
Agricultural Resources and their Productivity: A Transatlantic Perspective

Submitted 12/08/20, 1st revision 25/09/20, 2nd revision 20/10/20, accepted 15/11/20

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Abstract:

Purpose: The aim of the paper is to assess the production potential of the agricultural sector of the EU, including Poland, and the USA based on the assessment of resources and inputs of respective production factors, their relationships and their productivity, while also indicating changes in the farm structure and support policies addressing the agricultural sector.

Design/Methodology/Approach: The volume of land and labor resources as well as capital input in agriculture are presented, which is followed by an evaluation of the ratios between inputs and their productivity. Analyses were also conducted on the farm structure. Changes in the agricultural support policy were analyzed using a selected set of OECD indicators.

Findings: A stronger competitive position determined by more advantageous relationships between inputs, productivity and a greater scale of advanced concentration processes is found in the US agricultural sector. In the EU, despite evident structural transformation processes, a considerable gap is observed between agriculture of the EU-13 and that of the EU-15 in terms of both inputs and productivity. Although the share of financial support in total income of agricultural producers in the EU and the USA was decreasing, the income was nevertheless higher compared to that they would have attained without state intervention measures.

Practical Implications: The study refers to the discussion on the competitive position of the EU and the USA on the international agricultural market and helps to answer the question: Are EU producers able to cope with the competitive pressure of the US agriculture?

Originality/value: This is the first attempt to develop a comprehensive and up-to-date analysis of the agricultural potential and its productivity within the transatlantic partnership and rivalry, covering both the EU composed of 28 countries, including Poland, and the USA.

Keywords: Agricultural inputs, agricultural output, partial factor productivity, multi-factor productivity, production potential, farm structure, agricultural support, EU, USA.

JEL classification: O57, P23, Q15, Q18.

Paper Type: Research study.

Acknowledgement: This research was funded by the National Science Centre within the OPUS research project No. 2015/17/B/HS4/00262, titled „Polish agri-food sector under the implementation of the Transatlantic Trade and Investment Partnership agreement (TTIP)”.

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1. Introduction

Agriculture plays an important role in each economy being a contributor of food products which are necessary to meet the basic needs of the population. The role of agriculture in providing employment opportunities and income sources and as a result in reducing poverty is also crucial (Irz *et al.*, 2001; Kim and Lee, 2020). Considering both physical and economic availability of food, agriculture embodied in its production potential is of key importance to improving food security (Smutka *et al.* 2009; Otsuka, 2013; Yu and You, 2013; Pawlak and Kołodziejczak, 2020). The production potential of agriculture, making it possible to attain specific production and income outcomes from farming, comprises land, labor and capital resources. It is worth mentioning here that the value-creating role of labor, capital and land is grounded in the classical theory of economics and has been already considered by Petty, Smith and Say (Guth and Smędzik-Ambroży, 2020).

A significant aspect that determines the effects of farming is not only the resources of specific inputs themselves, but also their relationships. It is the latter that determine the quality of production factors and – next to the rational utilization of these inputs – they are the primary condition ensuring efficiency of the production process (Schultz, 1964; Baer-Nawrocka and Markiewicz, 2013). At the same time productivity is considered to be both one of the key sources and the most credible indicators of competitiveness in the long run (Smędzik-Ambroży *et al.*, 2019). It means that the long-term ability to maintain a high level of productivity facilitates attaining a favorable level of competitiveness (Skapars *et al.*, 2017). This also applies to the agricultural sector (Brinkman, 1987; Abbott and Bredhal, 1994).

According to Latruffe (2010), productivity is the ability of the production factors to produce a given level of output. In other words, productivity may be easily defined as a ratio between the volume of output and the volume of inputs (OECD, 2001), while the volume can be measured either in physical terms or in value terms. Agricultural productivity can be measured as partial factor productivity or multi-factor productivity (total productivity). There are many studies that deal with these two concepts of productivity measurement. Partial factor productivity indicators were used e.g., by Bureau and Butault (1992), Alston *et al.* (2010), Martin-Retortillo and Pinilla (2012), Petrick and Kloss (2012), Cherlet *et al.* (2013), Takács (2014), Smędzik-Ambroży and Majchrzak (2017), Diao *et al.* (2018), Gołaś (2019), and Kusz (2020). In turn, the total factor productivity (TFP) approach was employed by Ahearn *et al.* (1998), Davidova *et al.* (2003), Coelli and Prasada Rao (2005), Latruffe *et al.* (2008), Jin *et al.* (2010), Ludena (2010), Gasques *et al.* (2012), Rahman and Salim (2013), Jitea and Pocol (2014), Nin-Pratt (2015), Wang *et al.* (2015), Anik *et al.* (2017), Kijek *et al.* (2019), Kijek and Matras-Bolibok (2019), Liu *et al.* (2020) or Sheng *et al.* (2020).

Differences in agricultural productivity across countries stem among others from the size distribution of farms. This aspect was discussed e.g., by Alvarez and Arias (2004), Lipton (2009), Hayami (2010), Adamopoulos and Restuccia (2014), Desiere and

Jolliffe (2018), and Sheng *et al.* (2019). Agricultural trade and support policies also strongly affect the performance and competitiveness of the agricultural sector (Rizov *et al.*, 2013; Brooks and Matthews, 2015; Dithmer and Abdulai, 2017; Garonne *et al.*, 2018). As stated by Dunmore (1986), government policies including domestic macroeconomic policies, domestic farm policies and foreign trade and agricultural policies are even more important than natural endowments in determining competitiveness in the long run. While the role of trade in promoting growth of production and achieving food security is unequivocally positive, the impact of subsidies on agricultural productivity may vary. Existing empirical studies suggest that subsidies may either increase or reduce agricultural productivity (Hennessy, 1998; Alston and James, 2002; Blancard *et al.*, 2006; Ciaian and Swinnen, 2009; Latruffe *et al.*, 2009; Sauer and Park, 2009; Hüttel *et al.*, 2010; Mary, 2013; Minviel and Latruffe, 2017).

The European Union (EU) and the United States (USA) are the largest players in the international agricultural market. On the one hand, these two entities are important trade partners for each other. On the other hand, they compete for many export markets. In 2018, the value of agri-food exports from the EU amounted to nearly 596 billion USD (including intra-EU trade), while the exports from the USA reached 139 billion USD, representing 38% and 9% of the world total, respectively (UNCTADstat, 2020). It means that taken together, the EU and the USA determine a half of the world agri-food export value. At the same time, when excluding intra-EU trade the shares of these countries in the global agri-food exports are almost equal at around 9% (EU – 9.8%, USA – 8.9%).

In this context and in view of the status quo in the liberalization of both international and transatlantic trade, differences in the production structure in the agricultural sector may prove to be a decisive factor determining the competitive position of the EU and the USA on the world agricultural market. Agricultural sectors and policies of these countries are evolving in line with the changes in global and regional markets. One of the most substantial changes shaping the EU agriculture was the accession of Central and Eastern European countries (CEECs) to the EU in 2004 (Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia) and 2007 (Bulgaria and Romania). Poland's agricultural sector represents the biggest competitive capacity in the so-called new member states of the EU (Pawlak, 2013). Hence, the aim of the paper is to assess the production potential of the agricultural sector of the EU, including Poland, and the USA based on the assessment of resources and inputs of respective production factors, their relationships and their productivity, while also indicating changes in the farm structure and support policies addressing the agricultural sector.

It should be stressed here that problems of agricultural potential and productivity, as well as agricultural support policies in the EU and the US have been the subject of a multitude of analyses, but most of them focused only on one of these economies. Agricultural productivity in the EU countries was studied e.g., by Serrão (2003),

Swinnen and Vranken (2010), Baráth and Fertő (2016), Jaroszewska and Rembisz (2019), Kijek *et al.* (2019), while the US case was discussed by Ahearn *et al.* (1998), Wang *et al.* (2015) and Fuglie *et al.* (2017). Those analyses used TFP indices or all partial productivity indicators. At the same time some authors described only labor productivity (Takács, 2014; Gołaś, 2019), land productivity (Cherlet *et al.*, 2013; Smędzik-Ambroży and Majchrzak, 2017) or capital productivity in selected countries (Petrick and Kloss, 2012). Agricultural structures were also included in the scope of scientific interests. Changes in the farm structure in the EU were addressed by Daniłowska (2018) and Božek *et al.* (2020). In turn, the structure of the US agricultural farms was analyzed by Hoppe *et al.* (2004), MacDonald (2011; 2020) or Berbeka and Rutkiewicz (2020).

There were also attempts to verify relationships between agricultural resources and productivity or between farm structure and productivity. The relationship between agricultural production factors and partial productivity of the EU agriculture was assessed by Baer-Nawrocka and Markiewicz (2013), while the effects of farm size on productivity were explained by Alvarez and Arias (2004) and MacDonald (2020). At the same time it should be indicated here that an inverse farm size-productivity relationship was observed in developing countries of Asia (Lipton, 2009; Hayami, 2010; Sheng *et al.*, 2019), Africa (Kimhi, 2006; Barrett *et al.*, 2010) or Latin America (Deininger and Byerlee, 2012; Desiere and Jolliffe, 2018) rather than in developed countries (Sheng and Chancellor, 2019). As mentioned above, the role of subsidies in shaping the productivity in the EU agriculture was investigated by Rizov *et al.* (2013), Czyżewski and Smędzik-Ambroży (2017), and Garonne *et al.* (2018).

As far as the EU agriculture is concerned, regional level analyses were conducted as well. For example, the dynamics of agricultural productivity in the EU-15 regions was demonstrated by Cuerva (2011). The diversity of factor endowments and technical efficiency of different types of agricultural production in the enlarged EU-28 was presented by Guth and Smędzik-Ambroży (2020), while differences in the TFP level among the EU regions were shown by Kijek and Matras-Bolibok (2019). The production potential of Polish agriculture was examined e.g. by Łukiewska and Chrobocińska (2015) or Kusz (2020), while regional diversity and changes in the farm structure were discussed by Klepacki and Żak (2013) and Marks-Bielska (2016). Some studies included international comparisons and showed the position of Polish agriculture against that of the other EU countries (Smędzik-Ambroży *et al.*, 2019; Pawlak, 2013; Czyżewski and Staniszewski, 2017; Rzeszutko and Kita, 2018).

In contrast, there were only a few comparative studies (Bureau *et al.*, 1995; Gopinath *et al.*, 1997; USDA, 2004; Pawlak, 2015; Pawlak, 2018a; 2018b). Gopinath *et al.* (1997) decomposed growth in agricultural GDP into three effects: price effect, input effect and total factor productivity effect. They showed that in a majority of the EU countries and in the USA it was TFP that constituted the major source of growth over the period 1974-1993; however, the growth of TFP in the US agriculture was relatively stable, while the rates of growth in TFP in the EU appeared to be highly variable and

declining over time. A comparative analysis of non-parametric measures of productivity in nine EU countries and in the USA over the 1973-1989 period was presented by Bureau *et al.* (1995). The adopted approach revealed similar patterns of productivity growth in the agriculture of investigated economies. The USDA (2004) provided a more comprehensive analysis of the agricultural sectors of the EU and the USA. It included a comparison of farm structures, composition of agricultural output, agri-food trade, farm policies and agricultural productivity measured by the TFP growth. The study used the data ending in 2002, hence the CEECs were not the core of interest in most cases. It should also be noted here that neither the ratios between factors of production nor partial factor productivity were considered in the USDA (2004) report.

An attempt to simply compare these aspects in the EU (as a group of 27 countries) and the USA was made by Pawlak (2015; 2018a). She concluded that due to the favorable ratios between factors of production, higher partial factor productivity and a more concentrated farm structure, the competitive position of the US agriculture is stronger in relation to the EU. Pawlak (2018b) also offered a long-term analysis of changes in the agricultural support policy in the EU and the USA over the years 1986-2016. She noticed that the levels of support for EU and US agricultural producers were declining in the analyzed period, while the EU provided farmers with twice as much support as the US.

In both economies some positive developments have been observed in the structure of support as the price support measures have been gradually replaced by payments less distorting the trade and market processes. It should be stressed here that none of the above-mentioned studies referred to farm structure by economic size class, while Poland was partially out of scope of research. In view of the above and according to our best knowledge, this is the first attempt to develop a comprehensive and up-to-date analysis of the agricultural potential and its productivity within the transatlantic partnership and rivalry, covering both the EU composed of 28 countries, including Poland, and the USA.

2. Materials and Methods

These analyses used statistical data from the European Statistical Office (Eurostat) database, the Food and Agriculture Organization of the United Nations Statistical Database (FAOSTAT), publications of the United States Department of Agriculture (USDA) presenting agricultural census data from 2007 and 2017 as well as the Producer and Consumer Support Estimates Database of the Organization for Economic Cooperation and Development (OECD). The timeframe of the study was determined by the availability of comprehensive and comparable data on the international scale and thus covered the years 2007-2017 (or 2007 and 2017).

This paper presents the volume of land and labor resources as well as capital input in agriculture of the EU (divided into the EU-15 and the EU-13 countries), Poland and

the USA, which is followed by an assessment of relationships between inputs, as well as their productivity measured by the value of agricultural output. The following ratios between factors of production were assessed:

- (N/L) – land-to-labor ratio,
- (K/L) – capital-to-labor ratio,
- (K/N) – capital-to-land ratio.

Several productivity measures were employed in the research, including partial factor productivity indicators and total productivity index. There were (more on this see e.g. FAO, 2017):

1. Land productivity (P_N) – it was calculated as the ratio between the monetary value of agricultural output (Y) and total land used in farms (N):

$$P_N = Y/N \quad (1)$$

Land in farms was understood as utilized agricultural area. It should be noted here that land productivity is the most fixed factor among the three partial productivities of agricultural inputs due to the nature of farmland (Marks-Bielska and Bieniek, 2018);

2. Labor productivity (P_L) – it was measured as the ratio between the monetary value of agricultural output (Y) and the total units of labor used (L):

$$P_L = Y/L \quad (2)$$

Employment in agriculture comprises all persons of working age who during the specified period were included in paid employment or self-employment categories (FAO, 2020);

3. Capital productivity (P_K) – it was computed as the ratio between the monetary value of agricultural output (Y) and the volume of capital employed in the agricultural production process (K):

$$P_K = Y/K \quad (3)$$

Capital input was calculated as the sum of intermediate consumption and fixed capital consumption;

4. Total productivity (P_T) – the level of total productivity was estimated as the ratio between the monetary value of agricultural output (Y) and the aggregated monetary value of all inputs (X) used to produce the output:

$$P_T = Y/X, \text{ where } X = N + L + K \quad (4)$$

The total input value is composed of the following items: intermediate consumption, fixed capital consumption, compensation of employees, other taxes on production, rents and other real estate rental charges to be paid and interest paid (Eurostat, 2020b).

To identify the effect of agricultural support on the productivity level all the above-mentioned indicators were calculated using two categories of agricultural output, i.e. the value of agricultural production with or without subsidies on products. For the EU countries these values were represented by production value at basic price and the sum of production value at basic price and subsidies on products, respectively, while for

the USA there were market value of agricultural products sold and market value of agricultural products sold and government payments (Eurostat, 2020b; USDA, 2009; USDA, 2019). The analysis was supplemented with a study on the area structure of farms and land use structure in these farms, as well as farm structure in terms of their economic size and the structure of produced agricultural output (standard output in the EU and value of agricultural products sold in the USA) (Eurostat, 2020b; USDA, 2009; USDA, 2019). The Lorenz curves illustrating the distribution of farms were designed.

The impact of policy measures on agricultural producers was analyzed in more detail using the OECD indicators of agricultural support (OECD, 2020), which are the only internationally comparable and comprehensive source of knowledge concerning the level and structure of agricultural support in all OECD member countries, the six non-OECD EU member states, as well as a set of emerging economies (since 1995). The study used a range of nominal indicators, ratio indicators and percentage indicators. There were as follows (OECD, 2018):

1. Total Support Estimate (TSE) – the annual monetary value of all gross transfers from taxpayers and consumers arising from agricultural support policy. It consists of Producer Support Estimate (PSE), General Services Support Estimate (GSSE) and Transfers to Consumers from Taxpayers (TCT);
2. Producer Support Estimate (PSE) – the annual monetary value of gross transfers from consumers and taxpayers to agricultural producers (measured at the farm gate), arising from the agricultural support policy;
3. Market Price Support (MPS) – the annual monetary value of gross transfers from consumers and taxpayers to agricultural producers arising from policy measures that demonstrate a gap between domestic market prices and border prices (measured at the farm gate);
4. General Services Support Estimate (GSSE) – the annual monetary value of gross transfers to general services provided to agricultural producers collectively, arising from the agricultural support policy. The GSSE exclude payments to individual producers;
5. Transfers to Consumers from Taxpayers (TCT) – the annual budgetary payments to consumers that are given to compensate them for the higher prices they pay for agricultural products arising from policy measures that support producer prices;
6. Producer Nominal Assistance Coefficient (producer NAC) – the ratio between the value of gross farm receipts (including support) and gross farm receipts (at the farm gate) valued at border prices (measured at the farm gate);
7. Producer Nominal Protection Coefficient (producer NPC) – the ratio between the average price received by producers at the farm gate (including payments per metric ton of current output) and the border price (measured at the farm gate);
8. Percentage TSE (%TSE) – TSE transfers as a percentage of GDP;

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9. Percentage PSE (%PSE) – PSE transfers as a share of gross farm receipts.

3. Results and Discussion

3.1 Ratios Between Factors of Production and Productivity Measurement

Table 1 presents the volume of production factors in the agriculture of the EU-28, including Poland, and the USA, as well as the ratios between them in 2007 and 2017. In 2017 the agriculture of the EU-28 countries used 173.4 million hectares of utilized agricultural area (UAA), of which 71% were concentrated in the EU-15. In the group of the new EU member countries the greatest resources of utilized agricultural areas were found in Poland. Polish farms comprised 14.4 million ha UAA, i.e. approx. 8% total agricultural land resources in the EU-28. The total utilized agricultural area in the USA was over 2-fold greater than in the EU-28 (364.3 million ha in 2017), which together with the over 4-fold lower number of people employed in agriculture resulted in the UAA per 1 person employed in the US agriculture in 2017 amounting to 166.5 ha, being 6.5-fold higher than in the EU-15, almost 16-fold higher than in the EU-13 and 19-fold higher than in Poland.

However, what is more important, in relation to the decrease in employment compared to that in 2007, at relatively stable land resources the UAA per 1 person employed in agriculture in the EU increased, while in the USA an opposite trend was observed. Finally in 2017, per 1 person employed in the US agriculture the available UAA was by over 31 ha smaller than in 2007. In view of the above, firstly it indicates a much greater concentration of the agrarian structure in the USA than in the EU, which promotes a higher labor productivity (Tables 2 and 3), while secondly it points to progressing land structure concentration processes in the EU countries, particularly the EU-13. This aspect was investigated by Daniłowska (2018), and Bożek *et al.* (2020), whereas the importance of land-labor ratios in the modification of labor productivity in European agriculture was stressed by Martin-Retortillo and Pinilla (2012). It needs to be stressed here that relatively large land resources promote greater flexibility in the production structure and facilitate production with a lower capital intensity – cheaper and increasingly desirable as being environmentally friendly (Pawlak, 2015). This is reflected in the capital-land ratios.

In 2017 in the USA on average capital input per 1 ha UAA was equivalent to 570 Euro, i.e. over 2-fold lower than in Poland and the other EU-13 countries, and 3.5-fold lower than in the EU-15. In turn, a low capital input-land ratio in the USA resulted in a lower land productivity than in the EU (Tables 2 and 3). However, it needs to be stressed here that at least in some EU countries in Central and Eastern Europe the extensive character of agricultural production is not connected so much with a rational decision of the farmer, attempting at cheaper production thanks to its lower capital intensity (similarly as it is in the USA), but it results from necessity and (despite the implemented support policy) the insufficient capital input.

A decrease in employment in agriculture as well as a simultaneous increase in capital input in agricultural production resulted in an improvement of capital-labor ratios in the EU countries. An approximately 20% increase in capital input observed in the years 2007-2017 both in the EU-15 and the EU-13 led to a more than proportional increase in capital assets per employee. In Poland the capital assets per employee involved in production increased by almost 70%, while still the value of capital input per 1 person employed in agriculture was 5-fold lower than in the EU-15 and almost 10-fold lower than in the USA (Table 1). A similar gap in this respect was also observed for the other EU-13 countries from the EU-15 or the USA.

These differences in the capital-labor ratios indicate the weakness of the competitive potential of agriculture in Poland and the other EU-13 countries in relation to the EU-15 and the USA and explain the differences in labor productivity. Regardless of the granted subsidies on products, in 2017 labor productivity measured by the value of agricultural output per 1 person employed in agriculture in the EU-13 was approx. 5-fold lower than in the EU-15 and 10-fold lower than in the USA (Tables 2 and 3). Similar observations concerning the analysis of production factor relationships in agriculture of the EU countries were provided by earlier studies of Baer-Nawrocka and Markiewicz (2013) and Jaroszewska and Rembisz (2019). When evaluating the competitive potential of agriculture in the EU and the USA in terms of capital assets invested in labor a similar conclusion may be reached, this time indicating the advantage of the agricultural sector in the USA over that of the EU.

Table 1. Resources and inputs of production factors as well as their ratios in agriculture of the EU, Poland and the USA in 2007 and 2017

Specification	Years	EU-15	EU-13	EU-28	Poland	USA
Utilised agricultural area (thous. ha)	2007	124 812	48 918	173 730	15 477	373 159
	2017 ^a	123 921	49 418	173 339	14 406	364 305
	2007=100	99.3	101.0	99.8	93.1	97.6
Employment (thous. persons)	2007	6 079	6 342	12 420	2 247	1 888
	2017	4 805	4 674	9 479	1 672	2 188
	2007=100	79.0	73.7	76.3	74.4	115.9
Capital input (current prices, million Euro ^b)	2007	217 189	42 559	259 748	13 333	130 881
	2017	254 626	50 550	305 177	16 758	207 892
	2007=100	117.2	118.8	117.5	125.7	158.8
Number of persons employed per 100 ha UAA	2007	4.9	13.0	7.1	14.5	0.5
	2017	3.9	9.5	5.5	11.6	0.6
UAA per 1 person employed (ha)	2007	20.5	7.7	14.0	6.9	197.7
	2017	25.8	10.6	18.3	8.6	166.5
Value of capital input per 1 person employed (thous. Euro)	2007	35.7	6.7	20.9	5.9	69.3
	2017	53.0	10.8	32.2	10.0	95.0
Value of capital input per 1 ha UAA (thous. Euro)	2007	1.7	0.9	1.5	0.9	0.4
	2017	2.1	1.0	1.8	1.2	0.6

Note: a – for EU data for 2016; b – value of capital input in the US agricultural sector converted from USD to Euro according to mean annual exchange rate of the National Bank of Poland from a given year.

Source: The authors' calculations based on Eurostat (2020a, 2020b), FAO (2020), USDA (2009), USDA (2019), NBP (2020).

Lesser disparities between the EU countries and the USA were observed in terms of efficiency of capital inputs involved in the production process. In 2017 both in the EU-15 and the EU-13 a capital input of 1 Euro contributed to the generation of 1.4 Euro in agricultural production, whereas in the USA the value of production generated from the equivalent of 1 Euro invested capital was by approx. 20% higher (Tables 2 and 3). Higher productivity of capital input was recorded in Poland (1.5 Euro from 1 Euro capital input). Moreover, while in the years 2007-2017 productivity of capital in Poland and the other EU-13 countries increased, it decreased in the EU-15 and the USA. This is consistent with the theory of production, according to which an increase in inputs in the developed agriculture leads to a decrease in their efficiency, whereas benefits from their increased levels result from an increased volume of production and income (Pawlak, 2013). Even lesser differences than those in productivity of capital were recorded for total productivity in the EU and the USA.

Table 2. Productivity of inputs measured by the value of agricultural output without subsidies on products (in current prices) in agriculture of the EU, Poland and the USA in 2007 and 2017

Countries	Years	Agricultural output (Euro)			
		per 1 ha UAA	per 1 person employed	per 1 Euro of capital input	per 1 Euro of total input
EU-15	2007	2 384	48 945	1.37	1.10
	2017	2 789	71 934	1.36	1.10
	2007=100	117.0	147.0	99.1	100.8
EU-13	2007	1 168	9 008	1.34	1.14
	2017	1 417	14 978	1.38	1.16
	2007=100	121.3	166.3	103.2	102.0
UE-28	2007	2 041	28 554	1.37	1.10
	2017	2 398	43 850	1.36	1.11
	2007=100	117.5	153.6	99.8	101.0
Poland	2007	1 291	8 897	1.50	1.32
	2017	1 773	15 277	1.52	1.32
	2007=100	137.3	171.7	101.7	99.9
USA	2007	583	115 210	1.66	1.23
	2017	946	157 535	1.66	1.19
	2007=100	162.4	136.7	99.8	96.6

Source: See, Table 1.

In 2017 from 1 Euro of total investments in the EU-28 the generated value of production amounted to 1.1 Euro, while in the USA it was 1.2 Euro (Table 2). Thus it may be concluded that agricultural productivity is influenced to a greater extent by an increase in land productivity and especially labor productivity, rather than by an increase in capital productivity (Wang *et al.*, 2015). In this context the key issue for the improvement of agricultural productivity and competitiveness of the agricultural sector in the EU countries in relation to the USA seems to stem from a reduction of employment in agriculture and the progressing concentration of farmland, particularly in the new EU members, including Poland. This recommendation is in line with studies by Pawlak (2013), Czyżewski and Staniszewski (2017) or Kołodziejczak (2020). Czyżewski and Staniszewski (2017) noted that actually changes to the

distribution of labor are even more important than changes to the distribution of land; however, the former cannot take place without the latter ones.

Table 3. Productivity of inputs measured by the value of agricultural output with subsidies on products (in current prices) in agriculture of the EU, Poland and the USA in 2007 and 2017

Countries	Years	Agricultural output with subsidies on products (Euro)			
		per 1 ha UAA	per 1 person employed	per 1 Euro of capital input	per 1 Euro of total input
EU-15	2007	2 432	49 946	1.40	1.12
	2017	2 817	72 644	1.37	1.12
	2007=100	115.8	145.4	98.1	99.8
EU-13	2007	1 218	9 399	1.40	1.19
	2017	1 451	15 345	1.42	1.19
	2007=100	119.1	163.3	101.3	100.2
UE-28	2007	2 091	29 243	1.40	1.13
	2017	2 427	44 391	1.38	1.13
	2007=100	116.1	151.8	98.6	99.9
Poland	2007	1 367	9 418	1.59	1.40
	2017	1 811	15 600	1.56	1.35
	2007=100	132.5	165.6	98.1	96.4
USA	2007	598	118 305	1.71	1.27
	2017	968	161 162	1.70	1.22
	2007=100	161.7	136.2	99.4	96.2

Source: See, Table 1.

As Ahearn *et al.* (1998) stated in their study, government programs are one of the important sources of productivity. It may be noticed that incorporation of subsidies on products in the calculation of productivity both in the EU and the USA made the levels of partial factor productivities and total productivity higher; however, the differences in the levels between the analyzed countries did not significantly change. Nevertheless it has to be remembered that the analysis considered solely subsidies on products (i.e. subsidies payable per unit of a good produced; Eurostat, 2020b), whereas as indicated by Rizov *et al.* (2013), Czyżewski and Smędzik-Ambroży (2017), the effects of individual support forms on productivity of agriculture vary considerably.

Summing up, it results from the analyses that high or low productivity levels primarily arise from favorable or unfavorable ratios between production factors. In other words, the productivity is affected by resource-related determinants. This problem has been already discussed by Baer-Nawrocka and Markiewicz (2013) or Guth and Smędzik-Ambroży (2020). In turn, lower levels of productivity in agriculture in the EU-13 compared to that in the EU-15 (and excluding land productivity - also in the USA) were shown in the works by Pawlak (2013), Czyżewski and Smędzik-Ambroży (2017) or Smędzik-Ambroży *et al.* (2019).

3.2 Farm Structure

As mentioned, farm structure and land concentration determine production capacity and the level of productivity in agriculture; however, existing studies provide ambiguous evidence on the relationship between farm size and agricultural performance. In general, larger farms are better performers due to the economies of scale and benefits from access to input and output markets (Huffman and Evenson, 2001; Yee *et al.*, 2004; Latruffe *et al.*, 2004), but some studies proved an inverse relationship (Huffman and Evenson, 2001; Munroe, 2001). Finally, it was also found that the relationship between farm size and performance is U-shaped (Latruffe *et al.*, 2005; Tonsor and Featherstone, 2009). The analysis of farm structure and land use in the EU and the USA in the years 2007 and 2016 (or 2017 for the USA) is consistent with the former point of view.

In 2016 the average area of a farm in the EU-13 was 8.2 ha and it was by 2.2 ha greater than in 2007, while still being almost 3.5-fold lower than the average in the EU-15 (27.8 ha in 2016; Table 4) and 22-fold lower than in the USA (178.4 ha; Table 5). The average size of farms in Poland exceeded the average of the EU-13, as in this country in the years 2007-2016 the mean UAA per 1 farm increased by almost 60%, from 6.5 ha to 10.2 ha. Despite the progressing concentration processes, the average area of a farm in Poland was almost 3-fold smaller than in the EU-15 and over 17-fold lower than in the USA. Farm operators in the USA worked under completely different conditions than in the EU. While – as it results from the above-mentioned studies (Huffman and Evenson, 2001; Munroe, 2001; Yee *et al.*, 2004; Latruffe *et al.*, 2004; Latruffe *et al.*, 2005; Tonsor and Featherstone, 2009) – the area of a farm does not define its production potential, it nevertheless considerably determines it and greatly affects the level of capital and labor productivity as well as the volume of income and accumulation (Cuerva, 2011; Marks-Bielska, 2016; Daniłowska, 2018).

Thus it may be stated that a relatively smaller area of individual farms in the EU compared to the USA is a factor weakening their competitive position both on the regional and the world markets. In this context we need to stress the trend observed in the years 2007-2016 towards an increase in the average farm area in the EU, to a greater extent – particularly in the EU-13 excluding Poland – resulting from a decrease in the number of farms rather than the reduction of utilized agricultural area (Table 4).

In the years 2007-2016 the number of farms in the EU-28 dropped by almost 25%, from 13.8 million to 10.5 million. In the EU-15 this reduction affected all area size groups of farms below 100 ha UAA, while in the CEECs it was for farms of max. 20 ha UAA. Similar changes affected the agricultural utilized area. Overall in the EU-28 in the years 2007-2016 the area of utilized agricultural land in farms of max. 100 ha UAA decreased by almost 11 million ha, at a simultaneous increase by 10.5 million ha in farms of over 100 ha UAA. In Poland over the investigated period the UAA in farms decreased by almost 1.1 million ha, with farms of less than 20 ha UAA losing almost 2 million ha UAA, whereas in larger farms (min. 20 ha) the area increased by

over 860 thousand ha UAA. The number of farms in the analyzed years dropped by 980 thousand and as a rule this pertained only to farms of max. 20 ha UAA. Such a situation results probably from the fact that some of the land from eliminated farms was acquired by existing farms by purchase or lease.

Table 4. *The farm structure and the land use structure in the EU countries in 2007 and 2016*

Agricultural size of farm (ha)	2007				2016				Dynamics	
	Farms		UAA		Farms		UAA		Farms	UAA
	thous.	%	thous. ha	%	thous.	%	thous. ha	%	2007=100	
EU-15										
0-4.9	3 010.3	53.9	5 430.8	4.4	2 143.0	48.0	4 148.1	3.3	71.2	76.4
5-9.9	729.4	13.0	5 142.8	4.1	627.8	14.1	4 461.4	3.6	86.1	86.8
10-19.9	594.5	10.6	8 449.4	6.8	524.5	11.7	7 440.4	6.0	88.2	88.1
20-49.9	636.0	11.4	20 447.6	16.4	557.6	12.5	17 962.8	14.5	87.7	87.8
50-99.9	354.5	6.3	24 890.6	19.9	325.0	7.3	22 943.6	18.5	91.7	92.2
> 100	264.6	4.7	60 450.8	48.4	286.8	6.4	66 964.8	54.0	108.4	110.8
Total	5 589.3	100.0	124 812.0	100.0	4 464.7	100.0	123 921.1	100.0	79.9	99.3
Average	22.3				27.8				124.3	
EU-13										
0-4.9	6 697.4	81.5	9 114.8	18.6	4 724.4	78.7	6 475.1	13.1	70.5	71.0
5-9.9	856.0	10.4	5 936.9	12.1	636.8	10.6	4 419.7	8.9	74.4	74.4
10-19.9	408.1	5.0	5 569.5	11.4	342.3	5.7	4 695.7	9.5	83.9	84.3
20-49.9	174.8	2.1	5 134.9	10.5	184.7	3.1	5 551.3	11.2	105.7	108.1
50-99.9	40.8	0.5	2 785.7	5.7	56.5	0.9	3 905.6	7.9	138.5	140.2
> 100	42.2	0.5	20 375.8	41.7	58.6	1.0	24 370.1	49.3	138.9	119.6
Total	8 219.3	100.0	48 917.6	100.0	6 003.3	100.0	49 417.5	100.0	73.0	101.0
Average	6.0				8.2				138.3	
EU-28										
0-4.9	9 707.7	70.3	14 545.6	8.4	6 867.4	65.6	10 623.2	6.1	70.7	73.0
5-9.9	1 585.4	11.5	11 079.7	6.4	1 264.6	12.1	8 881.1	5.1	79.8	80.2
10-19.9	1 002.6	7.3	14 018.9	8.1	866.8	8.3	12 136.1	7.0	86.5	86.6
20-49.9	810.8	5.9	25 582.5	14.7	742.3	7.1	23 514.1	13.6	91.6	91.9
50-99.9	395.3	2.9	27 676.3	15.9	381.5	3.6	26 849.2	15.5	96.5	97.0
> 100	306.8	2.2	80 826.6	46.5	345.4	3.3	91 334.9	52.7	112.6	113.0
Total	13 808.6	100.0	173 729.6	100.0	10 468.0	100.0	173 338.6	100.0	75.8	99.8
Average	12.6				16.6				131.6	
Poland										
0-4.9	1 637.2	68.5	2 724.0	17.6	766.5	54.3	1 908.3	13.2	46.8	70.1
5-9.9	389.4	16.3	2 764.2	17.9	306.2	21.7	2 155.5	15.0	78.6	78.0
10-19.9	239.3	10.0	3 292.3	21.3	202.4	14.3	2 782.4	19.3	84.6	84.5
20-49.9	101.4	4.2	2 930.5	18.9	101.2	7.2	3 002.2	20.8	99.8	102.4
50-99.9	15.8	0.7	1 058.4	6.8	22.4	1.6	1 524.8	10.6	141.8	144.1
> 100	7.9	0.3	2 707.8	17.5	12.0	0.9	3 032.5	21.1	151.9	112.0
Total	2 391.0	100.0	15 477.2	100.0	1 410.7	100.0	14 405.7	100.0	59.0	93.1
Average	6.5				10.2				157.8	

Source: *The authors' calculations based on Eurostat (2020a).*

Table 5. *The farm structure and the land use structure in the USA in 2007 and 2017*

Agricultural size of farm	2007				2017				Dynamics	
	Farms		UAA		Farms		UAA		Farms	UAA
	thous.	%	thous. ha	%	thous.	%	thous. ha	%	2007=100	
1-9 acres (1-4 ha)	232.8	10.6	437.1	0.1	273.3	13.4	527.0	0.1	117.4	120.6
10-49 acres (4-20 ha)	620.3	28.1	6 442.0	1.7	583.0	28.5	5 984.5	1.6	94.0	92.9
50-139 acres (20-56 ha)	521.0	23.6	18 221.9	4.9	447.9	21.9	15 622.3	4.3	86.0	85.7
140-259 acres (56-105 ha)	295.3	13.4	22 458.5	6.0	248.1	12.1	18 871.2	5.2	84.0	84.0
260-999 acres (105-404 ha)	362.3	16.4	72 856.6	19.5	317.1	15.5	64 202.7	17.6	87.5	88.1
> 1000 acres (> 404 ha)	173.1	7.9	252 742.9	67.7	172.8	8.5	259 097.5	71.1	99.8	102.5
Total	2 204.8	100.0	373 158.9	100.0	2 042.2	100.0	364 305.1	100.0	92.6	97.6
Average			169.2				178.4			105.4

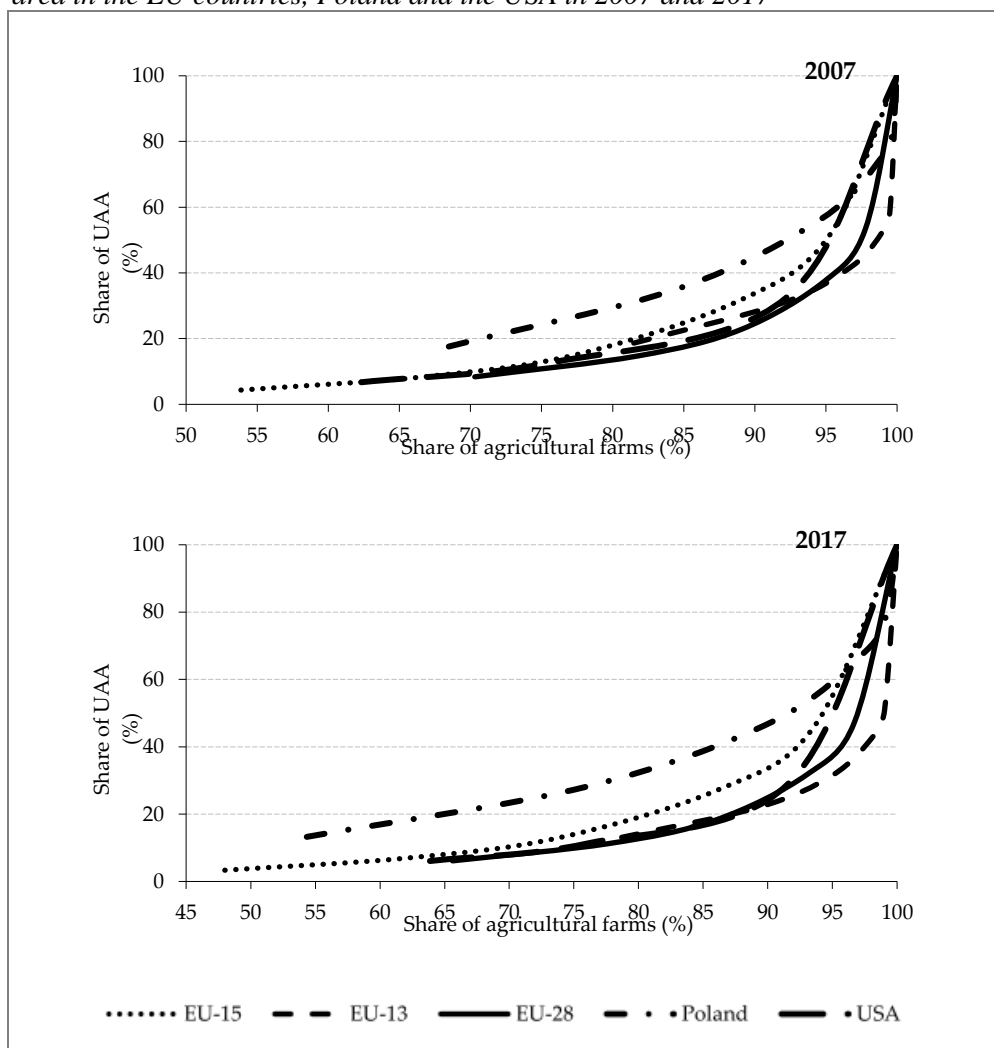
Source: *The authors' calculations based on USDA (2009, 2019).*

Despite intensive structural transformation in agriculture both in the EU-15 and the EU-13, the area structure of farms in the EU remains markedly diverse and the gap between the old and new EU member countries is still considerable (cf. Bożek *et al.*, 2020). As a consequence, in farms of most EU-13 countries the ratios between inputs, especially labor and land, are inappropriate, thus resulting in low labor productivity and low income levels, which leads to economic and social problems on the micro-scale (that of the farm and the household), while processes of the expanded reproduction of assets are very limited and even impossible. In 2016 almost 80% all farms in the EU-28 (8.1 million) were small farms (max. 10 ha UAA), which comprised 11% total UAA (19.5 million ha).

At the same time slightly over 3% of the largest farms (over 100 ha UAA) operated on 53% total UAA in the EU-28 (Table 4, Figure 1). An even more striking polarity in the agrarian structure was found in the new EU member countries, where farms of less than 10 UAA, using typically traditional cultivation and animal production methods and being subsistence farms, accounted for 90% all farms (5.4 million) and operated on 22% total UAA. On the other hand, 1% all farms were those with an area exceeding 100 ha UAA, based on hired labor and operating according to the principles of rational economics, and utilized almost 50% of available agricultural land. The area structure of farms in Poland is more advantageous than the EU-13 average, but it still it does not meet the EU-15 standards. In 2016 in Poland there were over 1 million small farms (max. 10 ha UAA) and they accounted for 76% all farms.

However, it is of greater importance that they operated on over 4 million ha total UAA, i.e. almost 30%. The largest farms (over 100 ha UAA) accounted for approx. 1% all farms, but they used only 21% total UAA, i.e. by 28 percentage points less than the EU-13 average.

Figure 1. Lorenz curves for accumulated percentages of the number of farms and farm area in the EU countries, Poland and the USA in 2007 and 2017



Note: for EU data for 2016.

Source: Authors' calculations based on Tables 4 and 5.

The rate of structural transformations in Poland and the other EU-13 countries is evident rather in the absolute terms (differences in thousands) than the relative terms (Lorenz curves) (Table 4, Figure 1); however, in view of changes in the average area of farms it is slower than in the EU-15. For the point of view of improvement in

competitiveness of the agricultural sector in this group of countries, this indicates the need or even a necessity for further structural transformations. When seeking the reasons for the diversity in farm and agricultural land distribution between the EU-15 and EU-13 a few should be mentioned. Most of all these are related with the historical context and the state transformations in the CEECs, their accession to the EU and the resulting implementation of the EU Common Agricultural Policy with its support measures, as well as the multi-functional use of agricultural land (Marks-Bielska, 2016; Daniłowska, 2018).

Other directions of transformations were taking place in the analogous period within the agrarian structure of farms in the USA. In the years 2007-2017 the number of farms decreased by 162.6 thousand (less than 7.5%), to slightly over 2 million, while the area of farmland in 2017 was 364.3 million ha UAA, which was by 8.9 million ha, i.e. approx. 2.5% lower than in 2007 (Table 5). Although in the years 2007-2017 in the USA the number of the smallest farms (1-4 ha) increased and the area of land farmed by them increased as well, still their share in the total number of farms in the USA was over 3.5-fold lower than for the comparable area size group (1-5 ha) in the EU-15 and almost 6-fold lower than in the EU-13 (13.4% in the USA compared to 48% in the EU-15 and 78.7% in the EU-13).

The area of the utilized agricultural land they operated on accounted for 0.1% total resources of land used by agriculture compared to 3.3% in the EU-15 and 13.1% in the EU-13. Farms of over 105 ha, which in 2017 numbered 490 thousand, accounted for almost 25% all farms, but comprised over 71% total UAA (323.3 million ha; for more on changes in farm structure in the USA in the long run see Berbeka and Rutkiewicz, 2020). Differences in farm and land use distribution between the EU countries and the USA are comprehensively illustrated by the shape of Lorenz curves (Figure 1).

A significant element used to identify resource competitiveness of agriculture is provided by the analysis of farm economic size. The analysis of farm structure based on their economic size in the EU countries and in the USA (Tables 6 and 7) confirms observations arising from the analysis of their area structure. Despite evident concentration processes and a markedly faster growth rate for the farms of the greatest economic size in the EU-13, including Poland, compared to the EU-15, in the absolute terms the gap between agriculture of these two groups of countries was even greater than in the case of farm area structure. While the average area of a farm in the EU-15 in 2016 was approx. 3.5-fold larger than in the EU-13, the average economic size of the farm measured by standard output was 6.5 times greater (Tables 4 and 6). The rate of observed concentration processes was faster than in the case of the area structure.

The average farm area in the EU-15 and the EU-13 increased in the analyzed period by approx. 24% and 38%, respectively, while the economic size increased by 57% and 93.5%. In Poland the rate of transformation in the area structure of farms measured by the dynamics of increase in the average farm area was slightly below 58%, whereas

in terms of the economic size structure it was almost 150% (the growth dynamics index for the average economic size of farms was 248.8%).

Table 6. *The farm structure and the agricultural output structure based on the economic size of farms in the EU countries in 2007 and 2016*

Economic size of farm (Euro)	2007				2016				Dynamics	
	Farms		Standard output		Farms		Standard output		Farms	Standard output
	thous.	%	thous. Euro	%	thous.	%	thous. Euro	%	2007=100	
EU-15										
0-1999	1 234	22.1	1 244	0.5	767	17.2	798	0.3	62.2	64.2
2000-2999	873	15.6	2 548	1.1	622	13.9	1 818	0.6	71.3	71.3
4000-7999	906	16.2	5 191	2.2	637	14.3	3 660	1.2	70.3	70.5
8000-14999	671	12.0	7 383	3.1	562	12.6	6 238	2.1	83.8	84.5
15000-49999	938	16.8	26 201	10.9	849	19.0	23 732	7.9	90.6	90.6
50000-99999	415	7.4	29 522	12.3	370	8.3	26 430	8.8	89.1	89.5
100000-499999	493	8.8	100 167	41.6	553	12.4	120 504	40.0	112.2	120.3
> 500000	60	1.1	68 572	28.5	104	2.3	118 282	39.2	173.8	172.5
Total	5 589	100.0	240 828	100.0	4 465	100.0	301 461	100.0	79.9	125.2
Average	43.1				67.5				156.7	
EU-13										
0-1999	5 122	62.3	3 678	8.3	3 265	54.4	2 589	4.1	63.7	70.4
2000-2999	1 451	17.7	4 141	9.3	1 026	17.1	2 939	4.7	70.7	71.0
4000-7999	870	10.6	4 808	10.8	756	12.6	4 236	6.8	87.0	88.1
8000-14999	380	4.6	4 089	9.2	404	6.7	4 385	7.0	106.3	107.3
15000-49999	308	3.8	7 892	17.8	380	6.3	10 155	16.2	123.1	128.7
50000-99999	51	0.6	3 470	7.8	96	1.6	6 635	10.6	188.3	191.2
100000-499999	30	0.4	5 848	13.2	64	1.1	12 576	20.1	215.2	215.1
> 500000	7	0.1	10 419	23.5	13	0.2	19 141	30.5	180.0	183.7
Total	8 219	100.0	44 344	100.0	6 003	100.0	62 657	100.0	73.0	141.3
Average	5.4				10.4				193.5	
EU-28										
0-1999	6 356	46.0	4 922	1.7	4 032	38.5	3 388	0.9	63.4	68.8
2000-2999	2 324	16.8	6 689	2.3	1 649	15.7	4 757	1.3	70.9	71.1
4000-7999	1 775	12.9	9 999	3.5	1 393	13.3	7 896	2.2	78.5	79.0
8000-14999	1 052	7.6	11 472	4.0	967	9.2	10 624	2.9	91.9	92.6
15000-49999	1 246	9.0	34 093	12.0	1 229	11.7	33 887	9.3	98.6	99.4
50000-99999	466	3.4	32 992	11.6	466	4.5	33 065	9.1	100.0	100.2
100000-499999	523	3.8	106 015	37.2	617	5.9	133 080	36.5	118.0	125.5
> 500000	67	0.5	78 991	27.7	117	1.1	137 423	37.7	174.4	174.0
Total	13 809	100.0	285 172	100.0	10 468	100.0	364 119	100.0	75.8	127.7
Average	20.7				34.8				168.4	
Poland										
0-1999	1 302	54.4	859	5.0	391	27.7	428	1.7	30.1	49.8
2000-2999	354	14.8	1 020	6.0	270	19.1	783	3.1	76.2	76.7
4000-7999	302	12.6	1 719	10.1	253	17.9	1 439	5.8	83.6	83.7
8000-14999	195	8.2	2 133	12.5	185	13.1	2 030	8.1	94.6	95.2
15000-49999	194	8.1	5 005	29.4	219	15.6	5 990	24.0	112.9	119.7
50000-99999	29	1.2	1 945	11.4	59	4.2	4 037	16.1	203.1	207.5
100000-499999	13	0.5	2 323	13.6	30	2.1	5 645	22.6	240.5	243.0
> 500000	2	0.1	2 032	11.9	4	0.2	4 654	18.6	218.8	229.1
Total	2 391	100.0	17 036	100.0	1 411	100.0	25 006	100.0	59.0	146.8
Average	7.1				17.7				248.8	

Source: See, Table 4.

Table 7. *The farm structure and the agricultural output structure based on the economic size of farms in the USA in 2007 and 2017*

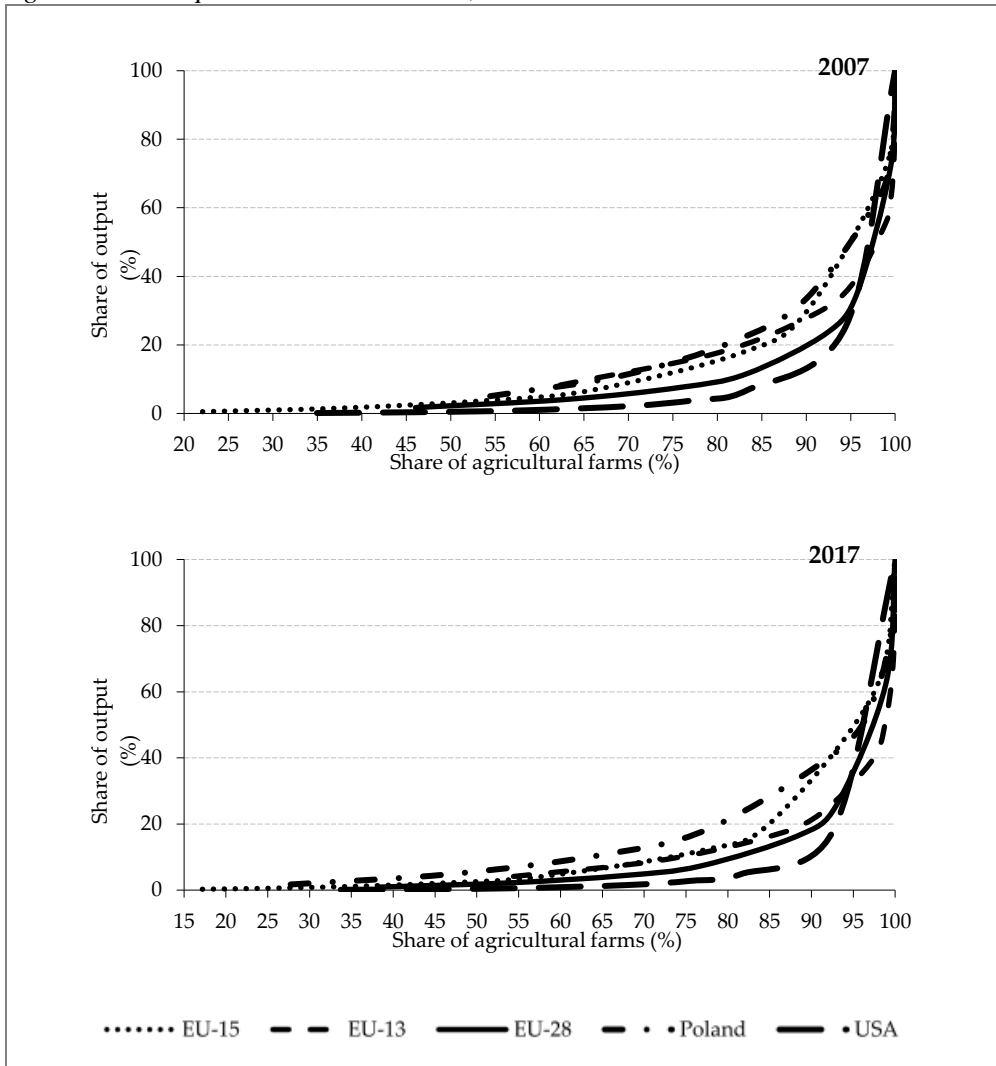
Economic size of farm (USD)	2007				2017				Dynamics	
	Farms		Agricultural output		Farms		Agricultural output		Farms	Agricultural output
	thous.	%	thous. USD	%	thous.	%	thous. USD	%	2007=100	
0-2499	771	31.2	409	0.1	689	33.7	383	0.1	89.4	93.6
2500-4999	246	11.2	685	0.2	211	10.3	629	0.2	85.8	91.9
5000-9999	255	11.6	1 488	0.5	234	11.5	1 415	0.4	91.9	95.1
10000-24999	274	12.4	3 810	1.3	253	12.4	3 505	0.9	92.1	92.0
25000-49999	164	7.4	5 286	1.8	155	7.6	4 915	1.3	94.9	93.0
50000-99999	129	5.9	8 644	2.9	126	6.2	8 255	2.1	97.5	95.5
100000-499999	245	11.1	56 236	18.9	223	10.9	51 092	13.2	91.0	90.9
> 500000	121	5.5	220 663	74.2	151	7.4	318 329	81.9	124.9	144.3
Total	2 205	100.0	297 220	100.0	2 042	100.0	388 523	100.0	92.6	130.7
Average			134.8				190.2			141.1

Source: See, Table 5.

When comparing the farm structure in terms of their economic size in the EU and the USA, it may be stated that in relative terms (Lorenz curves) the differences in the distribution of farms and the generated agricultural output, particularly in larger economic size classes, are smaller than in terms of the area structure (Figure 2). It should be stressed here that due to the differences in the way data are collected and reported a comparison of the farm structure according to the economic size classes in absolute terms is impossible. In the USA the distribution of farms by sales classes is available, while in the EU the data coming from the Farm Accountancy Data Network (FADN) refer only to the sample of commercial farms rather than all the farms and are presented based on the so-called standard output (cf. USDA, 2004). Farms in the sample are therefore larger in economic size than the average EU farm. Despite this fact, it is evident that farms in the USA are, on average, much bigger in economic size than those in the EU (Tables 6 and 7).

It may be concluded that an inadequate agrarian structure is the primary cause for low labor and capital productivity, while it is also a factor limiting progress and technical change in production. For this reason, in order to improve competitiveness of farms from countries with a fragmented agrarian structure it is necessary to implement concentration processes leading to the formation of a group of competitive farms linked with the agricultural markets, both regional and global. Progressing concentration in the area and economic size structures of farms in the EU are evident. Still the degree of land resource concentration promoting the effect of scale for production and generating productivity advantages is much greater in the US agriculture USA than in the EU.

Figure 2. Lorenz curves for accumulated percentages of the number of farms and agricultural output in the EU countries, Poland and the USA in 2007 and 2017



Note: Standard output in the EU and market value of agricultural products sold in the USA; for EU data for 2016.

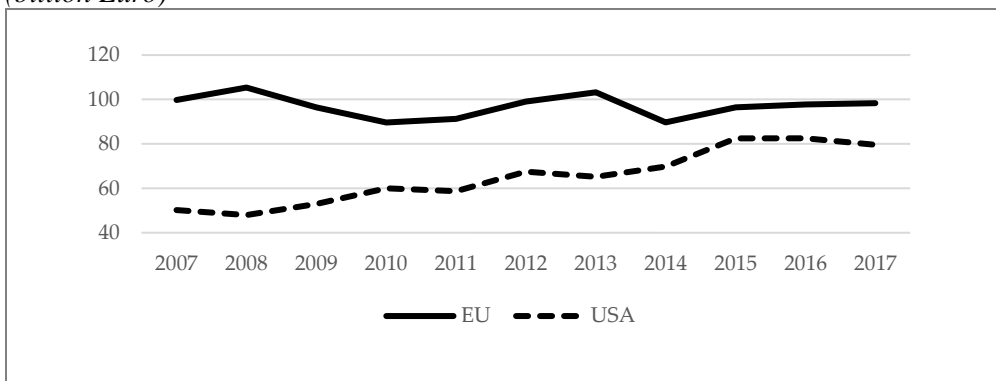
Source: The authors' calculations based on Tables 6 and 7.

3.3 Agricultural Support Policy

Both the EU and the USA share many goals of agricultural policies that range from such primarily established as stabilizing agricultural production and supporting farm income to those that more recently come into force, such as assuring food and nutrition security or encouraging rural development and environmental protection. A wide range of agricultural policy measures is used in all these countries to influence

producers' decisions on resource allocation (OECD, 2011). In absolute terms in the years 2007-2017 the total value of gross transfers from taxpayers and consumers that supported agriculture in the EU was relatively stable and amounted to around 90-100 billion Euro per year (Figure 3). Within the same period the value of mean annual transfers to agricultural producers and the agricultural sector in the USA increased by approx. 60%, from the equivalent of 50 billion Euro in 2007 to 80 billion Euro in 2017. This means that while at the beginning of the investigated period the amount of funds allocated to support agricultural producers and the agricultural sector in the EU was 2-fold greater, in 2017 it was by 20% higher than in the USA.

Figure 3. Total support to agriculture (TSE) in the EU and the USA in 2007-2017 (billion Euro)



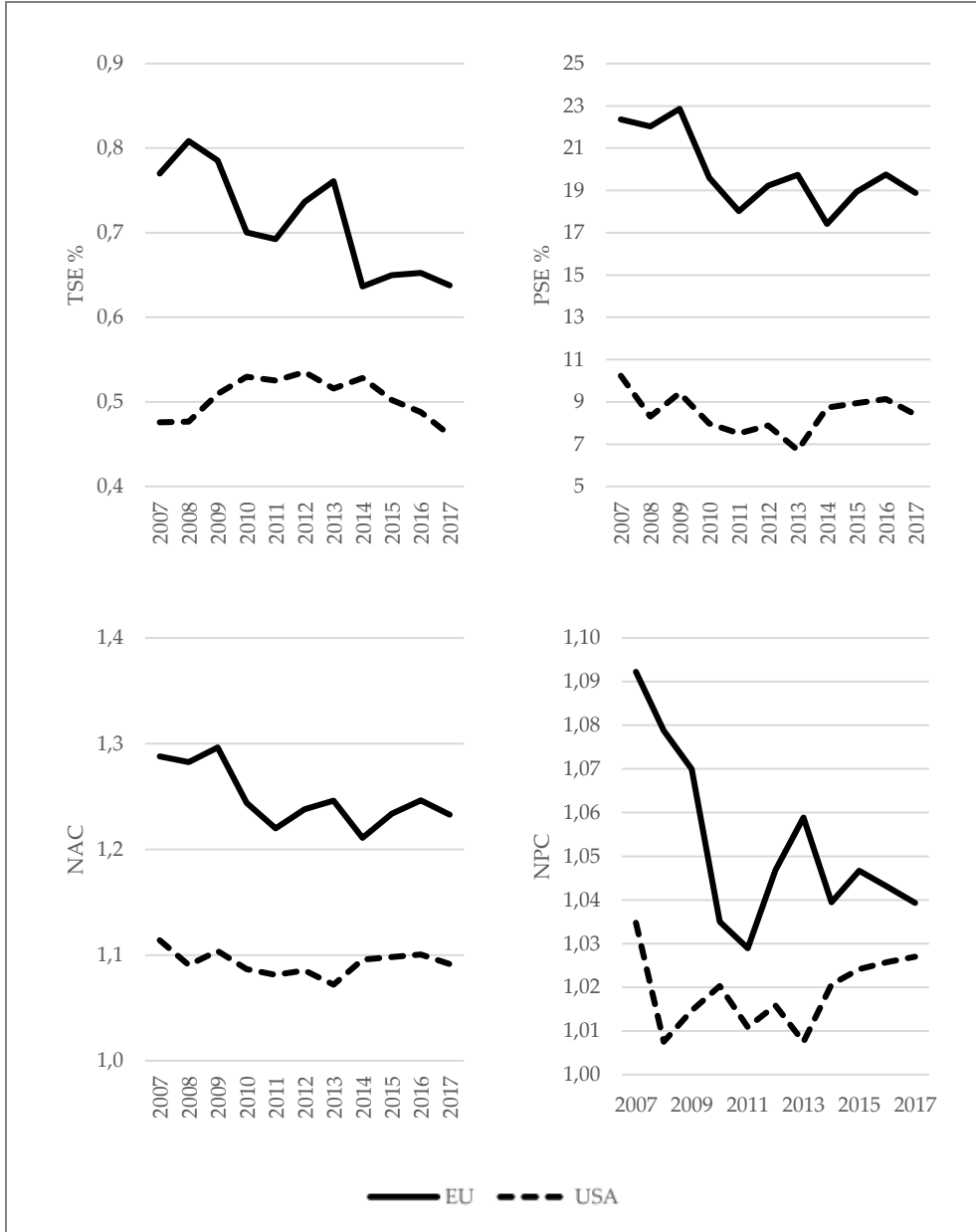
Source: The authors' elaboration based on OECD (2020).

What is essential, together with an increase in absolute values of support for agricultural producers and the agricultural sector in the USA, in the years 2007-2014 the GDP burden with transfers to agricultural producers and the agricultural sector increased (TSE%=0.48% in 2007 and TSE%=0.53% in 2014; Figure 4). After 2013, despite a further increase in financial support in absolute terms the overall burden of agricultural support on the US economy declined to 0.46% in 2017. In contrast, in the EU countries the total support for agriculture decreased from 0.77% PKB in 2007 to 0.64% in 2017. However, domestic support measures continue to be important for the agricultural sector in the analyzed countries, as TSE relative to agricultural value added was around 42% (OECD, 2018).

In the case of the structure of financial support for agriculture, in the EU countries transfers to agricultural producers (PSE) are predominant in the total support volume. In the years 2007-2017 the share of PSE in the total value of transfers to agricultural producers and the agricultural sector was maintained at approx. 88% and starting from 2008 it was over 2-fold higher than in the USA (Figure 5). A greater share in the structure of financial support for agriculture in the USA compared to that of PSE was recorded for support mechanisms for demand for food products (i.e. TCT), which indirectly also support agricultural producers. In the years 2007-2017 the value of this category of transfers increased 2-fold from 20.3 billion Euro to 40.9 billion Euro

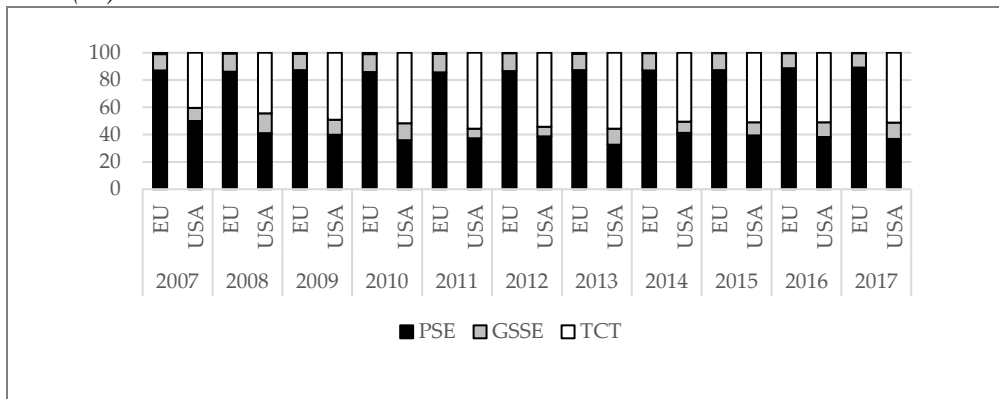
(OECD, 2020), while their share in the total support for agricultural producers and the agricultural sector grew from 40.4% to 51.3% (Figure 5).

Table 4. Changes in selected indicators of agricultural support in the EU and the USA in 2007-2017



Source: See, Figure 3.

Figure 5. Composition of the Total Support Estimate in the EU and the USA in 2007-2017 (%)

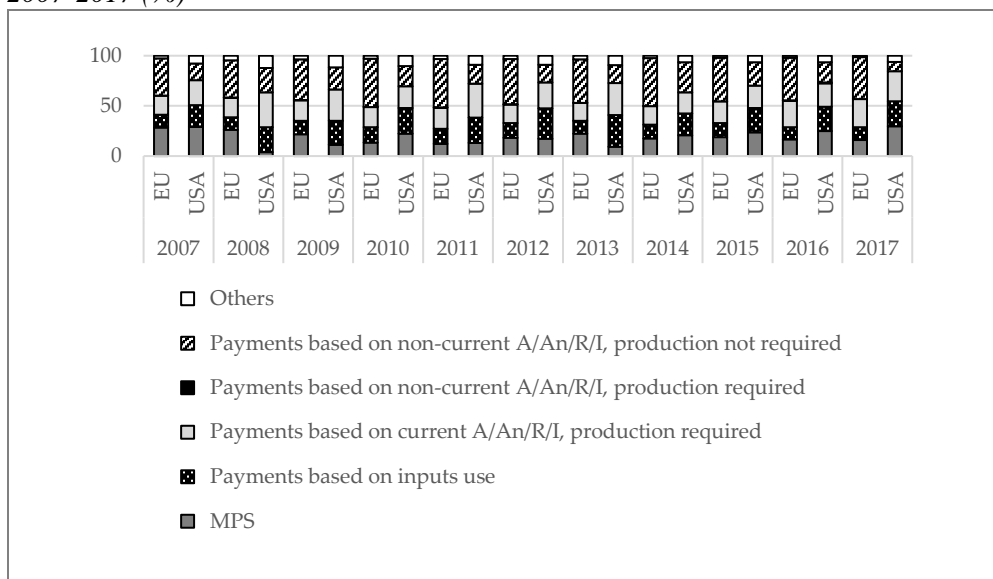


Source: See, Figure 3.

It needs to be stressed here that in 2017 the value of transfers to support food consumption in the USA exceeded by over an equivalent of 11.5 billion Euro the value of support granted to agricultural producers. For comparison, in the EU in the same year the value of food aid programs, approximated by the TCT index, was slightly below 370 million Euro, with a trend towards a reduction of such support observed over the entire analyzed period (OECD, 2020). In view of the above it may be stated that the USA is executing a policy of support for agriculture and agricultural producers, which is unique on the global scale and completely different from that in the EU. However, it also needs to be stressed that in the USA the PSE indicator is not completely reliable, since it does not include funds exceeding the value of support for agricultural producers and which are allocated to support food consumption. The importance of transfers to general services provided to agricultural producers collectively (GSSE) in both the investigated economies over the entire analyzed period was comparable and accounted for 10-15% total support (Figure 5).

It should be stated here that in the years 2007-2017 both in the EU and in the USA the share of financial support in total revenue of agricultural producers (PSE%) decreased, in the EU it was from 22.36% to 18.89%, while in the USA from 10.23% to 8.39% (Figure 4). Still income obtained by farmers in the EU countries in 2017 was by 23% higher and in the USA by 9% higher compared to that they would have attained with no state intervention measures (NAC). What is essential, both the EU countries and the USA to a greater extent used instruments to support the income of producers than instruments distorting prices in the internal markets (NAC > NPC). In the 2007-2017 period prices received by producers both in the EU and the USA were relatively close to those on the world markets. In 2017 the gap between effective producer prices in the EU and the USA and the world prices was on average 4% and 3%, respectively. It should be noted here that this relatively narrow gap between domestic and world prices means that market signals are becoming increasingly important for agricultural producers' decisions (OECD, 2018).

Figure 6. Composition of the Producer Support Estimate in the EU and the USA in 2007-2017 (%)



Source: See, Figure 3.

The level of price distortions was not high, as the analyzed countries provided producers with a larger share of support through less distorting measures (Figure 6). In the EU they were mainly direct payments based on non-current criteria without production requirements (average 43% PSE in the years 2007-2017) and payments based on the current area, animal numbers, farm receipts or farm income by which production is required (21% PSE). In turn, in the USA apart from the two above-mentioned categories of instruments also payments based on input use were applied. In the starting and final years of the analyzed period the share of these three components in the PSE structure was comparable and accounted jointly for approx. 63-64%.

In the EU the importance of these support forms in the years 2007-2017 increased (from slightly below 70% to over 82.5%) together with a decreasing share of price support (MPS). The structure of support for agricultural producers (PSE) in the analyzed years may be considered stable. More significant changes in the support structure, consisting in the considerable reduction of price support in favor of those less distorting to trade and market processes were introduced in the earlier years and they resulted from the implementation of the Uruguay Round Agreement on Agriculture as well as reforms in domestic agricultural policies (more on this see e.g. Poczta-Wajda, 2013; Pawlak, 2018b). The direction of changes in the support policy for agricultural producers and the agricultural sector in the EU and the USA was similar, whereas the persisting differences in the support structure may be explained, among other things, by past historical conditions, budget limits, trade constraints and expanding the range of agricultural policy goals (USDA, 2004).

4. Conclusions

The EU and the USA are key players in the international market of agricultural products. The character of the participation of these economies in the world agricultural market as well as the level of competitive advantages gained by agricultural producers are determined by numerous conditions, among which an important role is played by the volume, quality and efficiency of utilization of production factors.

This paper presents a comparative analysis of the production potential of the agricultural sector in the EU and the USA, including an evaluation of relationships between inputs and assessment of their productivity, changes in the area and economic size structure of farms as well as the support policy for the agricultural sector, determining decisions of agricultural producers concerning the allocation of inputs. These investigations covered also the agricultural sector of Poland, representing the biggest competitive capacity within the new member states of the EU from the region of Central and Eastern Europe.

It results from the conducted analyses that a stronger competitive position determined by more advantageous ratios between inputs, productivity and a greater scale of advanced farmland concentration processes is observed for the US agricultural sector. At over 4-fold lower labor resources and almost 50% lower capital inputs, in 2017 the US agriculture had approx. 2-fold greater land resources, resulting in the advantage of US farms in terms of the labour input actively involved on the production process equipped with the other two inputs, i.e. land and capital, which contributed to greater labor productivity in the sector terms. In turn, land productivity in the USA was lower than in the EU.

However, it needs to be stressed that extensive agricultural production in that country results from a rational decision of farmers, which through lower capital intensity of production strive to attain cheaper production, in contrast to the situation caused by a shortage of capital input, as is the case in at least some EU members from Central and Eastern Europe. Relatively small disproportions between the EU countries and the USA were observed in terms of productivity of capital input involved in the production process. Thus it may be assumed that agricultural productivity was affected to a greater extent by an increase in land and first of all labor productivity, rather than an increase in capital productivity. These two former parameters are closely interrelated, since changes in the distribution of labor are not possible without changes in the distribution of agricultural land.

This particularly concerns the EU-13, including Poland, which despite observed positive structural transformations in agriculture still suffers from a considerable gap from the EU-15 both in terms of input and productivity ratios in agriculture. The rate of structural changes in Poland and the other EU-13 countries is more evident in the absolute terms (differences in thousands) than relative terms (Lorenz curves), while it

is also slower than in the EU-15. Thus, the area structure of farms in the EU-13 remains highly diversified and a considerable part of agricultural land resources is managed by small and medium-sized farms. As a result the ratios between inputs, particularly labor and land, remain inadequate and thus labor productivity continues to be low.

A disproportionately large scale of agricultural land concentration is found in the US agriculture compared to the EU. For this reason, to improve competitiveness of farms from the EU countries progressing concentration processes are required together with an accompanying reduction of employment in agriculture, facilitating the benefits of the effects of scale of production and increase in its efficiency, leading to the formation of a group of highly competitive farms with strong links to the agricultural market. In all the investigated countries the concentration processes were occurring faster in the economic size structure rather than in the area structure of farms. However, in the absolute terms the gap between the agriculture of the EU-15 and that in the EU-13 was greater, while in relative terms (Lorenz curves) the differences in the distribution of farms and their agricultural output in the EU and the USA were manifested to be lesser, particularly in larger economic size classes.

It can be also concluded that high or low productivity levels primarily arise from favorable or unfavorable ratios between production factors, while subsidies on products both in the EU and the USA made the levels of partial factor productivities and total productivity higher; however, the differences in the levels between analyzed countries did not significantly change. The agricultural support policy, next to the farm structure, is a significant factor determining producers' decisions on resource allocation. Although the share of financial support in total income of agricultural producers in the EU and the USA decreased, in 2017 income attained by farmers in the EU continued to be by 23% higher and in the USA by 9% higher than those they would have attained with no state interference.

Assuming that in the USA the PSE indicator is not completely reliable, since it does not include funds allocated to support food consumption exceeding the value of support for agricultural producers, it may be stated that consumers in the USA are net beneficiaries of support programs for agriculture, while EU consumers typically suffer from a greater burden of financial support for agricultural producers than they receive in off-setting benefits. What is essential, in both economies instruments supporting producers' income were used to a greater extent than those distorting price levels on internal markets, as a result of which prices in internal markets of the analyzed countries were comparable to those on the world market. The direction of changes in the support policy for agricultural producers and the agricultural sector in the EU and the USA was similar, while regardless of the already executed transformations in the support structure, the still applied production and trade distorting policy measures linked to output or input use need to be gradually reduced.

Considering that partial factor productivity and total productivity levels do not

describe comprehensively the efficiency of utilization of the production potential of the agricultural sector, productivity changes in both economies would require additional research. It may be valuable to assess the rates of productivity convergence between the analyzed economies, as the level of relative productivity is an important source of international competitiveness. Interesting insights can also arise from the more specific analysis of agricultural production potential within the EU regions and individual US states. This type of regional analysis would allow to identify similarities and differences between individual units in a given time, while if developed for several points, it would make it possible to determine the pattern of changes in the allocation of resources and their productivity.

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