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Applying Shift-Share Analysis to Assess the Growth Potential of Crucial Bioeconomy Sectors in Poland

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Abstract:

Purpose: *The article evaluates the main sectors that create the bioeconomy in the voivodeships in Poland based on the structural-geographical shift-share method.*
Design/Methodology/Approach: *The study utilizes the structural-geographical shift-share method to analyze the development dynamics of the bioeconomy sectors across Polish voivodeships. This method allows for the decomposition of changes in employment or output into structural, regional, and interactive components, providing insights into the contributions of sectoral and regional factors to overall growth. Data collected by the Central Statistical Office was used to analyze the five areas constituting the bioeconomy.*
Findings: *The conducted research enabled the assessment of the level of development in key sectors of the bioeconomy in Poland and identified variations in development potential and structural transformations within this sector. The identification and analysis covered five areas belonging to the bioeconomy, agriculture, food, textiles, wood, and chemicals.*
Practical Implications: *Valuable insights for policymakers and regional authorities aiming to promote sustainable development through the bioeconomy are provided by the findings of this study. Regional disparities, structural transformations, and sectors with the highest growth potential are identified, offering a foundation for the design of targeted policies and strategies that enhance the development of the bioeconomy across Poland's voivodeships.*
Originality/Value: *The article makes a significant contribution to both theoretical and practical discussions on the development of the bioeconomy in Poland by analysing the situation in individual voivodeships.*

Keywords: *Bioeconomy development, regional analysis, sectoral dynamics.*

JEL code: *O10, O40, Q01, R1.*

Paper type: *Research article.*

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1. Introduction

The bioeconomy holds significant importance, prominently featured in the document on National Smart Specializations listing 13 smart specializations (NSS, 2023). Given that most voivodeships in Poland base their development on sectors utilizing natural resources (Gołębiewski, 2014), the bioeconomy has emerged as a focal point within regional smart specializations, aimed at harnessing endogenous potential (Gralak, 2015).

Furthermore, the bioeconomy aligns with the objectives outlined in the "Europe 2020" strategy (Chyłek and Rzepecka, 2011), emphasizing sustainable and inclusive growth (Kraska and Kot, 2022). The current "Europe 2030" strategy seeks to advance a sustainable and circular bioeconomy, tasked with decarbonizing economies and mitigating shortages of non-renewable resources. Recognized as a forward-looking concept for regional economies, the bioeconomy offers opportunities for economic diversification, innovation support, and job creation (Kriesch and Losacker, 2024).

This study aims to evaluate the potential of key sectors contributing to Poland's bioeconomy amidst ongoing changes across voivodeships. The literature review defines and underscores the significance of the bioeconomy. Subsequently, it outlines the research methodology and sources of data, culminating in an analysis of the findings that delineates both the changes and potential of pivotal sectors shaping Poland's bioeconomy.

2. Justification of the Conducted Research in the Field of Bioeconomy

The issue of the impact of civilization progress on the natural environment and its natural resources has been of interest since the time of the Chinese Zhou dynasty, a thousand years before our era (Zhou, 2009). Already during that period, attention was drawn to the necessity of protecting natural resources. It can also be noted that R. Malthus, in his considerations on the limits to population growth, highlighted the limited nature of land resources amidst continuous population growth (Rok, 2022; Rogowska, 2016).

It was not until 1992, at the Rio de Janeiro conference, that issues concerning the relationship between the natural environment and economic development gained prominence. The outcome of the conference was the adoption of Agenda 21, outlining the implementation of sustainable development programs globally.

It also emphasized that sustainable development comprises three interconnected pillars, the natural environment, economy, and society. It is defined as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs" (Our Common Future, 1980, p. 27).

Achieving sustainable development in economic terms requires, on one hand, maintaining a balance between meeting current human needs and the availability of resources, and on the other hand, securing these resources for future generations' needs (Stanny, Czarnecki, 2011). Therefore, economic development should take place through the use of renewable resources and ensure their recovery in the long term.

In this context, the concept of the bioeconomy has become a realization of sustainable development, focusing on the conversion of renewable biological resources from the natural world into high-value-added products through the application of knowledge and innovation. Its potential can help address challenges such as climate change, dependence on fossil fuels, food security (Marcinek, Smol, 2020), and contribute to increasing resilience to unforeseen events like the coronavirus pandemic (Lasarte-López *et al.*, 2023).

Therefore, the bioeconomy should be understood in a broad sense as "a sustainable and balanced process of transforming renewable biological resources into food, energy, and other industrial goods" (Kraska and Kot, 2022, p. 375). In the literature, there are many definitions describing the bioeconomy, but all of them emphasize the use of natural resources in the production process (Pajewski, 2014).

The operationalization of research in the article is based on the definition presented by the European Commission, which states *that "the bioeconomy encompasses all sectors relying on biological resources –animals, plants, microorganisms, and the biomass derived from them, including organic waste –their functions and principles. It includes and integrates: terrestrial and aquatic ecosystems and the services they provide; all primary production sectors that utilize and create biological resources (agriculture, forestry, aquaculture); and all economic sectors that utilize biological resources and process them into food, feed, biobased products, energy, and services"* (European Commission 2018).

In 2022, the European Commission expanded the concept of the bioeconomy, acknowledging that it includes all types of activities that "produce, use, process, distribute, or consume biological resources, including ecosystem services" (European Commission 2022, p. 1). Therefore, it is recognized that the bioeconomy comprises sectors related to agriculture, forestry, fisheries, food and paper production, as well as selected industries such as chemicals, wood-based materials, biotechnology, textiles, biofuels, and bioenergy.

Presenting the potential of sectors contributing to the bioeconomy in Poland is challenging due to their diverse nature and interconnectedness. The article adopts the official classification of sectors contributing to the bioeconomy as presented by R. M'Barek, C. Parisi, T. Ronzon (table 1) for conducting research.

***Table. 1**. Sectors contributing to the bioeconomy*

L.p.	The name of the sector	Symbol NACE (PKD)
1	Agriculture	A01
2	Forestry	A02
3	Fisheries and aquaculture	A03
4	Food, beverages and tabacco	C10, C11, C12
5	Textiles of bioloical origin	C13, C14, C15
6	Wood products and furniture	C16, C31
7	Paper	C17
8	Chemicals of biological origin, pharmaceuticals, plastics, and rubber (excluding biofuels)	C20, C21, C22
9	Liquid biofuels	C2014, C2059
10	Bioelectricity	D3511

***Source:** Based on own elaboration.*

The conflict of interests between economy, society, and the environment is increasingly visible nowadays. Therefore, it is essential to identify the factors influencing changes in the competitive position of sectors contributing to the bioeconomy using tools such as shift-share analysis. Research in Poland on the bioeconomy covers a growing thematic area and employs complex research methods aimed at exploring innovative solutions that support sustainable development and efficient utilization of biological resources in the production process.

So far, the following studies have been conducted in Poland, which included:

- Determining regional specialization in various sectors of the bioeconomy using Florence's specialization index (Komor, 2014);
- Presenting the state of the bioeconomy in Poland in the context of the EU based on a review of legal acts and data collected by the Central Statistical Office (GUS) from 2009 to 2015 (Woźniak and Twardowski, 2016);
- Assessing the diversity of workforce potential in bioeconomic enterprises at the regional level using the share of workers in selected bioeconomy sectors as a proportion of total employment in a given spatial unit (Komor, 2017);
- Creating a synthetic measure of bioeconomy development and determining the level of bioeconomy development in Poland on a regional basis from 2009 to 2013 (Skorwider and Namiotko, 2015);
- Determining the level of bioeconomy development in Polish regions using a synthetic measure over the period 2010-2019 (Kot and Kraska, 2022);
- Assessing the potential for sustainable bioeconomy development without exceeding ecological limits using biocapacity and carbon footprint (Faber and Jarosz, 2023);
- Evaluating the potential of bioeconomy sectors in the Polish economy using an Input-Output model (Loizou, Jurga, Rozakis, and Faber, 2019);
- Identifying factors influencing bioeconomy development through analysis of their social, economic, and environmental aspects in the EU and Poland (Woźniak, Tyczewska, and Twardowski, 2021).

3. Selection and Delineation of Areas

The selection of areas included in the bioeconomy in these studies is based on the bioeconomy sectors proposed by M'Barek R., Parisi C., Ronzon T. (eds.) in the work "Getting (some) numbers right – derived economic indicators for the bioeconomy" (see table 1). From the proposed sectors, five areas of analysis were identified for the study, named agriculture, food, textiles, wood, and chemicals.

In Table 1, areas labeled as L.P. 1-3 were categorized as Agriculture, area L.P. 4 was designated as Food for the purposes of the study, and subsequently Textiles (L.P. 5), Wood (L.P. 6-7), and Chemicals (L.P. 8) were identified accordingly. However, areas L.P. 9 and 10, due to their detailed classification under NACE codes C014, C2059, and D3511, were not included in the study due to a lack of unit-level data for individual voivodeships.

Each of the five identified areas was placed within respective sections of the Polish Classification of Activities (PKD), and linked to appropriate divisions as follows:

Agriculture: Section A (Agriculture, Forestry, Hunting, and Fishing)
- Division 01 - Crop and animal production, hunting, including related service activities
- Division 02 - Forestry and logging
- Division 03 - Fishing

Food: Section C (Manufacturing - Food Products)
- Division 10 - Manufacture of food products
- Division 11 - Manufacture of beverages
- Division 12 - Manufacture of tobacco products

Textiles: Section C (Manufacturing - Textiles, Apparel)
- Division 13 - Manufacture of textiles
- Division 14 - Manufacture of wearing apparel
- Division 15 - Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness, and footwear production

Wood: Section C (Manufacturing - Wood Products, Paper, Furniture)
- Division 16 - Manufacture of wood and cork products, except furniture; manufacture of straw and plaiting materials
- Division 17 - Manufacture of paper and paper products
- Division 31 - Manufacture of furniture

Chemicals: Section C (Manufacturing - Chemicals, Pharmaceuticals)
- Division 20 - Manufacture of chemicals, fertilizers, nitrogen compounds, plastics, and synthetic rubber in primary forms
- Division 21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations
- Division 22 - Manufacture of plastics products

In each of the five areas identified for analysis, three detailed sectors were specified. These delineated areas demonstrate the detailed structure of each of the five sectors.

4. Research Data and Method

The main aim of the article is to analyse and assess the key sectors forming the bioeconomy in the voivodeships of Poland using the structural-geographic shift-share analysis method. To evaluate the development potential of these key sectors of the bioeconomy, data from the Central Statistical Office databases were utilized. The development potential of the bioeconomy was expressed in terms of production volume in each respective area. Data were collected over a period of 10 years, specifically for the years 2014 and 2023. This decade included operational support program payments and was marked by significant events such as the Covid pandemic and the outbreak of full-scale war in Ukraine.

The assessment of structural changes in the bioeconomy will be conducted using the classical shift-share analysis method (Suchecki, 2010), which allows for a multidimensional analysis of the nature of changes that have occurred in the regions constituting the bioeconomy at the regional level in two study periods (current, i.e., 2023, in relation to base year, i.e., 2014). Shift-share analysis also enables the examination and evaluation of the level of bioeconomy development in a given region compared to others. In this method, the net effect is calculated for each unit studied, representing the relative change in bioeconomy potential areas in a particular voivodeship adjusted for changes in those areas in other voivodeships (Dinc, 2002).

Shift-share analysis can be applied to analyse changes in the production structure across various sectors of the economy to identify sources of growth or decline. It allows for the decomposition of changes into components resulting from overall economic trends, specific sectoral changes, and local shifts.

Shift-share analysis computes absolute changes, meaning it calculates changes in each sector within the analyzed region and at the national level between the beginning and end of the period. These changes are computed across three components. The first is the National Growth Effect (NGE), which captures changes stemming from general trends of economic growth or decline (Formula 1).

$$\mathrm{NGE_{ri}} = \mathrm{E_{ri,0}} \times \frac{\mathrm{E_{n,t}}}{\mathrm{E_{n,o}}};$$

where:

$E_{ri,0}$ – *is the initial production value in sector i in region r;*

$E_{n,t}$ – *is the total production value at the national level in the end period;*

$E_{n,0}$ – is the total production value at the national level in the start period;

$\frac{E_{n,t}}{E_{n,0}}$ – *is the growth rate index of production values at the national level.*

Industrial Mix Effect (IME): The Industrial Mix Effect captures the portion of the change that results from differences in sectoral structures between the region and the national level.

$$\mathrm{IME}_{ri} = E_{ri,0} \times \left(\frac{E_{i,t}}{E_{i,0}} - \frac{E_{n,t}}{E_{n,0}}\right);$$

where*:*

$E_{i,t} - production\ value\ in\ sector\ ii\ at\ the\ national\ level\ in\ the\ end\ period.$

$E_{i,0} - production\ value\ in\ sector\ ii\ at\ the\ national\ level\ in\ the\ start\ period;$

$\frac{E_{i,t}}{E_{i,0}}$

$- wgrowth\ rate\ index\ of\ production\ value\ in\ sector\ ii\ at\ the\ national\ level;$

$\left(\frac{E_{i,t}}{E_{i,0}} - \frac{E_{n,t}}{E_{n,0}}\right) -$

$difference\ between\ the\ growth\ rate\ index\ in\ sector\ ii\ and\ the\ national\ growth\ rate\ index$

Regional Shift Effect (RSE): The Regional Shift Effect captures the portion of the change that results from local factors specific to a given region.

$$\mathrm{RSE}_{ri} = E_{ri,0} \times \left(\frac{E_{ri,t}}{E_{ri,0}} - \frac{E_{i,t}}{E_{i,0}}\right);$$

$where:$

$E_{ri,t} - production\ value\ in\ sector\ ii\ in\ region\ rr\ in\ the\ end\ period.$

Each component analysis (NGE, IME, RSE) allows us to understand whether changes arise from general national trends, specific structural differences between the region and the country, or unique local factors. Based on the results, conclusions can be drawn regarding regional economic development strategies, employment policies, or other intervention measures.

5. Identification of the Bioeconomy Potential in Individual Voivodeships - Results of the Applied Shift-Share Analysis

First, the identification of the bioeconomy potential in its various sectors and voivodeships was conducted at the national level. Subsequently, each of the specified areas was described in detail.

5.1 Poland Overall

In Poland over the span of 10 years, from 2014 to 2023, among the identified sectors, only 2 have shown positive average growth rates. These sectors are Wood (growth of 14.34%) and Food (growth of 0.75%). The remaining three sectors, namely Chemicals, Agriculture, and Textiles, experienced declines of -3.36%, -

4.56%, and -14.09% respectively (see Table 2. Specifically, in Table 3, average growth rates were calculated for each voivodeship in the examined sectors. The Wood sector showed positive growth rates across all 16 voivodeships, with the leading voivodeships being małopolskie (increase by 2.4%) and wielkopolskie (increase by 2.2%). On the other hand, the Textiles sector saw a decrease in potential, showing declines across all voivodeships.

Table 2. *The average rate of change in Poland*

Name of the bioeconomy area	Average rate of change in the years 2014-2023
Wood	14.34%
Food	0.75%
Chemicals	-3.36%
Agriculture	-4.56%
Textiles	-14.09 %

Source: *Own study based on data collected by the Statistics Poland.*

Table 3. *Average rate of change in the studied areas*

Regions	Wood	Food	Chemicals	Agriculture	Textiles
Dolnośląskie	0.9%	0.3%	0,1%	-0.6%	-0.5%
Kujawsko-Pomorskie	0.2%	-0.3%	-0.4%	-0.2%	-0.6%
Lubelskie	0.7%	0.1%	0.0%	-0.6%	-0.3%
Lubuskie	0.0%	-0.1%	-0.3%	-0.3%	-0.4%
Łódzkie	1.2%	-0.5%	-0.7%	0.0%	-4.1%
Małopolskie	2.4%	0.5%	0.1%	0.0%	-1.2%
Mazowieckie	1.9%	1.4%	-0.3%	-0.4%	-1.9%
Opolskie	0.2%	-0.2%	-0.1%	-0.3%	-0.1%
Podkarpackie	1.2%	0.0%	0.0%	0.0%	-0.2%
Podlaskie	0.4%	0.2%	0.1%	-0.6%	-0.3%
Pomorskie	0.7%	-0.1%	-0.8%	-0.5%	-0.2%
Śląskie	1.2%	-0.5%	-0.5%	0.5%	-2.0%
Świętokrzyskie	0.3%	-0.1%	0.0%	-0.2%	-0.2%
Warmińsko-Mazurskie	0.5%	0.0%	0.3%	-0.3%	-0.3%
Wielkopolskie	2.2%	0.2%	-0.8%	-0.5%	-1.1%
Zachodniopomorskie	0.2%	-0.2%	-0.1%	-0.6%	-0.5%

Source: *Own study based on data collected by the Statistics Poland.*

5.2 Sector: Wood

Subjecting the Wood sector to analysis involved examining its development both at the sectoral level, illustrating structural changes (Table 4), and at the regional level (Table 5). Considering Poland overall, the Wood sector saw the highest growth potential in furniture production, while the largest decline was observed in paper and paper product manufacturing. It should also be noted that actual sectoral growth in Section C, Division 16 (manufacture of wood and cork products, excluding furniture, straw and plaiting materials) amounted to -13.02%, despite showing an average growth rate of 1.32%.

Table 4. *The average rate of change in the components of the wood*

	The wood sector		
	Section C, div. 16	Section C, div. 17	Section C, div. 31
The average growth rate	1.00%	-12.00%	37.00%
Structural (sectoral) growth rate	-13.02%	-26.24%	22.60%

Source: *Own study based on data collected by the Statistics Poland.*

Table 5 presents the results of the conducted shift-share analysis, detailing changes in sectoral competitiveness (structure) and regional development potential. It is important to note that the overall change in a province's potential, whether growth or decline, is influenced by changes in sector competitiveness (structural effect) as well as changes in potential compared to other provinces (geographical effect).

The shift-share analysis in the Wood sector illustrates significant variations in the dynamics of development across different provinces in this area (table 5). The largest negative overall effect occurred in lubuskie (-14.34%), driven by a negative structural effect (-2.90%) and geographical effect (-12.12%). A similar trend was observed in kujawsko-pomorskie (-9.15%) and zachodniopomorskie (-9.22%). The highest growth, mainly due to local conditions, was observed in łódzkie (5.63%) and małopolskie (5.37%).

Table 5. *Shift-share analysis in the wood sector*

Region	NGE	IME	RSE
Dolnośląskie	-0.33%	-0.75%	0.42%
Kujawsko-Pomorskie	-9.15%	-0.03%	-9.12%
Lubelskie	0.54%	-2.90%	3.44%
Lubuskie	-14.34%	-2.21%	-12.12%
Łódzkie	5.63%	3.04%	2.59%
Małopolskie	5.37%	-0.75%	6.11%
Mazowieckie	1.98%	1.39%	0.58%
Opolskie	-5.82%	0.67%	-6.49%
Podkarpackie	3.05%	-1.93%	4.98%
Podlaskie	-1.09%	0.43%	-1.52%
Pomorskie	-2.71%	1.36%	-4.08%
Śląskie	-0.63%	-1.39%	0.76%
Świętokrzyskie	-3.84%	-4.69%	0.84%
Warmińsko-Mazurskie	-1.59%	1.47%	-3.06%
Wielkopolskie	3.27%	2.57%	0.70%
Zachodniopomorskie	-9.22%	-1.96%	-7.26%

Source: *Own study based on data collected by the Statistics Poland.*

5.3 Sector: Food

Subjecting to analysis the second sector under study, namely Food, we presented the development of this sector in both sectoral (Table 6) and structural terms (Table 7).

The Food sector exhibited a slight positive growth rate during the study period, ranging from 0.74% to 1.28%, depending on the specific sector analysed. Similar dynamics of changes were observed in the sectoral perspective, where the growth rates ranged from -0.01% to 0.54%.

Table 6. *The average rate of change in the components of the food*

	The food sector		
	Section C, div. 10	Section C, div. 11	Section C, div. 12
The average growth rate	0.74%	0.90%	1.28%
Structural (sectoral) growth rate	-0.01%	0.16%	0.54%

Source: *Own study based on data collected by the Statistics Poland.*

In all provinces, changes in the Food sector result from local factors. The greatest growth in this area was observed in two provinces: podlaskie (9.09%) and mazowieckie (7.67%). The result achieved by podlaskie province stems from agricultural traditions prevalent in the region and natural conditions. Meanwhile, mazowieckie province benefits from good infrastructure and access to capital markets, making it attractive for investments in the food sector. The most unfavorable conditions for sectoral development were observed in opolskie (-8.23%), łódzkie (-7.00%), and kujawsko-pomorskie (-5.96%) provinces. Negative trends were noted in 10 provinces, while this sector remained stable in two provinces.

Table 7. *Shift-share analysis in the food sector*

Region	NGE	IME	RSE
Dolnośląskie	4.06%	0.00%	4.06%
Kujawsko-Pomorskie	-5.96%	0.00%	-5.96%
Lubelskie	0.97%	0.00%	0.97%
Lubuskie	-4.93%	0.00%	-4.93%
Łódzkie	-7.00%	0.00%	-7.00%
Małopolskie	4.23%	0.00%	4.23%
Mazowieckie	7.67%	0.00%	7.66%
Opolskie	-8.23%	-0.01%	-8.22%
Podkarpackie	-1.14%	0.00%	-1.14%
Podlaskie	9.09%	0.00%	9.09%
Pomorskie	-1.97%	0.00%	-1.97%
Śląskie	-5.21%	0.00%	-5.21%
Świętokrzyskie	-4.85%	0.00%	-4.85%
Warmińsko-Mazurskie	-1.49%	0.00%	-1.49%
Wielkopolskie	0.84%	0.00%	0.84%
Zachodniopomorskie	-4.11%	0.00%	-4.11%

Source: *Own study based on data collected by the Statistics Poland.*

5.4 Sector: Chemicals

Section C, division 20, which includes the production of chemicals, fertilizers, nitrogen compounds, basic forms of plastics, and synthetic rubber, has the highest average growth rate, amounting to 10%. Meanwhile, division 22, which focuses on the production of plastic products, shows a negative growth rate of 8%. Considering competitiveness aspects, in terms of sectoral changes observed during the study period, section C division 20 exhibits the highest competitiveness (Table 8).

Table 8. *The average rate of change in the components of the chemicals*

	The chemicals sector		
	Section C, div. 20	Section C, div. 21	Section C, div. 22
The average growth rate	10.00%	-1.00%	-8.00%
Structural (sectoral) growth rate	13.53%	2.41%	-4.55%

Source: *Own study based on data collected by the Statistics Poland.*

In the chemicals sector, similar to the food sector, the structural effect had a minimal impact on the overall changes occurring in this sector, indicating that the results are primarily influenced by geographical conditions. The largest increase in potential was observed in the warmińsko-mazurskie (17.95%) and the podlaskie (12.12%), suggesting a dynamic development in this sector. The largest decrease in potential occurred in the pomorskie (-9.95%) and the lubuskie (-7.96%)(Table 9).

Table 9. *Shift-share analysis in the chemicals sector*

Region	NGE	IME	RSE
Dolnośląskie	4.83%	-0.62%	5.46%
Kujawsko-Pomorskie	-2.78%	0.03%	-2.81%
Lubelskie	4.97%	0.75%	4.22%
Lubuskie	-8.88%	-0.92%	-7.96%
Łódzkie	-5.43%	0.12%	-5.55%
Małopolskie	4.68%	-0.33%	5.00%
Mazowieckie	1.59%	1.04%	0.55%
Opolskie	-0.80%	0.67%	-1.46%
Podkarpackie	3.47%	-0.62%	4.09%
Podlaskie	11.34%	-0.79%	12.12%
Pomorskie	-9.55%	0.39%	-9.95%
Śląskie	-0.65%	-0.71%	0.05%
Świętokrzyskie	1.62%	0.40%	1.22%
Warmińsko-Mazurskie	17.20%	-0.75%	17.95%
Wielkopolskie	-4.39%	-0.31%	-4.08%
Zachodniopomorskie	-0.01%	-0.23%	0.22%

Source: *Own study based on data collected by the Statistics Poland.*

5.5 Sector: Agriculture

The fourth sector analyzed is agriculture. Table 10 presents calculated average rates of change in divisions 01, 02, and 03 of Section A of the PKD. The average rate of

change for each division is negative. However, the sectoral rate of change is positive in the fisheries and crop production, animal husbandry, hunting, excluding service activities sections.

Table 10. *The average rate of change in the components of the agriculture*

	The agriculture sector		
	Section C, div. 01	Section C, div. 02	Section C, div. 03
The average growth rate	-3.06%	-9.08%	-0.68%
Structural (sectoral) growth rate	1.50%	-4.52%	3.88%

Source: *Own study based on data collected by the Statistics Poland.*

The most dynamic growth in the agriculture sector was observed in the śląskie (12.07%). Positive changes also occurred in the podkarpackie (4.06%) and małopolskie (4.31%). The largest negative total effect was observed in the podlaskie (-11.16%), lubelskie (-6.66%), and dolnośląskie (-4.34%), which resulted from a negative geographical effect in these regions. The largest negative structural effect was observed in the podkarpackie (-1.98%), indicating that the structure of the analyzed sector in this region is less favorable than the national average (Table 11).

Table 11. *Shift-share analysis in the chemicals sector*

Region	NGE	IME	RSE
Dolnośląskie	-4.34%	-0.70%	-3.64%
Kujawsko-Pomorskie	1.70%	0.40%	1.30%
Lubelskie	-6.66%	0.06%	-6.71%
Lubuskie	-2.50%	-0.74%	-1.77%
Łódzkie	5.05%	0.68%	4.37%
Małopolskie	4.31%	0.06%	4.25%
Mazowieckie	1.54%	0.75%	0.79%
Opolskie	-2.61%	-0.38%	-2.22%
Podkarpackie	4.06%	-1.98%	6.03%
Podlaskie	-11.16%	-0.42%	-10.73%
Pomorskie	-4.19%	-0.08%	-4.11%
Śląskie	12.07%	-0.06%	12.13%
Świętokrzyskie	-3.17%	-0.54%	-2.63%
Warmińsko-Mazurskie	-0.94%	-0.52%	-0.42%
Wielkopolskie	1.04%	0.72%	0.32%
Zachodniopomorskie	-2.73%	-0.22%	-2.52%

Source: *Own study based on data collected by the Statistics Poland.*

5.6 Sector: Textiles

The fifth sector included in the bioeconomy was textiles, comprising divisions 13, 14, and 15 of section C (Table 12). The most competitive division among those studied was division 13 of section C, specifically the manufacture of textile products, while the least competitive was division 15 of section C, which includes

the manufacture of leather, tanning, manufacture of luggage, handbags, and similar leather goods, as well as the manufacture of saddlery.

Table 12. *The average rate of change in the components of the textiles*

	The textiles sector		
	Section C, div. 13	Section C, div. 14	Section C, div. 15
The average growth rate	9.00%	-20.00%	-21.00%
Structural (sectoral) growth rate	22.71%	-5.49%	-7.18%

Source: *Own study based on data collected by the Statistics Poland.*

The highest growth rate in the textile sector was in the pomorskie (8.35%), opolskie (7.32%) and podkarpackie (6.95%) region, which is due not only to the positive structural effect (IME), but also to the geographic effect (RSE) (Table 13). Negative total effects occurred in lubuskie (-7.90%), łódzkie (-6.98%) and warmińsko-mazurskie (-3.43%) provinces, which in this case is the result of negative geographic effects.

Table 13. *Shift-share analysis in the textiles sector*

Region	NGE	IME	RSE
Dolnośląskie	4.79%	0.54%	4.25%
Kujawsko-Pomorskie	-1.11%	0.96%	-2.07%
Lubelskie	4.02%	0.15%	3.87%
Lubuskie	-7.90%	1.32%	-9.21%
Łódzkie	-6.98%	0.12%	-7.11%
Małopolskie	3.24%	-1.77%	5.01%
Mazowieckie	2.53%	-1.12%	3.65%
Opolskie	7.32%	1.77%	5.55%
Podkarpackie	6.95%	0.20%	6.75%
Podlaskie	-4.32%	0.53%	-4.85%
Pomorskie	8.35%	1.12%	7.23%
Śląskie	-2.72%	0.81%	-3.53%
Świętokrzyskie	3.33%	0.65%	2.68%
Warmińsko-Mazurskie	-3.43%	0.59%	-4.02%
Wielkopolskie	2.71%	0.41%	2.30%
Zachodniopomorskie	-3.75%	0.40%	-4.15%

Source: *Own study based on data collected by the Statistics Poland.*

6. Conclusion

The conducted empirical research allowed for the identification and analysis of structural-spatial changes in the bioeconomy sector in Poland. During the study period, at the national level, an increase in production value was observed in two out of five sectors constituting the bioeconomy: wood and food. In the remaining sectors (textiles, agriculture, and chemicals), a decrease in production value was noted. Poland exhibits significant regional diversity in terms of production values generated

in the studied industries, which should be reflected in regional innovation strategies. Table 14 highlights positive total effects in gray color obtained during the study period using shift-share analysis for each analyzed voivodeship. Voivodeships such as małopolskie, mazowieckie, and podkarpackie demonstrate positive changes across all five analyzed areas of the bioeconomy. Conversely, zachodniopomorskie and lubuskie voivodeships obtained negative total effects across all areas.

Table 14. *Designation of positive and negative total effect values obtained using shift-share analysis (gray color for positive values, no color for negative values)*

Regions	Wood	Food	Chemicals	Agriculture	Textiles
Dolnośląskie					
Kujawsko-Pomorskie					
Lubelskie					
Lubuskie					
Łódzkie					
Małopolskie					
Mazowieckie					
Opolskie					
Podkarpackie					
Podlaskie					
Pomorskie					
Śląskie					
Świętokrzyskie					
Warmińsko-Mazurskie					
Wielkopolskie					
Zachodniopomorskie					

Source: *Own study based on data collected by the Statistics Poland.*

The proper direction of development for industries, considering the existing potential of the region, can contribute to the advancement of the bioeconomy level. The analysis conducted in the article is not exhaustive. Each analyzed region has its specific conditions that influence the pace and directions of development of the studied industries. The application of shift-share analysis can serve as a tool for assessing the economic or business situation of regions.

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