



Assessment of the Concentration and Structure of the Bioeconomy: The Regional Approach

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Abstract

The bioeconomy is seen as crucial for achieving a climate-neutral Europe by 2050; therefore, it is important to monitor and illustrate the performance and trends of the bioeconomy development not only at state level but also in regions. The research aims to develop a methodology for the identification of bioeconomy concentration and the structure of bioeconomy enterprises at a regional level. The methodology of the research is based on four main steps: (1) defining the framework of bioeconomy enterprises; (2) setting data sources and research limitations; (3) estimating the bio-based share of bioeconomy industries; (4) estimating a location quotient which provide data serving to assess the level of concentration of the factor analysed. The research is based on the analysis of 119 municipalities and 30 387 bioeconomy enterprises by using a location quotient. The research results revealed that the municipalities could be classified into three groups according to the concentration of the bioeconomy. Such a classification of municipalities allowed us to identify the strengths and weaknesses of each municipality in the field of bioeconomy and potential development possibilities. The novelty of the research provides a methodological background for municipal-level monitoring of the bioeconomy and suggestions for improving the uneven development of the bioeconomy.

Keywords:

Bioeconomy;
Bioeconomy Sectors;
Location Quotient;
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1- Introduction

Currently, the global economy is facing a shift from quantitative growth to qualitative development in order to improve sustainability [1] and meet global sustainable development goals such as promoting sustained, inclusive and sustainable economic growth; full and productive employment; decent work for all; ensuring sustainable consumption and production patterns; achieving food security; and taking urgent action to combat climate change and its impacts [2]. A recently developed concept that can incorporate economic activities related to the invention, development, production, and use of biological products and processes for energy, materials, and chemicals, more commonly known as the "bioeconomy" [3], might make a promising contribution to a transformation towards a sustainable economy and way of living [4]. The sustainability and qualitative growth of current production and consumption patterns may be improved through a change from a fossil-based throughput economy towards a bioeconomy with bio-based and recirculated products and renewable energy [4, 5]. Therefore, "the State should issue green policies to encourage environmental initiatives and projects. Promote research and promulgation of green technical norms, standards, and guidelines" [6].

According to a common understanding of the bioeconomy, it can be described as a complex and multidisciplinary concept, a new approach to economic growth centered on research, development, and innovation policy that addresses the challenges facing our society, namely climate change, energy and resource efficiency, health, and demographic

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change [7]. Taking into account that the bioeconomy can be shaped by sectors exploiting biomass, it may make up a substantial part of the economy: land and marine ecosystems and the services they provide; all primary production industries that use and produce biological resources (agriculture, forestry, fisheries, and aquaculture); and all economic and industrial sectors that use biological resources and processes to produce food, feed, bio-based products, energy, and services [8]. This is one of the reasons why the bioeconomy is seen as the future of Europe [9]; and in this context, the Council of the European Union [10] points out that a sustainable bioeconomy has the potential to:

- Contribute to competitiveness, sustainable growth (in urban, rural and coastal areas throughout the European Union), the renewal of European manufacturing industries, the modernization of European primary production systems, the protection of the environment and the improvement of biodiversity;
- Foster employment, social inclusion and local development in rural areas;
- Create economic value and increase prosperity;
- Support the establishment of new value chains across Europe, which determines the need for detailed research on the development of bioeconomy industries not only nationally but also regionally.

In several countries, scientists have emphasized that the development of bioeconomy sectors determines the growth of the economy and especially of rural regions. For example, "the new bioeconomy is and can be an important contributor to more environmentally and socially sustainable economic growth, particularly in the rural areas of the Nordics" [11]. In the Czech Republic, scientists stress that "there is insufficient theoretical and practical knowledge to exploit the potential of bioeconomy based on the principles of sustainable development, and it is therefore necessary to focus more resources on research and development, innovation, new technologies, and practices meeting the priority objectives of bioeconomy and circular economy" [12]. Scientists have made similar conclusions in their studies about Italy [13], Finland [14], and Canada [15] etc. In addition, the European Union [10] points out that a sustainable and circular European bioeconomy should be one of the key elements in implementing the European Green Deal. The Council of the European Union has also concluded that a sustainable circular bioeconomy is crucial in achieving a climate-neutral Europe by 2050 and contributing to food and nutrition security, sustainable biomass production and use in order to reduce food waste and restore and enhance ecosystem services and biodiversity [16]. In Latvia, the bioeconomy is also considered to be the basis for growth in the national economy. The Ministry of Agriculture of the Republic of Latvia [17] states that bioeconomy industries contribute to the viability of areas of Latvia and have great growth potential for creating well-paid jobs. The bioeconomy is a part of the economy, which exploits renewable natural resources in a sustainable and prudent way to produce food and feed, industrial products and energy.

Being aware the role of the bioeconomy, many countries around the world more or less support and promote growth in the bioeconomy through various support programmes, strategies, action plans and other policy documents [18]. In 2017, Latvia designed a national bioeconomy strategy for the period up to 2030 that focuses on the following bioeconomy industries: agriculture, forestry, fishing, aquaculture, food, pulp and paper production, as well as partly on the chemical, biotechnology, and energy industries, which are innovation leaders in exploiting and preserving natural capital and increasing the value of it efficiently and sustainably in the Baltic States. The strategy states that in Latvia, bioeconomy industries have great potential for creating jobs and promoting balanced economic development as well as exploiting natural resources, thereby contributing to solving environmental and climate problems [17].

In this context, the assessment and monitoring of the development of the bioeconomy at different levels – the European Union, national regional levels – have become particularly important [18]. In order to identify the performance and trends of the bioeconomy and the social and economic importance of the bioeconomy industries, the researchers in their latest studies have used various indicators: employment, turnover, value added, labour productivity (in terms of turnover per person employed), export, sales in the domestic market, contribution to GDP and investment, as well as changes in the indicators over time [18-25]. In this research, one of the indicators "economically active enterprises of the market sector" was used to give insight into economic activity and assess the performance of the bioeconomy, with emphasis on the concentration and structure of bioeconomy enterprises in a particular administrative territory thus revealing regional aspects of bioeconomy development in Latvia.

This research aims to develop methodology for identification of bioeconomy concentration and the structure of bioeconomy enterprises at regional level. Two specific research tasks were set to achieve the aim: (1) to calculate a location quotient (LQ) by using the indicator "number of economically active enterprises of the market sector"; (2) to give insight into the diversity of bioeconomy at regional level, i.e. in the municipalities of Latvia.

The novelty of the research involves developed methodology for estimating the concentration of the bioeconomy and assessment of the structure of bioeconomy enterprises at regional level based on the case study of Latvia municipalities by using the indicator "number of economically active enterprises of the market sector", which could be used by scientists in other countries to determine the potential development of bioeconomy industries not only nationally but also regionally.

2- Research Methodology

In order to identify the concentration and structure of the bioeconomy at municipal level, the methodology of the research is based on four main steps: (1) defining the framework of bioeconomy enterprises; (2) setting data sources and research limitations; (3) estimating the bio-based share of bioeconomy industries; (4) estimating a location quotient.

2-1- Defining the Framework of Bioeconomy Enterprises

To identify the concentration and structure of the bioeconomy enterprises, the research follows the most common understanding of the bioeconomy used in the European Union and the Member States [1, 5, 6, 8, 10, 17, 20], which states that the bioeconomy incorporates all economic activities related to production and manufacturing of biomass. To identify what economic activities make the framework for the bioeconomy, the authors used the Statistical Classification of Economic Activities in the European Community (NACE Rev. 2) that provides an international integrated system of economic classifications [26, 27] and gives an initial starting point for selecting industries that are involved in production or manufacture of biomass. According to the NACE classification, the authors have selected 16 industries that can be divided into 3 groups according to the type of biomass generation or use (see Figure 1).

- **Production of biomass:** Section A (NACE) includes industries that give inputs to the production of biomass. The industries are: crop and animal production, hunting and related service activities (A01), forestry and logging (A02), fishing and aquaculture (A03).
- **Manufacture of biomass:** Section C (NACE) includes industries that use biomass for manufacturing other products. Taking into account that for some industries biomass is exclusive feedstock, while for other industries biomass can be used as alternative feedstock, two groups of industries can be listed in Section C:
 - Industries that exclusively use biomass as feedstock: manufacture of food (division C10), manufacture of beverages (C11), manufacture of tobacco (C12), manufacture of leather and related products (C15), manufacture of wood and of products of wood and cork, except furniture (C16), manufacture of paper and paper products (C17);
 - Industries that can use biomass as feedstock: manufacture of textiles (C13), manufacture of wearing apparel (C14), manufacture of chemicals and chemical products (C20), manufacture of basic pharmaceutical products and pharmaceutical preparations (C21), manufacture of rubber and plastic products (C22) and manufacture of furniture (C31).
- **Production of bio-based electricity:** Section D (NACE) comprises the production of electricity (D3511), from which the production of bio-based electricity is estimated.

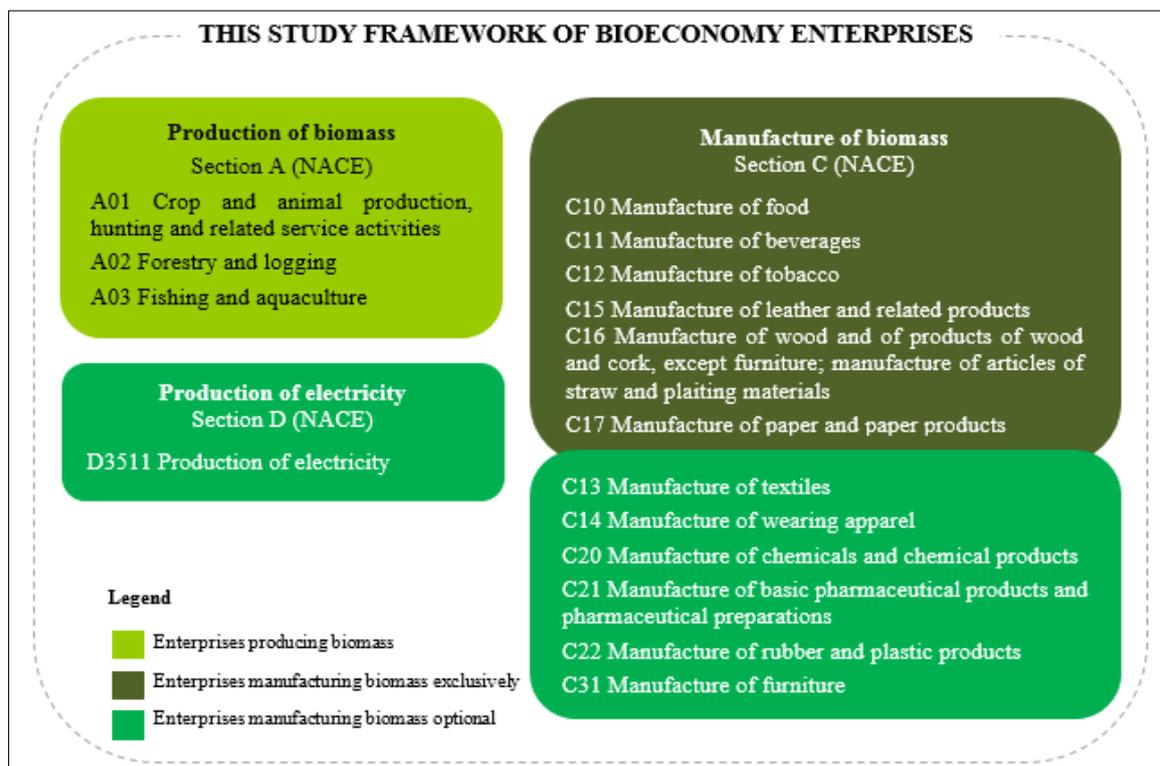


Figure 1. The framework of bioeconomy enterprises (according to the NACE Rev. 2 classification) used in the study

The NACE classification of economic activities is a commonly used approach for monitoring the bioeconomy at the European Union and national levels [27]. A similar classification of bioeconomy industries has been used by T. Ronzon and co-authors in their research on understanding and quantifying the European Union's bioeconomy [20, 28]. However, there can be observed also slight differences in understanding the scope of the bioeconomy. For example, M. Kardung with co-authors expands an understanding of bioeconomy industries and includes industries dealing with water, sewerage, waste management and remediation activities, wholesale activities, construction and civil engineering activities, as well as other activities [24].

2-2- Data Sources and Research Limitations

The second stage of the research identified the available statistical data on the bioeconomy broken down by NACE industry and by administrative and territorial unit (in Latvia – by municipality). Usually, an analysis of bioeconomy performance is made at national level by using Eurostat statistics [27, 29]; and the most commonly used indicators are: turnover, value-added and jobs [20]. The present research represents the first attempt to give insight into the nature of the bioeconomy in smaller administrative and territorial units. An analysis of statistical data allowed us to establish that in Latvia, the statistical data were available only on the number of economically active enterprises of the market sector (hereinafter the number of enterprises) broken down by administrative and territorial unit. The data were also used at the fourth stage to calculate location quotients. In total, the research analysed 119 municipalities and 30 387 bioeconomy enterprises, which made up 17.6% of the total enterprises in the country [29]. The breakdown of bioeconomy enterprises by industry is as follows: a) section A (agriculture, forestry, fishing and aquaculture) – 25772 enterprises or 84.8% of the total; b) section C (food, beverages, tobacco, leather, wood, paper) totally bio-based – 3300 enterprises (10.9%); c) section C (textiles, wearing apparel, chemicals, pharmacy, rubber and plastic, furniture) with bio-based share – 1299 enterprises (4.3%); d) section D (electricity) with bio-based share – 16 enterprises. At the beginning of 2022 when the research was begun, all the statistical data needed for the research were available for 2019; therefore, 2019 was chosen for the research.

2-3- Estimating the Bio-Based share of Bioeconomy Industries

The first stage of the research found that there were several industries that could not fully use biomass in their production process. Therefore, at the third stage (aimed at estimating the bio-based share by industry of the bioeconomy), the authors identified a bio-based share for seven bioeconomy industries (divisions C13, C14, C20, C21, C22, C31 and D3511). First, based on national (i.e. Central Statistical Bureau of the Republic of Latvia) [29] and European Union [27] statistics, bio-based shares for the above-mentioned industries were calculated in terms of employment, value added and turnover in Latvia (see Table 1).

Table 1. Bio-based shares of bioeconomy industries (divisions C13, C14, C20, C21, C22, C31 and D3511) in Latvia in 2019, (%)

Bioeconomy industries (NACE division)	Indicators used for calculating a bio-based share for an industry			Calculated average bio-based share for an industry used to adjust national data (%)
	Bio-based share of turnover generated in the corresponding biomass feedstock converting industry (%)	Bio-based share of value added generated in the corresponding biomass feedstock converting industry (%)	Bio-based share of employment in the corresponding biomass feedstock converting industry (%)	
Bio-based textile (C13*)	45	31	35	37
Bio-based wearing apparel (C14*)	31	31	31	31
Bio-based chemicals (excluding biofuels) (C20*)	18	23	29	23
Bio-based pharmaceuticals (C21*)	40	40	35	38
Rubber and bio-based plastics (C22*)	2	2	2	2
Wooden furniture (C31*)	70	74	74	73
Bio-based electricity (D3511*)	5	5	3	4

* Hybrid industries: bio-based shares are applied to estimate the activity generated by the manufacture of biomass feedstock only.

An indicator of the bioeconomy (turnover, value added, employment) for the corresponding industry (i.e., divisions C13, C14, C20, C21, C22, C31 and D3511) was divided by the corresponding national average for the corresponding industry. Then the national (CSB) data on the number of economically active enterprises of the market sector broken down by bioeconomy industry were adjusted for the bio-based shares calculated.

2-4- Estimating the Location Quotient

From the beginning of 2011 to 1 July 2021, Latvia consisted of 119 administrative and territorial units (municipalities): 9 cities of national significance and 110 amalgamated municipalities. As a result of the administrative and territorial reform of 2021, 46 administrative territories were established: 10 State cities and 36 amalgamated municipalities with administrative centres. Since the research was based on data for 2019, the fourth stage of the research (estimates of the location quotient) calculated location quotients by region and by city of national significance, thereby creating a data set with 119 administrative and territorial units.

The research used location quotients (LQ) to identify the concentration of bioeconomy enterprises in a municipality. A location quotient is a commonly used tool for estimating an industrial concentration in a particular area [30] and is critical to identifying an area's specific strengths and weaknesses [31]. The research used location quotients to determine the concentration and structure of bioeconomy enterprises in a particular municipality. It helps to show what makes a particular municipality "unique" in comparison with other municipalities and the national average.

Lizinska and Kisiel [32] have pointed out that the values of a location quotient provide data serving to assess the level of concentration of the factor analysed. The threshold value of a LQ is assumed to be 1.00. Accordingly, if a LQ is equal to 1.00, the concentration of the bioeconomy in a particular area (municipality) is the same as the national average [31, 32].

Based on Kardung et al. [24], LQ values were calculated by using the following Equation 1:

$$LQ_{i,l} = \frac{\frac{EB_{nov i,l}}{ET_{nov i,l}}}{\frac{EB_{LV}}{ET_{LV}}}, \quad (1)$$

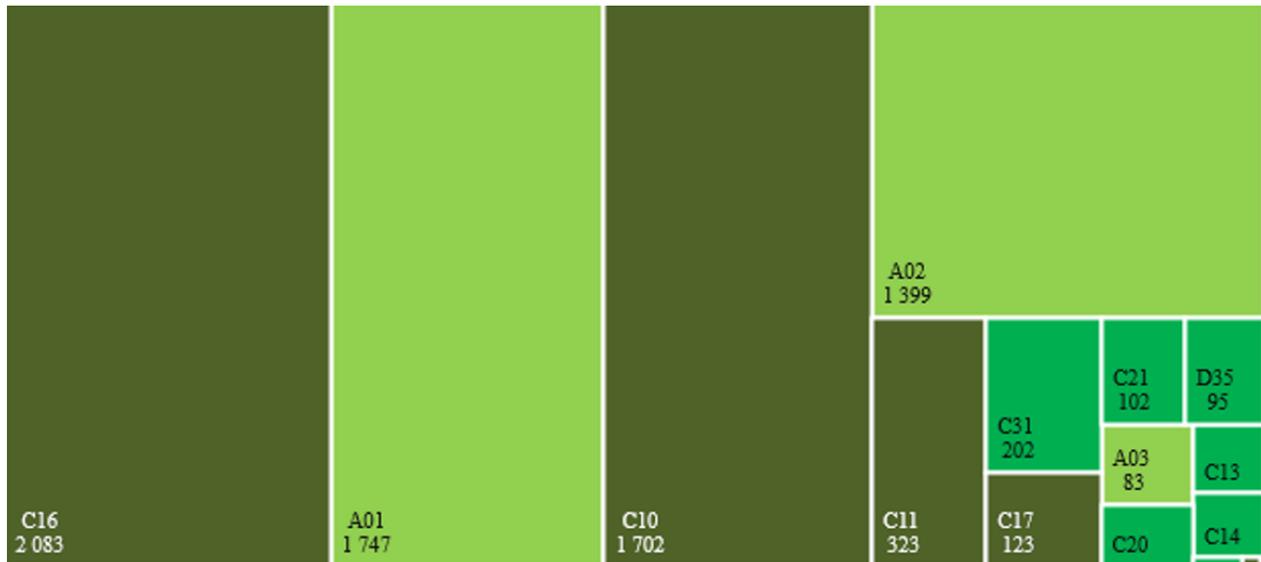
where $LQ_{i,l}$ is location quotient for the bioeconomy in the i -th region of Latvia and for year l , where $i \in \{1, \dots, 119\}$; $EB_{nov i,l}$ is number of economically active enterprises of the market sector in the i -th region of Latvia and for year l ; $ET_{nov i,l}$ is total number of economically active enterprises of the market sector in the i -th region of Latvia and for year l ; EB_{LV} is number of economically active enterprises of the market sector in Latvia and for year l ; ET_{LV} is total number of economically active enterprises of the market sector in Latvia and for year l .

In order to assess the degree of concentration, the following intervals for LQ values were adopted from Lizinska and Kisiel [32] and used in the research:

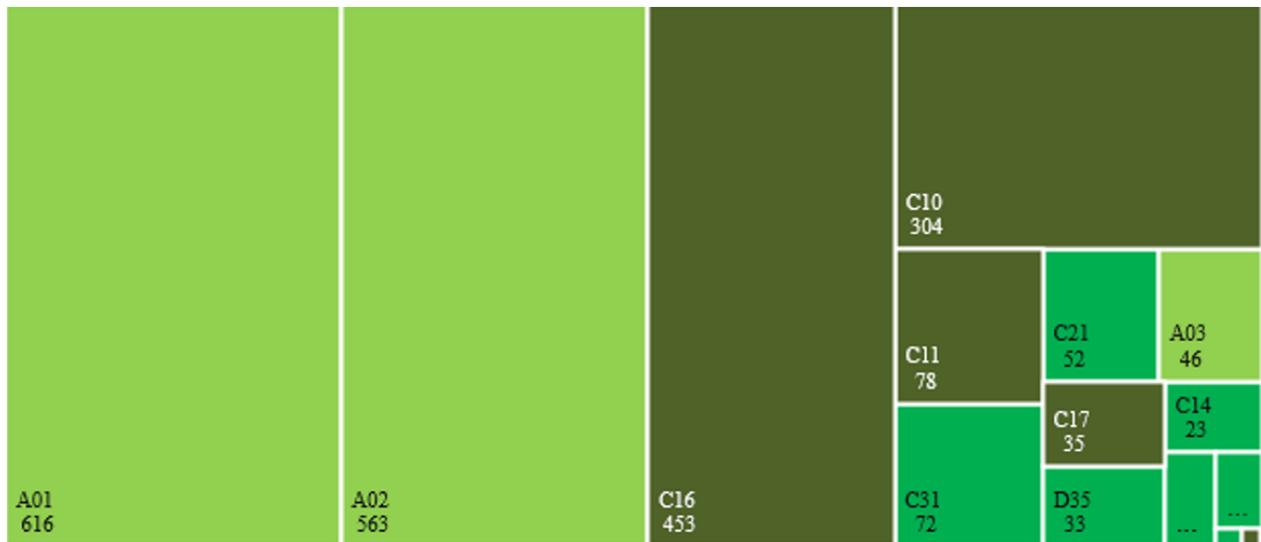
- a LQ value >1 means a higher concentration of the characteristic analysed than the average for Latvia;
- a LQ value <1 means a potential deficit in the characteristic analysed;
- a LQ value $=1 (\pm 0.15)$ means that the distribution of the variable analysed runs a similar course as the distribution of this variable in the reference area.

3- Results

One of the development opportunities for Latvia is the use of natural resources in a more sustainable and efficient manner. The bioeconomy provides an integrated approach for the inclusion of knowledge-based economic growth, social welfare, and environmental protection in agriculture, forestry, and fisheries in conformity with the fundamental principles of the circular economy [17]. The analysis of the statistical data on the European Union [28] revealed that in 2019, the number of people employed in the bioeconomy in Latvia was 121.7 thousand, of which more than half were employed in the primary production of bioresources (agriculture (37%), forestry (14%), and fishing and aquaculture (only 1%)) (Figure 2). It is worth mentioning that despite the fact that Latvia is located on the shores of the Baltic Sea (the total length of the coast of Latvia is 497 km), the number of companies engaged in fisheries and aquaculture was small. In 2019, in Latvia, the turnover of industries producing and converting biomass amounted to more than EUR 8 billion, while the value added totalled EUR 2.3 billion. The contribution of primary production of bioresources to the total turnover of the bioeconomy was 40% (agriculture - 22%, forestry - 17%, fishing and aquaculture - 1%), while to the value added - 53% (27%, 24% and 2%, respectively). Among the industries processing bioresources, the manufacture of food products (division C10) and wood and of products of wood and cork (division C16) prevailed in Latvia. Both industries of the bioeconomy generated a turnover of EUR 3.8 billion (47% of the total turnover of the bioeconomy) and a value added of EUR 0.76 billion in 2019, employing more than 40 000 people (17% and 17%, respectively). However, the contribution of bio-based biomass feedstock-converting industries (bio-based chemicals, pharmaceuticals, plastics and rubber, bio-based textiles, bio-based electricity) to employment, turnover, and value-added was small in Latvia.



a) Turnover in the bioeconomy industries in Latvia (total turnover of the bioeconomy: EUR 8 037 million)



b) Value added in the bioeconomy industries in Latvia (total value added of the bioeconomy: EUR 306 million)



c) Employment in the bioeconomy industries in Latvia (total employment in the bioeconomy: 121 679)

Legend: ■ Sectors producing biomass ■ Sectors manufacturing biomass exclusively ■ Sectors manufacturing biomass optional

Figure 2. Turnover (million EUR) and value added (million EUR) of and employment in the bioeconomy industries in Latvia in 2019 [20]

In Latvia, the overall performance of the bioeconomy is promising and shows that the bioeconomy industries play an important role in the national economy. However, for further growth in the bioeconomy to be persistent, it is necessary to identify whether the growth is balanced throughout the country and the capacity of the bioeconomy in terms of number of companies. The research sought to do it by identifying the concentration and structure of bioeconomy companies by municipality.

To show the presence and diversity of the bioeconomy in the regions of Latvia, two differentiation criteria were used: (1) a location quotient for the bioeconomy and (2) a share of enterprises engaged in primary production of bioresources (divisions A01, A02 and A03) in the total bioeconomy enterprises. The locations of the municipalities analysed on the regression line, depending on the differentiation criteria used, are shown in Figure 3.

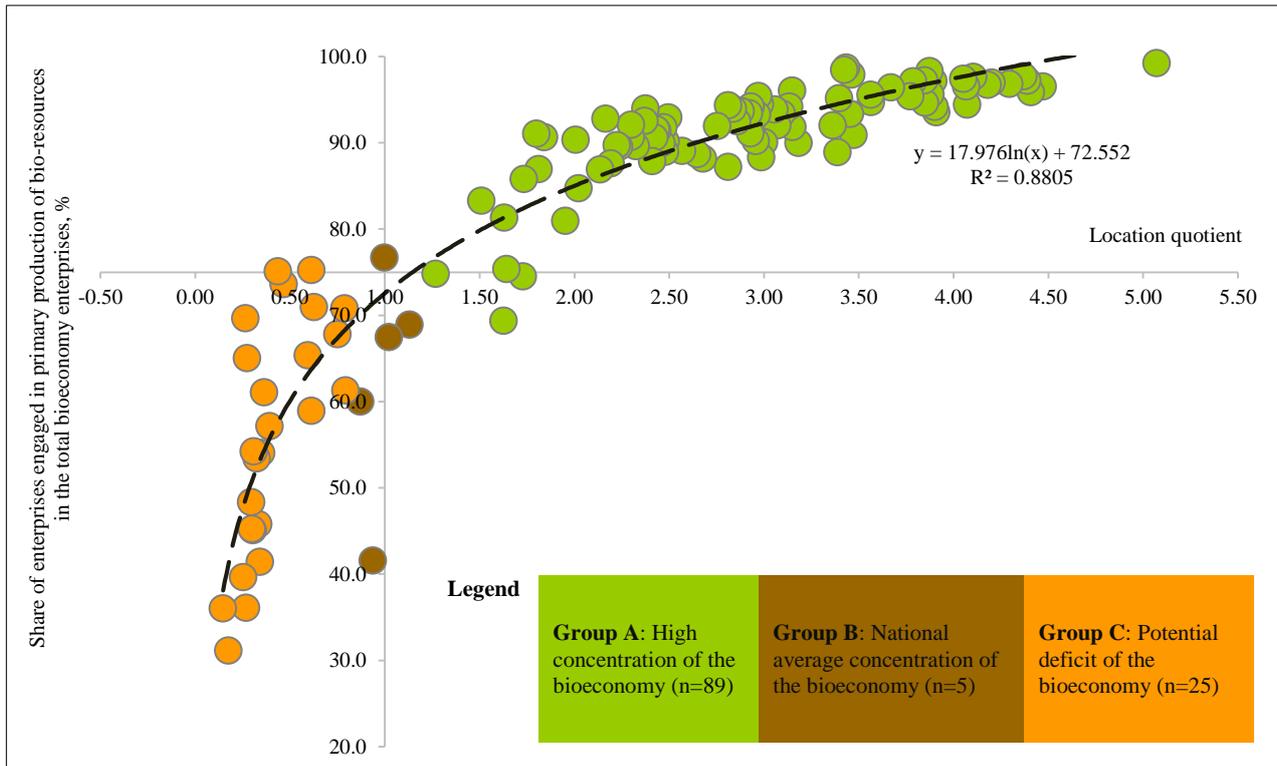


Figure 3. Scatter diagram of location quotients for the bioeconomy (coefficient) and the shares of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises (%) in 2019; the regression curve and the equation

The analysis of the locations of administrative territories of Latvia in connection with location quotients for the bioeconomy (coefficient) and the shares of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises allowed us to divide the municipalities into three main groups, depending on the bioeconomy concentration.

- Group A: municipalities with a higher concentration of the bioeconomy than the national average and more than a 75% share of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises.
- Group B: municipalities with the same concentration of the bioeconomy as the national average and less than a 75% share of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises.
- Group C: municipalities with a potential deficit in the bioeconomy and less than a 75% share of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises.

The locations of the groups of municipalities are shown in Figure 4. This suggests that Group A municipalities with a high concentration of the bioeconomy are located in rural areas, while Groups B and C municipalities with a lower concentration of the bioeconomy are located in cities of national significance and municipalities adjacent to Riga.

Next, the authors give a detailed description of the identified groups of municipalities. Table 2 summarizes the data on each group of municipalities: their numbers, shares in the total municipalities, statistical values of location quotient, as well as TOP bioeconomy industries.

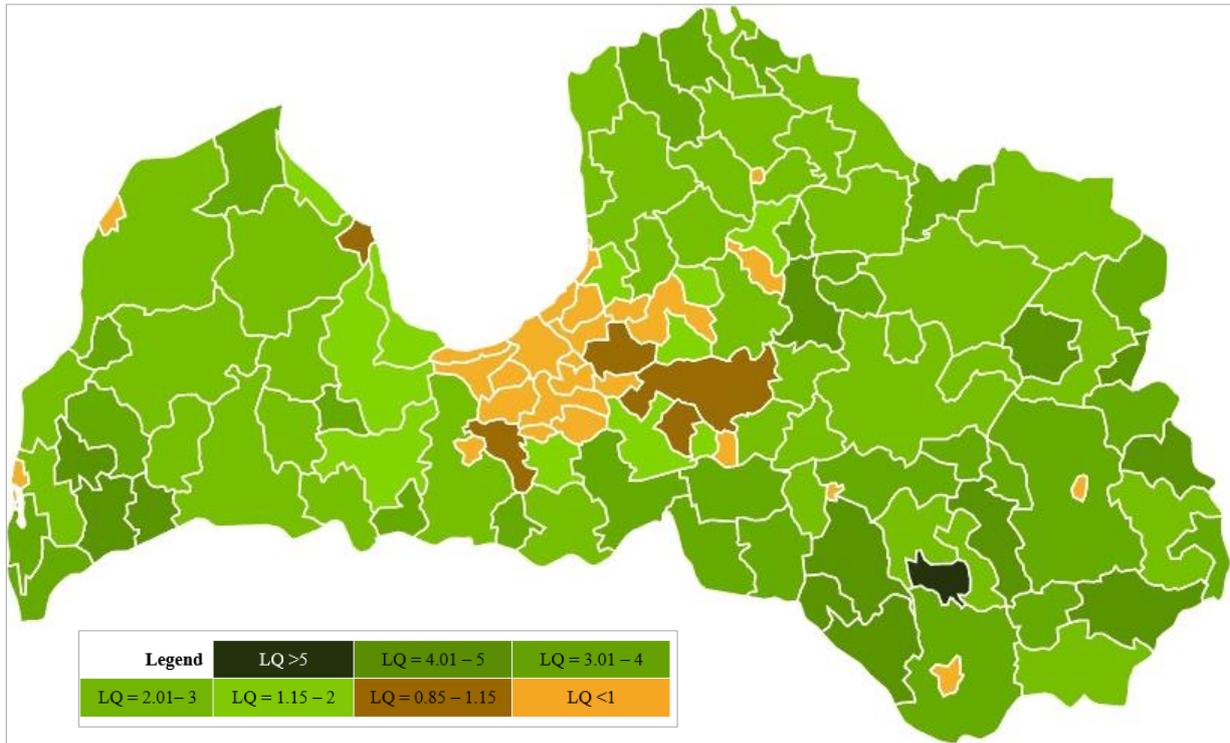


Figure 4. Spatial distribution of location quotients for the bioeconomy (LQ) in 2019

Table 2. Groups of municipalities with different bioeconomy concentration levels in Latvia

Group of municipalities	Municipalities		Location quotient (LQ)			TOP bioeconomy industries (NACE)
	Number (n)	Share (%)	Min.	Max.	Avg.	
Group A: municipalities with a high concentration of the bioeconomy	89	75	1.15	5.07	2.98	Crop and animal production, hunting and related service activities (A01) Forestry and logging (A02)
Group B: municipalities with a national average concentration of the bioeconomy	5	4	0.87	1.13	0.99	Manufacture of food (C10) Manufacture of wood and of products of wood and cork, except furniture (C16)
Group C: municipalities with a potential deficit of the bioeconomy	25	21	0.15	0.79	0.42	Manufacture of food (C10) Manufacture of wood and of products of wood and cork, except furniture (C16)

3-1- Group A: Municipalities with a High Concentration of the Bioeconomy

This group is characterized by a higher concentration of the bioeconomy than the national average of 70% and more than a 75% share of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises. Group A includes most of the municipalities of Latvia (89 or 75%). For the municipalities belonging to this group, the bioeconomy concentration indicator varied from 1.15 to 5.07, and most of the economically active enterprises of the market sector were engaged in the primary production of bioresources (mostly in divisions A01, A02). Consequently, the dominant industries represented the primary production of bioresources in these municipalities. In municipalities with an LQ of more than 3, the share of enterprises engaged in primary production of bioresources exceeded half of the total enterprises. In nine municipalities (Varkava, Rugaji, Riebini, Baltinava, Jekabpils, Priekule, Durbe, Akniste, Dagda), the share of enterprises included in NACE section A exceeded even 70%.

A more detailed analysis of the data on municipalities (32 in total) in which the share of enterprises engaged in primary production of bioresources was below 40% allowed us to conclude that TOP 5 industries by number of economically active enterprises of the market sector (according to NACE Rev. 2 classification) (hereinafter - TOP 5 industries) were as follows:

1. **Agriculture, Forestry and Fishing (section A);**
2. Wholesale and retail trade; repair of motor vehicles and motorcycles (section G);
3. **Manufacturing (section C);**
4. Professional, scientific and technical activities (section M);
5. Real estate activities (section L).

Since part of manufacturing relates to the bioeconomy, the NACE divisions analysed were classified into 2 groups:

- Bioresource-processing industries (i.e. divisions C10, C11, C12, C15, C16 and C17, as well as the bio-based share of divisions C13, C14, C20, C21, C22, C31);
- Other industries of NACE section C (i.e. divisions C13, C14, C20, C21, C22, C31 and the non-bio-based share of C3511 and other section C divisions: C18, C19, C23-C30, C32, C33);

Analysing the composition of manufacturing allowed us to establish that:

- Bioresource-processing industries (mostly divisions C10 and C16) prevailed in terms of number (more than half of the total enterprises included in division C) in most (24 out of 32) of the municipalities analysed;
- In other municipalities (8 out of 32), i.e. Bauska, Broceni, Burtnieki, Iecava, Koceni, Lubana, Saldus and Strenci municipalities, other sector C divisions prevailed (the share exceeded half of the total enterprises included in section C).

3-2- Group B: Municipalities with a National Average Concentration of the Bioeconomy

In this group of municipalities, the concentration of the bioeconomy was the same as the national average, and the share of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises was less than 75%. This group included 5 municipalities: Mersrags, Lielvarde, Ozolnieki, Ropazi and Ogre. In Figure 5, the authors have summarized the overall composition of enterprises, which shows the share of bioeconomy enterprises. Since the concentration of the bioeconomy in the municipalities belonging to this group was the same as the national average, Figure 4 also shows the average concentration and structure of bioeconomy enterprises in Latvia.

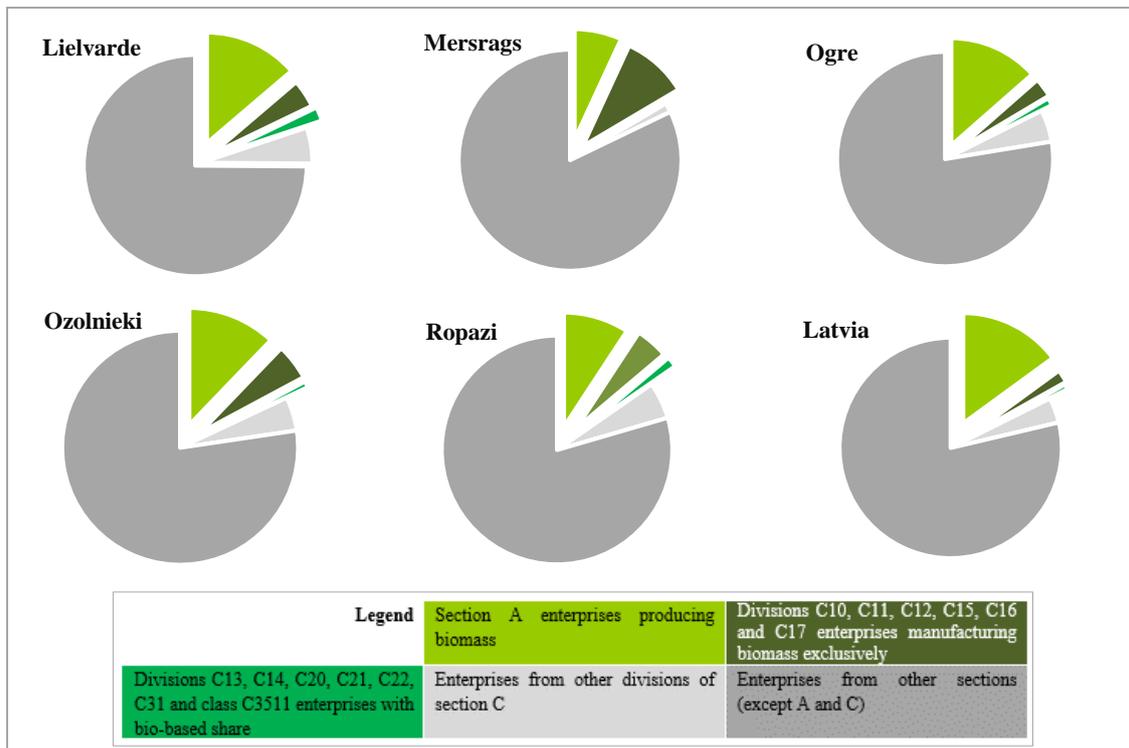


Figure 5. Distribution of divisions (according to the NACE Rev. 2 classification) by number of economically active enterprises of the market sector in the municipalities belonging to Group B in 2019, %

TOP 5 industries in Group B municipalities were as follows:

1. Wholesale and retail trade; repair of motor vehicles and motorcycles (section G);
2. Manufacturing (**section C**);
3. Professional, scientific and technical activities (section M);
4. Construction (section F);
5. **Agriculture, forestry and fishing (section A).**

The share of section A varied from 7% (in Mersrags municipality) to 14% (in Lielvarde municipality), while the share of divisions included in manufacturing varied from 9% (in Ogre municipality) to 11% (in other municipalities).

The analysis of the data on manufacturing revealed that:

- Bioresource-processing industries prevailed in Mersrags municipality (mostly divisions C10 and C16) (the share exceeded 88% of the total enterprises included in section C);
- In Lielvarde, Ozolnieki and Ropazi municipalities, bioresource-processing industries (mostly divisions C10 and C16) slightly prevailed (55%) over other section C divisions (about 45%);
- In Ogre municipality, in contrast, other section C divisions (54%) slightly prevailed over bioresource-processing industries (mostly divisions C10 and C16)) (46%).

3-3- Group C: Municipalities with a Potential Deficit of the Bioeconomy

In this group of municipalities, the share of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises was less than 75%. This group included 16 municipalities of Latvia and all (nine) cities of national significance. Most of the municipalities included in this group are areas adjacent to the capital city. In Figure 6, the authors have summarized the overall composition of enterprises, which shows the share of bioeconomy enterprises.

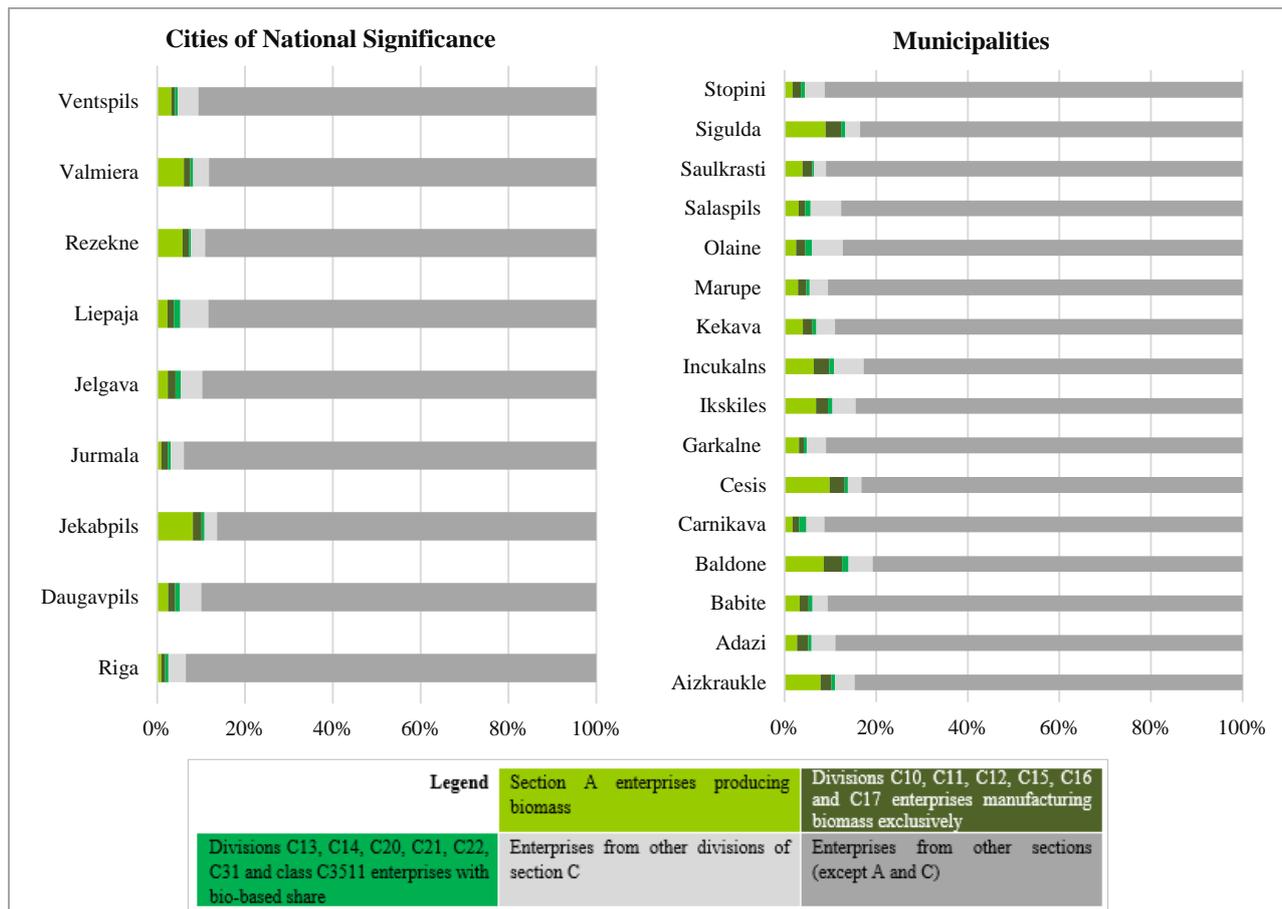


Figure 6. Distribution of divisions (according to the NACE Rev. 2 classification) by number of economically active enterprises of the market sector in the municipalities belonging to Group C in 2019, %

The share of economically active enterprises of the market sector engaged in the bioeconomy in the total bioeconomy enterprises varied from 2.6% in the capital city to 14.0% in Baldone municipality. Compared with Groups A and B, this group is characterized by a higher share (above the national average) of enterprises engaged in primary production of bioresources. The bioeconomy industries did not prevail in these administrative territories.

TOP 5 industries in cities of national significance included in Group B were as follows:

1. Wholesale and retail trade; repair of motor vehicles and motorcycles (section G);
2. Real estate activities (section L);
3. Professional, scientific and technical activities (section M);
4. Construction (section F);
5. **Manufacturing (section C).**

TOP 5 industries in municipalities included in Group C were as follows:

1. Wholesale and retail trade; repair of motor vehicles and motorcycles (section G);
2. Construction (section F);
3. Professional, scientific and technical activities (section M);
4. **Manufacturing (section C);**
5. Real estate activities (section L).

The analysis of the data on the number of enterprises by manufacturing industry revealed that:

- In Baldone municipality, bioresource-processing industries (mostly divisions C10 and C16) and other section C divisions were equally developed (50/50);
- In Cesis and Sigulda municipalities, bioresource-processing industries (mostly divisions C10 and C16) slightly prevailed over other section C divisions;
- In Jekabpils, Saulkrasti and Babite municipalities, other section C divisions slightly prevailed over bioresource-processing industries (mostly divisions C10 un C16);
- In other municipalities and cities, other section C divisions prevailed.

4- Discussion

4-1- Further Prospects and Challenges for Bioeconomy Development in Latvia

The research results revealed that the administrative territories of Latvia were dominated by enterprises engaged in traditional bioeconomy industries focusing on the primary production of bioresources (mainly in agriculture and forestry). The experts of the Employers Confederation of Latvia have also concluded in the study that most of the enterprises in Latvia operated in the fields of **crop and livestock production, hunting**, retail trade, provision of personal services, real estate, as well as wholesale trade. The number of enterprises operating in other fields did not exceed 5% in each of the fields. Although the mentioned industries were equally common in almost all the regions of Latvia, there were some regional differences. In Riga region, the share of enterprises engaged in crop and livestock production and hunting in the total enterprises was much smaller, while the share of wholesalers was larger than that in other regions. The share of forestry and logging enterprises was higher in Vidzeme, Kurzeme and Latgale than in other regions. Zemgale is traditionally considered to be an agricultural as well as an industrial region. Researching the competitiveness of enterprises in the municipalities of Latvia, the experts of the Employers Confederation of Latvia concluded that there were differences between the regions of Latvia and that most of the regional differences could be attributed to the geographical location factor – distance from the capital city, proximity to the sea and road junctions, **availability of natural resources** etc. The authors of the paper also believe that the availability of natural resources is a crucial factor for the development of the bioeconomy, especially the primary production of bioresources (mainly agriculture and forestry) throughout the country. This was also confirmed by a correlation analysis performed by the authors, which showed that there was a strong non-linear relationship between the location quotient for the bioeconomy and the share of enterprises engaged in primary production of bioresources in the total bioeconomy enterprises ($r=0.9383$).

The experts of the Employers Confederation of Latvia analysed the sustainable development strategies designed by the cities and municipalities of Latvia and their implementation plans in order to summarize information on their specializations in business and economic development and concluded that a relatively large number of the municipalities (27%) associated the specializations of their territories with natural capital, viewing nature primarily as a resource, while 6% viewed nature as something to be protected and preserved. The authors of the paper assume that in Latvia there is an insufficient understanding of the role of local government administration in the promotion and development of economic activity in the municipality. The goals set in the sustainable development strategies and implementation plans designed by the cities and municipalities of Latvia regarding entrepreneurship and economic development are often modest and limited to further growth in current economic activity rather than ambitious; therefore, stimuli and support instruments are needed for educating local governments in this field. The experts of the Ministry of Environmental Protection and Regional Development of the Republic of Latvia (hereinafter – MEPRD) have also stated in the Regional Policy Guidelines for 2021-2027 that the planning capacity of local governments is one of the significant challenges and investment needs after 2020. The need to increase development planning capacity has also been pointed out by the State Audit Office of the Republic of Latvia, which has established in its audit that 47 local governments did not employ a specialist in spatial development planning, for whom this would be the basic responsibility. Besides, in some cases, drawing up policy documents for municipal territorial development is outsourced, which does not always ensure a complete connection with the population in matters of development planning. Consequently, the practice of drawing up spatial development policy documents with the participation of stakeholders should be improved. In 30 municipalities,

according to the data available to the MEPRD, there was no specialist responsible for business issues, although this is one of the functions of any local government. In addition, this was not the only responsibility for specialists in business issues in several municipalities (in 50 municipalities this was the main responsibility for the respective specialist).

Industries could be divided into several groups according to the technologies used. One of the most widely used classifications is as follows: high-tech (bioresource-processing division C21), medium-high-tech (bioresource-processing division C20), medium-low-tech (bioresource-processing division C22) and low-tech (bioresource-processing divisions C10-C17 and C31) [33]. Based on this classification, its authors concluded that in Latvia, low-tech industries prevailed in bioresource processing, i.e. manufacture of food products (division C10) and wood and products of wood and cork (division C16); therefore, stimuli and support instruments are needed for both local governments and businesspersons to facilitate the transition from low-tech to medium-high (C20) and high-tech (C21) industries, which leads to more sustainable bioeconomy development and national economic growth. The national Guidelines for the National Industrial Policy for 2021–2027 [34] and research studies by other scientists [23, 35, 36] also emphasize that it is necessary to stimulate wider use of innovations in the bioeconomy, aiming at creating higher value-added products for faster productivity growth and at fostering exports based on innovation and productivity. Besides, given the challenges posed by climate change, it is essential to purposefully develop research competences (human capital) and innovation capacity to adapt forestry and agriculture to the climate change. In view of the significant impact of this field on export performance, as well as the overall impact on the development of sustainable thinking in society, the effective dissemination, accumulation, effective transformation and transfer of knowledge to future generations is of paramount importance.

4-2- Research Findings

The scarcity of natural resources, unsustainable consumption patterns, the increase in waste and environmental pollution, the demand for agricultural products and climate change are considered the current challenges that must be solved [37-39]. The development of bioeconomy industries is considered to be a solution to dealing with these problems [10-15, 28, 40]. The bioeconomy is characterized by more efficient management of natural resources, greater food security, as well as a reduction in both the emission of greenhouse gases and the generation of residue and waste [28, 37, 40].

The bioeconomy makes an important contribution to achieving the United Nations Sustainable Development Goals (Goal 2 (Zero Hunger), Goal 7 (Affordable and Clean Energy), Goal 8 (Decent Work and Economic Growth), Goal 12 (Responsible Consumption and production), Goal 13 (Climate Action), Goal 14 (Life Below Water), Goal 15 (Life on Land)) [41-43].

As mentioned above, being aware the role of the bioeconomy, many countries around the world more or less support and promote growth in the bioeconomy through various support programmes, strategies, action plans and other policy documents [19]. There are currently ten European Union Member States with dedicated bioeconomy strategies and seven European Union Member States that are in the process of developing their respective strategies [43]. The findings show that 28 regions in the EU-27 have fully dedicated bioeconomy strategies, while one region is elaborating such a strategy. Sixty-two regions have strategic frameworks with strong bioeconomy focus, with other 7 regions elaborating such a strategy. Lastly, 94 regions have strategies with minimum bioeconomy content, while another 2 regions are developing such a strategy. Overall, there are 359 bioeconomy-related strategies at regional level in the EU-27. All the bioeconomy strategies of EU regions contribute to the development of regional bioeconomy industries in order to increase their role at national level [44]. On the one hand, the development of strategy documents requires an assessment of the most current situation to make decisions based on facts about development scenarios. On the other hand, the implementation of plans and strategies also requires the creation of monitoring systems that involve a quantification of socio-economic developments in the sectors of activity that form the bioeconomy [28].

Most often, various quantitative indicators – “number of people employed”, “turnover”, “value added” and “labour productivity” – and their changes over time are employed to assess the situation in bioeconomy industries. These are absolute indicators describing the main business processes and the performance or quantitative results.

Analysing the situation in Europe [45], the authors found that a monitoring system for the bioeconomy has not been developed in 14 European Union Member States (including Latvia), in six Member States it was under development and in another five it has been developed. Examining the indicators of the economic impact of the bioeconomy included in the evaluation system of the five countries that have developed a monitoring system for the bioeconomy, the authors concluded that they were “bioeconomy turnover”, “value added”, “investments”, “export of goods” and “employment”. Only the monitoring system of Italy had the indicator “number of start-up enterprises in the bioeconomy”, which was similar to the indicator employed by the authors and represented business entry (independent variable).

To assess the development of the European Union’s bioeconomy, the European Commission [43, 46] employs the following indicators: “number of people employed”, “turnover”, “value added” and “labour productivity”.

A research study by Ronzon et al. (2020) [28], the results of which were also used to assess the implementation of the European Union's Bioeconomy Strategy 2018, was based on the following bioeconomy indicators: "value added at factor cost", "the number of people employed," "apparent labour productivity" and "location quotient". According to this research, a location quotient refers to the ratio of the proportion of persons employed in the bioeconomy in a given Member State to the European proportion. A location quotient greater than 1 means that the labour market of the Member State is more "concentrated" in the bioeconomy than the EU-27 labour market. The research calculated location quotients at the national and EU-27 levels.

To calculate a "location quotient for the bioeconomy in the region", the author used the process input indicator (independent variable) – "economically active enterprises of the market sector" –, which has not been used in scientific research regarding the bioeconomy so far and allows assessing the concentration of bioeconomy industries at regional level and thus predicting their potential development in the future.

According to Ronzon et al. (2020) [28], Latvia belonged to the Green group together with others Eastern Member States, while Portugal and Greece were characterised by a labour market that was highly specialised in the bioeconomy (location quotient ≥ 1.5) and below-average apparent labour productivity in the bioeconomy (\leq half the EU-27 level). In these countries, a high proportion of bioeconomy jobs were in biomass production industries (agriculture, forestry, and fishing and aquaculture) and labour-intensive production industries such as the manufacturing of textiles and/or wood products. This is also consistent with the results of the present research, i.e. the administrative territories (municipalities) of Latvia are dominated by companies that operate in traditional bioeconomy industries and focus on the primary production of bioresources (mainly in agriculture and forestry) and thus indicate the reliance of the national economy, especially in the regions, on the development opportunities provided by the sector. However, low-tech sectors prevail in bioresource processing industries in Latvia, i.e. the manufacture of food products (division C10) and wood and products of wood and cork (division C16).

Conducting the research study by employing the indicators suggested by Ronzon et al. (2020) [28] at the level of administrative territories (municipalities) of Latvia was not possible due to the limited availability of statistical data. The indicator proposed by the authors of the present research is more available to countries; therefore, it is possible to assess the future growth of bioeconomy industries at regional level and analyse whether the specific industries are developing in a balanced way throughout the country and identify the capacity of companies in the bioeconomy in terms of number of companies. The authors tried to answer this question by identifying the concentration and structure of bioeconomy companies at regional level in the country. Based on the research results, it could be assumed that the proposed methodology provides an idea of the development of the bioeconomy at regional level and does not contradict the results of other research studies; therefore, the aim set for the present research has been achieved.

To test the research methodology, data for one year (2019) were employed, while the research by Ronzon et al. (2020) [28] was based on a three-year average. To further test the research methodology, it is necessary to conduct a research study on the most optimal period for calculating a "location quotient for the bioeconomy in the region" according to the methodology proposed by the authors.

4-3- Implications of Findings

The methodology developed diversifies and complements the indicators of the economic impact of the bioeconomy, which could be used for assessing the situation in the regions as well as integrated into the monitoring system. The larger the range of indicators available, the more versatile is an assessment of bioeconomy industries, which would be available to policy makers and implementers, as well as researchers implementing various innovations and thus enhancing faster growth in the bioeconomy. To date, the input indicator "economically active enterprises of the market sector" for assessing the development of the bioeconomy and calculating the indicator "location quotient" according to the methodology developed by the authors has not been used in other similar studies.

The results of the present research could be used for developing a national and especially a regional-level bioeconomy strategy, as well as a monitoring system for the bioeconomy. The methodology developed by the authors could also be useful for the assessment and enhancement of the Latvian Bioeconomy Strategy 2030.

The present research classified municipalities into three groups (A, B, and C), creating clusters of municipalities with similar situations in the development of the bioeconomy. Therefore, the research results provide municipal leaders and various stakeholders, including public organizations, businesspersons, and entrepreneurs, with knowledge about the development of the bioeconomy in the regions and therefore could facilitate the creation of cooperation networks for the development of the bioeconomy. Often, human capital and investments made within one municipality are insufficient to ensure sustainable development; therefore, it is necessary to cooperate with other municipalities by combining resources and seeking common stimuli and instruments to promote the development of bioeconomy industries, especially for the transition from low-tech sectors to medium-high technology (C20) and high-tech (C21) sectors. The cooperation will also promote future synergies between various stakeholders.

The research results could also be used by local government leaders and policymakers as arguments for educating the public and businesspersons and entrepreneurs about the development of a more sustainable bioeconomy and the growth of the region. This is especially important for local governments, which associate the specialization of their territories with natural capital and primarily perceive nature as a resource. The European Commission [43] has also stated that public involvement in research and innovation has shown good results so far and should be strengthened. The research results could serve as arguments for public involvement in the development of the bioeconomy, especially for the transition from low-tech sectors to moderately high-tech (C20) and high-tech (C21) sectors to foster the growth of the national economy according to the "bottom-up" approach and the principle of "individual to general".

5- Conclusions, Recommendations and Future Research Priorities

In Latvia, municipalities could be classified into three groups, depending on the level of concentration of bioeconomy enterprises:

- Group A - those with a high concentration of the bioeconomy, representing 75% of the total municipalities, where the most common bioeconomy enterprises are engaged in crop and animal production, hunting and related service activities (A01), forestry and logging (A02), which are located mostly in rural areas;
- Group B - those with a national average concentration of the bioeconomy, representing 4% of the total, where the most common enterprises are engaged in the manufacture of food (C10), as well as the manufacture of wood and of products of wood and cork, except furniture (C16); and
- Group C - those with a potential deficit in the bioeconomy, representing 21% of the total, where the most common bioeconomy enterprises are engaged in the manufacture of food (C10), as well as the manufacture of wood and of products of wood and cork, except furniture (C16).

Such a classification of municipalities allows us to identify the strengths and weaknesses of each municipality in the field of bioeconomy and potential further steps that should be taken. One of the weaknesses identified in all the municipalities was the relatively small number of enterprises engaged in processing bioresources. Therefore, to foster the development of bioresource processing in the municipalities of Latvia (especially in Group A municipalities), it is necessary to develop infrastructure (transportation arteries and junctions, water supply and sewerage, electricity connections, and IT infrastructure), which is currently a significant barrier to attracting investments and implementing business plans. Infrastructure problems should be addressed jointly through agreement and cooperation between businesspersons or investors and municipal or national institutions.

To contribute to the growth of the bioeconomy (especially processing) in the regions of Latvia, it is also necessary to promote the availability of qualified labour; therefore, cooperation between bioeconomy enterprises and educational institutions is needed to prepare specialists for the labour market.

The research results showed that the bioeconomy of Latvia is characterized by low-tech industries, i.e., manufacture of food (C10), as well as manufacture of wood and of products of wood and cork (C16); therefore, stimuli and support instruments are needed for both local governments and businesspersons to facilitate the transition from low-tech to medium-high (C20) and high-tech (C21) industries, which leads to more sustainable bioeconomy development and national economic growth. To achieve faster growth in the national economy, raising competitiveness needs to be based on the development of technologies and innovations in bioresource-processing industries.

The leaders of municipalities, policy makers, and the public in Latvia need to be familiar with the research results as well as the results could be used by scientists from other countries in their research to identify development opportunities for the bioeconomy not only nationally but also regionally. To further test the research methodology, it is necessary to conduct a research study on the most optimal period for calculating the "location quotient for the bioeconomy in the region" according to the methodology suggested by the authors.

6- Declarations

6-1- Author Contributions

Conceptualization, A.M. and D.P.; methodology, A.M. and D.P.; software, A.M. and I.P.; validation, A.M. and D.P.; formal analysis, A.M. and D.P.; investigation, A.M. and I.P.; resources, A.M. and I.P.; data curation, A.M. and I.P.; writing—original draft preparation, D.P.; writing—review and editing, A.M. and D.P.; visualization, A.M. and D.P.; supervision, D.P.; project administration, D.P.; funding acquisition, A.M., D.P. and I.P. All authors have read and agreed to the published version of the manuscript.

6-2- Data Availability Statement

Publicly available datasets were analysed in this study. This data can be found here: CSB Database <https://stat.gov.lv/en/statistics-themes/business/number-enterprises-and-enterprise-demography/tables/uzs030-economically>; https://data.stat.gov.lv/pxweb/en/OSP_PUB/START__ENT__UF__UFR/UFR050/.

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6-4- Institutional Review Board Statement

Not applicable.

6-5- Informed Consent Statement

Not applicable.

6-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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