The economic efficiency of agriculture and its contribution to regional economies in Poland

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Abstract: The study assesses the variation in terms of the share of agriculture in the economy of individual regions in Poland and assesses its economic effectiveness in comparison to the entire regional economy. The economic efficiency of agriculture is assessed using the indicators of labour productivity and fixed assets productivity. The research uses the public statistics panel data from 2002-2015. It was found that the level of employment in agriculture, and labour productivity in agriculture, against the background of the economy of regions is highly diversified. Large differences in labour productivity in the sector are an obstacle for the convergence of regional agriculture. A positive relationship was observed between the state of development of the economy of individual regions, and the effectiveness and potential of agriculture. A higher level of regional economic development makes it possible to effectively eliminate structural defects in agriculture, especially related to excess labour force. As a result of the research, a beneficial feedback loop was shown between the development of a region's economy and the economic efficiency of agriculture, expressed, among others, by labour productivity and the productivity of fixed assets.

Keywords: agriculture, national economy, technical labour equipment, economic efficiency

JEL: E01, R11, Q1

Introduction

The role of agriculture in the national economy is undergoing significant transformations. While the impact of agriculture on the basic macroeconomic indicators is becoming weaker in relative terms, its links to the national economy are growing stronger, taking on a new significance in the context of public-goods supply by agriculture [Van Huylenbroeck et al. 2007, p.7, Wilkin 2010, pp. 9-10; Czyżewski, Kułyk 2011, pp. 16-25; Kisiel and Babuchowska 2013, p. 62].

The global economy is changing as a result of the transitions from the industrial stage to the post-industrial stage, to the information stage, causing structural transformations in the economy. This process, coupled with globalisation and integration, causes transformations in the spatial structures and industry structures of national economies, as well as redefines the significance of individual sectors for the economic development of spatial systems

at different levels (local, regional, national and international) [Rachwał et al. 2009, p. 31]. These transformations affect the entire economy, including agriculture. Integration with the EU was one of the impetuses behind the changes in Polish agriculture, as it compelled the sector to adapt its production mix to the requirements of the common market. However, there are significant regional variations in the scale and rate of these adaptive processes in Poland, including in agricultural modernisation and restructuring [Pietrzykowski and Wicki 2011, p. 8].

Polish agriculture distinguishes itself through its regional diversity in terms of production capacity and economic efficiency. Underlying the changes that Polish agriculture has been undergoing in recent years are many factors, both exogenous and endogenous. These include Poland's membership of the EU, the adoption of Common Agricultural Policy (CAP) mechanisms, legal considerations (concerning, in particular, animal welfare and environmental protection), global considerations for the competitiveness of the agri-food sector on international markets (including, in particular, the outcomes of WTO negotiations, the situation on the global market for raw materials and agricultural products, including non-food materials, the situation on the financial, energy and fuel markets, etc.), geopolitical changes affecting international trade in agri-food products, changes in the prices of agricultural products and input-price relationships, as well as advancements in production technology [Chavas 2011, pp. 384-385; Czudec et al. 2017, p. 52]. While it is difficult to identify the impact of these individual factors on agricultural transformations and developments, the positive role of CAP instruments is admittedly significant [Andreosso-O'Callaghan 2003, pp. 89-127].

Agriculture is integral to the economies of individual Polish regions. Its significance for regional economies should be assessed not so much on its gross GDP contribution, as on its role in realising the potential of the labour factor, and using land resources to serve the purpose of not only production but also of public-goods supply [Wilkin 2010; Czudec 2009; Czudec and Kata 2013].

Whatever the strategy for regional development, in order to meet the objective of bridging development gaps, it is essential to effect structural changes leading to better use of resources in each region and more dynamic endogenous development [Capello 2009]. Agricultural and rural resources represent an important part of regional resources in Poland. It is impossible to bring about dynamic and sustainable regional development unless these resources are efficiently used and unless agriculture is well-aligned with the regional economic structure [Czudec et al. 2017, p. 52-104].

Study aim and methodology

The aim of this study is to determine the regional variations in the significance of agriculture for the economies of individual regions in Poland. This significance is defined as the contribution of agriculture to selected regional economic factors (employment, capital expenditures, Gross Value Added, fixed-asset value) and the economic efficiency of agriculture relative to the economy of a region at large. To this end, a comparative analysis was employed, using the following measures: labour efficiency (Gross Value Added per employee), fixed-asset productivity (Gross Value Added/gross fixed asset value), technical labour equipment (the gross value of fixed assets per employee) and investment outlays per employee. The analysis covered two three-year periods – 2002-2004 (the years directly preceding Poland's accession to the EU) and 2013-2015. The aim was to determine how these measures changed over time, and to investigate whether there was convergence or divergence in the agricultural contribution to regional economies, and in its economic efficiency in these periods. The economic efficiency of agriculture was assessed with the measure of labour productivity (calculated as the ratio of gross value added to the number of persons employed in agriculture) and the productivity of fixed assets (calculated as the ratio of gross value added to the gross value of fixed assets).

The Central Statistical Office (Statistics Poland) data from 2002-2015 was used as empirical material. CPI-based fixed prices from 2015 were used to make sure that the values in monetary terms are comparable. A hierarchical cluster analysis using Ward's method was applied to group individual regions according to the significance of agriculture for their economies. Using this method, it is possible to identify clusters of objects similar in terms of selected statistics, so that there is as little variation as possible within each cluster, and as much variation as possible between individual clusters [Hydzik and Sobolewski 2009, pp. 142-151]. Variance analysis was employed to estimate the distance between individual units [Stanisz 2007, p. 122]. Prior to the analysis, the attributes were standardised.

Results

In Poland, agriculture is a significant sector of the national economy. This significance is reflected in its contribution to the Gross Value Added of Polish economy. In the years 2002-2004, this contribution averaged 3.2 percent, and between 2013 and 2015 it shrank to 2.8 percent (Figure 1). This shows that agriculture is losing its significance as an income-generating sector of the national economy, as a result of the higher rates at which other sectors of the economy are growing. Ultimately, this proves that the economy is evolving towards a modern structure [Andreosso-O'Callaghan 2003, pp. 26-30; Mrówczyńska-Kamińska 2008,

p. 97]. There is substantial regional variation in the contribution of agriculture to Gross Value Added (Figure 1). In both periods under study (2002-2004, 2013-2015), this contribution was found to be lower than the national average in five regions – Śląskie, Podkarpackie, Małopolskie, Dolnośląskie and Mazowieckie (Figure 1). In most regions, agricultural contribution to Gross Value Added was lower in 2013-2015 than in 2002-2004 (except for the Podlaskie, Lubelskie, Lubuskie and Pomorskie regions).

Fig. 1. Share of agriculture in Gross Value Added of individual Polish regions and of total economy of Poland [%]
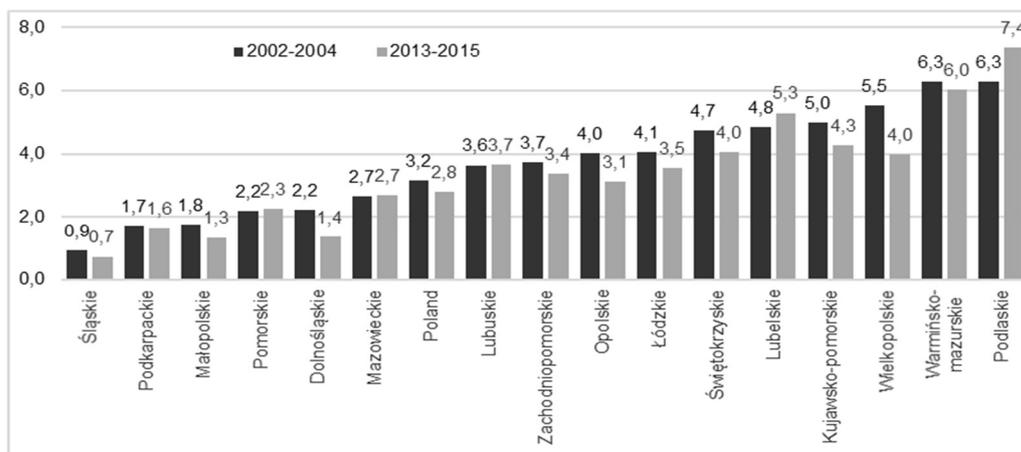
Source: own calculations based on Central Statistical Office (CSO) data.

Another important indicator of the role of agriculture in the national economy is agricultural contribution to gross fixed-asset value, which was 6.9 percent in 2002-2004 and decreased to 4.6 percent in 2013-2015 (Figure 2). In regions where agriculture was a larger contributor to Gross Value Added of these regional economies, the agricultural sector also had higher fixed-asset values. It is also important to note that agricultural contribution to the value of all fixed assets in the economy was found to have decreased in all Polish regions (Figure 2).

Fig. 2. The share of agriculture in gross fixed-assets value in the economy [%]
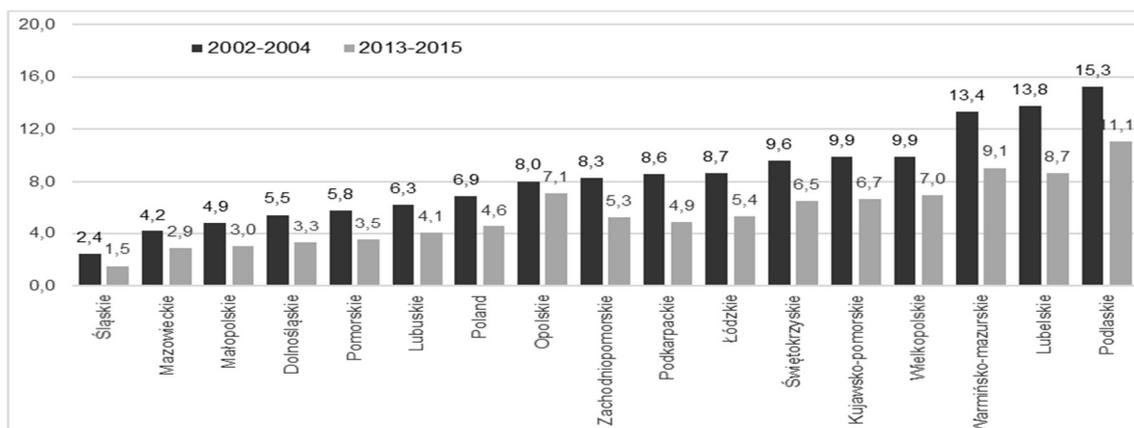
Source: own calculations based on Central Statistical Office (CSO) data.

Technical labour equipment is a function of capital expenditures. The share of agricultural investment expenditures in the investment outlays of the national economy was slightly lower in 2013-2015 than in 2002-2004 (Figure 3). More specifically, this figure increased in seven regions, in one region it remained unchanged, and in eight regions the figure decreased (Figure 3). The increase in the share of agriculture in the total investments of regional economies occurred in those regions where the scale of investment in agriculture, in the post-accession period, was the highest. A general observation can be made that the hierarchy of regions in relation to both this measure and the preceding measure is largely the same. This shows a relationship between the contribution of agriculture to Gross Value Added and its fixed asset and investment outlays levels.

Fig. 3. The share of agriculture in investment outlays in the economy [%]
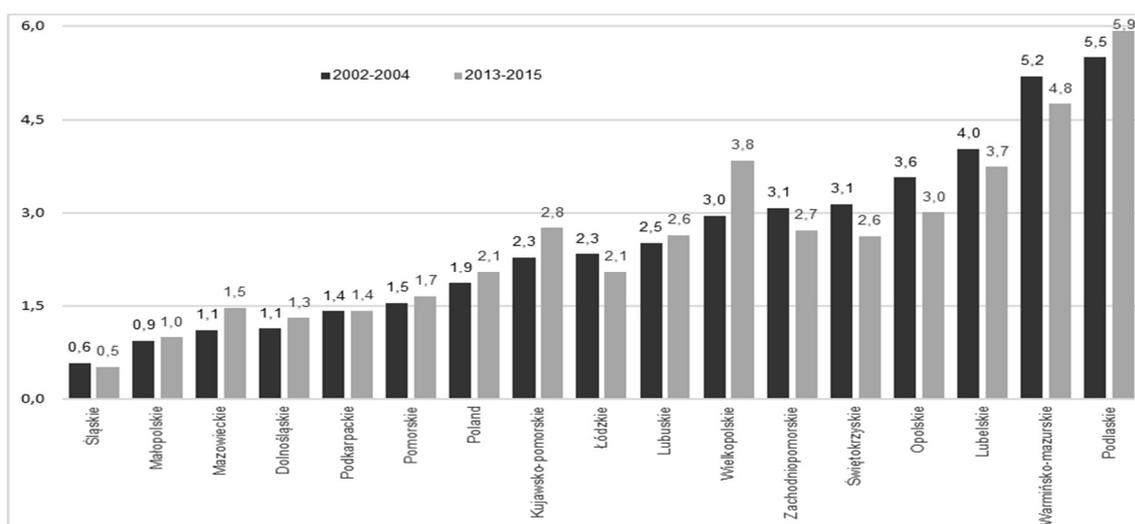
Source: own calculations based on Central Statistical Office (CSO) data.

Agricultural development mainly involves structural changes, concentration of production and the redistribution of surplus labour to non-agricultural sectors. A comparison between the 2013-2015 and 2002-2004 periods shows that the agricultural contribution to overall employment decreased from 18.6 percent to 11.7 percent (Figure 4). This rate dropped in all regions, including the most in regions with relatively high agricultural employment rates in 2002-2004. Notably, there is substantial regional variation in the agricultural contribution to employment. Śląskie region, where the level of industrialisation is the highest in Poland, had the lowest agricultural employment rate (4.1 percent in 2002-2004 and 2.7 percent in 2013-2015). In both periods under study, this indicator came below the national average in nine regions (Figure 4). For the Małopolskie region, the agricultural contribution to employment fell below the national average, whereas in the Wielkopolskie and Łódzkie regions this figure slightly exceeded the national average, which equals 11.7% (Figure

4). The agricultural contribution to employment was markedly higher in the Podkarpackie (in 2013-2015 the difference was 4.9 p.p. in relation to the national average), Świętokrzyskie (difference of 10.7 p.p.), Podlaskie (difference of 12.1 p.p.) and Lubelskie (difference of 12.2 p.p.) regions, i.e. regions with high agricultural land fragmentation and relatively low levels of economic development [Poczta and Bartkowiak 2012, p. 99; Czudec et al. 2017]. It is important to add, however, that in the periods under study, agricultural employment rates in these regions dropped the most (from 13.9 p.p. in Podkarpacie to 8.4 p.p. in Świętokrzyskie) (Figure 4).

Fig. 4. Share of agriculture in employment in the economy
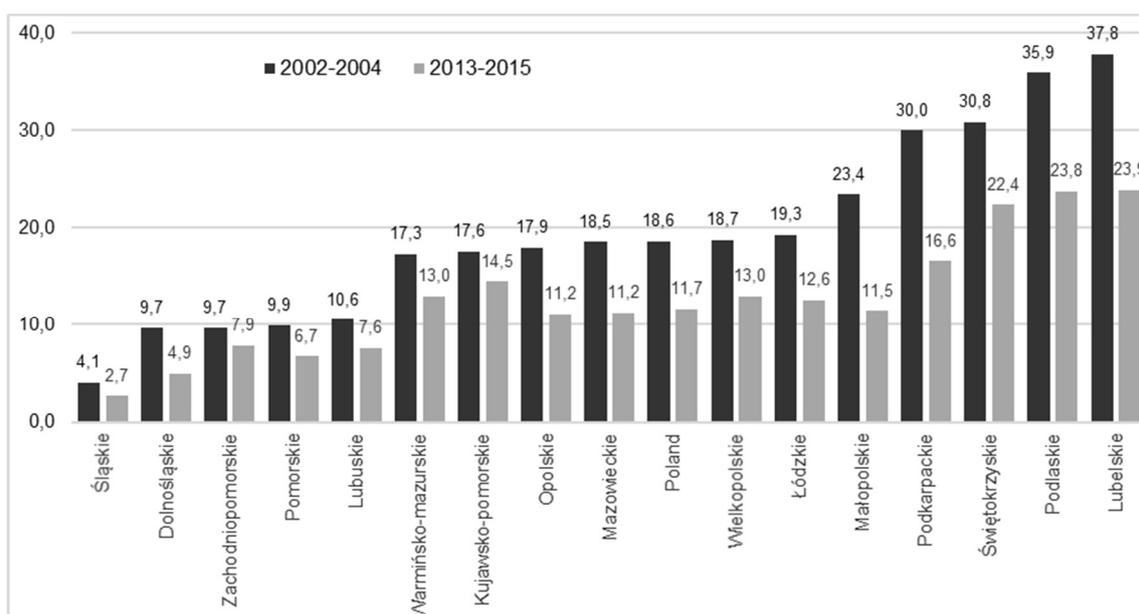
Source: own calculations based on Central Statistical Office (CSO) data.

Despite this downward trend, the agricultural sector continues to be a major employer (11.6 percent), as opposed to many EU countries, where it accounts for 1-2 percent of the overall employment [Góral and Rembisz 2017, p. 120]. Reduction in agricultural employment, while maintaining at least the current level of agricultural production, is essential if the sector is to become more efficient. The modernisation, structural changes and concentration, and scaling up of production of agricultural holdings "push" labour out of agriculture. However, in order for labour resources to continue depleting, a second mechanism must be at work in which other sectors of the economy "pull" labour out of agriculture [Kusz and Misiak 2017, p. 147]. In order for this to happen, the economy must be developing at a high rate.

Technical labour equipment (capital-labour ratio) characterises the quantity of fixed assets per unit of labour (a full-time employee). A low capital-labour ratio has an adverse effect on labour efficiency [Gołaś and Kozera 2008, p. 73]. Furthermore, because of the relatively

high rate at which labour costs grow compared to other factors of production, employing labour-saving technologies becomes a necessity [Mundlak 1988, p. 172; Runowski and Ziętara 2011, p. 30]. Compared to other sectors of the national economy in Poland, agriculture is characterised by a much lower capital-labour ratio, which is one of the reasons its labour efficiency is lower than in other sectors. This unfavourable disproportion was observed in both 2002-2004 and 2013-2015. Technical labour equipment increased between the periods under study in both agriculture and the national economy at large, with agriculture experiencing a slightly higher increase (Table 1). This means that the rate of modernisation and investment in agriculture is higher than in the economy at large. Nonetheless, the disproportion between agriculture and other sectors is still significant. In addition, agriculture exhibits significant regional variations in the capital-labour ratio. These disproportions are higher than in the economy at large (Table 1). Nevertheless, in the period under study (2002-2005), the difference between the regions with the highest and lowest technical labour equipment in agriculture had shrunk from a 5.6 times to a 3.8 times. This might indicate an ongoing, albeit slow, regional convergence of agriculture in terms oftechnical labour equipment.

Table 1. Technical labour equipment (thousands PLN) investment expenditures per worker (thousands PLN) in agriculture and national economy in Poland

Region	Agriculture			Region	National economy		
	2002-2004	2013-2015	2002-2004=1		2002-2004	2013-2015	2002-2004=1
	thousands PLN				thousands PLN		
A/ Technical labour equipment							
Zachodniopomorskie	151.3	165.4	1.09	Mazowieckie	243.1	261.8	1.08
Dolnośląskie	101.3	159.3	1.57	Pomorskie	173.1	196.7	1.14
Opolskie	87.5	133.9	1.53	Śląskie	170.1	213.7	1.26
Warmińsko-mazurskie	112.8	123.2	1.09	Opolskie	193.5	210.1	1.09
Śląskie	102.7	122.8	1.19	Dolnośląskie	179.1	236.4	1.32
Lubuskie	82.2	120.2	1.46	Warmińsko-mazurskie	146.3	176.4	1.21
Wielkopolskie	77.3	118,9	1.54	Wielkopolskie	146.0	221.8	1.52
Pomorskie	102.2	103.1	1.01	Zachodniopomorskie	175.0	246.1	1.41
Podlaskie	58.6	84.5	1.44	Podlaskie	138.1	181.2	1.31
Kujawsko-pomorskie	69.7	83.8	1.19	Lubuskie	138.5	219.7	1.59
Łódzkie	53.2	68.6	1.28	Małopolskie	128.8	185.4	1.44
Mazowieckie	55.7	67.1	1.22	Świętokrzyskie	129.5	147.9	1.14
Podkarpackie	34.4	53.1	1.56	Łódzkie	118.7	159.9	1.35

Lubelskie	39.7	51.6	1.30	Podkarpackie	120.0	180.4	1.50
Małopolskie	26.7	49.4	1.84	Lubelskie	109.1	141.7	1.30
Świętokrzyskie	40.4	43.1	1.07	Kujawsko-pomorskie	123.5	180.6	1.46
Poland	**59.0**	**80.0**	**1.36**	**Poland**	**158.37**	**204.84**	**1.29**
B/ Investment expenditures per worker							
Zachodniopomorskie	3.23	6.49	2.01	Mazowieckie	18.08	20.48	1.13
Dolnośląskie	1.60	5.23	3.27	Lubuskie	9.32	12.99	1.39
Wielkopolskie	1.86	4.88	2.62	Pomorskie	11.61	16.26	1.40
Warmińsko-mazurskie	2.46	4.70	1.91	Dolnośląskie	13.63	19.81	1.45
Lubuskie	2.22	4.55	2.05	Wielkopolskie	12.01	16.59	1.38
Opolskie	1.69	4.38	2.59	Zachodniopomorskie	10.10	18.80	1.86
Pomorskie	1.81	4.00	2.21	Śląskie	11.31	15.52	1.37
Podlaskie	1.13	3.39	3.00	Opolskie	8.50	16.59	1.95
Śląskie	1.60	3.03	1.89	Małopolskie	9.46	14.65	1.55
Mazowieckie	1.09	2.67	2.45	Warmińsko-mazurskie	8.20	12.90	1.57
Kujawsko-pomorskie	1.01	2.63	2.60	Podkarpackie	7.79	14.39	1.85
Łódzkie	0.93	2.17	2.33	Kujawsko-pomorskie	7.72	14.25	1.85
Lubelskie	0.57	1.62	2.84	Świętokrzyskie	7.51	9.08	1.21
Małopolskie	0.38	1.27	3.34	Podlaskie	7.47	13.62	1.82
Podkarpackie	0.37	1.24	3.35	Lubelskie	5.30	10.24	1.93
Świętokrzyskie	0.77	1.06	1.38	Łódzkie	7.7	13.34	1.73
Poland	**1.08**	**2.77**	**2.56**	**Poland**	**10.72**	**15.76**	**1.47**

Source: own calculations based on CSO data.

An increase in the capital-labour ratio is a result of an increase in capital expenditures per employee. For agriculture, this parameter is much lower than for the national economy (Table 1). Between 2002 and 2004 the value of investment outlays per employee differed by 10 times, whereas over 2013-2015 the difference had shrunk to 5.7 times. The differences between the national economy and agriculture in regional breakdown are, however, much larger. The largest disproportions in this respect between 2002 and 2004 were recorded for the Małopolska and Podkarpacie regions (a difference of 24.9 times and 21.1 times). Conversely, the smallest differences in investment expenditures per employee were observed in the Zachodniopomorskie and Warmińsko-Mazurskie regions (by a factor somewhat greater than 3). Between 2013 and 2015 the largest and smallest differences in capital expenditures per employee were recorded for the same regions, although the disproportions were smaller (from 2.7 times to 11.6 times). These disproportions had shrunk, to varying degrees, in all regions.

As technical labour equipment improves, so should labour efficiency, defined as the relationship between outputs per unit of labour. This study took Gross Value Added as the measure of output, as it is available in public statistics as an income category. Labour efficiency in both agriculture and the national economy was higher in 2013-2015 than in 2002-2004, but agriculture experienced a higher rate of growth in labour efficiency (Table 2). This is a positive development for the development of this sector. What remains problematic is that agricultural labour efficiency varies considerably between regions – much more considerably than in the case of the regional economy at large. For regional economies, the increase in labour efficiency ranged from 36 percent to 51 percent, while agricultural labour efficiency increased by a mere 3 percent (Dolny Śląsk) or as much as 88 percent (Podlasie).

The lowest agricultural labour efficiency was recorded in the Podkarpacie region, while Zachodniopomorskie region had the highest agricultural efficiency. These are data for both periods under study – in 2002-2004 the difference in labour efficiency between the most and least efficient regions was 9.5 times, and in 2013-2015 it decreased to a factor of slightly over 8 times. The substantial agricultural labour-efficiency differences between regions continue to exist, and the rate at which they are decreasing is too slow. A faster increase in labour efficiency would be particularly desirable in regions with fragmented agriculture. It is also important to note that the labour efficiency of Polish agriculture is considerably below the EU average, thus making it less competitive internationally [Poczta et al. 2009, p. 48].

Table 2. Gross value added per working person (thousands PLN) in agriculture and national economy in Poland

Region	Agriculture			Region	National economy		
	2002-2004	2013-2015	2002-2004=1		2002-2004	2013-2015	2002-2004=1
	thousands PLN				thousands PLN		
Zachodniopomorskie	31.79	39.43	1.24	Mazowieckie	95.92	144.50	1.51
Lubuskie	27.00	36.36	1.35	Śląskie	84.17	116.12	1.38
Warmińsko-mazurskie	25.81	35.33	1.37	Dolnośląskie	83.35	124.89	1.50
Pomorskie	18.70	30.62	1.64	Wielkopolskie	74.69	106.73	1.43
Mazowieckie	16.43	29.82	1.81	Kujawsko-pomorskie	71.69	98.52	1.37
Wielkopolskie	24.04	28.71	1.19	Pomorskie	82.20	113.72	1.38
Kujawsko-pomorskie	20.11	26.88	1.34	Zachodniopomorskie	80.43	110.56	1.37
Opolskie	17.42	22.46	1.29	Opolskie	74.03	104.35	1.41
Podlaskie	11.29	21.26	1.88	Łódzkie	67.52	99.71	1.48
Dolnośląskie	20.04	20.68	1.03	Lubuskie	78.09	104.70	1.34

Region	Agriculture			Region	National economy		
	2002-2004	2013-2015	2002-2004=1		2002-2004	2013-2015	2002-2004=1
	thousands PLN				thousands PLN		
Łódzkie	12.91	18.72	1.45	Warmińsko-mazurskie	70.97	96.62	1.36
Śląskie	12.81	15.65	1.22	Małopolskie	68.00	95.95	1.41
Lubelskie	7.06	12.03	1.70	Świętokrzyskie	59.41	82.00	1.38
Świętokrzyskie	8.50	10.73	1.26	Podlaskie	59.73	86.14	1.44
Małopolskie	5.38	6.89	1.28	Podkarpackie	57.45	81.26	1.41
Podkarpackie	3.32	4.88	1.47	Lubelskie	55.16	78.44	1.42
Poland	**13.54**	**19.56**	**1.44**	**Poland**	**76.22**	**109,54**	**1.44**

Source: own calculations based on CSO data.

In 2002-2015 both the national economy and agriculture experienced an increase in fixed-asset productivity expressed as the relationship between Gross Value Added and the gross fixed-asset value (Table 3). This increase was larger for agriculture than for the national economy at large, but the ratio was still substantially lower for agriculture than for the national economy in 2002-2004, as well as in 2013-2015. However, this gap had been bridged considerably in many regions, or eliminated altogether, as in the case of Mazowieckie region. This means that fixed-asset productivity in agriculture can be substantially improved to a level that is close to that of the national economy.

Table 3. Gross value added in relation to the gross value of fixed assets (%) in agriculture and national economy in Poland

Region	Agriculture			Region	National economy		
	2002-2004	2013-2015	2002-2004=1		2002-2004	2013-2015	2002-2004=1
Podkarpackie	8.91	13.94	1.56	Opolskie	35.42	41.49	1.17
Lubelskie	14.50	25.81	1.78	Podlaskie	39.19	40.23	1.03
Podlaskie	16.33	26.70	1.64	Lubelskie	41.09	42.27	1.03
Małopolskie	17.33	21.66	1.25	Warmińsko-mazurskie	41.98	43.03	1.03
Pomorskie	17.54	30.65	1.75	Zachodniopomorskie	42.22	40.90	0.97
Opolskie	17.86	18.23	1.02	Świętokrzyskie	42.39	42.88	1.01
Dolnośląskie	18.73	20.42	1.09	Mazowieckie	42.90	49.81	1.16
Zachodniopomorskie	19.08	25.94	1.36	Podkarpackie	44.35	41.87	0.94
Śląskie	19.38	22.95	1.18	Lubuskie	45.51	37.78	0.83

Region	Agriculture			Region	National economy		
	2002-2004	2013-2015	2002-2004=1		2002-2004	2013-2015	2002-2004=1
Warmińsko-mazurskie	19.87	28.60	1.44	Dolnośląskie	46.41	49.73	1.07
Świętokrzyskie	21.07	26.58	1.26	Pomorskie	46.91	47.67	1.02
Łódzkie	22.70	30.51	1.34	Małopolskie	47.49	49.35	1.04
Kujawsko-pomorskie	25.27	30.00	1.19	Łódzkie	47.93	46.36	0.97
Lubuskie	26.75	33.83	1.26	Wielkopolskie	49.40	50.09	1.01
Mazowieckie	27.02	46.01	1.70	Kujawsko-pomorskie	49.49	47.04	0.95
Wielkopolskie	27.88	28.50	1.02	Śląskie	50.34	48.24	0.96
Poland	**20.83**	**28.66**	**1.38**	**Poland**	**45.41**	**46.93**	**1.03**

Source: own calculations based on CSO data.

Based on the variables related to the economic efficiency of agriculture (Tables 1, 2 and 3), as discussed above, the regions were grouped into three more-or-less uniform sets (clusters) using Ward's cluster analysis method [Stec et al. 2005, p. 141].The dendrogram in Figure 5 illustrates the results of this grouping. The first cluster included Podkarpackie, Świętokrzyskie, Małopolskie and Lubelskie regions, i.e. regions with the lowest economic efficiency of agriculture and the poorest productivity, attributable to the fragmentation of agricultural land. The second cluster comprised Mazowieckie, Podlaskie, Łódzkie and Kujawsko-Pomorskie regions and the third cluster included Zachodniopomorskie, Warmińsko-Mazurskie, Pomorskie, Wielkopolskie, Lubuskie, Śląskie, Opolskie and Dolnośląskie regions.

Fig. 5. Groups of regions in the aspect of economic efficiency of agriculture and the share of agriculture in the economy
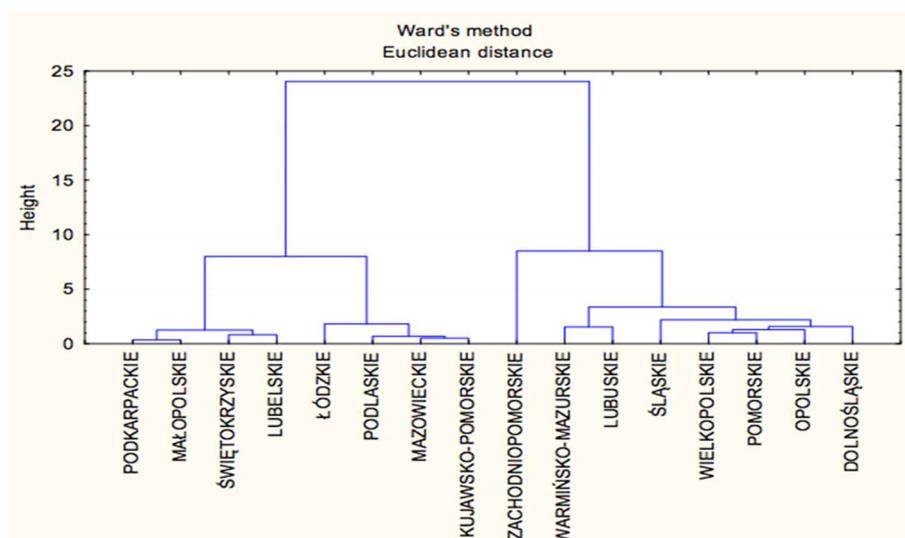
Source: own calculations based on CSO data.

Agriculture in cluster-1 regions exhibited a relatively high contribution to employment, much lower labour-capital ratios and low capital expenditures per employee (Table 4). In the remaining two clusters, economic efficiencies were much higher, with cluster-3 regions standing out above other Polish regions in terms of higher capital-labour ratios, high capital expenditures per employee, a lower agricultural contribution to employment and high labour efficiencies. Cluster-2 regions had the strongest agricultural sectors in terms of their contribution to regional economies and the highest fixed-asset productivity (Table 4).

Table 4. Average annual values of selected features of agriculture and a region's economy in separated clusters of regions

Variables	Cluster 1	Cluster 2	Cluster 3
A/ Agriculture			
Share of agriculture in gross value added	3.27	4.63	3.26
The share of agriculture in the gross value of fixed assets	7.42	8.00	6.22
Share of agriculture in investments	2.20	2.82	2.41
Share of agriculture in employment	24.7	18.33	9.94
Technical labour equipment in agriculture [thousands PLN]	39.81	68.32	114.70
Investment expenditures per one employee [thousands PLN]	0.82	1.92	3.12
Labour efficiency in agriculture [thousands PLN]	7.79	20.24	25.60
Productivity of fixed assets [%]	20.42	29.73	24.22
B/ Region's economy			
Technical labour equipment in agriculture [thousands PLN]	135.56	169.92	181.68
Investment expenditures per one employee [thousands PLN]	12.11	15.42	15.98
Labour efficiency in agriculture [thousands PLN]	72.89	90.96	94.93
Productivity of fixed assets [%]	46.21	47.64	47.10

Source: own calculations based on CSO data.

An analysis of the individual characteristics of agriculture in the respective regions showed that a lower agricultural contribution to employment is coupled with a higher capital-labour ratio and higher capital expenditures per employee, leading to increased labour efficiencies. The study results also show that there is a link between the economic development of a region and agricultural development (Table 4). It is evident that in regions experiencing higher rates of economic development, the economic efficiency of agriculture is higher as well.

Table 5. R – Spearman correlation coefficients between variables characterising agriculture and the economy of each region

Variables	Region's economy			
	Technical labour equipment	Investment expenditures per employee	Labour efficiency	Productivity of fixed assets
Technical labour equipment in agriculture	0.5482*	0.4220*	0.4915*	-0.0471
Investment expenditures per employee in agriculture	0.5095*	0.4766*	0.4864*	-0.1342
Labour productivity in agriculture	0.4998*	0.4588*	0.5304*	-0.0037
Productivity of fixed assets in agriculture	0.3673*	0.4956*	0.5782*	0.3305*
Share of agriculture in gross value added	-0.3334*	-0.3243*	-0.3986*	-0.3779*
The share of agriculture in the gross value of fixed assets	-0.5539*	-0.5937*	-0.6882*	-0.4518*
Share of agriculture in investments	-0.2169*	-0.3882*	-0.3806*	-0.5528*
Share of agriculture in employment	-0.6069*	-0.6557*	-0.7458*	-0.3908*

* significant for $p<0,05$

Source: own calculations.

A statistical analysis of the correlations between the investigated characteristics of agriculture and regional economies shows that there is a positive correlation between most variables describing the condition of regional economies and the variables describing the economic efficiency of agriculture. This includes technical labour equipment in agriculture, investment expenditures per employee, labour efficiency and fixed-asset productivity (Table 5). It is also important to note the negative correlations between the efficiency of regional economies and the agricultural contribution to regional economies. With regional economies developing, agricultural contribution to Gross Value Added, fixed-asset value, investment outlays and employment in these economies decreases. These findings corroborate the correlations described in the literature [Mrówczyńska-Kamińska 2008; Poczta and Bartkowiak 2012; Czudec et al. 2017].

Summary

1. Between 2002 and 2015 agriculture became less significant for regional economies, in that it contributed less to Gross Value Added and the fixed-asset value. This proves that the rate of structural changes was higher for the economy at large than for agriculture. Similarly, agriculture has been contributing less to employment, although the sector continues to be

a major employer. This is attributable to the unfavourable socio-economic structure of Polish agriculture, including in particular the high fragmentation of farms in many Polish regions.

2. The study found that labour efficiency in agriculture varied considerably between regions, much more than in respect of regional economies at large. National economic policies should prioritise increasing agricultural labour efficiency in Poland, since agriculture's weakness in this respect impedes regional income convergence.

3. Also, the study found a positive correlation between the state of economic development of individual regions and the economic efficiency and productivity of agriculture. Higher levels of regional economic development allow regions to fast-track changes in the relationship between agricultural factors of production, leading to increased labour efficiency and fixed-asset productivity. In addition, this helps to mitigate the structural barriers in agriculture more effectively, but above all it facilitates the reduction of redundant labour.

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