

DYNAMICS OF LABOUR PRODUCTIVITY CHANGES IN AGRICULTURE AT THE REGIONAL LEVEL IN SELECTED EUROPEAN UNION COUNTRIES

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ABSTRACT

A comparison of the labour productivity disproportions in agriculture is usually carried out at the state level. Conducted research usually concerns the countries of the so-called old Union and newly admitted countries. As a result of analyses carried out in such a way such and the aggregation effect information about the actual scale of diversification at the regional level are lost. The paper proposes an analysis at the NUTS level 2 for selected European Union countries to show their internal differentiation in terms of labour productivity and changes taking place in the analysed period. It was also found that the distribution of labour productivity in agriculture in the regions should also be defined, which would require the use of more advanced statistical methods.

Key words: convergence, divergence, labour productivity

INTRODUCTION

According to the preamble of the Treaty of Rome one of the objectives in the creation of the European Community was to reduce disparity between the levels of development of regions and underdevelopment of less-favoured regions¹. In article 174 (former article 158 of the EC Treaty) we can read that special attention in this regard is given to rural areas. To offset these differences the EU uses its structural funds policy, European Investment Bank and other financial instruments. However, despite pursuing the policy, there is still strong regional differentiation in the EU. This subject was subject of research, undertaken among

others by Alexiadis [2010] and Martín-Retortillo and Pinilla [2012]. Main research on agricultural labour productivity is conducted at the national level showing the diversity between the “old” EU countries, and recently admitted, between eastern and western Europe [Gutierrez 2000, Martín-Retortillo and Pinilla 2012, Jaroszewska and Pietrzykowski 2017]. However, factors that affect the differentiation between countries also differentiate agriculture within borders of individual countries. This differentiation at the regional level is also associated with the uneven distribution of production factors, and various efficiency of their use. And that, as a result, favours spatial differentiation of the economies of individual countries, and further

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their regional differentiation of labour productivity levels [Kuźmar 2015]. A closer understanding of the structure of this phenomenon is important from the point of view of shaping and directing the policy of regional development and the European Community's agricultural policy.

One of the factors determining the competitiveness of states in the international arena is labour productivity [Misala and Ślusarczyk 1999, Poczta 2003, Gołaś and Kozera 2008, EC 2009, Latruffe 2010, OECD 2011, Mrówczyńska-Kamińska 2013]. It is essential here to adjust the resources and expenditures of achievable agricultural production so as to achieve high efficiency of their use [Kołodziejczak 2014]. The level of the studied factor is significantly differentiated between countries due to the natural and cultural conditions, different history of political systems of these countries, different levels of economic development land-to-work ratio, fertilization level, mechanization, innovation, structural changes, as well as the institutional factor, and human capital [Baer-Nawrocka 2010, Baer-Nawrocka and Markiewicz 2010, Martín-Retortillo and Pinilla 2012]. According to the conducted research, economic results of the majority of recently admitted countries are improving, their agricultural incomes increase, and so is the value of production [Baer-Nawrocka 2013]. However, the disparity of labour productivity within these countries is still significant and persistent. In most of the "old" EU countries the process of increasing labour productivity has stopped. There is a serious premise that these results are the result of data averaging at the state level. The present research is intended to approximate the scale of this differentiation.

Hence, the main objective of this work is to assess changes in labour productivity at the regional level

against the background of changes in labour productivity at the national level, and an attempt to determine the direction of these changes. In addition, the work sought to determine the dynamics of changes in labour productivity in agriculture, and whether disproportions between regions are tend to reduce, as well as their distribution patterns over studied period.

MATERIAL AND METHODS

This work uses data from the Statistical Office of the European Communities (Eurostat). Also used in the study was Economic Accounts for Agriculture at the NUTS level 2. These accounts are drawn up in accordance with a uniform methodology² developed by Eurostat which entitles to make comparisons of the economic situation of agriculture between the countries of the Community. Gross added value³ in current prices⁴ in millions of EUR was derived from these accounts (this value includes direct payments to production). On the other hand labour inputs originate from national statistics where as a reflection of the labour inputs involved in agriculture the value of total labour inputs employed in the agricultural holding in thousands of AWU was selected⁵. Analysed time interval was determined by regional statistics on labour inputs, which applies to years 2005, 2007, 2010 and 2013 only. Thus it was decided to limit analysis to 10 countries (i.e. 98 regions): Bulgaria (6 regions), Poland (16 regions), the Czech Republic (7 regions), Greece (13 regions), Italy (21 regions), Hungary (7 regions), Austria (9 regions), Portugal (7 regions), Slovakia (4 regions), and Sweden (8 regions). On the basis of the available data the economic work efficiency was calculated expressed as the ratio of the sum of products produced to the incurred

² Methodology of economic accounts for agriculture is available on the Eurostat website: http://ec.europa.eu/eurostat/cache/metadata/en/aact_esms.htm.

³ Gross added value is the value of production in the agricultural sector less the value of intermediate consumption (mineral fertilizers, plant protection chemicals, fodder, energy, fuel, seed material, veterinary services, agricultural services, and other).

⁴ Regional economic accounts for agriculture are available only in current prices (according to the methodology).

⁵ The annual work unit (AWU) equals to full-time employment. It is calculated by dividing the number of hours worked per year by the annual number of hours corresponding to full-time. In Poland a unit of work equal to 2,120 working hours per year was used, i.e. 265 working days for 8 hours a day. When calculating the work inputs expressed in the AWU (in accordance with the Eurostat methodology) the condition that 1 person cannot exceed 1 AWU was followed even if in reality that person is working longer.

labour inputs (full-time employed) [Adamowski et al. 1984]. Obtained value expresses the necessary work input which changes depending on the change in the level of productive forces.

In literature we can find two main convergence concepts, i.e. sigma (σ) type convergence, and beta (β) type convergence [Sala-i-Martin 1990]. Sigma convergence is observed if the level of the studied phenomenon decreases in the examined period of time. Beta convergence determines the dependence of the average value of the observed feature and its initial level. Division of beta convergence into conditional and unconditional was proposed by Sala-i-Martin [1996]. Sigma and beta convergences are very closely related. The convergence of sigma type may suggest the occurrence of β -convergence. Sigma convergence shows how regions have come together over time, while β -convergence shows the average level of the phenomenon and its development. If we observe changes that are non-linear in nature, the beta convergence will not be a good measure. In addition to the basic measures related to the sigma and beta convergence tests other measures are determined which indicate the importance of the problem being studied.

The following coefficients are associated with the β -convergence [Łaźniewska et al. 2011]:

- convergence coefficient – β
- speed of convergence coefficient – γ

$$\ln\left(\frac{y_{it}}{y_{i0}}\right) = \alpha + \beta \ln(y_{i0}) + \varepsilon_i \quad (1)$$

$$\gamma = \frac{\ln(1 + \beta)}{t} \quad (2)$$

where: y_{it} – actual level of the phenomenon being studied in time t ;
 y_{i0} – base level of the phenomenon being studied in time t ;
 α – constant regression coefficient (intercept);
 β – regression coefficient (slope);
 ε_i – random error $\varepsilon_i \sim N(0, \sigma^2)$
 γ – speed of convergence coefficient.

Process of σ -convergence can be measured by various coefficients as follows [Łaźniewska et al. 2011]:

- coefficient of $\sigma(t)$ for sample – $S(t)$

$$S(t) = \sqrt{\frac{\sum_{i=1}^n (y_{it} - \bar{y}_t)^2}{n-1}} \quad (3)$$

- variation coefficient – V

$$V = \frac{S(t)}{\bar{y}} \quad (4)$$

- Williamson's coefficient – V_w

$$V_w = \frac{\sqrt{\sum_{i=1}^n (y_i - \bar{y})^2 \frac{n_i}{N}}}{\bar{x}} \quad (5)$$

- Theil's coefficient – V_T

$$V_T = \sum_{i=1}^n y_i \ln\left(\frac{y_i}{P_i}\right) \quad (6)$$

- Atkinson's coefficient – V_A

$$V_A = 1 - e^{-V_T} \quad (7)$$

All the mentioned indicators do not give a clear definition of how the dynamics of the studied phenomenon is shaped over time. In this work, due to the set goals, i.e. to obtain a comparison of the dynamics of convergence/divergence changes at the regional level the indicator proposed by Williamson and Fleming [1996] was used calculated in accordance with the following formula:

$$K = \frac{V_{t0} - V_{t1}}{V_{t0} (t_1 - t_0)} \cdot 100 \quad (8)$$

where: K – average rate of convergence/divergence per year;

V_{t0} – coefficient of variation at the earlier year t_0 ;
 V_{t1} – coefficient of variation at the end year t_1 .

The value of the coefficient K determined in accordance with the formula (8) depending on the value obtained indicates the rate of economic processes taking place. If the value of the coefficient K is greater than zero then we observe the rate of convergence processes, whereas if we get the value that is below zero, then we talk about the divergence processes.

RESULTS

The results of the labour productivity analysis in recently admitted countries in the period 2000–2016 showed an average annual rate of change at the level of 0.06%, while the group of the “old” EU countries recorded a slight increase at 0.01% [Jaroszewska and Pietrzykowski 2017]. Despite positive changes at the level of countries recently admitted to EU in terms of labour productivity, individual regions of these countries (Bulgaria, Poland and Slovakia) show a large differentiation of labour productivity. In Bulgaria there are both weaker and stronger regions in terms of labour productivity, and they are highly differentiated (Table 1). In 2010 the difference between them was even of eight times. The Yuzhen tsentralen Region was characterized by a 25% share of labour productivity at the national level while the Severen tsentralen Region exceeded twice the average performance of Bulgaria. In the Polish regions however, there is a clear division into regions below the national average, and above the national average. South-eastern part of Poland is characterized by lower labour productivity, in particular the Małopolskie and Podkarpackie Voivodships where the efficiency stays at the level of 40 and 20% of the country’s productivity respectively. This condition persists in the studied years. However, a large part of Poland is characterized by labour productivity significantly above the national average in particular the Zachodniopomorskie, Wielkopolskie, and Lubuskie Voivodships. Similarly substantial differentiation can be observed in Slovakia, where half of the country is characterized by a much lower level of labour productivity, these are the Stredné Slovensko, and Východné Slovensko regions. Labour productivity does not reach even half of the country’s productivity there. The other two regions however achieve labour productivity far above the national average. A different situation takes place in the other two new EU countries, i.e. in the Czech Republic and Hungary where work productivity is less differentiated, and fluctuates around the average for the whole country throughout the analysed period. Greece on the other hand is also differentiated

in terms of labour productivity, although it joined the EU in 1981 (Table 2).

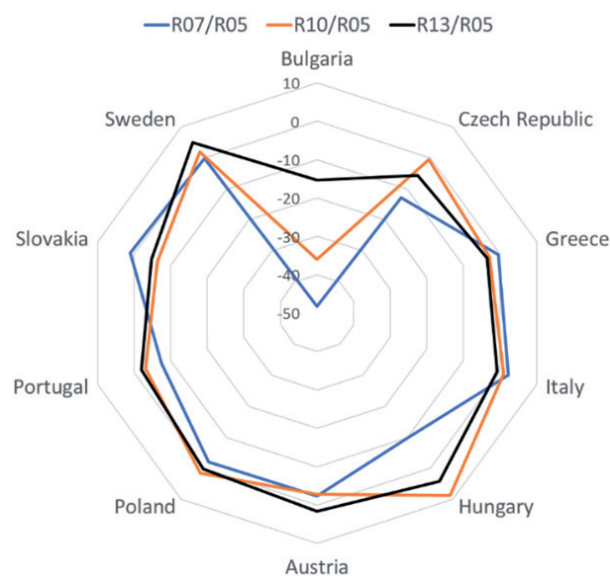
The three regions of Ipeiros, Ionia Nisia, and Voreio Aigaio are characterized by relatively low labour productivity at the level of approx. 40% of the average productivity in the country, and this state remains at the same level over studied period. Whereas two regions of Thessalia and Kentriki Makedonia clearly outperform domestic agricultural productivity in the analysed years. The remaining analysed countries, i.e. members of the “old” EU (Austria, Sweden and Portugal) do not show a clear differentiation in terms of labour productivity at the NUTS level 2. Table 2 presents a comparison showing the dynamics of changes in labour productivity in new and the “old” EU countries based on the K factor.

In order to illustrate changes in regional labour productivity for selected European Union states, its dynamics were divided into three periods (Fig. 1). Selected countries are located on the horizontal axis. The values of coefficient K on a regional basis for a given country were placed on the vertical axis. The individual bars indicate changes in studied periods. The data show that in the analysed periods most frequently occurred strong regional divergence (negative coefficient K). This was especially true for Bulgaria, Hungary and Poland. On the other hand the favourable period in which convergence within countries was the most frequent was the period of 2010–2013. The positive phenomenon affected Bulgaria, Italy, Hungary, and Sweden. Noteworthy is Bulgaria which was admitted to the EU during studied period⁶. In the period 2005–2007 (R07 / R05) the coefficient K was (–48.22) which indicates a very significant regional divergence. In the following period, i.e. 2010–2007 (R10 / R07) the coefficient K (–14.18) decreased which would suggest a reduction in divergence in the regions. In the last period of 2013–2010 (R13 / R10) we already observe a positive coefficient K (6.75) which would indicate the phenomenon of convergence in the regions. Bulgarian example show high strength of the dynamics of the studied phenomenon which turns from divergence into convergence. In the case of this country it is

⁶ The accession of Bulgaria to the EU took place in 2007.

Table 1. Regional differentiation in labour productivity in selected countries admitted to the EU after 2004

Regions NUTS 2	2005	2007	2010	2013	Regions NUTS 2	2005	2007	2010	2013
Bulgaria = 1.00					Slovakia = 1.00				
Severozapaden	1.15	0.78	1.60	1.72	Bratislavský kraj	1.22	1.11	2.23	1.66
Severen tseutralen	1.24	1.09	2.00	1.47	Západné Slovensko	1.67	1.67	1.71	1.90
Severoiztochen	1.31	1.02	1.73	1.68	Stredné Slovensko	0.42	0.46	0.43	0.27
Yugoiztochen	0.96	1.99	1.32	0.47	Východné Slovensko	0.37	0.37	0.10	0.9
Yugozapaden	0.82	0.75	0.30	0.70					
Yuzhen tseutralen	0.75	0.80	0.25	0.70					
Czech Republic = 1.00					Hungary = 1.00				
Strední Čechy	1.28	1.28	1.20	1.39	Közép-Magyarország	0.58	0.45	0.87	0.76
Jihozápad	0.93	1.04	1.08	0.87	Közép-Dunántúl	0.91	0.93	1.22	0.96
Severozápad	0.88	1.22	0.96	1.28	Nyugat-Dunántúl	0.78	1.23	1.09	0.91
Severovýchod	1.17	1.05	0.90	0.83	Dél-Dunántúl	1.13	0.83	1.11	1.10
Jihovýchod	0.90	0.91	1.04	0.99	Észak-Magyarország	0.95	1.01	0.96	0.82
Strední Morava	1.01	0.87	0.86	0.97	Észak-Alföld	1.06	1.18	0.86	1.01
Moravskoslezsko	0.90	0.73	0.75	0.82	Dél-Alföld	1.21	1.07	1.00	1.17
Poland = 1.00									
Łódzkie	0.96	1.04	0.71	0.56					
Mazowieckie	1.01	0.89	1.23	1.18					
Małopolskie	0.38	0.45	0.39	0.31					
Śląskie	0.70	0.69	0.81	0.79					
Lubelskie	0.62	0.70	0.79	0.79					
Podkarpackie	0.24	0.29	0.19	0.22					
Świętokrzyskie	0.57	0.69	0.53	0.49					
Podlaskie	1.52	1.48	1.21	1.36					
Wielkopolskie	2.04	1.59	1.46	1.69					
Zachodniopomorskie	1.99	2.42	1.84	1.73					
Lubuskie	1.96	2.55	1.57	2.00					
Dolnośląskie	1.42	1.17	1.61	1.24					
Opolskie	1.53	1.93	1.99	1.53					
Kujawsko-Pomorskie	1.47	1.57	1.51	1.83					
Warmińsko-Mazurskie	2.05	1.65	1.36	1.34					
Pomorskie	1.26	1.56	1.62	1.66					



Source: Own elaboration based on Eurostat, economic accounts for agriculture by NUTS 2 regions [agr_r_accts] and labour force: number of persons and farm work (AWU) by sex of workers and NUTS 2 regions [ef_olfreg] (AWU: total, labour force directly employed by the holding).

Table 2. Regional differentiation in labour productivity in selected countries of the “old” Union

Regions NUTS 2	2005	2007	2010	2013	Regions NUTS 2	2005	2007	2010	2013
Austria = 1.00					Portugal = 1.00				
Burgenland (AT)	1.53	1.57	1.25	1.02	Norte	0.71	0.64	0.67	0.58
Niederösterreich	1.15	1.22	1.29	1.31	Algarve	1.42	1.27	1.33	1.25
Wien	1.37	1.06	0.71	0.70	Centro (PT)	0.83	0.79	0.76	0.94
Kärnten	0.63	0.66	0.69	0.67	Área Metropolitana de Lisboa	2.23	2.49	2.15	1.49
Steiermark	0.85	0.91	0.99	0.94	Alentejo	1.85	2.00	2.06	1.87
Oberösterreich	1.16	1.05	1.08	1.07	Região Autónoma dos Açores (PT)	2.10	2.26	2.55	2.69
Salzburg	0.69	0.62	0.51	0.67	Região Autónoma da Madeira (PT)	0.69	0.68	0.63	0.62
Tirol	0.71	0.62	0.48	0.59					
Vorarlberg	0.99	0.89	0.68	0.78					
Sweden = 1.00					Greece = 1.00				
Stockholm	1.54	1.66	1.70	1.11	Anatoliki Makedonia	0.88	0.84	0.83	0.73
Östra Mellansverige	0.57	0.89	0.81	0.84	Kentriki Makedonia	1.41	1.53	1.41	1.56
Småland med öarna	0.85	0.73	0.79	0.98	Dytiki Makedonia	0.98	1.19	1.07	1.17
Sydsverige	1.73	1.71	1.54	1.44	Ipeiros	0.53	0.41	0.45	0.39
Västsverige	0.87	0.85	0.84	0.86	Thessalia	1.59	1.23	1.78	1.76
Norra Mellansverige	0.66	0.65	0.70	0.71	Ionia Nisia	0.63	0.53	0.44	0.55
Mellersta Norrland	1.00	0.78	0.94	0.93	Dytiki Ellada	0.99	1.01	1.00	0.99
Övre Norrland	1.38	1.09	1.36	1.25	Stereia Ellada	1.10	0.96	1.04	0.88
					Peloponnisos	0.74	0.82	0.80	0.81
					Attiki	0.80	1.15	0.74	0.43
					Voreio Aigaio	0.41	0.26	0.40	0.40
					Notio Aigaio	0.62	0.96	0.83	1.00
					Kriti	0.90	1.03	0.87	0.73

Source: Own elaboration based on Eurostat, Economic accounts for agriculture by NUTS 2 regions [agr_r_accts] and labour force: number of persons and farm work (AWU) by sex of workers and NUTS 2 regions [ef_olfreg] (AWU: total, labour force directly employed by the holding).

possible that the effect of covering its agriculture with the CAP mechanism has been observed. For comparison purposes the value of the coefficient K for the entire period of 2005–2013 (R13 / R05) was also presented. The value of this coefficient was –15.40 which indicates divergence in the analysed period. It seems that such method of analysis by dividing into periods better describes the rate of change than in the long-term perspective. In the case of Bulgaria, the dynamics of changes was very significant and dividing the

examined period into time sub-periods better defines the dynamics of changes than the calculation of this coefficient for the whole period.

Figure 2 shows the average labour productivity in agriculture in the selected country and its regions. The points connected with the dashed line determine the average value of labour productivity in agriculture for the state. In the case of Bulgaria (Fig. 2a) we can see that the average labour productivity in agriculture increased over studied period. There is also a visible

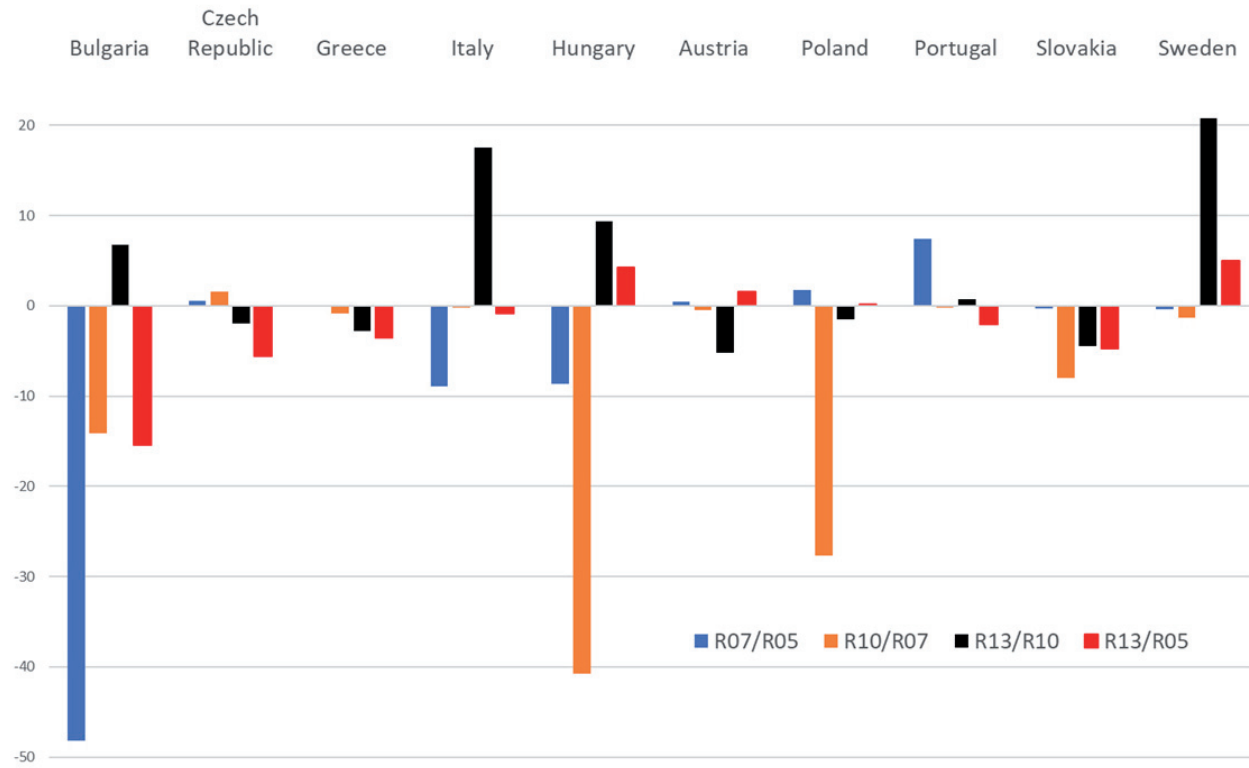


Fig. 1. Dynamics of changes in labour productivity in agriculture for selected countries on a regional basis

Source: Own elaboration based on Eurostat, economic accounts for agriculture by NUTS 2 regions [agr_r_accts] and Labour force: number of persons and farm work (AWU) by sex of workers and NUTS 2 regions [ef_olfreg] (AWU: total, labour force directly employed by the holding).

increase in the dispersion of labour productivity in individual years around the average value and a big difference between 2005 and 2013. We can therefore conclude that since 2005 the differentiation has increased in the regions in relation to 2013. Although it seems that the 2010 arrangement would suggest the existence of a convergence phenomenon in the regions. However, when comparing changes to 2005 we can observe divergence in regions (Fig. 1). Such a big change in dynamics for Bulgaria as described earlier is explained in Figure 2a.

We note that regional stratification has been increasing since 2005 through all the years. Such a big changes have not been recorded in other countries. Figure 2b shows the situation in Poland. Although there is a visible increase in labour productivity in agriculture according to the K-factor we rather

observe the divergence in the regions. This is evidenced by the coefficient K that is close to zero. Figure 2c shows how the work efficiency in agriculture in the Czech Republic has changed. Note that the regional stratification (variation) increased in 2013, and in earlier years (2005, 2007 and 2010) it can be assumed that it was at a similar level. What causes that in the regions we will observe the phenomenon of divergence although at the national level it will be effectively masked.

As mentioned earlier, in Greece there no differentiation in labour productivity was observed over studied years. Note (Fig. 2d) that regional variation in Greece remains at a similar level. It is not possible to tell from that figure whether or not we are talking about the same regions, it would require more detailed analysis, and the use of more advanced statistical methods. In

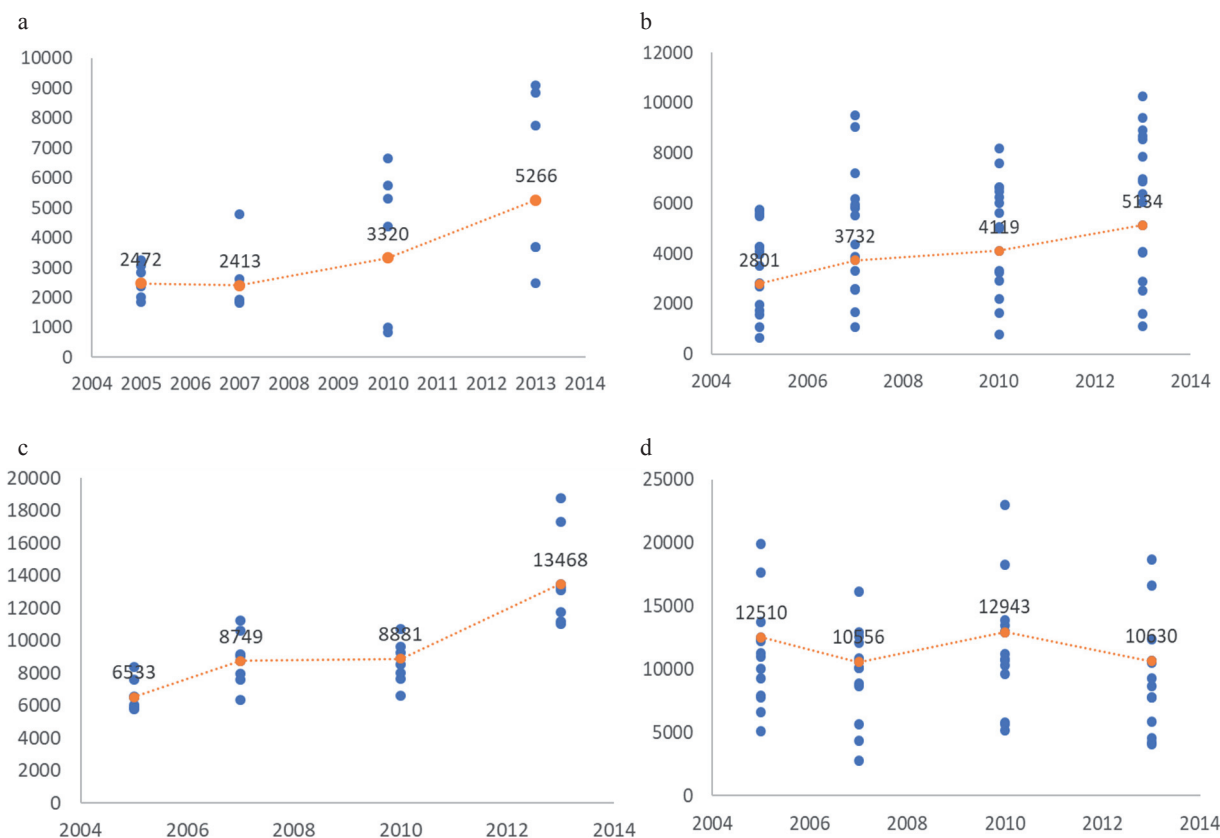


Fig. 2. Average labour productivity in agriculture at the regional level in Bulgaria (a), Poland (b), the Czech Republic (c), Greece (d)

Source: Own elaboration based on Eurostat, Economic accounts for agriculture by NUTS 2 regions [agr_r_accts] and labour force: number of persons and farm work (AWU) by sex of workers and NUTS 2 regions [ef_olfreg] (AWU: total, labour force directly employed by the holding).

case of other studied states of the “old” Union the phenomenon behaved in a similar way, hence graphs for these countries were not included.

CONCLUSIONS

The aim of the work was to assess changes in labour productivity at the regional level, and to determine the dynamics of these changes in the studied time period. A strong differentiation of labour productivity in agriculture has been determined at the regional level that is masked in the case of aggregation to the level

of countries. Strong differentiation of labour productivity at the regional level has been demonstrated in Bulgaria, Poland and Slovakia. However this problem also concerns Greece which has been a member of the EU for 36 years. In the case of Greece we must note that the regional differentiation is very strong and remains the same throughout the whole studied period. The remaining countries of the “old” EU were little, internally differentiated, their efficiency fluctuated around the average for the country. Based on the dynamics of labour productivity the persistence of regional structure in agriculture has been found. However, its exact determination requires detailed

research. One of the conclusions being drawn is the necessity to change the current policy which should – to a greater extent – activate the weaker regions aiming at lower volatility at the regional level. Here comes up the case of Bulgaria which was described in the work. Conducted study shows a positive transformation taking place in this country in terms of the convergence process. This positive change should be connected with the inclusion of this country in the system of subsidies for agriculture at the time of its accession to the EU which fell during the period analysed. The direction of further research leads to determining the distribution which characterizes agricultural labour efficiency in individual regions, but it requires a more detailed analysis, and the use of more advanced statistical methods.

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DYNAMIKA ZMIAN WYDAJNOŚCI PRACY W ROLNICTWIE NA POZIOMIE REGIONALNYM W WYBRANYCH PAŃSTWACH UNII EUROPEJSKIEJ

STRESZCZENIE

Porównanie dysproporcji wydajności pracy w rolnictwie zwykle prowadzi się na poziomie krajowym. Przeprowadzone badania dotyczą zwykle państw tzw. starej Unii i państw nowo przyjętych. W wyniku tak przeprowadzonych analiz i efektu agregacji tracone są informacje o rzeczywistej skali zróżnicowania na poziomie regionalnym. W pracy zaproponowano analizę na poziomie NUTS 2 dla wybranych państw Unii Europejskiej celem ukazania ich wewnętrznego zróżnicowania pod względem wydajności pracy oraz zmian zachodzących w badanym okresie. Stwierdzono także, że należałoby określić rozkład, jakim charakteryzuje się wydajność pracy w rolnictwie w regionach. Wymagałoby to zastosowania bardziej zaawansowanych metod statystycznych.

Słowa kluczowe: dywergencja, konwergencja, wydajność pracy