

THE SIGNIFICANCE OF FARM SIZE IN THE EVALUATION OF LABOUR PRODUCTIVITY IN AGRICULTURE

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Abstract

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The paper deal with the analysis of difference in labour productivity of farms categorised according to their size, to determine if the set subsidy system influences labour productivity in the size groups of the farms. The source of data for enterprises analysis was the firms database, which contains accounting data of 926 farms with at least one employee. The observed data were from the 6 year period (2007–2012). The farms were divided, according to their size into four categories defined by the European Commission: micro, small, medium and large enterprises. The analysis of the labour productivity I based on the added value and labour costs revealed that there are big differences of the labour productivity levels in particular size groups of farms. The further analysis revealed that an adjustment of the farm approach of the labour productivity, when the paid operation subsidies are added (labour productivity II), changes this conclusion and the differences between particular size groups of farms decreased. Using σ -convergence, it was proved that the relative variability of the labour productivity II values decreased significantly in the case of the medium-sized farms. We can say that subsidies significantly influence the labour productivity in farms. On one hand, there is decrease of differences between the level values of particular size groups of farms; on the other hand, there is no significant decrease its variability (except the medium-sized farms).

Keywords: labour productivity, agriculture, farm size, subsidies

INTRODUCTION

The labour productivity indicator describes the efficiency of the use of the production factor of labour in a company. This indicator can be defined in various ways when it is necessary to take into account also sector differences. One significant factor of the assessment of the size and dynamics of this indicator is the size of a company. The aim of this paper is to assess the significance of the size of farms in the assessment of the labour productivity in agriculture and the influence of different approach of the labour productivity indicator.

The basis for measuring productivity and performance of enterprises or economy is production function. This neoclassical production function is based on the Solow fundamental work. The aggregate production function can be written

as: $Q = F(K, L; t)$. Q represents output, K and L represent capital and labour inputs in „physical“ units and t represents technical change (Solow, 1957). Productivity is defined as the ratio outputs and inputs (Coelli *et al.*, 2005). The most frequently measured indicator is labour productivity. We have other types of productivity as capital productivity or total factor productivity. The capital productivity shows how productively capital is used to generate value added. Total factor productivity measure technological change. Total factor productivity determines labour productivity, not only directly, but also indirectly by determining capital per worker (Prescott, Lawrence, 1997). Labour productivity plays a significant role in economic growth, labour demand and employment situation of a particular economy (Bhattacharya, Narayan, 2010). There are

two sources of labour productivity growth: technical progress and increases in the average capital–labour ratio (C–LR). The average capital labour ratio can be affected by demographic change in two ways. The first is a mechanical effect as capital takes time to adjust to changes in labour for any equilibrium C–L ratio (Guest, 2011). Labour productivity is measured as the GDP per hour works (Palazuelos, Fernandez, 2010) or value added per labour input (worked hours) (Hara, Ichiue, 2011). Labour productivity is measured in agriculture as agricultural GDP to economically active population in agriculture (Fan, Chan-Kang, 2005) or net added value (NAV) per worker or recalculated worker (respectively AWU – annual work unit) (Brčák, 2009). Net added value (NAV) is currently a synthetic indicator of standard EU output, which expresses the overall effect of total production, efficiency of inputs and operational subsidies (Brčák, 2009). In agriculture enterprises we can labour productivity measured as value added per labour costs or per worker (Bervidová, 2002).

The agriculture is the main part of primary sector of the national economy. Formation of European agriculture and its dynamics and productivity is influenced by many heterogeneous processes and trends. The attention will be paid to the connections of the basic global trends, to the determining role of the CAP, the influence of agrarian markets, enforcement of the multifunctional agriculture trend, the development of GMO technologies and other (Svatoš, 2008). The European agriculture has influenced by the EU Common Agricultural Policy (CAP) for decades with the objective of increasing productivity and the income of farmers. The main aims of the CAP are: to improve agricultural productivity, so that consumers have a stable supply of affordable food, and to ensure that EU farmers can make a reasonable living. The main instrument of CAP is subsidies. Subsidy payments may induce structural changes in the economy, such as productivity growth and exit/entry of farms (Ciaian *et al.*, 2008). Various studies have shown that these CAP subsidies impact on the farm sector productivity. Some theoretical studies suggest that subsidies may have a positive or negative impact on farm production (Rizov *et al.*, 2013) and productivity (Ackrill, 2008). The next factor that could affect labour productivity (Lipton, 2006) or efficiency (Mugera *et al.*, 2012) is farm size.

MATERIALS AND METHODS

The aim of the research was to assess difference in labour productivity of farms categorised according to their size (methodology of the EU), to determine if the set subsidy system influences labour productivity in the size groups of the farms. The first step of the analysis was the assessment and comparison of the labour productivity development in the Czech Republic with the development of this indicator in Section 01 Crop and animal production, hunting and related service activities (NACE 2) and

the development of this indicator in agriculture (Economic Accounts for Agriculture) considering the business cycle. The goal of this step was to indicate sector differences. The source of the data used in this part of the paper was information provided by the Czech Statistical, the National Account Section recorded in years 1998–2012 (15 years) and the Economic Accounts for Agriculture. We used, for the following investigation, the company database called ALBERTINA, which contains accounting data of 926 farms (agricultural enterprises) with at least one employee. The observed company data were from the 6 year period (2007–2012) and the set of the 926 companies was for the whole observation period invariable. The farms were divided, in every year, according to their size into four categories defined by the European Commission (European Commission Directive (ES) No. 800/2008): micro, small, medium and large sized enterprises. Micro enterprises have fewer than 10 employees and their turnover or balance sheet total does not exceed 2 Million Euros. Small firms have less than 50 employees and their turnover or balance sheet total does not exceed 10 Million Euros. The Commission further regards an enterprise with fewer than 250 employees, a turnover not exceeding 50 Million Euro or a balance sheet total not exceeding 42 Million Euros as a medium-sized enterprise. A big is an enterprise which does not belong to any of the above mentioned categories.

At the same time, differently defined labour productivity indicators were analysed in order to determine differences in the level and variability of this indicator regarding the different size groups of companies. The analysed indicators contain the labour productivity defined on the macroeconomic level as ratio of gross value added (GVA) and compensations of employees, defined, from the enterprise perspective, in two ways: as a ratio of the accounting value added and labour costs (Labour Productivity I) and as a ratio of the accounting value added increased by other operation revenue and labour costs (Labour Productivity II).

The main reason is the fact that farms provide services in the form of non-production functions for the state and the state pays for the services in the form of operation subsidies.

To assess, if the subsidy system makes the relative variability of labour productivity values lower, the σ -convergence coming out from the neoclassic theory of economic growth was applied. The convergence between two economic entities can be expressed as follows:

$$|y_{1,t} - y_{2,t}| > |y_{1,t+1} - y_{2,t+1}|, \quad (1)$$

where quantities $y_{1,t}$ and $y_{2,t}$ are relative economic quantities in time t .

It is possible to meet also other formal notation, which assess the relative distance of economic levels of particular countries

$$\frac{y_{1,t}}{y_{2,t}} < \frac{y_{1,t+1}}{y_{2,t+1}}, \quad (2)$$

where $y_{1,t} > y_{2,t}$, and this relationship can be interpreted in the way that the relative distance between two economic quantities decreases in time. There are two convergences coming out from the neoclassic approach of the economic growth: β -convergence, which can be understood that a labour productivity growth in this case is negatively dependent on the initial economic level; and σ -convergence which represents a decrease of disperse rate of the labour productivity (i.e. the relative variability rate) in time.

σ -convergence can be expressed as

$$\sigma_t > \sigma_{t+1}. \quad (3)$$

Ex post, we can write

$$\sigma_{t-1} > \sigma_t. \quad (4)$$

As the relative variability rate is used variance coefficient c_x , which is a ratio of the standard deviation and the arithmetic mean of the observed variable

$$c_x = \frac{s_x}{\bar{x}},$$

where

$$s_x = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}}. \quad (5)$$

σ -convergence takes place if the variance coefficient, in this case of labour productivity of particular economic entities, decreases in time.

Assuming the usual definitions using relative distances, for example (Smrčková *et al.*, 2008), β -convergence and σ -convergence are *equivalent*, which means that when there is a quicker growth of economic entities with a lower initial level in time, the variance coefficient decreases. When defining on absolute differences, for example (Slavík, 2007),

the existence of β -convergence is a necessary condition for σ -convergence. However, this relation does not have to be true vice versa.

To prove if the results of the Labour Productivity II when the subsidies are included are less relatively variable and also their means converge, test of the hypothesis of no significant difference of the mean values, resp. of the variance. Based on a comparison of two independent samples, two populations are considered, from with the samples were taken (Hindls *et al.*, 2007). Using the software STATISTICA. The assumption that the average values of the labour productivity is between particular size group of farms do not differ (resp. the variance of the labour productivity values). The null hypothesis states that

$$H_0: \mu_1 = \mu_2,$$

resp.

$$H_0: \sigma_1^2 = \sigma_2^2. \quad (6)$$

The alternative hypothesis is, in case of the both sided test, as follows

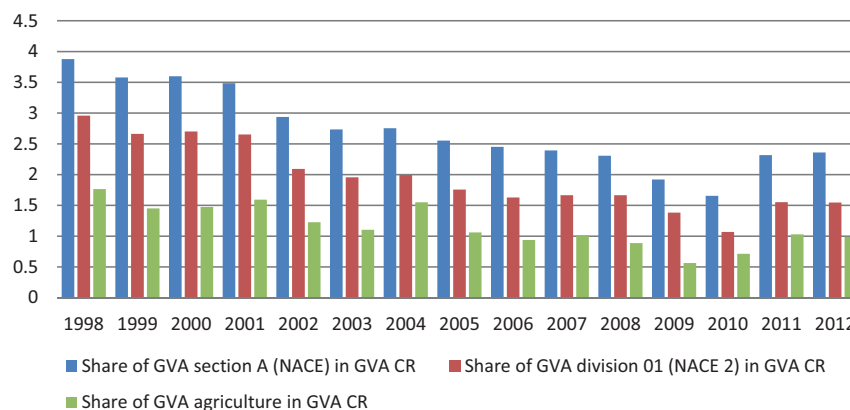
$$H_1: \mu_1 \neq \mu_2,$$

resp.

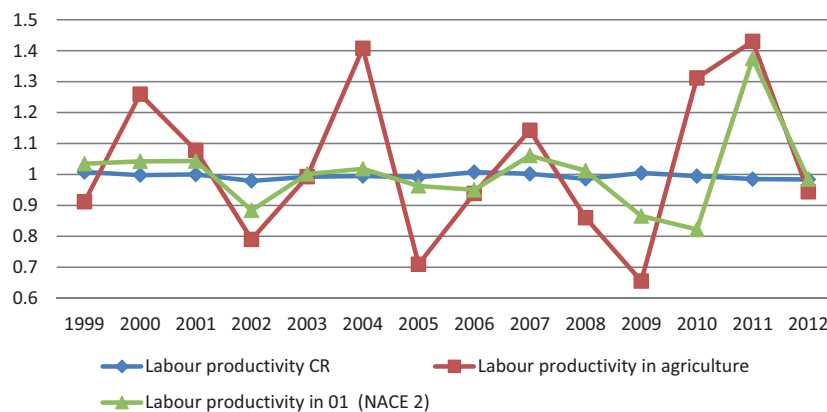
$$H_1: \sigma_1^2 \neq \sigma_2^2.$$

RESULTS

First, the attention was paid to the position of agriculture and its development within the framework of the economy of the Czech Republic, which is obvious from the share of gross value added (Fig. 1). Despite the fact that agriculture is an important part of an economy and its position is irreplaceable, its share decreases in the observed period. While in 1998, the section A (NACE) Agriculture, forestry and fishing comprised approximately 3.9% GVA of the national economy, ten years later the percentage share decreased by approximately 2% (to 1.9%) and in 2012, the share



1: Share of Gross value added (GVA) agriculture in GVA Czech Republic
Source: Own calculations based on the data of National accounts



2: Development of labour productivity (GVA / compensations of employees)

Source: Own calculations based on the data of National accounts



3: Relative frequency of farms

Source: Own calculations based on the data of firms database Albertina

increased to 2.4%. If we observe the share of GVA in agriculture more closely using the Economic Accounts for Agriculture, we will find an obvious drop which is more intense in, for agriculture, unsuccessful years caused by climatic impacts (e.g. year 2002 – floods, year 2009 – floods and price development influence of the worldwide crisis).

Another step of the analysis focused on the macroeconomic development of the labour productivity indicator. The development of this indicator is influenced not only by outputs, i.e. GVA, but also by inputs, i.e. by the development of labour production factor expressed as compensations of employees. Observing the time series of growth rate (inter-annual indexes) of labour productivity within the whole Czech Republic, there is no evident real business cycle (growth rates oscillate round the value 1). The dynamics of this indicator in Section 01 (NACE 2) show a cyclic development which is even more intense regarding labour productivity determined with the use of Economic Accounts for Agriculture (Fig. 2).

It is also evident that the growth rates of labour productivity in agriculture succumb to significantly bigger oscillations and these oscillations are not in accordance with the labour productivity

development considering in economy. The dynamics of the observed indicators support the fact that the indicators characterising the economic development in agriculture do not develop in accordance with the real business cycle (more in Novotná, Volek, 2014) and the development is acyclic. The reason is other factors (non-market), which have no connection with the real business cycle, primarily climatic influences.

Labour productivity was analysed more closely using a set of 926 farms (ALBERTINA) within the period of 2007–2012, which were categorised according to their size using the methodology of the EU (Fig. 3).

Fig. 3 shows that in the observed period of time, there is no significant share of micro farms (just under 20%), nor big farms (about 2%). The biggest changes in the structure of the observed farms are identified in the groups of small and medium-sized farms. Especially in the years 2010 and 2011, the share of the small farms increased at the expense of the medium-sized farms. It means that in these years, some of the medium-sized farms decreased the number of their employees or their turnover and these medium-sized farms became small farms. It is interesting that these changes are in the years

of biggest deviations of the labour productivity in Section 01 (NACE 2).

The farm indicators of the labour productivity were compared with the whole-national level in two alternative ways:

- a) as a ratio of the value added and labour costs,
- b) as a ratio of the accounting value added increased by other operation revenue and labour costs.

The level of the Labour Productivity I classified according to the farm size is presented in Fig. 4.

The big farms have definitely the highest added values allocated to CZK 1 of labour costs during the whole observed period. Other size groups did not reach so high efficiency from CZK 1 of labour costs and in the unfavourable years for (2008, 2009), it is possible to record even a significant drop. There is an evident significant distance of the small farms which did not even reach 20% of the level of the big agricultural companies. A possible explanation of the different efficiency of the labour product factor is a higher level of relation accounting value added in revenues in big farms. This ratio is important, as it can be understood, in a certain sense, as an indicator of economic development of business activities. To produce with as high added value as possible could be considered, generally, as desirable. Tab. I presents these relations for the different size groups.

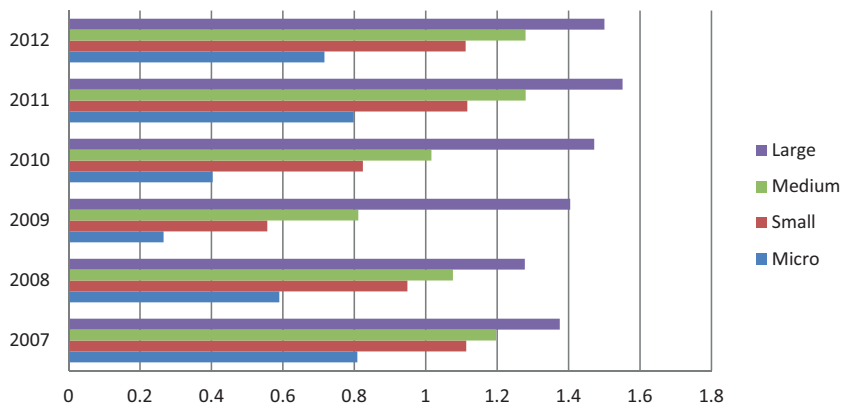
Tab. I presents that the one reason of a significantly higher labour productivity regarding the big farms is the higher share of the accounting value added produced of CZK 1 of revenue. Moreover, this share is, regarding the big farms, stable so there is no decrease in the less favourable years, while there was

a decrease in the other size groups of farms in the year 2009.

If we include into the calculations of the labour productivity operation subsidies (more precisely other operation yields), then it is possible to come to a different conclusions (Fig. 5). Besides the less favourable years, the highest Labour Productivity II can be identified in the micro farms, which even outcomes the labour productivity of the large farms. The reason can be the lower number of employees, it means lower labour costs (a smaller farm is not so complex regarding the organization of work, which means that there is a less number of managers and at the same time also of the labour costs). Overall, we can say that if we include the subsidies to the added value, there is a convergence of particular size groups of farms regarding this indicator.

The finding that subsidies of farms influence significantly the labour productivity, considering both the level of values of this indicator regarding different size groups of farms, and also the dynamics, was elaborated more deeply. As the average values of the labour productivity including the operation subsidies (Fig. 5) seem, regarding particular size groups of farms, to be more balanced than when the operation subsidies are excluded (Fig. 4), the following analysis focused on a relative value variability of the observed indicator values (Tab. II).

We can talk about a convergence of the labour productivity levels if the variance coefficient decreases in time, i.e. the relative variability of indicators values decreases. Observing Tab. II, we cannot make a clear conclusion. If we do not



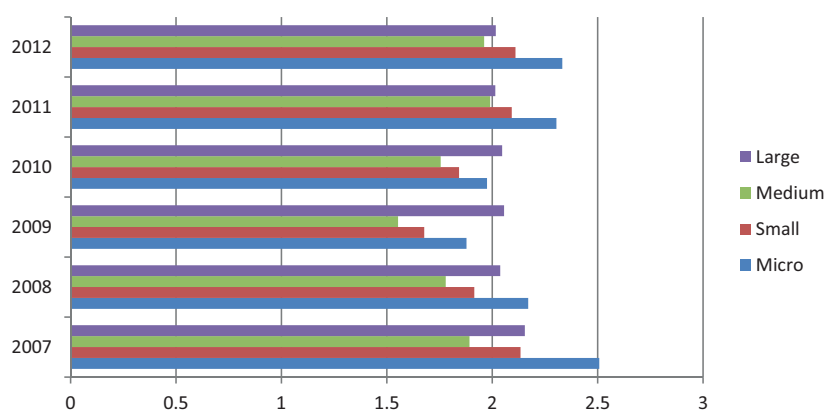
4: Labour productivity I – classified according to the farm size

Source: Own calculations based on the data of firms database Albertina

I: Ratio of accounting value added in revenue (in CZK)

Size farm	2007	2008	2009	2010	2011	2012
Micro	0.15	0.12	0.07	0.10	0.16	0.15
Small	0.29	0.24	0.17	0.23	0.28	0.27
Medium	0.33	0.30	0.25	0.29	0.31	0.30
Large	0.31	0.29	0.34	0.34	0.34	0.32

Source: Own calculations based on the data of firms database Albertina



5: Labour productivity II – classified according to the farm size

Source: Own calculations based on the data of firms database Albertina

II: Coefficient of Variation – Labour productivity II

Farm size	2007	2008	2009	2010	2011	2012
Micro	98.69	98.74	118.55	133.17	96.00	101.61
Small	54.25	62.06	68.46	56.36	53.23	54.16
Medium	42.32	30.90	39.93	28.63	29.37	25.50
Large	26.45	27.53	34.43	33.12	27.04	35.24
Total	89.88	96.28	103.06	84.68	67.93	68.69

Source: Own calculations based on the data of firms database Albertina

III: Labour productivity II – results T-test and F-test

	Value t	p-value	Standard deviation group.1.	Standard deviation group.2.	F-deviation	p-value
micro vs small	5.2604	0.0000*	2.5161	1.1727	4.6037	0.0000
micro vs medium	8.7730	0.0000*	2.5161	0.6274	16.0826	0.0000
micro vs large	0.8211	0.4118	2.5161	0.6235	16.2822	0.0000
small vs medium	6.7979	0.0000*	1.1727	0.6274	3.4934	0.0000
small vs large	-0.5401	0.5892	1.1727	0.6235	3.5367	0.0000
medium vs large	-3.5794	0.0003*	0.6274	0.6235	1.0124	0.9878

Source: Own calculations based on the data of firms database Albertina

Notes: * p < 0.05 statistically significant

consider the year 2009, which was, not only from the agriculture point of view, exceptional, we can talk about a moderate convergence of the labour productivity levels of farms in total. A more significant decrease of the variance coefficient can be identified in the medium-sized farms. We can say that thanks to the subsidy policy in the observed period of time in this category there is a decrease of differences in the efficiency of the labour production factor. Considering the micro farms, the situation is, in the observed period of time, almost without any change as it is also in the case of the big farms.

One reason of this development could be the capita – labour ratio. Medium-sized farms have a n easier access to investment subsidies and they buy long-term assets. This can be reflected in the

technical equipment and further also an increase and convergence of the efficiency of the production labour factor.

The conducted analysis on 95% significance level shows that we cannot reject the hypothesis that the average labour productivity values in micro farms (resp. small farms) equal to the mean value of big farms (t-test) (Tab. III). Testing the hypothesis about no difference between two variances (F test), we reject the null hypothesis, it means that there are significant differences in variances regarding the labour productivity of different size groups of farms, excluding the medium-sized farms vs. big farms. The test make us not to reject the null hypothesis, i. e. the variance of the medium-sized farms equals to the variance of the big farms.

DISCUSSION

Agriculture is an important part of economy and has an irreplaceable role, but its share on the creation of the gross value added of economy has been significantly decreased to the level of 2%. The development of the labour productivity in agriculture is dynamic and shows considerable deviations and does not develop in accordance with the real business cycle, as there are other influencing factors such as climatic and natural effects. Da-Rocha, Restuccia (2006) found the similar conclusion. They found that agriculture has certain distinctive features over the business cycle: output and employment in agriculture are more volatile than and not positively correlated with output and employment in the rest of the economy.

One goal of the Common Agricultural Policy, within which subsidies are paid out, is to increase the productivity. The conducted analysis shows that this goal seems to be partially accomplished. The question is if the subsidy policy should cause such a significant labour productivity levels. For example, farms situated in less favourable areas (LFA) focusing on an extensive production (e.g. cattle farming) employ a minimum of employees and obtain an inadequate revenue. This means that their labour productivity will be high. It is possible to decrease this revenue by changes of LFA support (Doucha *et al.*, 2012).

The paper dealt with an analysis of the labour productivity of particular size groups of farms (926) and it is based on the enterprise approach of the labour productivity. The analysis I of the labour productivity based on the added value and labour costs revealed there are big differences of the labour productivity levels in particular size groups of farms. The biggest labour productivity was identified in big farms. The main reason could be considered a wider range of farms activities of the big companies, which, besides the primary production, also process the primary products and use their free capacities to other farm activities. This statement

can be supported by the share of the added value in revenue. Regarding the big farms, this value exceeds 30%, when taking about the micro farms; it does not exceed the value of 16%. A similar finding in case of agricultural cooperatives in the U.S. was proven by Lerman and Parliament (1991). Another factor influencing the differences is, according to (Střeleček *et al.*, 2010), the natural condition of the location of particular farms. The indicator of the labour productivity I does not contain all activity results of farms, for example costs covering non-production functions financed with operation subsidies. If other operation revenue are included into the added value (Labour Productivity II), the differences between particular size groups of farms decreased. On the other hand, the highest labour productivity was identified in micro farms. The reason could be a more effective use of labour costs and savings of labour costs considering management and administrative staff or the transfer of some activities into services (outsourcing). The mentioned findings show clearly that operation subsidies of farms influence the labour productivity and its dynamics. This positive impact on farm productivity in the EU – 15 was affirmed by Rizov *et al.* (2013). Kazukauskas adds that subsidies had significant positive effects on farm productivity and behavioural changes related to farm specialization (Kazukauskas *et al.*, 2013).

Another analysis focused on the variability of the labour productivity, if there is a convergence. A convergence of the labour productivity takes place in time only in case of the medium-sized farms, considering the other size groups, this phenomenon is not clear. The authors of the paper would like to analyse this conclusion further in the future. One reason of the decrease of the relative variability of the labour productivity in the medium-sized farms could be the fact that this size type of farms is relatively financially stable and they can modernize long-term assets. This can be reflected in the technical equipment and further also in the labour productivity (with a possible delay).

CONCLUSION

The present paper focuses on the analysis the significance of the size of farms in the assessment the labour productivity in agriculture and the influence of a different approach of the labour productivity indicator. The analysis proved that the size of a farm has a significant influence on the labour productivity level calculated as a ratio of accounting added value and labour costs. The further analysis revealed that an adjustment of the farm approach of the labour productivity, when the paid operation subsidies are added, changes this conclusion. The consequence of the subsidy policy is a convergence of the labour productivity of the size groups of farms. This finding was partially proved by the statistical test of the hypothesis of no significant difference of the mean values. Using σ -convergence, it was proved that the relative variability of the Labour Productivity II values decreased significantly in the case of the medium-sized farms. We can say that subsidies significantly influence the labour productivity in farms. On one hand, there is decrease of differences between the level values of particular size groups of farms; on the other hand, there is no significant decrease its variability (except the medium-sized farms).

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