

## Convergence of Labour Productivity in Agriculture in the European Union

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**Abstract.** The aim of the paper is to assess changes in labour efficiency in the EU Member States. It was assumed that convergence is taking place in labour efficiency in agriculture between the “old” and the “new” EU Member States. The analysis covers the years 1998-2011. It has been found that there are large differences in labour productivity in agriculture among various countries. However, two groups of countries with different labour efficiency may be distinguished. The first group includes the old EU Member States, the second – the new ones. Countries with lower initial labour efficiency showed a higher average growth rate but absolute growths were lower there. No  $\beta$ -convergence or  $\sigma$ -convergence has been found with respect to labour efficiency in agriculture and the division into two groups has persisted. The most important factors limiting the occurrence of convergence are connected with farm structure and the number of agricultural workers.

**Key words:** labour productivity in agriculture, agriculture employment, convergence.

**JEL codes:** J43, O40, Q10

### Introduction

The issue of labour efficiency in agriculture has been discussed in many studies. Agriculture in many European countries, including Poland, is characterised by a relatively low level of labour efficiency and consequently low income from agriculture per one working person. Taking as example Poland, it should be pointed out that a sufficient level of labour efficiency is a necessary condition for the work in agricultural holdings to provide the major source of income for the farmers. Wasilewski (2006) observed that labour productivity in Polish agricultural holdings was very varied and depended on indebtedness level. An important aspect of the assessment of labour efficiency is the average size of agricultural holdings. In Poland, the average farm is as small as 8 ha. The owners are not fully occupied on small farms. On large farms, employing hired workforce, research shows also significant differences in the number of workers and labour efficiency, these being sometimes even three times as great as elsewhere (Wasilewska A, Wasilewski M., 2007). Grontkowska (2008) found that labour efficiency on large farms in Poland depended in a crucial way on their legal form and varied even by 50%. A significant variation in labour efficiency also occurs within particular countries. Sobczynski (2009) stated that the average labour efficiency in agriculture among regions in Germany was over twice as great in some regions than in others. Similar findings for Poland were presented by J. Mikołajczyk (2011). Regardless of the production type, the greater the average size of the farm, the higher labour efficiency has been observed. From the point of view of work profitability, differences have been even greater because the system of subsidies for agriculture is based on output size rather than employment, and the largest farms are favoured despite modulation. Sobczynski (2009), discussing agriculture in Germany, has not observed any farms becoming similar to one another in labour efficiency (convergence). In Poland, labour

efficiency in agriculture was as low as 30% of the average for EU Member States. This resulted from a very large share of farms of economic size up to 8 ESU in Poland. In the groups of farms of the economic size over 8 ESU, it was 45-58% (Sobczynski T., 2010). In other studies, it has been found that economic efficiency of labour in farms in one period after another has not increased (Czekaj M., Zmija J., 2011; Koloszko-Chomentowska Z., 2011). One of the main reasons for such situation is the absence of changes in relations between labour resources and land resources. In Poland, in the years 2004-2009, the number of persons employed in agriculture did not decrease significantly with relation to land resources (Zieminska A., 2011).

The differences observed among the EU Member States with regard to labour productivity in agriculture and a relatively low growth rate of productivity was the reasons for undertaking this research.

The aim of the research is to assess changes in labour efficiency in agriculture of the EU Member States, including Poland. The following research tasks have been set: 1) to determine the level and rate of changes in labour productivity in agriculture in the EU Member States including Poland; and 2) to determine whether convergence processes occur in labour efficiency in agriculture among the EU Member States. It has been assumed that 1) convergence exists among the EU Member States with respect to labour efficiency in agriculture; and 2) the EU membership countries with a lower productivity level are characterised by higher productivity increases than the countries with an initial productivity level.

Data for research were taken from the EUROSTAT statistics. The following variables were used: total agricultural labour force input (aact\_ali01), value of agricultural production and services at producer prices, and constant prices from 2005 (aact\_eaa03). Data for the years 1998-2011 were used in the research.

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Table 1

**Productivity of labour in the EU countries and its change between 1998 and 2011**

Country	Productivity of labour in agriculture			Average annual growth	Relative growth between 1998 and 2011
	1998	2011	change		
	in '000 euro/AWU				
Belgium	65.84	115.08	49.24	4.3%	75%
Bulgaria	3.85	7.87	4.02	5.5%	105%
Czech Republic	17.31	32.11	14.79	4.8%	85%
Denmark	86.78	154.40	67.62	4.4%	78%
Germany	49.25	73.87	24.62	3.1%	50%
Estonia	6.25	20.49	14.24	9.1%	228%
Ireland	25.88	33.36	7.47	2.0%	29%
Greece	16.88	16.09	-0.78	-0.4%	-5%
Spain	29.63	43.29	13.66	2.9%	46%
France	51.37	64.23	12.86	1.7%	25%
Italy	27.42	34.31	6.89	1.7%	25%
Latvia	3.25	8.48	5.22	7.4%	161%
Lithuania	4.67	10.69	6.01	6.4%	129%
Luxembourg	67.99	78.47	10.48	1.1%	15%
Hungary	7.39	11.92	4.53	3.7%	61%
Netherlands	85.06	124.84	39.77	3.0%	47%
Austria	28.90	39.85	10.95	2.5%	38%
Poland	4.84	7.37	2.53	3.2%	52%
Portugal	9.18	14.47	5.29	3.5%	58%
Romania	3.15	6.61	3.46	5.7%	110%
Slovenia	8.03	11.81	3.79	3.0%	47%
Slovakia	9.19	16.46	7.27	4.5%	79%
Finland	19.76	35.08	15.32	4.4%	78%
Sweden	43.04	69.03	25.98	3.6%	60%
United Kingdom	54.44	70.55	16.11	2.0%	30%

Calculations based on constant prices of 2005

**Source:** *author's calculations based on the EUROSTAT data*

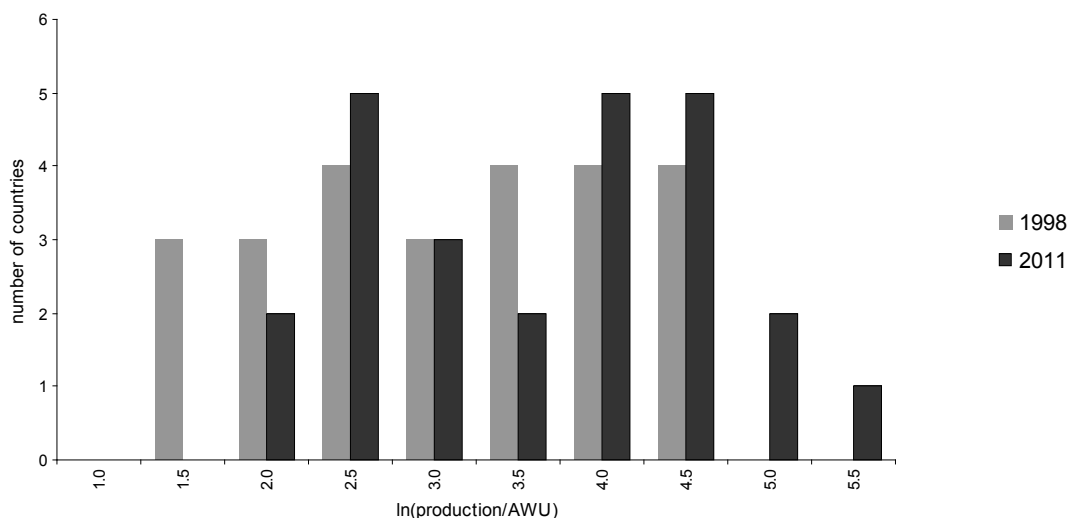
Labour productivity in agriculture has been determined using the indicator of work performed by one person occupied on a full-time basis (annual work unit, AWU). The rate of change has been defined as the average annual work productivity increase calculated according to the formula  $(\ln(Y_n/Y_0))/n$ , where 0 refers to 1998, and  $n = 13$  for 2011.

The coefficient of variation was used ( $v = \text{std.dev./avg.}$ ) to test sigma-convergence and the analysis of regression of the average work productivity growth rate depending on the initial level of labour productivity (in 1998) was used to test beta-convergence.

The term 'convergence' ('catch-up effect') most often refers to a relatively faster development of poorer countries (regions) as compared with richer ones, resulting in a smaller and smaller distance between the former and the latter. Two major concepts of convergence are found in the literature on the subject: sigma-convergence ( $\sigma$ -convergence) and beta-convergence ( $\beta$ -convergence). These terms were proposed by X.

Sala-i-Martin (1990) in his doctoral dissertation. The first occurs when dispersion (variation) of a phenomenon decreases in time across regions or countries, whereas beta-convergence refers to the relation between the average growth rate of a phenomenon and its initial level. Convergence is discussed in the literature in two variants — absolute and conditional. Absolute convergence assumes that countries (regions) become similar to one another regardless of their initial conditions, which means that less-developed countries (regions) develop faster than the developed ones and that the lower the initial level of the particular phenomenon, the faster the changes. Conditional convergence means that only countries with similar structural parameters begin to resemble one another. Conditional convergence has not been studied in the present work.

One can distinguish between two types of convergence in growth empirics:  $\sigma$ -convergence and  $\beta$ -convergence. When the dispersion of real value of some economic indicator (for example, income or



Source: author's calculations based on the EUROSTAT data

Fig. 1. The density distribution of countries according to the levels of labour productivity in 1998 and 2011

productivity) across a group of economies falls over time, there is  $\sigma$ -convergence. When the partial correlation between growth in income over time and its initial level is negative, there is  $\beta$ -convergence.

Beta-convergence is not a sufficient condition for  $\sigma$ -convergence. Quah (1993) and Friedman (1992) both suggest that  $\sigma$ -convergence should be of interest since it speaks directly as to whether the distribution of income across economies is becoming more equitable. Still,  $\beta$ -convergence remains a primary focus of economies convergence empirics, perhaps because, intuitively, it seems to be necessary for  $\sigma$ -convergence. Wide description how and why  $\beta$ -convergence is necessary for occurrence of  $\sigma$ -convergence can be found in Young, Higgins, and Levy (2004). They also conclude that  $\beta$ -convergence is necessary but not sufficient condition for the occurrence of  $\sigma$ -convergence.

### Research results and discussion

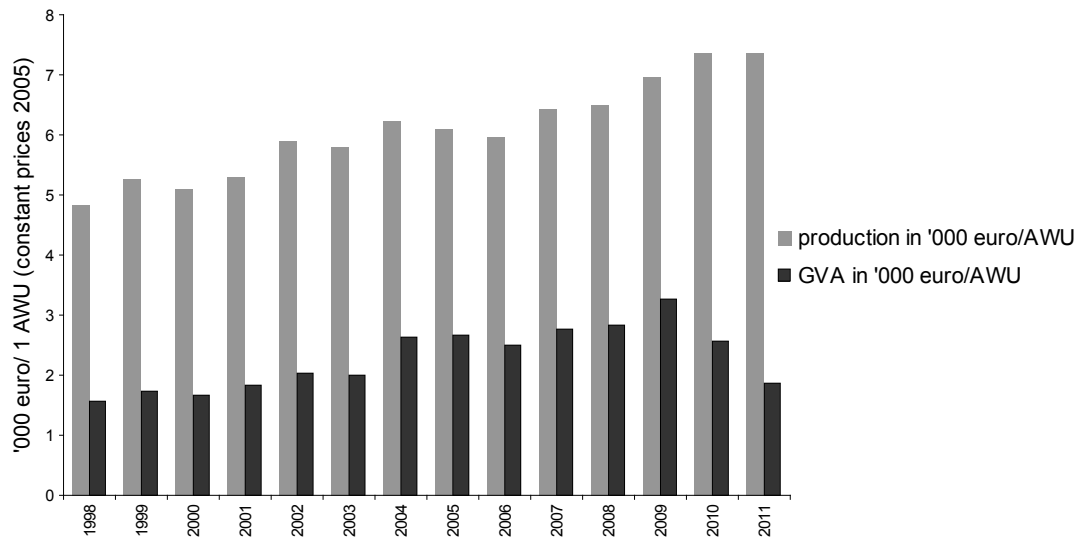
The average labour productivity level in the EU agriculture has grown from EUR 29 thousand/AWU to EUR 44 thousand/AWU in the years 1998-2011. This means that the annual average productivity has increased by 3.2%, and by 51% in the entire period under the analysis. The highest level of labour efficiency was observed in Denmark, Belgium, and the Netherlands, exceeding EUR 100 thousand/AWU (Table 1). The lowest level of labour efficiency was observed in the new Member States, such as Bulgaria, Latvia, Poland, and Rumania. Countries where the initial labour efficiency was high often showed further considerable increases of that efficiency. In absolute terms, the highest growth was observed in the countries where the labour efficiency was at the highest level (Denmark, the Netherlands, Belgium). In terms of the average growth rate, the fastest growth of labour efficiency occurred in Estonia, Latvia, Lithuania, and Bulgaria. In these countries, the growth rate was considerably higher than, for example, in Poland; in 2011, Latvia showed a higher level of labour

efficiency in agriculture than Poland, even though the reverse situation was observed in 1998. In countries with the highest annual average growth rate, the efficiency increased the most as compared with 1998.

Countries with low initial labour efficiency in agriculture developed relatively faster than those where high productivity was noted. The efficiency levels, however, were not observed to converge in the analysed period because the absolute growths were higher in the developed countries. This rather shows divergence, not convergence, with regard to the labour productivity level.

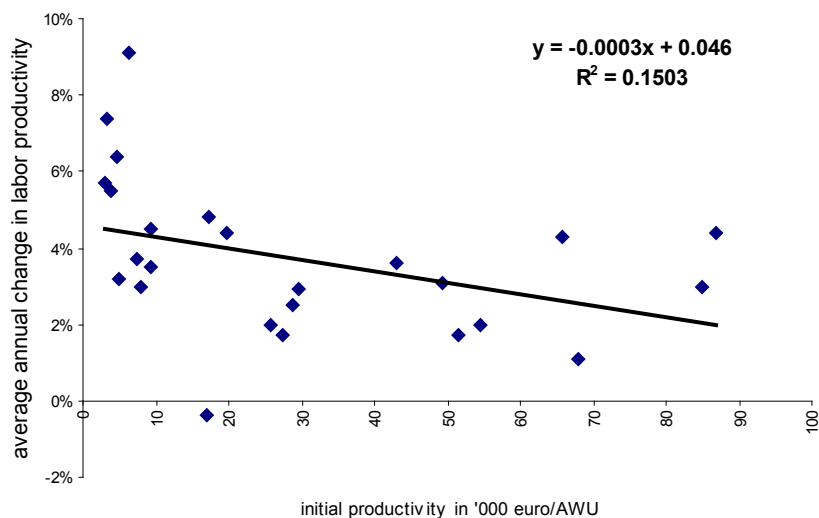
Figure 1 shows distribution of the number of countries by the level of labour productivity in agriculture in 1998 and 2011. On the vertical axis, a logarithmic scale was used as the indicator varied greatly. Bimodal distribution is used thereof. The distribution did not change in the years 1998-2011 but there was a shift toward higher values. In the first group in 2011, there are countries where the production per AWU was below EUR 20 thousand. This group includes all the new Member States, except for the Czech Republic, and two of the "old" Member States: Greece and Portugal. The second group includes the remaining EU countries, with labour productivity of EUR 60-90 thousand/AWU. In this group, three countries with the highest efficiency form a separate subgroup: Belgium, Denmark, and the Netherlands. Considering such distribution, at the next stages of the analysis, countries have been divided into two groups: "old" and "new" EU Member States. The most important factor that differentiates the labour productivity in agriculture in different countries seems to be the average size of farms and the related high level of employment. In Poland, the number of employees per 100 ha in 2010 was 14 AWU/100 ha, and, for example, in Germany or in France it was less than 4 AWU/100 ha. Further analysis of factors affecting labour productivity in agriculture has not been done in this study.

Changes in the labour productivity in agriculture in Poland have been presented separately for the years



Source: author's calculations based on the EUROSTAT data

Fig. 2. Changes in the labour productivity in Poland in 1998-2011



regression coefficient is not significant : p-value = 0.6239  $t_{0.05} = 2.0687$ ,  
 $t_{0.10} = 1.7139$   $t_{emp.} = -0.4969$

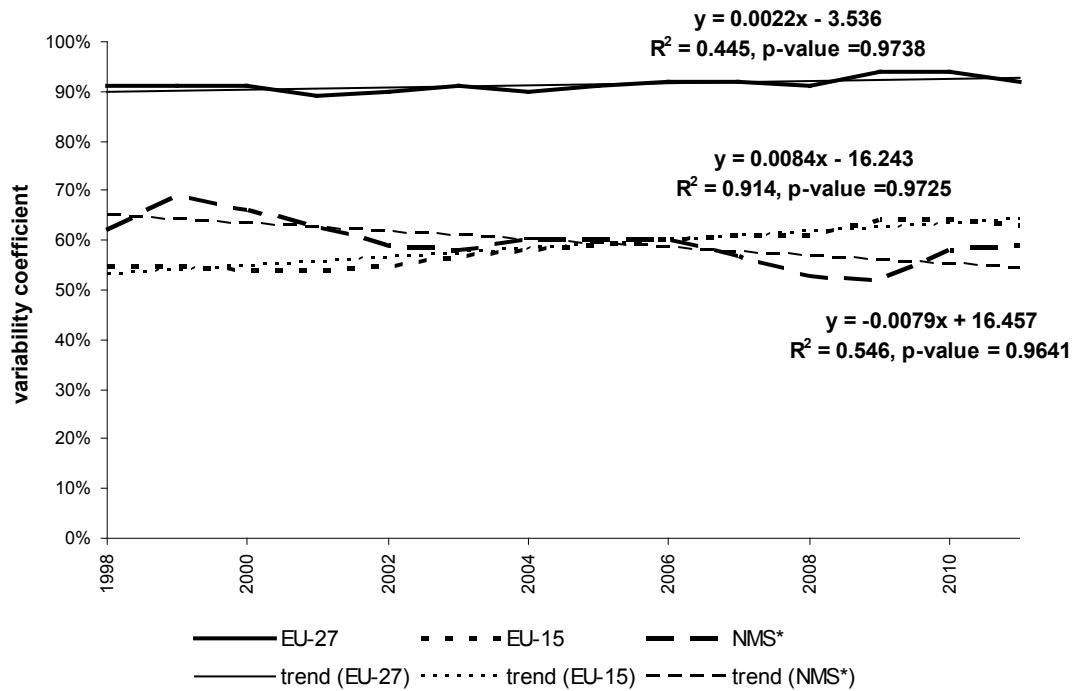
Source: author's calculations

Fig. 3. Beta-convergence analysis – dependence of the average change of labour productivity on the initial level of productivity

1998-2011. In that period, the productivity in agriculture grew by 54%, although labour efficiency measured by the GVA/AWU indicator increased by 19% only. This means that the efficiency increased slightly. If one wanted to find causes for such a situation, this would require a more detailed discussion. It may be only noticed that in the analysed period the number of persons employed in agriculture almost did not change, the average size of agricultural holdings did not change either. The most important factors that may contribute to increasing the labour efficiency in Poland seem to be greater production scale and mechanisation of production.

A detailed analysis of the factors influencing the rate of changes in labour productivity would be beyond the scope of the present study.

At the next stage of the analysis, it was determined whether there was a convergence in terms of labour productivity. Absolute convergence may be measured using regression. If countries with a lower initial level of labour productivity show actually a higher growth rate in respect of that productivity, then convergence takes place. Figure 2 shows the relation between the initial productivity level and the productivity growth rate. Countries with lower initial productivity level did have



\*NMS – New Member States

Source: author's calculations

Fig. 4. Analysis of  $\sigma$ -convergence based on the coefficient of variation of labour productivity in agriculture for the EU-27 Member States and EU-15, and NMS

higher growth rates; the connection, however, is tenuous and not statistically significant. This means that beta-convergence does not occur. In the countries with higher labour productivity level, this level increases faster than in the remaining countries. The causes of this phenomenon should be probably sought in structural factors in the agricultural systems of each country.

Figure 4 presents changes to coefficients of variation of labour productivity level in agriculture. This parameter was shown jointly for the 27 EU Member States as well as for groups of the countries. If the coefficient of variation goes down over time, this means that  $\sigma$ -convergence takes place.

Based on the presented results, it may be concluded that there is no sigma-convergence among the EU Member States with respect to labour productivity in agriculture. Regression slopes for the coefficient of variation are not statistically significant, which indicates a high level of p-value. The fact that the functions are well adjusted is proved as measured by  $R^2$  results from the absence of variation in time.

It is clear that clubs of countries are formed within which labour efficiency is similar. For new Member States, the coefficient of variation slightly decreased but remained on the level of 0.6. In the EU-15 group of the "old" Member States, the coefficient remained on a similar level – about 0.6; although, it was slightly on the increase. The total coefficient of variation for all the Member States was quite higher, amounting to 0.9.

The observed high level of the coefficient of variation for all the countries and lower for their groups means that the source of variation are differences in labour

productivity between the "old" and the "new" EU countries. Variation is lower inside each group.

The obtained results mean that there was no convergence in labour productivity in agriculture. There were large differences in this respect between the old and new Member States. Changes in the new Member States, even though higher growth rates are often observed, are lower in absolute terms than those in the old EU countries. One may only speak about a weak  $\sigma$ -convergence for the group of the new Member States.

Such a phenomenon may be caused by the lower average area of agricultural holdings. On smaller farms, labour resources are commonly not utilised completely. In the countries where agricultural holdings are relatively large, as in, for example, the Czech Republic, the observed labour productivity is close to the level found in Finland, Ireland, Spain, or Italy.

## Conclusions

Increased productivity of expenditures, including labour amount, is one of the most important factors of efficiency growth in agriculture in general. The paper compares the labour productivity level in agriculture in the EU Member States. It was found that there were very large differences, sometimes the level being ten times higher compared with another country, in labour productivity among the countries. The main dividing line is drawn between the old and the new Member States, which form two separate clusters differing with respect to the analysed variable. Only single countries from the new members, e.g. the Czech Republic, attain

labour productivity in agriculture on a level close to that observed in the old Member States, which have the lowest productivity indicator values.

Labour productivity increased in the majority of the analysed countries (except for Greece). Taking Poland as an example, one may conclude that this is a stable process which, however, does not have to lead to an increase in income per person due to an increase in costs of engaging other production factors than labour.

The conducted analysis of convergence in relation to the labour productivity level in agriculture in the EU Member States makes it possible to state that there is no convergence, in either absolute or relative terms. It is impossible to conclude that beta- or sigma-convergence exists. Nevertheless, examples of labour productivity growth rate being significantly higher than the average in such countries as Estonia, Latvia, Lithuania, or the Czech Republic, make it possible to state that wherever appropriate agricultural structures are found, a considerably higher growth rate may be achieved.

Based on the conducted analyses, one may conclude that labour productivity in agriculture is not converging in the EU Member States. This is a long-term process, because it requires restructuring the agricultural systems so that farms may increase their areas and it is connected with demographic processes of movement of labour from agriculture to other sectors of the economy. It is probable that convergence processes may be seen after considering data from longer periods.

Increasing labour productivity in agriculture will have to involve reduction in the number of agricultural workers, and consequently creating jobs outside agriculture as well as supporting non-agricultural activity in agricultural regions. As it happens quite often, problems of agriculture shall be solved outside agriculture.

Further researches should be directed towards identifying the main factors influencing the observed level of productivity, both positively and negatively.

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