# THE DEVELOPMENT OF AGRICULTURE IN POLAND IN THE YEARS 2004-2011 – THE TAXONOMIC AND ECONOMETRIC ANALYSES

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**Abstract:** The aim of the paper was to assess the regional differentiation of the level of agriculture and its changes over time. Based on the synthetic measure of development the rankings of regions (provinces) were created. The objects were also classified and divided into groups of a similar level of agriculture. In addition, in order to identify the long-term tendency in this sector of economy, the process of $\beta$-convergence of the level of agriculture has been studied. For the verification of hypotheses dynamic panel models were applied. All computations were performed in the Gretl, based on CSO data.

**Keywords**: regional differentiation, synthetic measure of development, $\beta$-convergence

## INTRODUCTION

Polish membership to the European Union, and thus the possibility to use EU funds have a significant impact on the development of Polish agriculture. Actions taken by farmers, due in part to the use of the Structural Funds have changed the nature of many farms. They cease to be only the source of income for the farmer and his family. More and more often, the farms become the enterprises that compete on the market of food producers. Implementation of new technologies, increasing the scale of production and the specialization are aimed to create a financial surplus to enable the further development of the farm.

Issues concerning the development of Polish agriculture and its regional differentiation, especially in the context of Polish accession to the European Union, have been widely discussed in the literature. These topics can be found in the works, among others, of Binderman [2010, 2012], Muszyńska [2009, 2010], and Szewczyk [2012].

The article presents the analysis of the level of agricultural development in Poland in the years 2004-2011. The study refers to private farms with area exceeding 1ha. The average farm in the province was adopted as the research unit.

For the purpose of the analysis, the synthetic measure of development was created. Its construction was based on the different aspects of agriculture. The economic size of the farm was one of the above mentioned characteristics. It is measured in PLN and determines production capacity of the farm, expressed as its potential income. Regional coefficients of standard output (SO), applied in the calculations, allowed to reflect local conditions, different for the four statistical regions in Poland.

The aim of the paper was to assess the regional differentiation of the level of agriculture and its changes over time. Based on the synthetic measure of development, constructed for each of the years of study, the rankings of regions (provinces) were created. The objects were also classified and divided into groups of a similar level of agriculture. In addition, the process of $\beta$-convergence of the level of agriculture has been studied. The validation of the hypothesis of the absolute $\beta$-convergence has allowed identifying the long-term tendency in this sector of economy. Based on the analysis of the conditional $\beta$-convergence, the article indicates the main determinants of development.

During the study, the authors applied taxonomic methods, widely discussed in the literature, inter alia, by Jajuga [1993] and Kolenda [2006]. In order to verify the hypotheses, which have been posed in the analysis, dynamic panel data models were used. The models were constructed and estimated according to the methods described in the literature, among others, by Baltagi [2005] and Dańska-Borsiak [2011]. All computations were performed in GRETL, using data available in the public statistics.

## THE TAXONOMIC ANALYSIS

The empirical study was based on data derived from the Local Data Bank and the statistical yearbooks, published by CSO. Availability of statistical data limited the scope of the analysis, both in space (provinces) and in time (years 2004-2011). It also enabled to take into account only some of the aspects of agricultural development[1]. The average in the province, private farm with an area exceeding 1 ha was the research unit. Diagnostic variables, used in the analysis were: economic

[1] Due to the lack of data, some of the characteristics were not taken into account, e.g. education level of farm owner, number of employees, the degree of mechanization of farms and others.

size of farm[2], agricultural land area of farm, level of investment in agriculture and fixed assets value.

The a.m. variables reflected the most important determinants of the development of agriculture. Production capacity of farm, structure and marketability of crops were described with the economic size of the farm. The other variables presented agricultural land area, the volume of investment in agricultural production and value of fixed assets of the farm.

All of the diagnostic variables were stimulants. They also met the postulate of maximum spatial differentiation. To ensure variable uniformity all of them were standardised before aggregation. Upon the value of the determinants Hellwig's measure of development was created. The measure was constructed in accordance with the formula:

$$d_i = 1 - \frac{c_{i0}}{\bar{c}_0 + 2s_0}, \tag{1}$$

where:

$c_{i0}$ – Euclidean distance[3] of the object *i* to the pattern[4],

$\bar{c}_0$ – average distance of the objects to the pattern,

$s_0$ – standard deviation of the distance.

Table 1 presents the value of the synthetic measure of development of agriculture ($d_i$), during the years 2004-2011.

As it can be seen in table 1, the values of the synthetic measure of development ($d_i$) for the best agricultural provinces were several times greater than the values of the weakest regions. This fact confirms the strong regional differentiation of the level of agriculture in Poland. Simultaneously, the low level of diversification of agriculture over time can be observed. During the analysed period, $d_i$ for most provinces remained at a similar level. For seven of sixteen regions, the synthetic measure of development did not exceed the value 0,5. In the whole period under investigation it remained at a low, almost constant level.

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[2] Economic size was calculated based on the regional coefficients of standard output (SO) and the data on major crops and acreage of basic animal husbandry. Details can be found in the paper of Müller-Frączek I., Muszyńska J. (2013) Regionalne zróżnicowanie wielkości ekonomicznej indywidualnych gospodarstw rolnych w Polsce, The Annals of The Polish Association of Agricultural and Agribusiness Economists, volume XV, no. 4.

[3] Euclidean distance was calculated according to the formula: $c_{i0} = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_{0j})^2}$

where: $z_{ij}$ – the standardised value of variable *j* for the object *i*, $z_{0j}$ – the standardised value of variable *j* for the pattern.

[4] Pattern – a hypothetical object with the best values of all diagnostic variables (in case of stimulants – maximum values).

Table 1. The value of synthetic measure of development of agriculture

| year / province | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|
| dolnośląskie | 0,52 | 0,50 | 0,48 | 0,50 | 0,52 | 0,54 | 0,52 | 0,56 |
| kujawsko-pomorskie | 0,67 | 0,62 | 0,62 | 0,61 | 0,70 | 0,71 | 0,69 | 0,68 |
| lubelskie | 0,30 | 0,27 | 0,26 | 0,26 | 0,28 | 0,29 | 0,27 | 0,26 |
| lubuskie | 0,51 | 0,55 | 0,60 | 0,49 | 0,61 | 0,61 | 0,67 | 0,68 |
| łódzkie | 0,34 | 0,33 | 0,31 | 0,32 | 0,33 | 0,33 | 0,33 | 0,32 |
| małopolskie | 0,12 | 0,13 | 0,13 | 0,13 | 0,14 | 0,13 | 0,15 | 0,13 |
| mazowieckie | 0,37 | 0,34 | 0,34 | 0,35 | 0,38 | 0,37 | 0,37 | 0,41 |
| opolskie | 0,68 | 0,61 | 0,63 | 0,65 | 0,62 | 0,69 | 0,76 | 0,84 |
| podkarpackie | 0,12 | 0,14 | 0,13 | 0,14 | 0,14 | 0,13 | 0,14 | 0,14 |
| podlaskie | 0,56 | 0,51 | 0,52 | 0,52 | 0,56 | 0,59 | 0,56 | 0,52 |
| pomorskie | 0,69 | 0,62 | 0,62 | 0,64 | 0,73 | 0,70 | 0,66 | 0,77 |
| śląskie | 0,22 | 0,21 | 0,24 | 0,25 | 0,26 | 0,26 | 0,23 | 0,23 |
| świętokrzyskie | 0,25 | 0,21 | 0,21 | 0,20 | 0,21 | 0,21 | 0,20 | 0,21 |
| warmińsko-mazurskie | 0,98 | 0,87 | 0,85 | 0,84 | 0,94 | 0,94 | 0,88 | 0,80 |
| wielkopolskie | 0,74 | 0,68 | 0,67 | 0,70 | 0,75 | 0,73 | 0,72 | 0,77 |
| zachodniopomorskie | 0,74 | 0,87 | 0,87 | 0,89 | 0,87 | 0,87 | 0,86 | 0,82 |

Source: own calculations based on CSO data

Based on the values of the synthetic measure of development rankings of the provinces were constructed. The results are shown in table 2.

Table 2. The rankings of the provinces

| year / province | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|
| warmińsko-mazurskie | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 3 |
| wielkopolskie | 2 | 3 | 3 | 3 | 3 | 3 | 4 | 5 |
| zachodniopomorskie | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| pomorskie | 4 | 4 | 6 | 5 | 4 | 5 | 7 | 4 |
| opolskie | 5 | 6 | 4 | 4 | 6 | 6 | 3 | 1 |
| kujawsko-pomorskie | 6 | 5 | 5 | 6 | 5 | 4 | 5 | 7 |
| podlaskie | 7 | 8 | 8 | 7 | 8 | 8 | 8 | 9 |
| dolnośląskie | 8 | 9 | 9 | 8 | 9 | 9 | 9 | 8 |
| lubuskie | 9 | 7 | 7 | 9 | 7 | 7 | 6 | 6 |
| mazowieckie | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| łódzkie | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| lubelskie | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| świętokrzyskie | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| śląskie | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |
| małopolskie | 15 | 16 | 15 | 16 | 15 | 15 | 15 | 16 |
| podkarpackie | 16 | 15 | 16 | 15 | 16 | 16 | 16 | 15 |

Source: own calculations based on CSO data

Compatibility of the results of the following years was assessed using Kendall's coefficient of concordance *W*, expressed by formula:

$$W = 12 \cdot \frac{N\left(\sum_{i=1}^{N} T_i^2\right) - \left(\sum_{i=1}^{N} T_i\right)^2}{m^2 (N^4 - N^2)}, \qquad (2)$$

where:

- $N$ – sample size,
- $m$ – number of rankings,
- $T_i$ – the sum of all ranks of the object $i$ .

The Kendall's coefficient yielded an observed $W$=0,975. Very high and statistically significant value of the coefficient has proved the compatibility of the rankings in the considered period.

The next step of the taxonomic analysis was to classify the regions and divide them into four groups with the same level of agricultural development. The classification was carried out using two methods: the standard deviation and maximum gradient. The results of clustering (see table 3) were very similar for both methods. In most cases, the region was assigned into the same group or a neighboring group.

We can distinguish three groups of provinces, for which the results of clustering were consistent in the whole period of the study:

- the best agricultural regions (group I) – provinces: warmińsko-mazurskie and zachodniopomorskie,
- average level of agricultural development (group II or I) – provinces: kujawsko-pomorskie, opolskie, pomorskie, wielkopolskie,
- the weakest agricultural regions (group IV) – provinces: małopolskie and podkarpackie.

For the remaining eight regions the results were not so unequivocal.

Table 3. The results of the clustering

<table>
<tr><th>year / province</th><th>clustering method</th><th>2004</th><th>2005</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th></tr>
<tr><td rowspan="2">dolnośląskie</td><td>*</td><td>II</td><td rowspan="2">II</td><td>II</td><td>II</td><td>II</td><td rowspan="2">II</td><td>II</td><td rowspan="2">II</td></tr>
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<tr><td rowspan="2">podkarpackie</td><td>*</td><td rowspan="2">IV</td><td rowspan="2">IV</td><td rowspan="2">IV</td><td rowspan="2">IV</td><td rowspan="2">IV</td><td rowspan="2">IV</td><td rowspan="2">IV</td><td rowspan="2">IV</td></tr>
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* - standard deviation method, ** - maximum gradient method

Source: own calculations based on CSO data

## THE ECONOMETRIC ANALYSIS

The next stage of research concerned the future of agriculture in Poland. Its aim was to assess the convergence of the level of agricultural development of private farms. The average in the province, private farm with an area exceeding 1 ha remained the research unit. The agricultural development was defined by the synthetic measure $d_i$, as it was described in the previous section. Analysis was based on a dynamic panel data model[5]:

$$\ln \frac{Y_{i,t}}{Y_{i,t-1}} = \alpha - \beta \ln Y_{i,t-1} + \eta_i + u_{it}, \tag{3}$$

where:
- $Y$ – the level of development,
- $i$ – the number of the region, $i = 1, ..., N$,
- $t$ – number of period $t = 1, ..., T$,
- $\eta_i$ – group effects,
- $u_{it}$ – error term.

The phenomenon of unconditional $\beta$-convergence of the process $Y$ occurs when the parameter $\beta$, in equation (3) is a positive value. It proves there is a constant over time, negative correlation between the level of the process and its growth rate. The existence of unconditional $\beta$-convergence means that the regions with initially lower level of the investigated process will catch up the better developed provinces. The speed of convergence to equilibrium (the rate of catching up) can be calculated according to the formula:

$$\lambda = -\ln(1-\beta). \tag{4}$$

In order to estimate parameters the dynamic panel data model, described by the equation (3), was transformed to the model:

$$y_{i,t} = \alpha + (1-\beta) y_{i,t-1} + \eta_i + u_{it}, \tag{5}$$

where: $y_{i,t} = \ln Y_{i,t}$.

Based on the values contained in table no 1, the empirical model of unconditional $\beta$-convergence was estimated. It took the following form:

$$\hat{y}_{i,t} = -0{,}083 + (1 - \underset{(\pm 0{,}061)}{0{,}104}) y_{i,t-1}, \tag{6}$$

Model parameters were estimated using the Blundell and Bond System Generalized Method of Moments Estimator (GMM-sys). The correctness of the estimated model was verified using the Arellano-Bond test for autocorrelation and the Sargan test of over-identifying restrictions. The estimation methods of dynamic panel data

[5] Static approach was unfeasible because of insufficient number of observations.

models and the statistical tests mentioned above are widely described in the literature, inter alia, by Ciołek [2004] and Dańska-Borsiak [2011].

The Sargan test checks if over-identifying restrictions omitted from the estimation process were correct. The null hypothesis of the test states that the applied instruments are correct in the sense of their being uncorrelated with the error terms of the first difference model. The Arellano-Bond test verifies the assumption regarding autocorrelation of the model error term. The model is properly specified (the GMM method provides consistent estimator) if there is no arguments for rejecting the null hypothesis about the absence of the second-order autocorrelation of the first difference model error term. Existence of the first-order autocorrelation is an expected phenomenon, resulting from the model construction.

Table 4. The test results for models described by equations (6) and (9)*

| test | model (6) | | model (9) | |
|---|---|---|---|---|
| | value of the test statistics | p-value | value of the test statistics | p-value |
| AR(1) | -1,741 | 0,081 | -1,881 | 0,060 |
| AR(2) | 0,675 | 0,500 | 0,214 | 0,831 |
| Sargan | 14,943 | 0,958 | 14,979 | 0,958 |
| Wald | 218,638 | 0,000 | 11357,900 | 0,000 |

*-verification was conducted at 10% level of significance

Source: own computations performed in GRETL

The tests results are compiled in table no 4. All the tests confirmed the proper specification of the models. For both models, the Sargan test gave no arguments for rejecting the null hypotheses. The instruments applied during the estimation process were not correlated with the error terms of the models. Also the Arellano-Bond test, used to verify the assumption about the absence of the second-order autocorrelation, provided no grounds for rejecting the null hypotheses. That means there was no the second-order autocorrelation of error terms in both models. Significance of the parameter estimates was proved using the Wald test.

A positive value of the coefficient $\beta$=0,104 in the model (6) positively verified the hypothesis regarding the existence of $\beta$-convergence process of the level of agricultural development of private farms in Poland. The rate of convergence was estimated at $\lambda$=11% and the time to cover halfway to the common equilibrium point were about 6,3 years[6].

The existence of $\beta$-convergence of the level of agricultural development has imposed the question of the conditions of this phenomenon. The next step in the analysis was therefore to test the conditional $\beta$-convergence, which takes into account the effect of other factors on the growth rate of the investigated process. This study was designed to not only confirm the impact of factors on convergence,

[6] The time was calculated according to the formula: $t = -\ln(0{,}5) / \lambda$.

in other words, to demonstrate the existence of conditional convergence. Its aim was to assess the strength of this effect. The speed of the conditional convergence was applied as the research tool.

The study of the conditional $\beta$-convergence was based on a model:

$$\ln \frac{Y_{i,t}}{Y_{i,t-1}} = \alpha - \beta \ln Y_{i,t-1} + \gamma \ln X_{it} + \eta_i + u_{it}, \quad (7)$$

where $X$ is an explanatory variable (a factor that affects the process of the study).

Same as before, the conditional convergence occurs when the parameter $\beta$ is positive, so there is a negative correlation between the process and its rate of growth. The rate of convergence can be estimated in accordance with the formula (4). However, this rate is determined by the strong assumption that the conditions affecting the growth rate of the process $Y$, in other words, the process $X$ are the same for all regions.

For the purpose of the estimation equation (7) is converted to the form:

$$y_{i,t} = \alpha + (1-\beta) y_{i,t-1} + \gamma x_{it} + \eta_i + u_{it}, \quad (8)$$

where: $y_{i,t} = \ln Y_{i,t}$ and $x_{i,t} = \ln X_{i,t}$.

The empirical model of conditional $\beta$-convergence[7], with the investments in agriculture as an explanatory variable took the form:

$$\hat{y}_{i,t} = -1{,}271 + \underset{(\pm 0{,}037)}{(1-0{,}147)} y_{i,t-1} + \underset{(\pm 0{,}035)}{0{,}150}\ x_{it}, \quad (9)$$

where $y_{i,t}$ is the logarithm of the measure of development, and $x_{i,t}$ the logarithm of investments in agriculture of the average farm in the region $i$ and year $t$.

A positive value of the coefficient $\beta$=0,147 in model (9) positively verified hypothesis regarding the existence of the conditional $\beta$-convergence with the investment in agriculture as a variable determining the phenomenon. The rate of convergence, assuming that the average investments in all the provinces is the same, was estimated at $\lambda$=15.9%. In comparison to the unconditional convergence the rate grew by 4,9%. Thus, by changing the level of investment in agriculture, the region would cover half the distance to the point of equilibrium in about 4 years.

The econometric analysis confirmed that it is possible to even out the average level of agricultural development of private farms in all regions in Poland. In addition it has indicated investments as a factor strongly influencing this phenomenon.

[7] For tests results see table 4.

## SUMMARY AND CONCLUSIONS:

The study, described in the article, did not cover all aspects of agricultural development. It was an attempt to assess the regional differentiation of this phenomenon. However, in spite of its simplicity, the synthetic measure of development, presented in the paper, seemed to characterise the level of agriculture in Poland properly. The analyses performed on the basis of this measure provided reliable results both in terms of content and statistics.

The survey showed a strong regional diversification in the level of the agricultural development and simultaneously a slight differentiation of this phenomenon in time. The econometric analysis confirmed the possibility of levelling of the agricultural development of private farms. In addition, the study has indicated investment as a key factor in this process.

Because of the short period of the study and incomplete statistical information the analysis did not cover many aspects of agriculture. Therefore, the next step will be to extend the synthetic measure of development using wider range of diagnostic variables.

## REFERENCES:

Baltagi B.H. (2005) Econometric Analysis of Panel Data, John Wiley & Sons, Ltd., Chichester.

Binderman A. (2010) Wpływ sposobu normalizacji zmiennych na ocenę regionalnego zróżnicowania rolnictwa, Quantitative Methods in Economics, volume XI, no.2.

Binderman A. (2012) Rozwój polskiego rolnictwa w kontekście regionalnego zróżnicowania w latach 1998-2010, Quantitative Methods in Economics, volume XIII, no.3.

Ciołek D. (2004) Konwergencja krajów w okresie transformacji do Unii Europejskiej, the doctors thesis, Uniwersytet Gdański, Gdańsk.

Dańska-Borsiak B. (2011) Dynamiczne modele panelowe w badaniach ekonomicznych, Wydawnictwo Uniwersytetu Łódzkiego, Łódź.

Goraj L., Bocian M., Cholewa I., Nachtman G., Tarasiuk R. (2012) Współczynniki Standardowej Produkcji "2007" dla celów Wspólnotowej Typologii Gospodarstw Rolnych, IERiGŻ PIB, Warszawa.

Hellwig Z. (1968) Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom rozwoju oraz zasoby i strukturę wykwalifikowanych kadr, Przegląd Statystyczny, no. 4.

Jajuga K (1993) Statystyczna analiza wielowymiarowa, PWN, Warszawa.

Kolenda M. (2006) Taksonomia numeryczna. Klasyfikacja, porządkowanie i analiza obiektów wielocechowych, Wydawnictwo Akademii Ekonomicznej we Wrocławiu, Wrocław.

Muszyńska J.(2009) Regionalne zróżnicowanie rolnictwa w Polsce w roku 2007, The Annals of The Polish Association of Agricultural and Agribusiness Economists, volume XI, no. 4.

Muszyńska J.(2010) Zmiany regionalnego zróżnicowania poziomu rolnictwa w Polsce, The Annals of The Polish Association of Agricultural and Agribusiness Economists, volume XII, no. 1.
Müller-Frączek I., Muszyńska J. (2013) Regionalne zróżnicowanie wielkości ekonomicznej indywidualnych gospodarstw rolnych w Polsce, The Annals of The Polish Association of Agricultural and Agribusiness Economists, volume XV, no. 4.
Szewczyk J. (2012) Miara zróżnicowania wyposażenia gospodarstw rolnych w techniczne środki produkcji, Quantitative Methods in Economics, volume XIII, no.1.
http://www.fadn.pl
http://www.stat.gov.pl/bank danych lokalnych

## BADANIE ROZWOJU ROLNICTWA W POLSCE W LATACH 2004-2011 – ANALIZA TAKSONOMICZNA I EKONOMETRYCZNA

**Streszczenie:** Celem artykułu była ocena regionalnego zróżnicowania poziomu rolnictwa oraz jego zmian w czasie. Dla kolejnych okresów badania ustalono rankingi województw oraz dokonano ich klasyfikacji. Ponadto badano proces $\beta$-konwergencji poziomu rozwoju rolnictwa. Weryfikacja hipotezy o zachodzeniu konwergencji absolutnej pozwoliła na identyfikację długoterminowych tendencji w tym dziale gospodarki. W oparciu o analizę konwergencji warunkowej wskazano główne determinanty rozwoju. Do weryfikacji postawionych hipotez wykorzystano dynamiczne modele panelowe. Obliczenia przeprowadzono w programie GRETL.

**Słowa kluczowe:** zróżnicowanie regionalne, syntetyczny miernik rozwoju, $\beta$-konwergencja