, Małopolska and Pogórze
Slovakia (1)	Slovakia
Slovenia (1)	Slovenia

^(L)The region represented only by livestock farms ^(M)The region represented only by mixed farms

Due to the value-oriented character of variables referring to the volume of production and the values of involved fixed and working capitals, values of these variables were corrected by the price index, i.e. they were expressed in fixed prices from the year 2000 taking into consideration annual national inflation indexes in relation to individual inputs. This conversion makes it possible to treat the above mentioned variables as synthetic aggregates for the volume of production and the amount of fixed and working capitals, respectively.

The analyzed regions vary in area and geographical locations, which significantly affects climatic and agronomic conditions. We may mention here regions of southern France or Greece and at the same time regions of Latvia or northern Poland. Moreover, they differ in the historical background which affected their economical conditions. Some problems arising from the transition from central planning to more market-based economies in Central and East European Countries were considered e.g. by Zellei, Gorton and Lowe (2005), Bogaerts, Williamson and Fendel, (2002), and recently also by Falkowski, Jakubowski and Strawiński (2014).

All this means that the numbers of farms, on the basis of which average farms were identified, were not uniform. This averaging, leading to the units of this study, reduces their variability and also the effect of erroneous observations and outliers. Anyway, we may expect high variation in values of analyzed economic indexes. It is reflected in the basic characteristics averaged in relation to years and economic size of analyzed units, which are contained in Table 2.

Table 2. Basic descriptive statistics of farms

Variables	Livestock farms				Mixed farms			
	Old regions		New regions		Old regions		New regions	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Total output (€1000)	162,08	172,05	157,04	232,87	194.22	281.62	123.09	236.96
Animal production (€1000)	138,07	149,06	128,89	211,19	115.97	141.53	60.42	113.86
Labor (100h)	192,43	123,48	479,45	654,57	51.26	71.24	100.86	167.96
Land (ha)	76,21	86,75	82,23	171,69	114.52	167.55	124.71	237.43
Working capital (€1000)	131,58	155,41	153,56	234,94	179.17	308.17	128.95	262.93
Capital (€ 1000)	20,05	17,46	18,94	38,87	29.14	38.74	17.88	46.75
Output/Labor (€/h)	36,73	24,26	14,17	10,52	37.66	21.35	8.74	5.22
Output/Land	5,03	14,03	7,00	17,00	2.14	1.66	1.00	0.37
Animal production/Labor	31,60	22,77	11,88	10,52	24.27	16.77	4.45	2.51
Animal production/Land	4,59	13,84	6,42	13,50	1.41	1.46	0.52	0.20
Working capital/Labor	29,22	20,68	12,61	10,56	31.78	20.88	8.25	6.07
Working capital/Land	3,61	9,08	6,36	13,58	1.67	1.36	0.85	0.37
Capital/Labor	5,27	3,50	1,38	0,77	6.10	4.04	1.16	0.66

When comparing the values presented in Table 1 in terms of the type of production they run, it can be observed that the productivity of land with respect to total output and to animal production in livestock farms is, on average, much higher than in mixed

farms. As to productivity of labor, it is similar in the old regions, but not in the new ones. In the new regions the ratio of total output to labor in livestock farms is almost two times higher than in mixed farms. In the case of animal production the productivity of labor is even higher. A much greater productivity of livestock farms than of mixed farms in Poland was also observed by Latruffe et al., (2005). Moreover, Pouliquen (2007) noted that long-term underproductive farm labor is one of the main problems of economic transition in the new EU members.

Taking into account the differences between the old and the new regions first it should be noted that for livestock farms from the old and new regions the following statistics: total output, animal production, land used and capital, are similar. In contrast, on average the input of labor in units from the new regions is more than two times bigger than that from the old regions. As a result, the productivity of labor in holdings from the old regions measured with respect to total output as well as to animal production is more than two times higher than in farms from the new regions. The biggest difference, however, is between the ratios of capital to labor. In farms from the old regions this ratio, on average, is four times bigger than in farms in the new regions. This suggests that the better productivity of labor and land in farms from the old regions is achieved on a significant scale, through better technical equipment.

In the case of mixed farms the situation is different. Among the main statistics, only utilized agricultural area is comparable for farms from the new and old regions. The labor input in farms from the new regions is, on average, two times bigger than in farms from the old ones. The values of other statistics for farms from the new regions are by 30-50% lower than the analogous values for farms from the old regions. As a result, labor and land productivity of farms from the new regions were much lower than those from the old ones. Productivity of land with respect to total output and to animal production in units from the old regions is two to three times higher than in farms from the new regions. The ratios related to labor in farms from the old regions are much higher. Also the ratios of capital to labor and working capital to land in the old regions were much more higher than in the analogous farms from the new regions. This confirms the fact that the better technical equipment and material resources make it possible to achieve higher productivity of the main inputs.

Concentration

Concentration and specialization are usually considered as ways to improve productivity and efficiency of economic activity. An excessive concentration of agricultural production, however, has also significant drawbacks, such as soil and water pollution, e.g. by higher amounts of manure, or loss of wildlife. On the other hand, persistence in a competitive market of a large number of small and non-productive farms that have emerged in the EU after its enlargement is not possible. As it was observed by Davidowa (2011): the Common Agricultural Policy has to accommodate this now (after the UE enlargement) widespread production system, through standard or new instruments, and help semi-subsistence farmers to commercialize or exit. Falkowski, Jakubowski and Stravinsky (2014) expressed a similar conclusion based on a study of farm profitability in Poland. Their study, covering the period of 1998-2008, indicates that returns from combining farm and off-farm activities were lower than returns from concentrating on farming or on self-employment outside agriculture. In this situation, the question of structural changes of farms, the pace and direction of these changes is especially important.

Changes in the farm structure are closely related with such values as labor inputs, utilized agricultural area and animal stocking, which as a result influence the economic size of farms. Dynamics of changes in these values, determined in the analyzed 6-year period based on the standard log-linear regression model, are presented in Table 3. Values contained in the second and fifth columns, if multiplied by 100, provide average annual change of a respective economic index.

Table 3. Changes of four economic variables, 2004-2009

Regions	Old regions			New regions		
	Yearly change	Standard deviation	R ²	Yearly change	Standard deviation	R ²
Total labor input						
Livestock	0.0009	0.0014	0.2987	-0.0101*	0.0014	0.9254
Mixed	-0.0002	0.0025	0.0334	-0.0058*	0.0019	0.6863
Livestock/Mixed	0.0005	0.0009	0.0843	-0.0067*	0.0011	0.9082
Total utilized agricultural area						
Livestock	0.0193*	0.0013	0.9817	0.0270*	0.0073	0.7757
Mixed	0.0145*	0.0030	0.8538	0.0261*	0.0022	0.9729
Livestock/Mixed	0.0177*	0.0012	0.9811	0.0268*	0.0031	0.9504
Total livestock units						
Livestock	0.0230*	0.0053	0.8260	-0.0115	0.0042	0.6497
Mixed	0.0150*	0.0048	0.7192	0.0192*	0.0029	0.9141
Livestock/Mixed	0.0211*	0.0048	0.8292	0.0091*	0.0025	0.7619
Economic size						
Livestock	0.0234*	0.0063	0.7765	0.0011	0.0014	0.3751
Mixed	0.0083	0.0048	0.6551	0.0198*	0.0036	0.8843
Livestock/Mixed	0.0194*	0.0050	0.7882	0.0147*	0.0032	0.8383

* The estimated parameter differs significantly from zero, $\alpha = 0.05$

In farms from the old regions labor inputs did not change, which may confirm stabilization of employment in these farms. In turn, the utilized agricultural area and animal stocking increased. In mixed farms the annual increase was approx. 1.5% a year, while in livestock farms, it was higher, approx. 2% a year. As a result this means improvement of labor efficiency. These changes are accompanied by an increase in economic size, which for livestock farms exceeded 2% a year.

In units representing the new regions we need to stress first of all a decrease in labor inputs, by 1% a year in animal production and by 0.6% in mixed production. This trend is consistent with the expectations expressed in a study by Pouliquen (2007), stating that after accession under Agenda 2000 schedule CEE will achieve European competitiveness at sharp decrease in farm employment levels.

Moreover, in farms of the new regions an average almost 1% decrease (statistically significant only $\alpha = 0.1$) in animal stocking on livestock farms and a 3% increase in utilized agricultural area, as well as an almost 2% increase in animal stocking in mixed farms. This results in an increase in labor efficiency, particularly evident in mixed farms. In the latter farms economic size also increased, on average by almost 2% annually.

These results indicate that in the analyzed period the utilized agricultural area of farms increased, at a slightly faster rate in the new regions, and animal stocking increased in both types of farms in the old regions and only in mixed farms from the

new regions. As a result, the economic standing of farms improved, but only in livestock farms from the old regions and mixed farms from the new regions.

Efficiency

Optimizing the structures of farms and their sizes, in particular, should be subordinated to improvement of their efficiency. Changes of technical efficiency are controlled by the Malmquist total factor productivity together with its components. These indexes, if greater than one, may be interpreted as a percentage increase of improvement. It is referred to the efficiency with respect to the best practice technology (known as pure technical efficiency change), or to the organization of production and the level of technical equipment (called shortly technical change), or to the scale of production.

Average values of these indexes for livestock farms and mixed farms are presented in Table 4. They were obtained by pooling together the data from 2004-2009 and estimating a single frontier for each specialization. The hypotheses on equality to one for the values of analyzed indexes were tested by the standard analysis of variance (ANOVA) under the assumption of normality of distribution, which assumption is justified, because the analyzed data are averages following from large samples. Such an approach was also used by Latruffe et al. (2005).

Table 4. Indexes of change for livestock and mixed farms

Regions	Old regions			New regions		
	Mean	Standard deviation	Sample size	Mean	Standard deviation	Sample size
Pure efficiency change						
Livestock	0.975*	0.0026	194	0.986*	0.0064	32
Mixed	0.965*	0.0040	83	0.954*	0.0074	24
Livestock/Mixed	0.970*	0.0024	277	0.970*	0.0049	56
Scale efficiency change						
Livestock	0.998	0.0018	194	1.003	0.0045	32
Mixed	0.999	0.0028	83	1.022*	0.0052	24
Livestock/Mixed	0.999	0.0017	277	1.012*	0.0034	56
Technical change						
Livestock	1.028*	0.0017	194	0.990*	0.0042	32
Mixed	1.028*	0.0026	83	0.995	0.0049	24
Livestock/Mixed	1.028*	0.0016	277	0.992*	0.0032	56
Malmquist productivity index						
Livestock	1.000	0.0024	194	0.978*	0.0059	32
Mixed	0.991*	0.0037	83	0.968*	0.0068	24
Livestock/Mixed	0.996*	0.0022	277	0.973*	0.0045	56

* The estimated parameter differs significantly from one, $\alpha = 0.05$

Indexes of pure efficiency change for both types of farms from the old and new regions are significantly lower than one. Generally, it means a decrease of pure technical efficiency. This decrease for mixed farms, by average, was 3.5% in the old regions and 4.6% for the units from the new regions. For livestock farms precisely an

opposite trend was found, but on a lower level. For farms of the new regions the decrease was 1.4% and for farms from the old regions it was 2.5%. The dynamics of these changes in time are illustrated on Fig. 1.

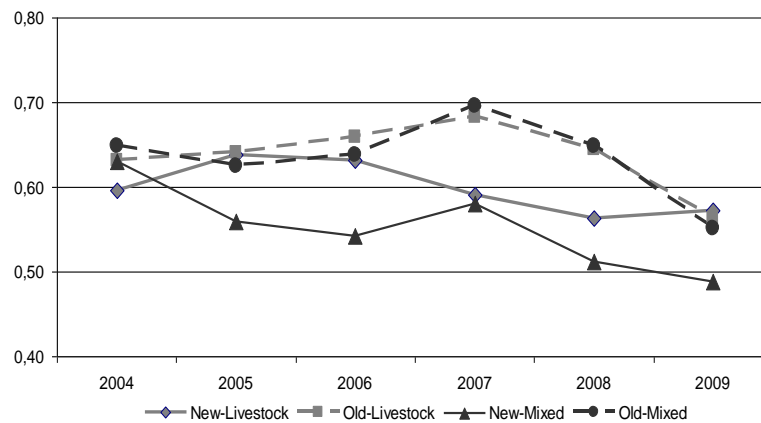


Fig. 1. Changes of pure technical efficiency: 2004-2009

Mean pure technical efficiency of both types of farms in the old regions increased up to 0.7 in 2007 and next decreased greatly. In the same time, pure efficiency of livestock farms from the new regions increased moderately in the years 2004-2005, and then gradually decreased. In the case of mixed farms from the new regions the picture is different. Their pure efficiency decreased almost throughout the whole analyzed period except for the years 2006-2007.

As to the scale efficiency change it should be noted that only for mixed farms from the new regions there was a 2.2% improvement. It means that these farms were trying to improve their situation by increasing the scale of production. This conclusion is in full agreement with the observation presented in Section 4 that these farms enlarged their agricultural area as well as animal stocking.

The most spectacular improvements are related with technical change, but only in the case of farms from the old regions. The values obtained for this index indicate an increase of technical efficiency by almost 3% for farms of both types. In the case of farms from the new regions this index is equal to one for mixed farms and indicates a 1% drop for livestock farms. This means that the farms of the old regions constantly adopt technological, organizational and technical solutions more effectively than the farms from the new regions.

An improvement of efficiency can be achieved, for example, by machinery-sharing arrangements. As it was observed by Larsén (2007), in Swedish agriculture the farm cooperation continuously increases, thus suggesting that the benefits exceed the costs, which can be regarded as a positive impact to improve efficiency.

In turn, Latruffe et al. (2005) demonstrated on the example of Polish agriculture that in Central and Eastern Europe farms are overcapitalized. This suggests weaknesses in management decisions to purchase an extensive range of machinery and equipment irrespective of farm size and its potential, with which it could be used. This

may be one of the many reasons for the low level of improvements in technical change in farms from the new regions.

In view of the rather large, on average 3% decrease of pure technical efficiency for all farms, a 2% improvement of scale efficiency, but only for mixed farms from the new regions, and an almost 3% increase of technical change for farms of the old regions and a 1% decrease for livestock farms of the new regions, it is not surprising that, on average, the Malmquist index, being a product of the aforementioned components, was almost unchanged for farms from the old regions and decreased by more than 2% for farms from the new regions. This rather disheartening observation corresponds to the conclusion following from the earlier paper by Błażejczyk-Majka, Kala, Maciejewski (2013), where instead of livestock farms the field crop farms were analyzed.

Conclusions

This study is devoted to the analysis of changes in the structure and technical efficiency of farms representing individual regions of the EU in the years 2004-2009. The analysis was based on data available in the FADN system and concerned averaged farms specializing in livestock production and running mixed production. In the analysis we distinguished two groups of farms. The first group comprised farms from the regions which were parts of the EU before 2004 (called the old regions), while the other group included the new regions, incorporated in the EU after enlargement in 2004.

In the analyses of efficiency and in the estimation of indexes of efficiency change we used the output-oriented DEA, with the total output, labor, utilized agricultural area, and the consumption of both fixed and working capital as input and output variables, respectively. In the evaluation of changes in the concentration of farms we also used total animal production and the economic size of farms. The value-oriented variables referring to the volume of production and the values of involved fixed and working capitals were corrected and expressed in fixed prices from the year 2000.

The main objective of the study was to find an answer to two questions, i.e. (i) whether the concentration of mixed farms is faster than the specialist farms and whether it is more intensive in the new regions than in the old ones, and (ii) whether changes in productivity of farms depend more on the type of farms than their belonging to the old or new regions.

As to the first question, it should be noted that in the analyzed period in the old regions the total agricultural area as well as animal stocking increased faster in the livestock farms than the mixed farms. These changes were accompanied by an increase of economical size. In turn, a statistically significant increase, by 2.3% per year, was observed only for livestock farms. In the case of farms from the new regions the increase of total agricultural area was also observed. This change was almost exactly the same (approx. 2.7% per year) for livestock and mixed units. Moreover, the animal stocking and economical size also increased (on average by 2%), but only for mixed farms. Simultaneously, in both types of farms the total labor input decreased – the larger decrease in livestock farms than in mixed ones. These changes suggest that the productivity of labor in the new regions increased – more in mixed farms than in livestock farms.

Comparing the farms from the old and new regions it should be noted that in the analyzed period farms of both types enlarged their total agricultural area and animal stocking. The enlargement of agricultural area of farms from the new regions was on average 2.7% per year, while in farms from the old regions it was 1.8%. In the case of animal stocking the increase on the part of farms from the old regions was approx. 2%, which was greater by one percentage point than in the new regions. These increases indicate an improvement in productivity of labor, in farms from the new regions strengthened by a decrease in labor (on average by 0.7% per year). All these changes resulted in an increase in the economic size of farms from the old regions on average by almost 2% per year, while in farms from the new regions it was a little lower (approx. 1.5%). Finally, we may state that the concentration, expressed by main agricultural inputs and by economical size, increased, but the process being faster and more harmonized in the old regions.

As to the second question, it turned out that a majority of indexes of change decreased in the analyzed period. This applies, first of all, to the index of pure technical efficiency change. It dropped on average by 3% per year. However, the biggest drop was noted for mixed farms from the new regions, where it decreased by more than 4%. Changes of the average pure technical efficiency (pte) index between 2004 and 2009 are illustrated on Fig. 1.

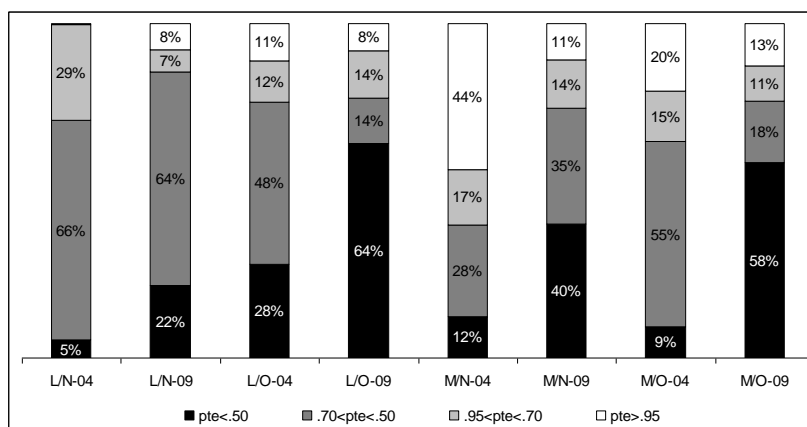


Fig. 2. Comparison of pure technical efficiency, 2004 vs. 2009:

L – livestock, M – mixed, N – new, O – old

Figure 2 shows a comparison of distributions of pte between 2004 and 2009. It is evident that the percentage of the least efficient units (pte less than 0.5) dramatically increased for both types of farms as well as for both groups of regions (the greatest increase was observed for mixed farms from the old regions). It means that the share of the other, more efficient farms decreased. The only exception was the most efficient (pte greater than 0.95) livestock farms from the new regions, where the percentage increased by eight percentage points. However, the most spectacular change was found for mixed farms from the new regions, where the class of the most efficient farms was significantly reduced.

The indexes of scale efficiency change indicate a lack of change in the scale of production for all farms from the old regions and for livestock farms from the new regions. The only significant change (a 2% increase per year) was observed for mixed farms of the new regions, which may be associated with the highest decrease of pure technical efficiency in this group of farms.

The highest growth rate is related with technical change. This index increased on average by almost 3% for all farms from the old regions, but decreased by approx. 1% for farms from the new regions. This indicates constant progress in absorbing technical, technological and organizational solutions in farms from the old regions and stagnation or even regression in these aspects in farms from the new regions.

Varied changes in individual components of the total factor productivity resulted in differences of the Malmquist indexes. Their values indicate a decrease by 3% for farms from the new regions and by 1% for mixed farms from the old regions. This confirms the conclusion that farms from the old regions better endure a generally difficult period of stagnation. Actually, the economic standing of all farms, except for livestock ones from the old regions, deteriorated, but those from the new regions suffered greater losses.

Taking into account the generally very difficult period of six years after the enlargement of the EU and the beginning of the economic crisis in 2008, these evaluations indicate, first of all, that farms from the old regions achieve better economical results than those from the new regions. It stems mainly from the faster adoption of technological and organizational solutions, from greater availability of capital equipment and material resources as well as from continuous improvement of the structure of agriculture holdings. The changes in farms from the new regions also took place, but they were less intensive and mainly were found for mixed farms, which achieve better economic results than the livestock farms. The most noticeable change was related with the increase of productivity of labor and with the change in scale of agriculture holdings.

Finally we need to stress that the above conclusions were formulated for average units, actually having very specific production profiles in the group of livestock farms as well as the group of mixed farms. Nevertheless, the question whether the current stimulating mechanisms in the EU are sufficient to strengthen farms of the new regions is still open.

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