Spatial differentiation of the remuneration and labour productivity in Polish agriculture

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Abstract

The objective of the study was to show the strength of the dependency of the distribution of the labour factor productivity variable in Polish agriculture and remuneration variable in regional terms. The hypothesis adopted is that the remuneration differentiation is correlated with the labour productivity differentiation in spatial terms. Analysis was conducted on a basis of the analytical aspect and empirical studies based on the information from the CSO Local Data Bank. To examine these dependencies, the authors used the Gini coefficient and regression and correlation analysis. We observed the greater differentiation and variation in the labour factor productivity rather than in its remuneration. The distributions of those variables in spatial terms did not match each other in terms of their equality. The labour productivity differentiation resulted mainly from the differentiation in the capital-labour ratio and land-labour ratio.

Keywords: *labour productivity, remunerations, Gini coefficient, agriculture*
JEL Classification: *E24, O11, R11, Q12*
DOI: 10.14659/SEMF.2018.01.15

1 Introduction

In microeconomics, it is assumed, according to the Neo-Classical trend, that the relationships between the labour factor productivity and its remuneration are important. Taking, above all, these variables into account, it is assumed that the level and changes in the labour factor remuneration should result from, or be shaped by, the level of and changes in its productivity. We can also identify other determinants undermining the relationship between those two variables, but the literature enables a sufficient justification of the importance of the analysed relationship. It is also undertaken in economics of agriculture.

The objective of the study was to show the relationship and strength of the dependency of the distribution of the labour factor productivity variable in Polish agriculture and remuneration variable in spatial (regional) terms. The main question was: to what extent the unequal distribution of the labour factor remuneration is due to the unequal distribution of its productivity? Therefore, the first hypothesis was adopted that the differentiated remuneration is correlated with the differentiated labour productivity in regional terms. Moreover, the secondary study objective was to show the

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main reasons for the differentiation of the labour factor remuneration in the regional system. These reasons, according to the theory of economics of agriculture and microeconomics, include the capital-labour ratio and land-labour ratio. They are, respectively: relationship between the employed capital factor and the number of the employed and the relationship between the land factor and one employed person. In fact, they are characteristic of the agrarian structure, i.e. the factor structure of agriculture. This can be considered as normal. It is assumed that structural changes in agriculture are a major source of growth in income of agricultural producers. Consequently, the second hypothesis appeared stating that the unequal distribution of the labour productivity corresponds to the unequal distribution of the capital-labour ratio and land-labour ratio analysed in regional terms. The authors proved this on a basis of theoretical assumptions, as well as analytically.

2 Analytical assumptions

The issue of the relationship between the labour remuneration and productivity results from the theory of the producer's equilibrium. The producer maximising his objective function should balance the remuneration level with the marginal productivity of each production factor. This equilibrium is reached when the production factor remunerations are equal to their marginal productivities and when the marginal productivities are equal to average productivities (production function theory). This latter point also defines the sphere of rational management in terms of technical efficiency (Rembisz and Sielska, 2015). We can adopt the following relationship for the given product prices p_y as constants (which meets the conditions of competitive equilibrium):

$$\frac{\partial_y}{\partial_L} = \frac{y}{L} = p_L \quad \text{and} \quad \frac{y}{L} = w_L \quad \text{we have:} \quad w_L \approx p_L .$$

In fact, when we cancel the assumption that the product prices are determined, the remuneration is defined both by the labour productivity and by the level of product prices. However, in our analysis the prices are determined, therefore, we disregard their impact $w_L \cdot p_Y \approx p_L$.

Therefore, the labour factor productivity should determine its remuneration. The inequality in terms of concentration of both these values, i.e. w_L and p_L for the agricultural sector in regional terms has been analysed (Tsoku and Matarise, 2014; Guiteras and Jack, 2018).

It has been assumed that the labour factor productivity is determined in the sense of identity by the capital-labour ratio (relationship between the capital factor K and the labour factor L) and by the land-labour ratio (relationship between the land factor Z and the labour factor L). For the given capital factor productivity:

$\frac{y}{K} = a$ and the land factor productivity $\frac{y}{Z} = b$, we have: $w_L \approx \frac{K}{L} \cdot a$ and $w_L \approx \frac{Z}{L} \cdot b$.

3 Methodological assumptions

These dependencies were verified against empirical data based on the statistics i.e. the Gini coefficient (Barabesi et al., 2015; Ghosh, 2015; Rad et al., 2016; Tyrowicz et al., 2017). This is a commonly used indicator of the unequal distribution of variables (values), mostly income. It is within the range (0-1). The higher is the value of the indicator (1), the greater is the degree of concentration of the variable and thus the greater are the inequalities of, e.g. income (Ghosh, 2015; Rad et al., 2016; Prendergast and Staudte, 2016). The Gini coefficient is a normalised value, which makes it easier to make comparisons. On a basis of this statistics, the differentiation of the productivity and remuneration has been compared, by voivodeships. They were shown in the order adequate to the presented analytical aspect[3].

4 Differentiation of the labour productivity and remuneration – study results

The Gini coefficient and the coefficient of variation for section A (Polish Classification of Activity 2007, where section A is agriculture, forestry, fishing and fisheries) have been estimated. It is assumed conventionally that section A illustrates agriculture. Data from the CSO Local Data Bank for the years 2005-2014 has been analysed (Fig. 1 in appendix). The results for the labour factor productivity (gross value added per employee – GVA per employee in constant prices) and the average monthly gross remunerations in section A are presented in Table 1.

The inequality and variation of the labour productivity were relatively high. These results proved to be relatively stable over time (Harasim, 2006; Nowak, 2010; Kuźmar, 2017). The inequality of remunerations was significantly lower. There was an important condition that the differentiation and variation of remunerations proved to be lower than those of the labour productivity in spatial terms. In addition, small spatial inequalities of remunerations decreased over time, despite the fact that the differentiation of the labour productivity was invariable. This indicates a weak relationship between (in)equalities of the remuneration and productivity. This phenomenon may result from public aid transfers (Alexandri, 2017). The differentiation of remunerations is much lower and characterised by the more equal distribution. This confirms the above finding negatively verifying the first hypothesis. A discrepancy between the distributions of these two indicators is visible. From the point of view of social objectives, this is a positive phenomenon. From the purely economic point of view – it is not.

[3] The method of presenting the results refers to the approach applied by S. Kuźmar entitled *Differentiation of the regional labour productivity in Poland* (Contemporary Economic Issues, No. 11, 2015, pp. 137-147), which the authors found very accurate and comprehensible.

Table 1. Differentiation of the labour productivity per employee and average monthly gross remunerations in section A, by voivodeships in Poland in the years 2005-2014, 2005 = 100.

Years	Gini coefficient (labour productivity)	Coefficient of variation of labour productivity [%]	Gini coefficient (remunerations)	Coefficient of variation of remunerations [%]
2005	0.264	48.21	0.048	8.71
2006	0.265	48.27	0.042	7.84
2007	0.227	41.26	0.038	7.06
2008	0.218	39.45	0.046	9.42
2009	0.254	46.10	0.031	5.72
2010	0.251	45.47	0.034	6.37
2011	0.239	43.34	0.037	7.05
2012	0.252	45.53	0.042	8.26
2013	0.254	45.97	0.037	6.96
2014	0.260	46.85	0.035	6.84

The above finding has been confirmed by panel data analysis[4] (Table 2). The analyzed data was of cross-sectional nature, therefore a panel of 16 voivodeships in the years 2005-2014 was created. These dependencies were statistically significant in the case of the correlation coefficient (0.883). Panel data analysis showed slight impact of labour productivity on the remunerations. These findings, however, did not deny the logic of a theoretical relationship between the productivity and remuneration of the labour factor. They only showed that the inequality of the labour productivity was different than that of remunerations. It is obvious to restore this relationship and treat it as a standard. However, referring to the reasons (according to the analytical aspect[5]), the differentiation and inequality of the distribution of the relationship between the capital and land

[4] Panel data models are special models built on the basis of time-space data that describe a fixed group of objects in more than one period. The models can be in the form of (1) models with free expression decomposition (FEM) or (2) models with decomposition of a random component (Random Effects Model - REM). The model's assessment is based on chi-square statistics, which in turn is based on the reliability function (statistic Likelihood Ratio Test) and F statistics. The choice between the FEM and REM model is made using the Hausman test (Wooldrige, 2002).

[5] $w_L \approx \frac{K}{L} \cdot a$ and $w_L \approx \frac{Z}{L} \cdot b$ for the given voivodeships and given values ij.

factors to the labour factor in regional terms have been shown. The values of the Gini coefficients and the coefficients of variation have been estimated, which was shown in Table 3.

Table 2. Panel data model (REM) illustrating the dependency of remunerations (Y) on the labour productivity (X – GVA per employee), 2005 = 100.

Specification	***Coefficients***	***Standard error***	***t Stat***	***p-value***	
Constans	17.919	4.967	3.607	0.0003	***
GVA per emploee	0.069	0.015	4.507	<0.0001	***
GVA per emploee in previous year	0.013	0.019	0.679	0.4970	
Remunerations in previous year	0.948	0.031	3.782	<0.0001	***
Number of observations				*160 (16 voivodeships and 10 years)*	
Log Likelihood				*648.602*	
Hausmann test:		*1681.241 (p-value = 0.006)*			
Pesaran CD test for cross-sectional dependence:		*-1.972 (p-value = 0.048)*			
Test for normality of residual:		*6.636 (p-value = 0.036)*			

Table 3. Differentiation of the relationship of the land-labour ratio and capital-labour ratio (2005 = 100), by voivodeships, in the years 2005-2014.

Years	**Gini coefficient (land-labour ratio)**	**Coefficient of variation of land-labour ratio [%]**	**Gini coefficient (capital-labour ratio)**	**Coefficient of variation of capital--labour ratio [%]**
2005	0.188	37.55	0.209	38.59
2006	0.194	38.33	0.210	39.00
2007	0.201	38.86	0.213	38.95
2008	0.195	39.00	0.206	39.15
2009	0.207	41.87	0.217	41.61
2010	0.210	44.85	0.225	44.44
2011	0.205	43.52	0.237	46.19
2012	0.211	46.09	0.228	45.08
2013	0.218	47.03	0.248	46.55
2014	0.219	48.23	0.249	47.00

As we can see, the land-labour ratio (indicator roughly illustrating the agrarian structure) was highly differentiated with the unequal distribution. However, when comparing the data from Tables 1 and 3, it is evident that the inequality and differentiation of the land-labour ratio did not deviate from that for the labour productivity. This indicates the validity of adopting the second hypothesis and analytical assumption regarding the labour productivity conditions. The similar finding was outlined from comparing the differentiation and inequality of the capital-labour ratio and the labour productivity (Table 3). As we can see, the capital-labour ratio was characterised by the highly unequal distribution, for which the values of the Gini coefficient oscillated within the limits of 0,209-0,249. Even higher values were reached by the coefficient of variation (38.59-47.00%). In addition, the analysed differentiation of this coefficient increased in the analysed period of time more than in the case of the labour productivity.

From this analysis, it can be concluded that the capital-labour ratio and land-labour ratio (to some extent, the approximation of the indicator of the structure and concentration in agriculture) highly explain the differentiation in the labour factor productivity.

Analysis of the unequal distribution curves of the land-labour ratio and capital-labour ratio in the above charts confirms previous observations. The inequality and differentiation of the labour productivity and the land-labour ratio and capital-labour ratio can be linked, which verifies the second hypothesis positively. The same cannot be said regarding the differentiation of remunerations in relation to the labour productivity.

In order to verify the above observations, the dependency between the analysed values has been analysed statistically (correlation and panel data analysis). The results are shown in Table 4. These dependencies were statistically significant. Correlation between the labour productivity level and the land-labour ratio and capital-labour ratio amount to 0.919. and 0.868. This was a basis for positive verification of the second hypothesis (of the relationship between the differentiation of the labour productivity and its land-labour ratio and capital-labour ratio).

In analytical terms, in accordance with the last formulae, the regional differences in the productivity levels of production factors, i.e. capital and land, were analysed[6] (Table 5). The differentiation and inequality of the distribution in spatial terms in the case of the land productivity was milder than in the case of the productivity and land-labour ratio. This factor was similarly productive in various parts of the country. A similar conclusion resulted from analysis of the

[6] $\frac{y_{ij}}{K_{ij}} = a_{ij}$, $\frac{y_{ij}}{Z_{ij}} = b_{ij}$ for given value (production, capital, labour) and for the given voivodeship.

differentiation of the capital productivity. Here, the estimated indicators demonstrated the smallest differentiation and discrepancies.

Table 4. Panel data model (REM) illustrating the dependency between the differentiation of the labour productivity and its land-labour ratio and capital-labour ratio (2005 = 100).

Specification	*Coefficients*	*Standard error*	*t Stat*	*p-value*	
Constans	91.624	9.728	9.418	<0,0001	***
Land-labour ratio	0.145	0.022	6.547	<0,0001	***
Capital-labour ratio	0.192	0.073	2.629	0.008	***
Number of observations				*160 (16 voivodeships and 10 years)*	
Log Likelihood				*834.739*	
Hausmann test:	*51.394 (p-value = 0.000)*				
Pesaran CD test for cross-sectional dependence:	*13.829 (p-value = 0.000)*				
Test for normality of residual:	*21.289 (p-value = 0.000)*				

Table 5. Inequality and differentiation of the land productivity (agricultural production value per ha) and capital productivity (agr. production value in relation to the intermediate consumption and depreciation value) in section A, by voivodeships, in the years 2005-2014, 2005 = 100.

Years	**Gini coefficient for land productivity**	**Coefficient of variation of land productivity [%]**	**Gini coefficient for capital productivity**	**Coefficient of variation of capital productivity [%]**
2005	0.125	23.40	0.053	10.09
2006	0.123	22.51	0.048	8.98
2007	0.105	19.48	0.045	8.69
2008	0.112	20.23	0.050	9.17
2009	0.105	19.42	0.044	8.48
2010	0.108	19.57	0.054	10.17
2011	0.109	19.64	0.072	13.41
2012	0.117	21.36	0.063	12.22
2013	0.121	22.35	0.060	10.91
2014	0.123	22.45	0.061	11.38

The productivity distributions are more equal when compared to the labour productivity distribution, land-labour ratio and capital-labour ratio. This may point to the fact that the land-labour ratio and capital-labour ratio actually affect the differentiation of the labour productivity. The distributions of these values were similarly unequal. This confirmed the second hypothesis and the adopted analytical assumptions. Indeed, in the sense of the rules of agricultural economics, this means that the agrarian structure and capital-intensive production techniques are of paramount importance. This is confirmed indirectly by analysis of the statistics for the last analysed values i.e. productivity indicators in Table 6 (data base from Eurostat and CSO).

Table 6. Panel data model (REM) illustrating the dependency between the labour productivity and the capital and land factor productivity in the years 2005-2014, 2005 = 100.

Specification	***Coefficients***	***Standard error***	***t Stat***	***p-value***	
Constans	30.947	11.644	2.658	0.008	***
Land factor productivity	0.826	0.063	13.382	<0,0001	***
Capital factor productivity	4.678	6.589	0.710	0.478	
Number of observations				*160 (16 voivodeships and 10 years)*	
Log Likelihood				*788.099*	
Hausmann test:		*16.081 (p-value = 0.000)*			
Pesaran CD test for cross-sectional dependence:		*16.487 (p-value = 0.000)*			
Test for normality of residual:		*5.247 (p-value = 0.072)*			

* Correlation between the labour productivity and the productivity of land amount to 0.638. Correlation between the labour productivity and capital productivity amount to 0.096.

Conclusions

The article deals with the issue of the relationship between the labour remuneration and productivity and the factors shaping this relationship, by voivodeships. We observed the greater differentiation and variation in the labour factor productivity rather than in its remuneration. The distributions of those variables in spatial terms did not match each other in terms of their equality. The labour productivity differentiation resulted mainly from the differentiation in the capital-labour ratio and land-labour ratio. Here, the inequalities in the distribution of these variables matched each other. This had a negligible impact on the spatial differentiation of the capital and land productivity.

Analysis was conducted on a basis of the analytical aspect, which was therefore positively verified. The overall conclusion, the alignment of the differentiation in the labour factor

remuneration (agricultural income) in spatial terms did not result from the decreasing labour productivity differentiation. The alignment of the distribution of this latter indicator was more due to the decrease in the differentiation of the capital-labour ratio and land-labour ratio, and less due to the productivity of these factors. As a result, the alignment of differences in the amount of the analysed indicators in spatial terms may not be an important source of the agricultural development, as it is most often assumed. This can, however, be relevant for determining the agricultural policy, in particular in terms of cohesion. Authors disregarded the impact of subsidies and found them to be a less important source of agricultural development than labor productivity (the main source of growth and development). However, it is necessary to recognize these relationships in further research due to the high values of constant parameters and standard errors in all panel data models.

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APPENDIX

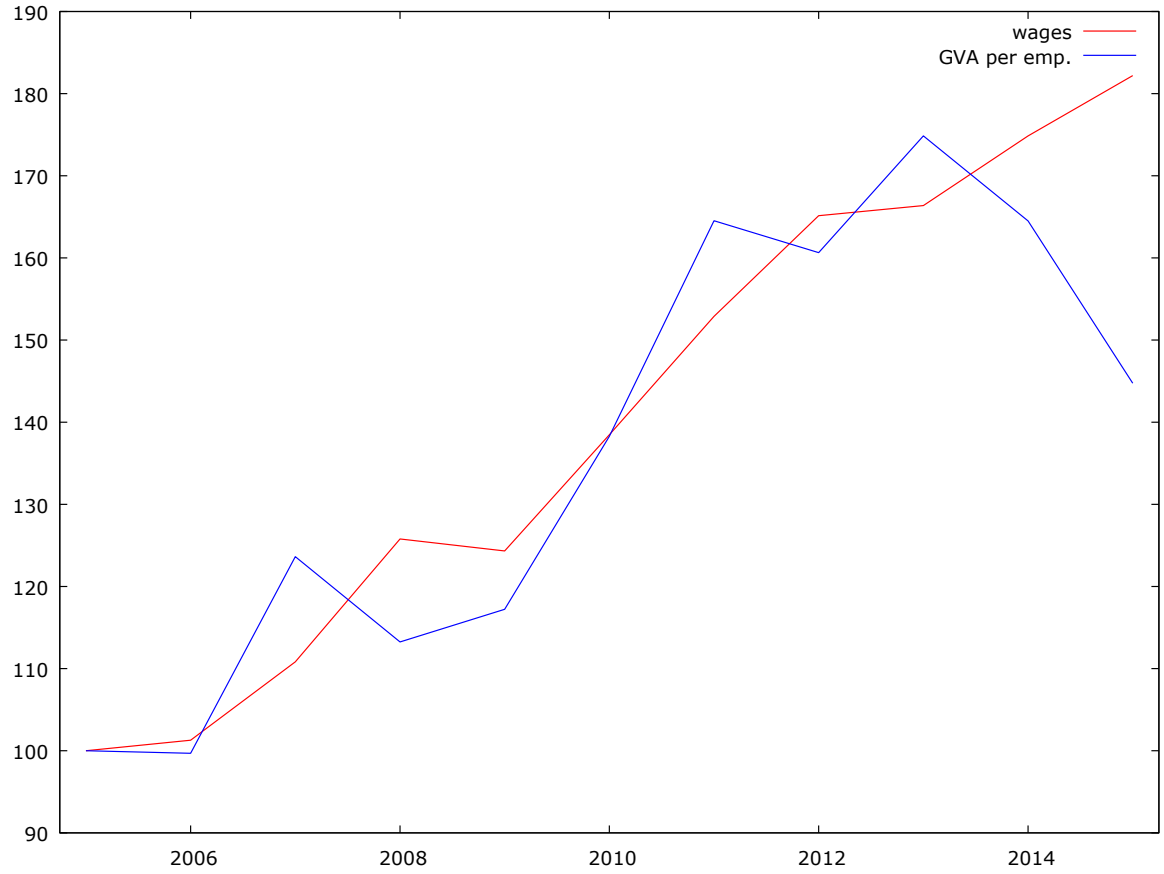

Fig. 1. Labour productivity (blue line) and remunerations (red) in 2005-2014 (2005 = 100).