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## **SPECIALIZATION AND COMPETITIVENESS OF POLISH VOIVODSHIPS IN CROP PRODUCTION IN POLAND**

**Summary:** The objective of the present paper is to classify Polish voivodships regarding specialization and competitiveness of crop production in the sectors of wheat, rye and oats. Crop production structure in the sectors grouped based on type of crop in the period of 2004-2014 was the subject of the analysis. The analysis was based on structural and geographical shift-share analysis which enabled a classification of Polish voivodships regarding crop production changes effects and also an assessment of crop production structures related to the reference space, i.e. regional area of the Polish voivodships. The performed research also allowed for the identification of crop production structures characterized by specialization and competitiveness in wheat, rye and oats.

**Keywords:** shift-share analysis, specialization, competitiveness.

### **Introduction**

Agriculture, as one of the few sectors of the economy, is heavily dependent on weather conditions. We need to keep in mind that by using appropriate methods of production we can improve the efficiency of agricultural production. External environment can also have high impact on the changes taking place in agriculture, in particular shaped by the Common Agricultural Policy (CAP), the findings of the World Trade Organization (WTO) and the behavior of markets (commodity, product and capital) [Kopiński, 2014]. Cereal production is one of the main directions of agricultural production in Poland. The share of cereals in the value of agricultural output in the period 2008-2012 was 20%, while the value of commercial agricultural production – 15%. In the structure of grain

crops account for nearly 74% of the total area of the national crop. Popularity growing crops due to the climate and soil conditions, with a relatively simple production technology, relatively low labor intensity, ease of storage, transportation and sales [Rynek zbóż..., 2013].

Today's economic conditions related to the operation and regional development within the European Union make it necessary to take on new diagnostic tests for the prospects of economic development of regions [Rozpędowska-Matraszek, 2010]. In this study, one of the spatial methods was used to diagnose spatial dynamics of changes: shift share analysis. The main aim of this work was to analyze changes in the volume of crop production (cereals) in the Polish voivodships in the years 2004-2014 by species (wheat, rye, oats) using the shift share method. The study assesses the pace of change in the size of the phenomenon.

## 1. The concept of shift-share analysis

Methods and models of shift share analysis (*Shift-Share Analysis* – SSA, *Spatial Shift-Share Analysis* – SSSA) belong to the group of structural and geographical analyzes [Ekonometria przestrzenna, 2010; Szewczyk, Łobos, 2011]. Perloff, Dunn, Lampard and Muth [1960] were the first who describe classic shift-share analysis. This method was modified since the 60s of the XIX century, the spatial factor was included to the research. Doing research the spatial distribution/intensity/changes in the level of the studied phenomenon the fact that each unit/region/country does not exist as a separate geographic area must be taken into consideration. The development of many phenomena depends on the spatial interaction with neighbouring areas. Observing the spatial relationship and interaction we should remember the first law of geography (spatial econometrics) formulated in 1970 by W. Tobler: “Everything is related to everything else, but near things are more related than distant things” [Tobler, 1970; Ekonometria przestrzenna, 2010].

The basis of spatial shift-share analysis in (SSSA) is the classic method of shift-share analysis (SSA).

SSA method allows testing and assess the level of development of the region (province) on the background the level of development of the reference area (country). Changes of regional growth of the analyzed phenomena are assessed in the context of the analysis of changes in the structure of phenomena [Antczak, 2014; Grzybowska, 2013; Mayor, Lopez, 2008].

The variable TX quantified in the form of a complex of absolute growth or the rate of change is tested in the classic shift-share analysis [Trzpiot i in., 2013; *Ekonometria przestrzenna*, 2010; Szewczyk, Tłuczak, Ruszczak, 2011]. The use in research the shift share analysis is based on the decomposition of the total change in the variable for the three components [Szewczyk, Zygmunt, 2011a]:

$$tx_{ri} = tx_{..} + \sum_i w_{r,(i)}(tx_{.i} - tx_{..}) + \sum_i w_{r,(i)}(tx_{ri} - tx_{.i}) \quad (1)$$

where:

$$m = tx_{..} = \frac{\sum_{r=1}^R \sum_{i=1}^S (x_{ri}^* - x_{ri})}{\sum_{r=1}^R \sum_{i=1}^S x_{ri}} - \text{national (global) share effect;}$$

$$e_i = tx_{.i} - tx_{..} = \frac{\sum_{r=1}^R (x_{ri}^* - x_{ri})}{\sum_{r=1}^R x_{ri}} - \frac{\sum_{r=1}^R \sum_{i=1}^S (x_{ri}^* - x_{ri})}{\sum_{r=1}^R \sum_{i=1}^S x_{ri}} - \text{structural share effect;}$$

$$u_{ri} = tx_{ri} - tx_{.i} = \frac{x_{ri}^* - x_{ri}}{x_{ri}} - \frac{\sum_{r=1}^R (x_{ri}^* - x_{ri})}{\sum_{r=1}^R x_{ri}} - \text{regional competitiveness share effect;}$$

$$w_{r,(i)} = \frac{x_{ri}}{x_{r..}} - \text{regional weight;}$$

$x_{ri}$  – the value of the variable in the  $r$ -th region of the  $i$ -th group of the cross-sectional distribution of the initial period;

$x_{ri}^*$  – the value of the variable in the  $r$ -th region of the  $i$ -th group of the cross-sectional distribution of the final period.

Transforming the equation (1) to formula [Szewczyk, Zygmunt, 2011b]:

$$tx_{ri} - tx_{..} = \sum_i w_{r,(i)}(tx_{.i} - tx_{..}) + \sum_i w_{r,(i)}(tx_{ri} - tx_{.i}) \quad (2)$$

we received the regional growth ( $tx_{ri} - t_{..}$ ) defined as the difference between regional and national growth rate. The relation described by equation (2) is called structural and geographical equation where geographic diversity of the regional average growth rate is decomposed into two effects:

– structural:  $s_r = \sum_i w_{r,(i)}(tx_{.i} - tx_{..})$  – which is the weighted arithmetic mean deviations of the average tempos of growth in the sector and the growth rate of national and indicates that the regions are differentiated by variations in the location;

– geographical:  $g_r = \sum_i w_{r,(i)}(tx_{ri} - tx_{.i})$  – which is the weighted arithmetic mean deviations of the regional growth rates from the regional average growth rate and indicates that the regions are differentiated by variations in the location;

- regional:  $g_r = \sum_i w_{r,(i)} (tx_{ri} - tx_{.i})$  – defined as the weighted arithmetic mean of regional variations prescribing categories of cross-cutting qualitative criterion to the respective regions.

The classic attitude in shift-share analysis does not take into account the spatial relationships, so the tested objects are treated individually as unrelated in any way areas. In 2004 Nazara and Hewings proposed to introduce to the equation (1) a spatial weight matrix:

$$tx_{ri} - tx_{..} = \sum_i w_{r,(i)} (Wtx_{.i} - tx_{..}) + \sum_i w_{r,(i)} (tx_{ri} - Wtx_{.i}) \quad (3)$$

where:

$W$  – standardized spatial weights matrix<sup>1</sup>.

Presented by equation (3) spatial structural and geographical equality developed in their research Marquez and Ramajo [2007]. They connected classic decomposition with the full spatial decomposition of the analyzed variable growth rates. After aggregating the results according to the formula of weighted average effects of structural and geographic equality (3) takes the form:

$$tx_{ri} - tx_{..} = \sum_i e_i w_{r,(i)} + \sum_i u_{ri} w_{r,(i)} + \sum_i w_{r,(i)} NLE_{ri} + \sum_i w_{r,(i)} LSE_{ri} + \sum_i w_{r,(i)} LDE_{ri} \quad (4)$$

where:

$e_i$  – national structural effect;

$u_{ri}$  – regional-national effect;

$NLE_{ri} = (Wtx_r - tx_{ri})$  – net local effect; it means that the growth rate of neighboring regions may lead to additional adjustment of individual regional effect;

$LSE_{ri} = (Wtx_i - Wtx_r)$  – local structural effect; it means a correction of growth in the various sectors under the influence growth rates in neighboring regions;

$LDE_{ri} = (tx_{ri} - Wtx_i)$  – local effect of diversity means the existence of specific dynamics of changes in activity in specific sectors of the  $r$ -region compared with the dynamics of sectoral change in neighboring regions.

<sup>1</sup> In this research a nearest neighbor binary borders matrix was considered.

## 2. Shift-share analysis of crop production in Poland

The subject of the research is agriculture production structure by types of cereals: wheat, rye, oats. The adopted time series of conducted research covers the period 2004-2014. The analysis covers 16 Polish voivodships. The necessary statistical information was obtained from the Polish Central Statistical Office database. Structural and geographic agriculture production analysis was conducted in voivodships by using classical and dynamic shift-share analysis and the Esteban-Marquillas model using allocation effect [Barff, Knight, 1988; Dunn, 1960; Esteban-Marquillas, 1972; Perloff et al., 1960; *Ekonometria przestrzenna*, 2010]. Shift-share analysis represents a research tool that allows determining the rate of changes related to total agriculture production in each Polish voivodship at the background of reference area, i.e. the Poland area.

Shift-share analysis of agriculture production in the Polish voivodships allowed for specifying structural and competitiveness changes of the size and type of crop changes grouped according to the types of cereals by positive and negative change effects values, as well as by specialization and competitiveness – the components of allocation effects.

The assessment of regional specialization and competitiveness in economy sectors requires specifying a reference structure, i.e. the one constituting the required reference basis. In the discussed framework this role will be played by plant agriculture production in the space of 16 Polish voivodships.

The information provided in Table 1 indicates that in Polish voivodships in the period 2004-2014, the largest average crop production share was definitely observed for the wheat, two other cereal types presented the same share in crop production. The changes occurring in the course of ten analyzed years were insignificant, which seems natural, since economic structures are most frequently characterized by slow and evolutionary type of changes over time.

**Table 1.** Crop agriculture production structure in Polish voivodships in the period 2004-2014 (in %)

Year	Wheat	Rye	Oats
2004	42	29	29
2014	43	29	28

Source: Author's own compilation based on CSO database.

Table 2 presents the effects of crop production structure changes which allow identifying the economy sectors exerting key impacts on the Polish voivodships' economic growth in the period 2004-2014. Net structural effects were defined by means of decreasing gross effects in terms of agriculture production growth

rate in Poland. Wheat production changes in 2014 resulted in higher crop production in all Polish voivodships, by 17.55% on average. The growth rate of oats production in 2014 influenced the slight growth of crop production size (1.97%). The largest crop production rate occurred in rye production sector (-34.76%).

**Table 2.** Results of classic shift-share analysis with regard to the effects of crop production changes in the sectors grouped according to types of crop

Effects of crop production changes in Polish voivodship (in %)		2014/2004
Total effect (growth rate of crop production in Poland)		1.77
Net structural effect	Wheat	17.55
	Rye	-34.76
	Oats	1.97

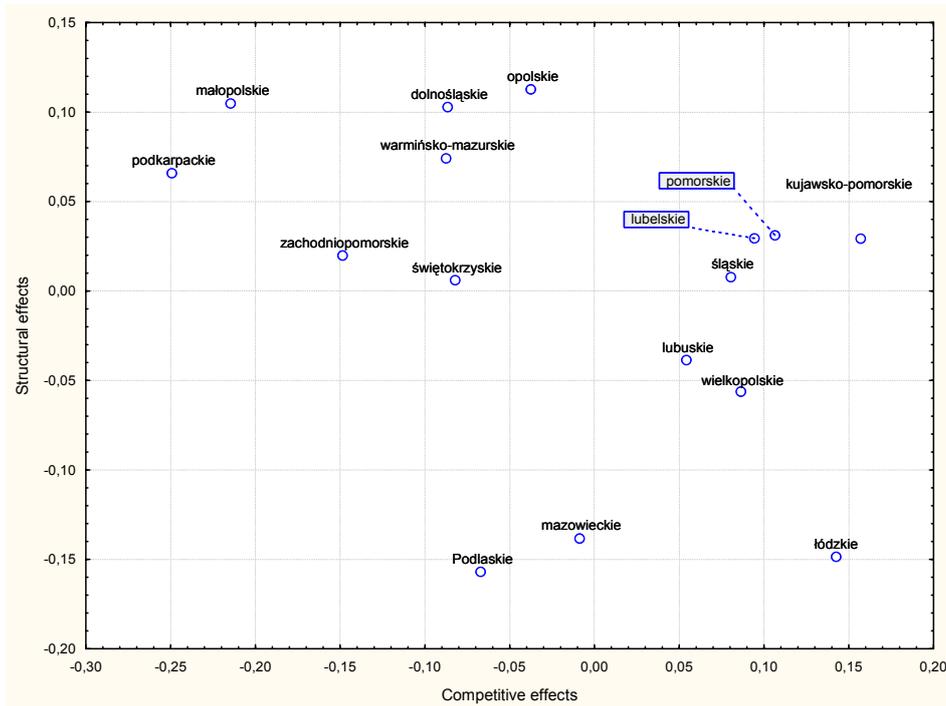
Source: Author's own compilation based on CSO database.

**Table 3.** Classification of Polish voivodships by positive and negative aggregated effects values: structural and competitive (dynamic shift-share analysis 2014/2004)

Criterion of division	Voivodships	Number of voivodships
Effects: structural (+) competitive (+)	śląskie, lubelskie, kujawsko-pomorskie, pomorskie	4
Effects: structural (+) competitive (-)	małopolskie, podkarpackie, świętokrzyskie, zachodniopomorskie, dolnośląskie, opolskie, warmińsko-mazurskie	7
Effects: structural (-) competitive (+)	łódzkie, lubuskie, wielkopolskie	3
Effects: structural (-) competitive (-)	mazowieckie, podlaskie	2

Source: Author's own compilation based on CSO database.

Table 3 and Figure 1 illustrate the classification of Polish voivodships with regard to aggregated structural and competitive effects. The first class covered those voivodships in which sectoral crop production structure has a positive impact on agriculture production rate growth and economic sectors are characterized by higher dynamics of crop production size fluctuations compared to other regions. This group includes four voivodships. In this class kujawsko-pomorskie stands out as characterized by very strong positive effects, both structural and competitive ones, definitely higher than in the other voivodships covered by this class. The second class characterized by a positive value only of the structural factor lists seven voivodships. The most favorable changes in agriculture production structure observed in this class in the analyzed period occurred in opolskie. This region was characterized by the highest structural effects and by slight, negative competitive effects.

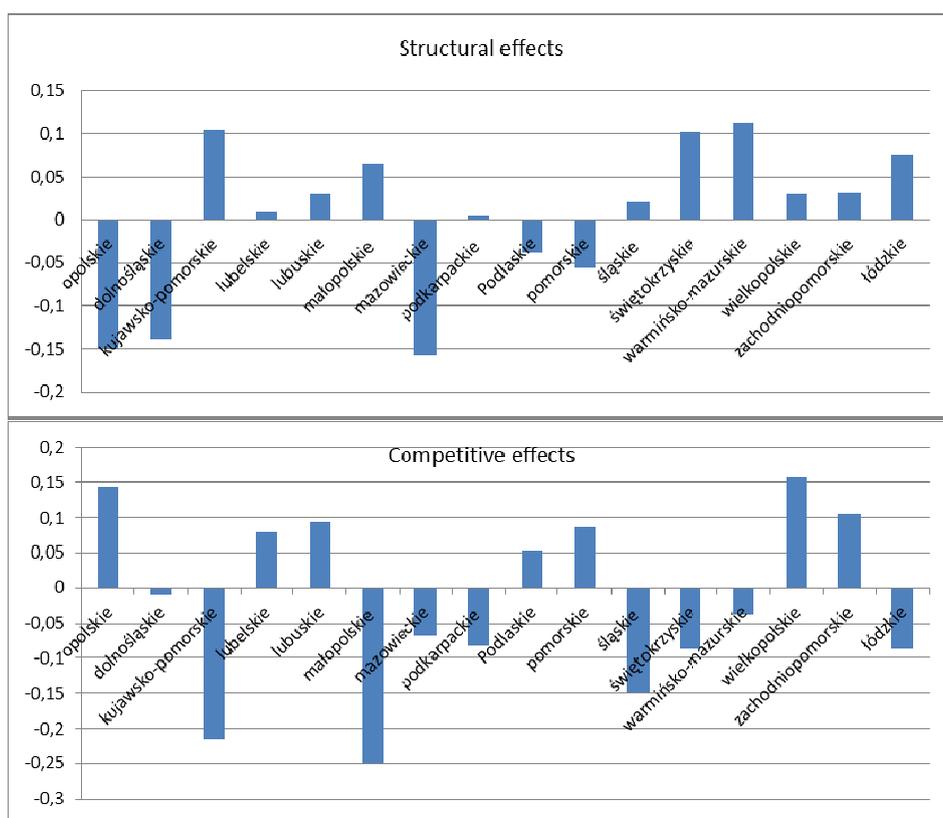


**Fig. 1.** Aggregated structural effects vs. aggregated competitive effects

Source: Author's own compilation based on CSO database.

The third class, featuring positive influence of only the competitive factor, covered three voivodships. In this class of regions lubuskie was characterized by definitely the least favorable changes in crop production structure. The fourth class covers the countries in which both crop structure and internal competitive development determinants exerted negative impacts. This is the smallest class including two voivodships. The most unfavorable competitive effects of crop production changes were observed in this class with reference to podlaskie, whereas the least favorable structural changes were recorded in podlaskie too.

Figure 2 presents the values of aggregated structural and competitive effects arranged according to the decreasing values calculated for 2004-2014. As it can be observed, in the analyzed period competitive factors exerted a much larger impact on crop production changes than the structural ones. The most favorable structural effects of changes occurred definitely in kujawsko-pomorskie, śląskie and warmińsko-mazurskie. The largest negative influence of workforce structure on employment changes was observed in podlaskie.



**Fig. 2.** Aggregated structural and competitive effects for Polish voivodships in the period 2004-2014

Source: Author's own compilation based on CSO database.

The most favorable internal competitive factors responsible for changes in crop production occurred in mazowieckie and opolskie. The least favorable situation was observed in dolnośląskie, pomorskie and świętokrzyskie, i.e. those voivodships which struggled with economic crisis in the analyzed period. Table 4 presents the classification of Polish voivodships with regard to allocation component effects: specialization or its absence as well as the advantage or disadvantage of competitiveness.

In the case of wheat a specialization and competitive advantage was observed for all the region under consideration. And in case of rye in regard to all voivodships – specialization and competitive disadvantage. Different situations can be noted in the case of oats, for eight provinces some specialization and competitive advantage was revealed and for another eight: specialization and competitive disadvantage.

**Table 4.** Classification of Polish voivodships with regard to allocation component effects in oats production in 2014

	Oats
Specialization and competitive advantage	łódzkie, mazowieckie, podkarpackie, podlaskie, świętokrzyskie, wielkopolskie, pomorskie, warmińsko-mazurskie
Specialization and competitive disadvantage	małopolskie, śląskie, lubelskie, lubuskie, zachodniopomorskie, dolnośląskie, opolskie, kujawsko-pomorskie

Source: Author's own compilation based on CSO database.

## Conclusion

The conducted research covering specialization and competitiveness of changes in crop production by types of crop in Polish voivodships in the period 2004-2014 allows for presenting the following conclusions:

1. Since 2004 voivodships recorded a growth in crop agriculture production by 1.77%. However, the changes in wheat production resulted in an average production rate growth by 17.55%. The wheat sector turned out to be the key one responsible for economic growth of agricultural production.
2. The most favorable structural effects of changes in crop production occurred in wielkopolskie, dolnośląskie and lubuskie, so in the voivodships characterized by a high share of wheat production sector presenting the level of respectively about 57%, 52%, 86%, 57% in 2014. Definitely the least favorable structural effects were observed in lubelskie, where wheat production amounted to about 18% in 2014. In the voivodships featuring positive structural effects rye production in ranged from 6% in lubelskie to 54% in kujawsko-pomorskie in 2014.
3. The most favorable competitive effects took place in mazowieckie and opolskie, whereas the least favorable ones in the voivodships included dolnośląskie, pomorskie and świętokrzyskie.
4. Finally shift-share analysis proved to be a useful method in identifying changes related to structure and dynamics of size of crop production in Polish voivodships.

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### SPECJALIZACJA I KONKURENCYJNOŚĆ WOJEWÓDZTW W ZAKRESIE PRODUKCJI ZBÓŻ W POLSCE

**Streszczenie:** Przestrzenna metoda przesunięć udziałów stanowi alternatywę klasycznej analizy shift-share, w której nie jest uwzględnione geograficzne położenie rozważanych regionów. Wiele zachodzących zjawisk, ich rozwój czy też kierunki zmian są bowiem uzależnione od przestrzennych interakcji zachodzących pomiędzy sąsiadującymi regionami. Model przestrzennej analizy shift-share został wprowadzony do badań przez Nazare i Hewingsa. Model ten przedstawia przestrzennie zmodyfikowane stopy wzrostu (tempa zmian) poszczególnych wariantów zjawiska przez uwzględnienie temp wzrostu zjawiska w obszarach sąsiadujących. Celem artykułu jest analiza zmian struktury produkcji rolnej w województwach Polski w latach 2004-2014 według rodzajów gatunków zbóż z zastosowaniem przestrzennej dynamicznej metody przesunięć udziałów. W opracowaniu dokonano oceny tempa wzrostu wielkości zjawiska. Ponadto zidentyfikowano i oszacowano udział czynników strukturalnych, sektorowych oraz regionalnych (lokalnych, przestrzennych) w wielkości efektu globalnego (produkcji zbóż w Polsce ogółem) w przekroju województw. Dodatkowo włączono do badania aspekty przestrzenne (zależności międzyregionalne) w postaci macierzy wag przestrzennych, która umożliwiła włączenie do badania aspektów związanych z zachodzącymi zależnościami ponadregionalnymi.

**Słowa kluczowe:** SSSA, produkcja zbóż, zróżnicowanie regionalne.