Management Theory and Studies for Rural Business and Infrastructure Development
ISSN 2345-0355. 2018. Vol. 40. No. 4: 492–513
Article DOI: http://doi.org/10.15544/mts.2018.45

ASSESSMENT OF BIOECONOMY DEVELOPMENT POTENTIAL FROM THE PERSPECTIVE OF INNOVATION ECONOMICS IN EUROPEAN REGIONS

***Virginija Kargytė[1], Rando Värnik[2], Vilija Aleknevičienė[3]**
[1] *Ph.D. Student in Economics. Aleksandras Stulginskis University. Universiteto Street 10, 53361 Akademija, Kaunas District, Lithuania. Phone +370 (656) 66 628. E-mail virginija.kargyte@asu.lt*
[2] *Prof. Dr. Estonian University of Life Sciences. E-mail rando.varnik@emu.ee*
[3] *Prof. Dr. Aleksandras Stulginskis University. E-mail vilija.alekneviciene@asu.lt*

Received 05 12 2018; accepted 20 12 2018

The European Commission expects that the development of bioeconomy across the EU will boost its rural and coastal economies. Although these areas have comparatively more spare biomass, at the same time they are associated with lower levels of entrepreneurship and R&D activities. One can argue that more urbanized and industrialized regions with higher innovation potential will develop high value added bio-based industries, while rural and coastal economies will remain or become to a greater extent biomass providers. Therefore, the article aims to explore links between regional biomass availability, bioeconomy business cluster and innovation potential, as well as how the development of bioeconomy can evolve in different groups of regions. For this purpose, bioeconomy development factors including aspects of innovation economics are analysed in year of 2016 using data of 237 NUTS 3 level regions of Norden, Western and Central Europe. Research results reveal that analysed regions can not be simply separated into potential bioeconomy development 'losers' and 'winners', however, several groups of analysed regions have distinctly higher potential in certain bioeconomy fields.

Keywords: innovation economy, bioeconomy development, European regions.
JEL Codes: O13, O14, O31, Q57, R11.

1. Introduction

In the context of growing global population, rapid depletion of many resources, increasing environmental pressures and climate change, Europe needs to radically change its approach to production, consumption, processing, storage, recycling and disposal of biological resources (European Commission, 2012). OECD (2016) suggests that the continuation of business-as-usual economic growth and development will have serious impacts on natural resources and the ecosystem services, on which human well-being depends, and highlights the necessity to move to a new growth path.

* *Corresponding Author*

This new growth path should be consistent with the protection of the environment and a sustainable use of scarce natural resources, while still achieving sizeable gains in living standards and reducing poverty. The bioeconomy comprises those parts of the economy that use renewable biological resources from land and sea – such as crops, forests, fish, animals and micro-organisms – to produce food, materials and energy (European Commission, 2012; 2018). Only concerted development across a range of sectors – arable and livestock farming, forestry, aquaculture, food processing, chemical industry, manufacturing of bio-based materials and energy – will create a smart, sustainable and inclusive bioeconomy, since individual sectors will be mutually dependent on each other for raw materials and energy (BECOTEPS, 2017). If one of these sectors is left behind, the inter-connectedness means that the entire biomass value chain is weakened. First proposals on the bioeconomy by the European Commission emphasised greater resource-efficiency, largely within an industrial perspective on global economic competitiveness, benefiting capital-intensive industries at higher levels of the value chain, however, involving all levels of bio-based supply chains in the knowledge-base could lead to a better-managed system, addressing the problems set out in the EU bioeconomy strategy (Schmidt, 2012). Consequently, in updated EU bioeconomy strategy, the European Commission (2018) proposes actions to support rural and coastal development, also in remote areas, ensuring a more proportionate sharing of the benefits of a competitive and sustainable bioeconomy across European territories and value chains.

Based on criteria specified by "BioEconomy Regional Strategy Toolkit" project consortium led by Agricultural Economics Institute of Wageningen University and Research Centre, regional bioeconomy development depends on biomass availability and land use, structure of bioeconomy employment and firms, demographics and quality of workforce, as well as on innovation capacity (BioEconomy..., 2016). Since balanced development of knowledge-driven bioeconomy is desired, abovementioned factors should be also more or less equally developed across European regions. Although rural and coastal areas have comparatively more spare biomass, these areas are frequently associated with lower levels of entrepreneurship and R&D activities. Therefore, one can argue that in the case of bioeconomy development, the phenomenon of 'resource curse' may appear, when territories with an abundance of natural resources (such as fossil fuels, certain minerals) tend to have less economic growth and worse development outcomes than those territories with fewer natural resources (Venables, 2016). In this scenario, more urbanized and industrialized regions with higher innovation potential will develop high value added bio-based industries, while rural and coastal economies will remain or become to a greater extent biomass providers. Of course, the phenomenon of 'resource curse' is not universal and affects certain types of regions under certain conditions (Ross, 2015). Nonetheless, even with large investments for socio-economic cohesion across regions and society groups in developed parts of the world, an inverted U-shaped relation between income inequality and economic growth proposed by Kuznets (1955) remains rather textbook concept than economic reality of today.

ISSN 2345-0355. 2018. Vol. 40. No. 4: 492–513
Article DOI: http://doi.org/10.15544/mts.2018.45

Investment in relevant research areas, encouraging innovation and making entrepreneurship within the bioeconomy a desirable career option are highlighted as key enablers to unlock the potential of the bioeconomy (European Commission, 2012, 2018; BECOTEPS, 2017). Concept of innovation economics integrates entrepreneurship capacity (Schumpeter, 1911; Baumol, 1996; Kirzner, 1997) together with knowledge and technological development (Antonelli, 2003) to enable the creation of more effective processes, products and business models, which are essential for the development of a competitive and sustainable bioeconomy. The analyses of good practice examples of bioeconomy development at regional level (Overbeek, 2016; Teräs, 2014) show the importance of innovation clusters, where coordinated cross-sectorial cooperation in the field of R&D is being facilitated to develop new bio-based products and to improve biomass value chains. In the EU, based on the concentration of national labour markets in the bioeconomy and the apparent labour productivity of the bioeconomy, four distinct groups of member states can be identified: (1) EU member states whose national labour markets are strongly specialised in the bioeconomy sectors, but have a low level of apparent labour productivity; (2) EU member states with a medium specialisation of national labour markets in the bioeconomy sectors and a medium-low level of apparent labour productivity; (3) EU member states with a low-to-medium specialisation of national labour markets in the bioeconomy and medium-high level of apparent labour productivity; (4) EU member states with a low level of bioeconomy specialisation in their national labour markets and high level of apparent labour productivity of the bioeconomy sectors (Ronzon, 2018a; Ronzon, 2018b). This illustrates that at least on national level there is a divide between territories specialised in biomass production, food processing and other traditional bio-based sectors (‘agrarian areas’) and those territories that are less specialised, but way more productive. So it is apparent that aspects of innovation economics (such as entrepreneurial and R&D activities in regions) could define which regions will gain the most from arising opportunities in the bioeconomy field. Remarkably, the bioeconomy development at regional (NUTS 3) level is less explored in the literature, making it an interesting avenue for further research.

As abundance of biomass resources, present cluster of business enterprises can be either advantage or disadvantage of a region for developing innovative bioeconomy. The bioeconomy development concerns the following economic activities by the NACE classification: agriculture (A01), forestry (A02), fishing and aquaculture (A03), manufacture of food (C10), beverages (C11) and tobacco (C12), manufacture of bio-based textiles (C13), bio-based wearing apparel (C14) and leather (C15), manufacture of wood products (C16), wooden furniture (C31) and paper (C17), manufacture of bio-based chemicals (C20), bio-based pharmaceuticals (C21), bio-based plastics and rubber (C22), manufacture of bioethanol (C2014) and biodiesel (C2059), production of bioelectricity (D3511) (Ronzon, 2018b). In some literature (BioEconomy..., 2016), construction industry is also considered as a part of the bioeconomy. According to various classifications of economic activities based on R&D intensity

(Galindo-Rueda, 2016; Eurostat, 2018), high and medium technology sectors related to the bioeconomy are manufacture of pharmaceuticals, chemicals, plastics and rubber, while remaining bioeconomy sectors are of low R&D intensity. Notably, research-driven biotechnology sector, which activities do not fall into one specific NACE category, is considered to be a cornerstone of the bioeconomy concept, offering great potential to improve bio-based products and related production processes (Woźniak, 2018; OECD, 2018). Therefore, regions with larger clusters of business enterprises operating in indicated high and medium technology sectors may have competitive advantage in regards to their R&D base and, as a result, a greater capacity to develop innovative bio-refinery technologies and bio-based products, including those from biological waste, which potentials are being increasingly recognized in Central and Eastern Europe (Piotrowski, 2018). Studies based on surveys of European bioeconomy development stakeholders (Vásáry, 2018) show that the most important innovation functions are 'counteracting the resistance to change' (i.e. building investor confidence in the bioeconomy) and 'resource mobilisation' (i.e. provision of access to financial support). This implies that the bioeconomy development requires strong interactions between business and research communities, as well as with governmental sector.

Hence, the aim of this research is to explore links between discussed bioeconomy development factors, i.e. local biomass availability, regional bioeconomy business cluster and regional innovation potential, and how the development of bioeconomy can evolve in different groups of regions based on their biomass, business, entrepreneurial and R&D resources. According earlier considered scenario, the following hypotheses are formulated for the research:

Hypothesis 1. Greater local biomass availability is related to larger regional cluster of biomass production business, but not to larger regional cluster of higher value added bio-based production business.

Hypothesis 2. Greater local biomass availability is related to lower regional innovation potential, i.e. to lower levels of entrepreneurship and R&D activities.

Hypothesis 3. Higher regional innovation potential is related to larger regional cluster of higher value added bio-based production business, but not to larger regional cluster of biomass production business.

Hypothesis 4. Regions are either rich with local biomass or with innovation potential.

2. Research data and methods

For the research, 25 variables describing 'local biomass availability', 'regional cluster of bioeconomy business' and 'regional innovation potential' were selected from the open access database of "BioEconomy Regional Strategy Toolkit" (BERST) project. The reference year is 2016 for all the variables. The full list of selected variables and their descriptions are provided in Table 1.

Management Theory and Studies for Rural Business and Infrastructure Development
ISSN 2345-0355. 2018. Vol. 40. No. 4: 492–513
Article DOI: http://doi.org/10.15544/mts.2018.45

Table 1. Definition of selected variables

Variable	Definition	Source
	Local biomass availability	
Agricultural_ biomass	Agricultural biomass production (kg/capita), NUTS 3 level, year of 2016	BERST
Forestry_biomass	Forestry biomass production (kg/capita), NUTS 3 level, year of 2016	BERST
Blue_biomass	Blue (maritime) biomass production (kg/capita), NUTS 3 level, year of 2016	BERST
Waste	Waste biomass production (kg/capita), NUTS 3 level, year of 2016	BERST
Total_biomass_ including_waste	Agricultural, forestry, blue (maritime) and waste biomass production (kg/capita), NUTS 3 level, year of 2016	BERST
Total_biomass_ excluding_waste	Agricultural, forestry and blue (maritime) biomass production (kg/capita), NUTS 3 level, year of 2016	BERST
Regional cluster of bioeconomy business		
..._firms	Number of firms in particular region by different bioeconomy sectors (i.e. Primary_biomass_firms, Food_and_feed_firms, Textile_ firms, Paper_and_pulp_firms, Construction_firms, Chemical_ firms, Energy_firms, Biotechnology_firms), NUTS 3 level, year of 2016	BERST
..._employment	Share of total employment in particular region by different bioeconomy sectors (i.e. Primary_biomass_employment, Food_and_feed_employment, Textile_employment, Paper_and_pulp_employment, Construction_employment, Chemical_employment, Energy_employment, Biotechnology_employment), NUTS 3 level, year of 2016	BERST
Regional innovation potential		
SME_birth_rate	New small and medium-sized enterprises as a percentage of total firms in particular region, NUTS 3 level, year of 2016	BERST
Research_and_ development_ expenditure	Regional Innovation Scoreboard index of R&D expenditure (EU=1), NUTS 3 level, year of 2016	BERST
Research_and_ development_ employment	R&D employment as a percentage of total employment in particular region, NUTS 3 level, year of 2016	BERST

Sample includes 237 regions of Norden, Western and Central Europe that have from 150 000 to 800 000 citizens (NUTS 3 level). More specifically, sample covers 20 regions in Norway, 19 regions in Finland, 5 regions in Estonia, 6 regions in Latvia, 133 regions in the United Kingdom, 40 regions in the Netherlands, 2 regions in Germany and 12 regions in Slovenia.

According to the study commissioned by the European Commission “Bioeconomy Development in EU Regions: Mapping of EU Member States’ / Regions’ Research and Innovation Plans and Strategies for Smart Specialisation on Bioeconomy for 2014–2020” (Spatial..., 2017), although in terms of bioeconomy research and innovation maturity analysed regions all together can be described as being around or above EU average performers, maturity of separate regions are varying from average to the highest levels. As can be seen from Table 2, analysed regions are quite different in terms of entrepreneurial activities and R&D capacity, as well as in regards to local biomass resources and the structure of their bio-based business clusters. These aspects are favourable for the analysis.

Table 2. Summary statistics for selected variables

Variable	N	Mean	Std. Deviation	Minimum	Maximum
Agricultural_biomass	237	1 414.865	2 056.1530	5.4	14 625.5
Forestry_biomass	237	3 413.877	10 914.3428	0.0	94 113.9
Blue_biomass	237	118.297	487.8686	0.0	3 703.7
Waste	237	1 276.432	3 355.6866	0.0	24 226.0
Total_biomass_including_ waste	237	6 223.471	13 926.9547	30.9	103 894.7
Total_biomass_excluding_ waste	237	4 947.039	11 423.1580	8.8	94 488.4
Primary_biomass_firms	237	1 452.60	1 738.653	0	7 133
Primary_biomass_ employment	237	3.184	3.8912	0.0	26.1
Food_and_feed_firms	237	59.39	83.847	0	429
Food_and_feed_ employment	237	1.030	1.0091	0.0	4.5
Textile_firms	237	50.88	87.243	0	807
Textile_employment	237	0.290	0.5884	0.0	4.3
Paper_and_pulp_firms	237	42.42	95.781	0	673
Paper_and_pulp_ employment	237	0.511	0.9224	0.0	9.3
Construction_firms	237	681.91	1 469.471	0	9 248
Construction_employment	237	1.893	2.5526	0.0	10.5
Chemical_firms	237	50.18	50.995	0	318
Chemical_employment	237	1.306	1.2495	0.0	9.9
Energy_firms	237	24.98	37.320	0	262
Energy_employment	237	0.579	0.6866	0.0	5.6
Biotechnology_firms	237	5.83	20.767	0	282
Biotechnology_ employment	237	0.020	0.0625	0.0	0.4
SME_birth_rate	235	10.503	3.2162	4.3	25.3
Research_and_ development_ expenditure	214	0.460	0.2697	0.1	2.6
Research_and_ development_ employment	229	0.657	0.6764	0.0	4.3

In order to link variables describing ‘local biomass availability’, ‘regional cluster of bioeconomy business’ and ‘regional innovation potential’ a number of Principal Component Analyses (PCA) were run. This method allows a set of correlated variables to be transformed into a smaller set of hypothetical uncorrelated constructions, i.e. principal components that then can be used to discover and describe the dependencies

Management Theory and Studies for Rural Business and Infrastructure Development
ISSN 2345-0355. 2018. Vol. 40. No. 4: 492–513
Article DOI: http://doi.org/10.15544/mts.2018.45

among variables and to study the relationships that might exist among cases (Timm, 2002). In addition to the application of PCA method, Pearson correlations between analysed variables were checked using interpretations proposed by Evans (1996), i. e. 0.00–0.19 is considered to be 'very weak' correlation, 0.20–0.39 – 'weak' correlation, 0.40–0.59 – 'moderate' correlation, 0.60–0.79 – 'strong' correlation, 0.80–1.00 – 'very strong' correlation. Finally, to distinguish and explore types of regions based on their bioeconomy development potential, Cluster Analysis (CA) was completed. This method is used to identify homogenous groups (clusters) of objects that share a number of common characteristics within a particular cluster, but are dissimilar to objects not belonging to that cluster (Sarstedt, 2014).

The analysis framework of regional bioeconomy development potential from the perspective of innovation economics is provided in Figure 1.

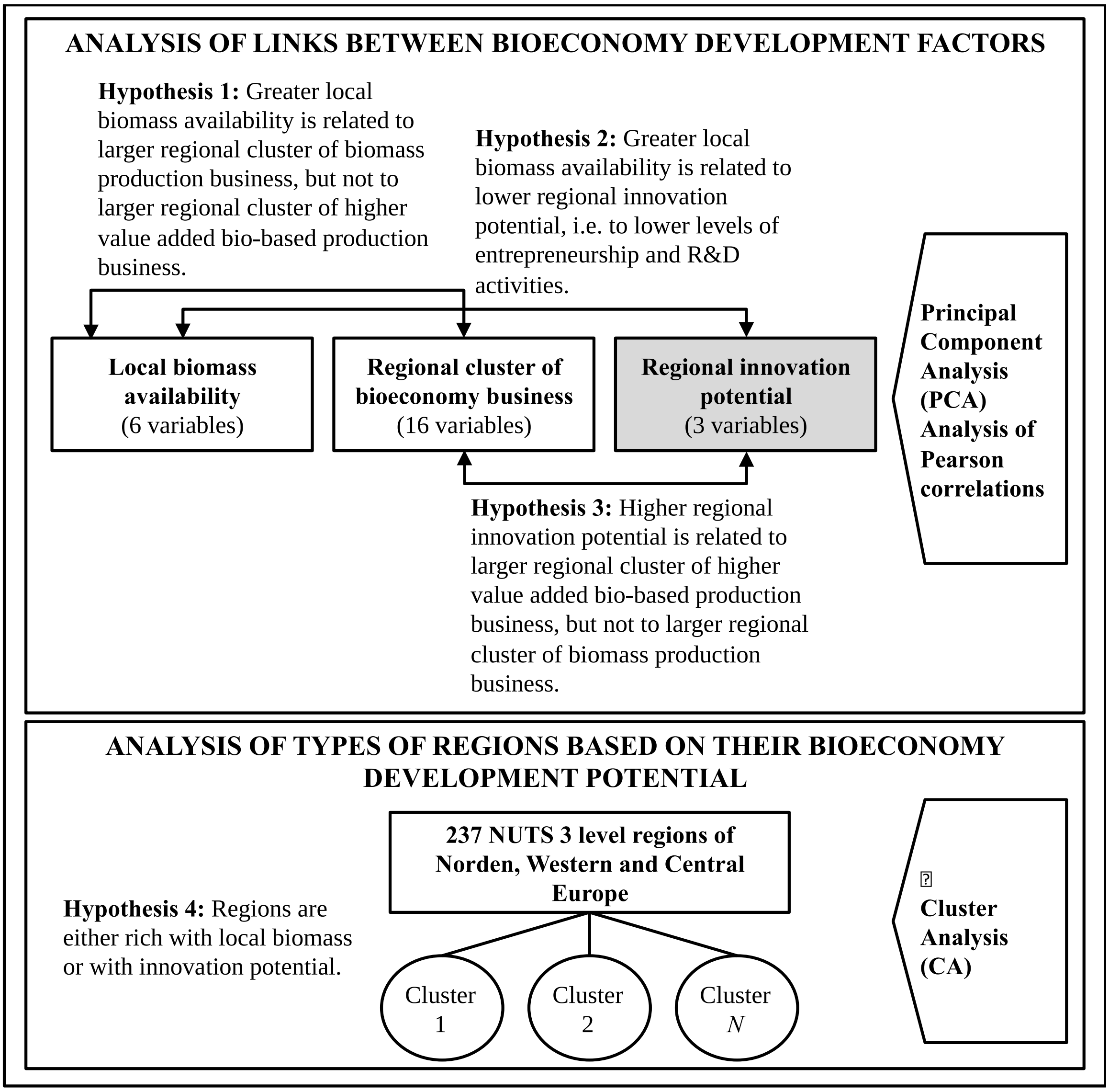


Figure 1. The analysis framework of regional bioeconomy development potential from the perspective of innovation economics

For statistical data analysis SPSS was used. Where possible (Garson, 2015), pairwise deletion (analysis of available regions) was preferred to minimize the loss that would occur in listwise deletion (analysis of regions with no missing data). Specifically, pairwise deletion was used for PCA and the analysis of Pearson correlations.

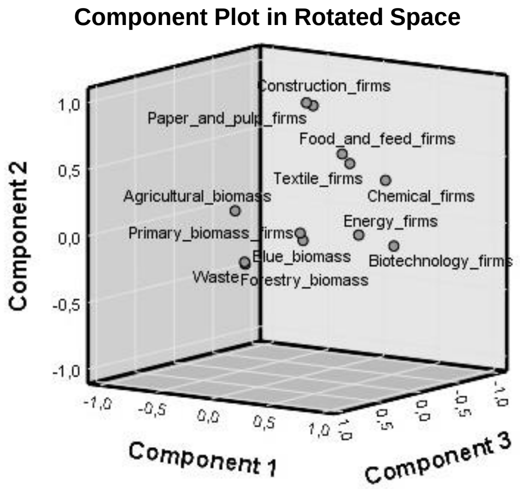
3. Research results

3.1. Relationships between local biomass availability and regional business cluster

Based on PCA, where the size of bioeconomy business clusters is measured by number of firms (Figure 2), variable of primary biomass firms falls in Component 3 with variables of waste, forestry and agricultural biomass availability, while variable of blue biomass availability remains separately in Component 4. Variables of biotechnology, energy, chemical and textile firms (Component 1), as well as variables of construction, paper and pulp, food and feed firms (Component 2) form separate components. Other PCA, where the size of bioeconomy business clusters is measured by share of total employment (Figure 3), shows the connection between variable of agricultural biomass availability and variables of employment in primary biomass, food and feed production, construction and textile sectors (Component 1). In this PCA, although weakly, the availability of blue biomass is negatively linked with employment in paper and pulp production and chemical industry (Component 2), while the availability of forestry and waste biomass is positively linked with employment in biotechnology sector (Component 3). Variable of employment in energy sector forms separate component (Component 4).

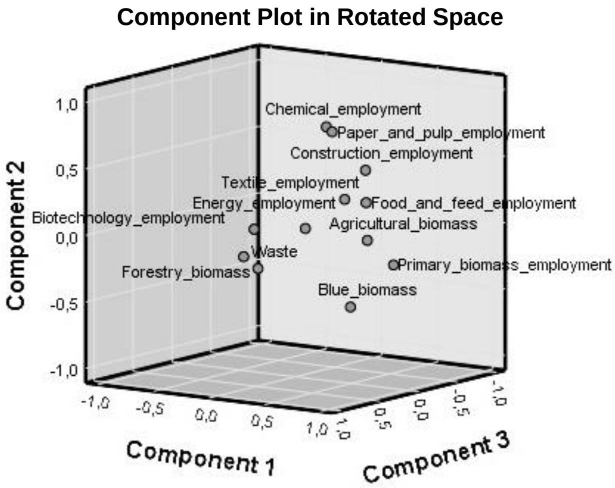
Results of these PCA imply that in analysed regions the availability of biomass resources (i.e. waste, forestry and agricultural biomass) can be linked with the size of primary biomass production cluster, while specifically the availability of agricultural biomass can be also linked with the size of food and feed production, construction and textile business clusters.

Management Theory and Studies for Rural Business and Infrastructure Development
ISSN 2345-0355. 2018. Vol. 40. No. 4: 492–513
Article DOI: http://doi.org/10.15544/mts.2018.45



KMO = 0.709; Sig. for Bartlett's Test = 0.000; Communalities ≥ 0.450; Variance explained by Component 1 = 23.5%; Variance explained by Components 1 and 2 = 47.0%; Variance explained by Components 1, 2 and 3 = 66.8%; Variance explained by Components 1, 2, 3 and 4 = 77.4%; Rotation Method: Varimax with Kaiser Normalization;
Source: Output obtained in SPSS with PCA

Figure 2. The position of variables describing local biomass availability and regional business cluster (number of bioeconomy firms) on the first factorial plane from PCA



KMO = 0.655; Sig. for Bartlett's Test = 0.000; Communalities ≥ 0.523 (excluding 0.236 for biotechnology employment); Variance explained by Component 1 = 23.2%; Variance explained by Components 1 and 2 = 39.5%; Variance explained by Components 1, 2 and 3 = 54.4%; Variance explained by Components 1, 2, 3 and 4 = 64.1%; Rotation Method: Varimax with Kaiser Normalization;
Source: Output obtained in SPSS with PCA

Figure 3. The position of variables describing local biomass availability and regional business cluster (employment in bioeconomy) on the first factorial plane from PCA

Analysis of Pearson correlations (Table 3) reveals that statistically significant moderate positive correlations exist between the availability of total biomass resources (especially, waste) and the number of primary biomass production firms, as well as between the availability of agricultural biomass and the levels of employment in primary biomass, food and feed production, construction and textile business. These results are consistent with results of already presented PCA. However, we can add that statistically significant weak positive correlations appear between waste, blue and forestry biomass and the number of energy firms in a region.

Table 3. Pearson correlation coefficients describing relationships between local biomass availability and regional business cluster

	Agricultur-al_biomass	Forest-ry_ biomass	Blue_ biomass	Waste	Total_ biomass_ includ-ing_ waste	Total_ biomass_ exclud-ing_ waste
Primary_biomass_firms	0.387**	0.366**	0.163*	0.502**	0.471**	0.427**
Primary_biomass_ employment	0.569**	0.134*	0.301**	0.136*	0.233**	0.244**
Food_and_feed_firms	0.177**	0.098	0.217**	0.211**	0.161*	0.135*
Food_and_feed_ employment	0.475**	0.121	–0.046	0.234**	0.219**	0.199**
Textile_firms	0.231**	0.087	0.013	0.147*	0.138*	0.125
Textile_employment	0.523**	0.102	–0.020	0.165*	0.196**	0.191**
Paper_and_pulp_firms	0.007	–0.105	–0.091	–0.115	–0.112	–0.103
Paper_and_pulp_ employment	0.116	–0.021	–0.116	–0.047	–0.015	–0.004
Construction_firms	0.054	–0.092	–0.078	–0.097	–0.090	–0.081
Construction_ employment	0.479**	0.052	–0.107	0.054	0.121	0.132*
Chemical_firms	–0.066	–0.109	–0.119	–0.098	–0.123	–0.121
Chemical_employment	0.035	–0.167**	–0.144*	–0.198**	–0.179**	–0.160*
Energy_firms	0.164*	0.279**	0.293**	0.362**	0.341**	0.309**
Energy_employment	0.126	–0.037	0.093	–0.053	–0.019	–0.008
Biotechnology_firms	–0.058	0.070	–0.018	0.099	0.070	0.056
Biotechnology_ employment	–0.023	0.133*	–0.038	0.193**	0.146*	0.121

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

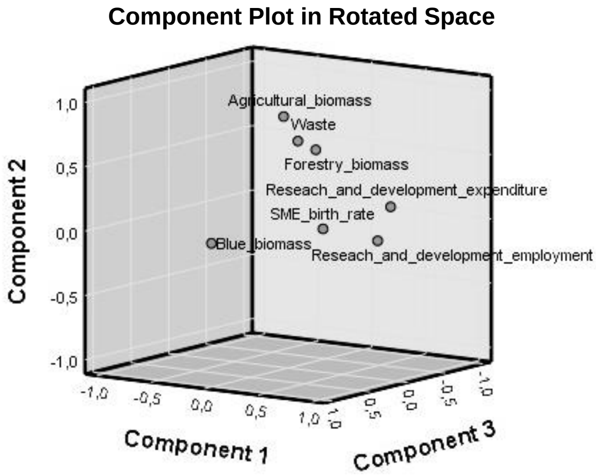
Notably, only level of employment in chemical industry is negatively correlated with the availability of biomass resources (i.e. with availability of waste, forestry and blue biomass). These correlations are statistically significant, but very weak. The same applies for employment in biotechnology sector, with which a few very weak positive correlations at different levels of significance appear with forestry and waste biomass availability variables. Therefore, it is not obvious that regions with greater biomass availability (rural regions) have smaller higher value added bio-based production clusters.

3.2. Relationships between local biomass availability and regional innovation potential

Based on PCA, where regional innovation potential is measured by levels of entrepreneurship and R&D activities (Figure 4), variables of R&D employment and expenditure fall in Component 1, biomass resources (i.e. agricultural, waste and forestry

ISSN 2345-0355. 2018. Vol. 40. No. 4: 492–513
Article DOI: http://doi.org/10.15544/mts.2018.45

biomass) form separate component (Component 2), while the availability of blue biomass is negatively linked with the birth rates of small and medium-sized businesses in Component 3.



KMO = 0.578; Sig. for Bartlett's Test = 0.000; Communalities ≥ 0.572; Variance explained by Component 1 = 28.5%; Variance explained by Components 1 and 2 = 52.4%; Variance explained by Components 1, 2 and 3 = 72.9%; Rotation Method: Varimax with Kaiser Normalization;
Source: Output obtained in SPSS with PCA

Figure 4. The position of variables describing local biomass availability and regional innovation potential on the first factorial plane from PCA

Analysis of Pearson correlations (Table 4) shows that there are statistically significant weak positive correlations between the levels of R&D activities (i.e. R&D expenditure and employment) and the availability of biomass (specifically, of waste and forestry biomass resources). These relationships could exist because more urbanized and industrialized areas with higher levels of R&D activities produce more waste, while Finnish and Norwegian regions being present in the sample could explain the relationship between R&D activities and forestry resources.

Table 4. Pearson correlation coefficients describing relationships between local biomass availability and regional innovation potential

	Agricul-tural_ biomass	Forest-ry_ biomass	Blue_ biomass	Waste	Total_ biomass_ includ-ing_ waste	Total_ biomass_ exclud-ing_ waste
SME_birth_rate	0.109	–0.315**	–0.262**	–0.452**	–0.349**	–0.293**
Research_and_develop-ment_expenditure	0.119	0.337**	–0.131	0.361**	0.363**	0.339**
Research_and_develop-ment_employment	–0.101	0.314**	0.033	0.297**	0.314**	0.297**

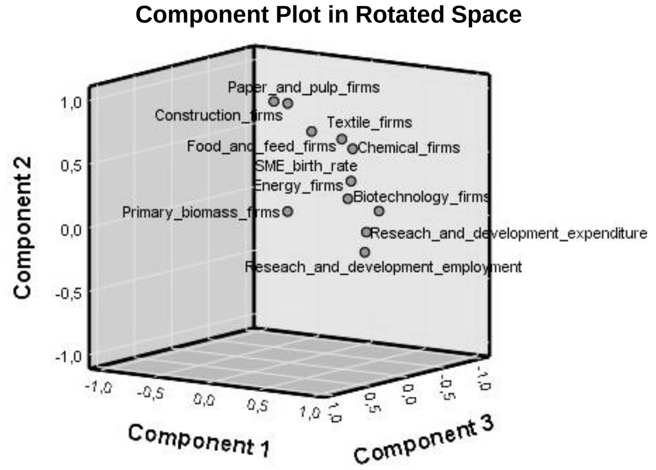
** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

In regards to entrepreneurial activities, statistically significant weak negative correlation appears between the birth rates of small and medium-sized businesses and the availability of biomass (specifically, of forestry and blue biomass resources), while negative correlation between entrepreneurial activities and waste biomass is stronger (statistically significant moderate correlation). This could imply that more urbanized and industrialized areas that produce more waste are less active in new business creation. Not all new small enterprises are high growth potential start-ups. As quality of entrepreneurs and their undertakings is more important than quantity (Poschke, 2013; Sieger, 2016), a high level of self-employment is not necessarily a good indicator of entrepreneurial activity (Kritikos, 2014). Otherwise, these results also suggest that areas with rich forest resources and coastal areas may be less entrepreneurial.

3.3. Relationships between regional business cluster and regional innovation potential

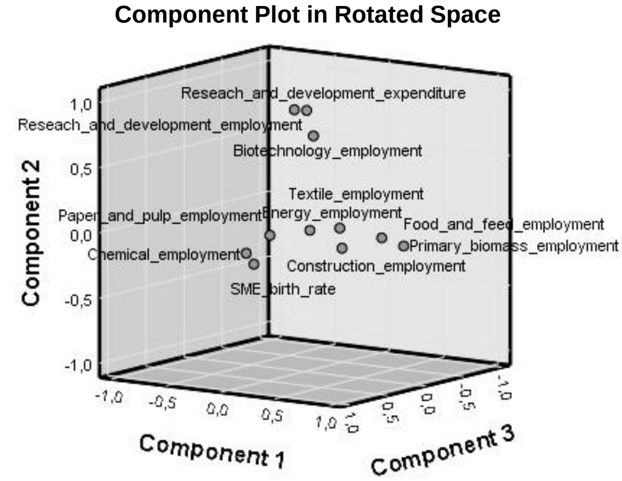
Based on PCA, where the size of bioeconomy business clusters is measured by number of firms (Figure 5), variables of R&D employment and expenditure fall in Component 1 with variables of biotechnology and energy firms, while variables of construction, paper and pulp, food and feed, textile and chemical firms form Component 2. Variable of entrepreneurial activities (i.e. birth rate of small and medium-sized businesses) is negatively linked with primary biomass production firms in Component 3.

Management Theory and Studies for Rural Business and Infrastructure Development
ISSN 2345-0355. 2018. Vol. 40. No. 4: 492–513
Article DOI: http://doi.org/10.15544/mts.2018.45



KMO = 0.730; Sig. for Bartlett's Test = 0.000; Communalities ≥ 0.570; Variance explained by Component 1 = 32.0%; Variance explained by Components 1 and 2 = 62.5%; Variance explained by Components 1, 2 and 3 = 77.3%; Rotation Method: Varimax with Kaiser Normalization;
Source: Output obtained in SPSS with PCA

Figure 5. The position of variables describing regional business cluster (number of bioeconomy firms) and regional innovation potential on the first factorial plane from PCA



KMO = 0.680; Sig. for Bartlett's Test = 0.000; Communalities ≥ 0.499; Variance explained by Component 1 = 19.6%; Variance explained by Components 1 and 2 = 38.8%; Variance explained by Components 1, 2 and 3 = 57.3%; Variance explained by Components 1, 2, 3 and 4 = 68.7%; Rotation Method: Varimax with Kaiser Normalization;
Source: Output obtained in SPSS with PCA

Figure 6. The position of variables describing regional business cluster (employment in bioeconomy) and regional innovation potential on the first factorial plane from PCA

Other PCA, where the size of bioeconomy business clusters is measured by share of total employment (Figure 6), shows the relationship between variables of employment in food and feed, primary biomass production and construction business (Component 1). Here variables of R&D expenditure and employment fall in Component 2 with variable of employment in biotechnology sector. Variables of entrepreneurial activities and employment in chemical, paper and pulp industry (Component 3) and variables of employment in energy and textile production business (Component 4) form separate components.

These results imply that we can associate higher levels of R&D activities with larger biotechnology sector (in terms of both number of firms and share of total employment). Analysis of Pearson correlations (Table 5) reveals that variable of R&D expenditure is positively correlated with the number of primary biomass production, energy and biotechnology firms and with biotechnology sector employment (statistically significant moderate correlations), as well as with the number of food and feed, textile production and chemical industry firms (statistically significant weak correlations).

Similar patterns apply for R&D employment variable, except that this variable has no significant correlation with the number of chemical industry firms. No significant correlations are found between R&D activities and variables of construction, paper and pulp industries.

These results show that not all bio-based production businesses, i.e. their presence or absence, can be related to higher or lower levels of R&D activities, but more importantly it demonstrates that larger number of primary biomass production firms do not imply less R&D funding or researchers in a region. However, these results should be treated with caution, since they differ based on business cluster measurement (i.e. whether it is number of firms or share of total employment).

Table 5. Pearson correlation coefficients describing relationships between regional business cluster and regional innovation potential

	SME_birth_rate	Research_and_ develop- ment_expenditure	Research_and_ develop- ment_employment
Primary_biomass_firms	–0.485**	0.505**	0.433**
Primary_biomass_ employment	–0.067	–0.033	–0.148*
Food_and_feed_firms	–0.078	0.326**	0.319**
Food_and_feed_ employment	0.071	0.047	–0.139*
Textile_firms	0.115	0.385**	0.335**
Textile_employment	0.291**	0.118	–0.068
Paper_and_pulp_firms	0.247**	0.020	–0.148*
Paper_and_pulp_ employment	0.286**	0.088	–0.049
Construction_firms	0.161*	–0.004	–0.166*
Construction_employment	0.337**	0.039	–0.183**
Chemical_firms	0.191**	0.224**	0.104
Chemical_employment	0.308**	–0.053	–0.175**
Energy_firms	–0.202**	0.587**	0.582**
Energy_employment	0.158*	–0.040	–0.015
Biotechnology_firms	–0.064	0.573**	0.572**
Biotechnology_ employment	–0.141*	0.448**	0.396**

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

As mentioned earlier, entrepreneurial activities (i.e. birth rate of small and medium-sized businesses) is negatively correlated with the number of primary biomass production firms (statistically significant moderate correlation). Large cluster of such firms can be associated with lower level of entrepreneurial activities or vice versa. Although weakly, higher birth rate of small and medium-sized businesses is positively correlated with employment in construction, chemical, textile, paper and pulp industries. This reveals that variables of entrepreneurial activities and R&D activities are differently linked with variables of separate bioeconomy business clusters (in some cases, e.g. with primary biomass production cluster, even the sign of statistically significant correlations is different).

3.4. Results of clustering regions based on local biomass availability and regional innovation potential

Considering the availability of agricultural biomass only (Table 6), majority of regions (204 regions) fall in Cluster 1, which is characterized by high to moderate levels of entrepreneurial activities (i.e. birth rates of small and medium-sized businesses) and by low levels of R&D activities (i.e. employment in R&D). Meanwhile, Cluster 2 (containing 9 NUTS 3 level regions in Finland, 5 regions in Norway and 5 regions in the United Kingdom) is characterized by slightly lower levels of entrepreneurial activities, but by comparatively higher levels of R&D activities. Several regions (i.e. 3 NUTS 3 level regions in Estonia and 1 region in the Netherlands) assigned to Cluster 3, compared to other regions, are very rich with agricultural biomass per capita, have moderate levels of entrepreneurial activities, however, can be distinguished by very low levels of R&D activities. These results suggest that regions having least agricultural biomass per capita (19 regions) are most advanced in R&D activities, while regions having great agricultural biomass availability (4 regions) are least advanced in R&D activities. Regardless of this, majority of regions (204 regions) are neither distinguishable by being rich of agricultural biomass resources on per capita basis, nor advanced in R&D activities.

Table 6. Clusters of regions based on agricultural biomass and innovation potential

Clusters	Agricultural_biomass		SME_birth_rate		Research_and_ development_employment	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Cluster 1: 204 regions	1 080.049	970.0855	10.501	2.9991	0.489	0.3064
Cluster 2: 19 regions	988.684	929.4671	8.679	3.7431	2.526	0.8061
Cluster 3: 4 regions	7 736.375	2 371.9497	9.925	0.2062	0.200	0.2309

Considering the availability of forestry biomass (Table 7), most regions (211 regions) are assigned to Cluster 1, which is characterized by high to moderate levels of entrepreneurial activities and by low levels of R&D activities. Regions within this cluster have lower levels of forestry biomass resources per capita. Meanwhile, 8 NUTS 3 level regions in Finland and 4 regions in Norway (Cluster 2) are characterized by higher levels of forestry biomass availability, very high levels of R&D activities, but low levels of entrepreneurial activities. Several regions (i.e. 4 NUTS 3 level regions in Finland) assigned to Cluster 3, compared to other regions, are very rich with forestry biomass per capita, have high levels of R&D activities, but are least entrepreneurial. These results show that majority of regions (211 regions) are neither distinguishable by being rich of forestry biomass resources on per capita basis, nor advanced in R&D activities. However, this CA reveals huge potential of Finnish and some Norwegian regions to develop innovative bioeconomy based on forest resources, not considering lower birth rates of small and medium-sized businesses in these regions.

Table 7. Clusters of regions based on forestry biomass and innovation potential

Clusters	Forestry_biomass		SME_birth_rate		Research_and_ development_employment	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Cluster 1: 211 regions	1 313.667	4 086.7451	10.647	2.9496	0.518	0.3951
Cluster 2: 12 regions	13 842.475	13 888.7879	6.600	1.3143	2.817	0.8632
Cluster 3: 4 regions	71 916.025	17 050.2677	5.300	0.6583	1.400	0.4546

Considering the availability of blue (maritime) biomass (Table 8), majority of regions (216 regions) fall in Cluster 1, which is characterized by low levels of blue biomass availability and levels of entrepreneurial and R&D activities close to mean levels of all analysed regions, since most of them are represented in this cluster. Cluster 2 (containing 6 NUTS 3 level regions in Norway and 1 region in the United Kingdom) can be distinguished as being very rich with blue biomass resources per capita. In these regions, levels of R&D activities (i.e. employment in R&D) are comparatively high, while the birth rates of small and medium-sized businesses are comparatively low. Several regions (i.e. 3 NUTS 3 level regions in Finland and 1 region in Norway) are characterized by low levels of blue biomass resources per capita, but have very high R&D employment and moderate level of entrepreneurial activities. So regions having low levels of blue biomass availability are either more entrepreneurial (216 regions) or more R&D oriented (4 regions). 6 Norwegian regions and 1 region in the United Kingdom (Cluster 2) show highest potential for innovative blue bioeconomy development based on their blue biomass and R&D resources.

Table 8. Clusters of regions based on blue biomass and innovation potential

Clusters	Blue_biomass		SME_birth_rate		Research_and_ development_employment	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Cluster 1: 216 regions	37.823	139.5048	10.517	3.0302	0.584	0.5053
Cluster 2: 7 regions	2 692.786	790.7794	6.371	1.3388	0.971	0.8920
Cluster 3: 4 regions	169.775	339.5500	7.675	1.4569	3.900	0.3266

Management Theory and Studies for Rural Business and Infrastructure Development
ISSN 2345-0355. 2018. Vol. 40. No. 4: 492–513
Article DOI: http://doi.org/10.15544/mts.2018.45

Considering the availability of waste biomass (Table 9), majority of regions (209 regions) fall in Cluster 1, which is characterized by lower levels of waste biomass availability, higher levels of entrepreneurial activities, but comparatively low levels of R&D employment. Cluster 2 (containing 6 NUTS 3 level regions in Finland and 4 regions in Norway) has higher levels of waste biomass per capita, as well as very high R&D employment. Cluster 3 (containing of other 6 NUTS 3 level regions in Finland and 2 regions in Estonia) has highest levels of waste biomass per capita and comparatively high R&D employment. Both regions in Cluster 2 and those in Cluster 3 have lower birth rates of small and medium-sized businesses. Results of this CA suggest that regions with highest levels of waste biomass per capita (i.e. regions assigned to Cluster 2 and Cluster 3) have highest potential to develop knowledge-based circular bioeconomy, not considering lower birth rates of small and medium-sized businesses in these regions.

Table 9. Clusters of regions based on waste and innovation potential

Clusters	Waste		SME_birth_rate		Research_and_ development_employment	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Cluster 1: 209 regions	592.187	1 696.3576	10.662	2.9504	0.525	0.3957
Cluster 2: 10 regions	4 021.220	2 822.3261	6.820	1.3340	2.980	0.8561
Cluster 3: 8 regions	15 258.037	5 663.4706	6.288	2.1761	1.138	0.8667

When all types of biomass resources are considered (Table 10), similar patterns as in the previous CA appear. Most regions (212 regions) fall in Cluster 1 with lower levels of biomass availability. Several regions (10 regions) are being assigned to cluster with very high biomass availability and comparably high R&D employment (Cluster 2), while several other regions (5 regions) are being assigned to cluster with comparably high biomass availability and very high R&D employment (Cluster 3). Both regions in Cluster 2 and those in Cluster 3 have lower birth rates of small and medium-sized businesses. In these clusters Finnish regions dominate. There are 10 Finnish regions of total 10 regions in Cluster 2 and 4 Finnish regions of total 5 regions in Cluster 3 (remaining one is Norwegian region).

Results of presented cluster analyses show that majority of analysed regions can not be distinguished as being either rich or poor of biomass resources on per capita basis and having either small or large R&D capacity in terms of R&D employment.

Table 10. Clusters of regions based on total biomass and innovation potential

Clusters	Total_biomass_ including_waste		SME_birth_rate		Research_and_ development_employment	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Cluster 1: 212 regions	3 039.580	6 062.8728	10.645	2.9279	0.538	0.4397
Cluster 2: 10 regions	58 869.560	22 727.3514	5.260	0.6240	1.610	0.6691
Cluster 3: 5 regions	16 334.640	13 402.5131	7.520	1.3084	3.680	0.5675

However, it is apparent that regions having least agricultural biomass per capita are most advanced in R&D activities, while fraction of regions having comparatively high levels of forestry, blue or waste biomass availability also have high R&D employment rates, therefore, and high innovation potential, not considering lower birth rates of small and medium-sized businesses in these regions.

4. Conclusions

1. Based on results of PCA, analysis of Pearson correlations and CA, all 4 hypotheses were rejected. Firstly, greater biomass resources can be associated with larger regional primary biomass production cluster in terms of number of firms and employment rates. However, greater agricultural biomass resources can be also linked with higher levels of employment in food and feed production, construction and textile business. Moreover, it is not obvious that greater biomass availability can not be associated with larger higher value added bio-based production clusters (e.g. with better developed biotechnology sector). Secondly, greater local biomass availability is not related to lower regional innovation potential, i.e. to lower levels of R&D activities. Thirdly, variable of R&D expenditure is positively correlated with the number of primary biomass production, energy and biotechnology firms and with biotechnology sector employment, as well as with the number of food and feed, textile production and chemical industry firms. Similar patterns apply for R&D employment variable. So larger number of primary biomass production firms does not imply less R&D funding or researchers in a region, also not all bio-based production businesses, i.e. their presence or absence, can be related to higher or lower levels of R&D activities. Fourthly, majority of analysed regions can not be distinguished as being either rich or poor of biomass resources on per capita basis and having either small or large R&D capacity in terms of R&D employment. Also, it is apparent that regions having least agricultural biomass per capita are most advanced in R&D activities, but frac-

tion of regions having comparatively high levels of forestry, blue or waste biomass availability have high R&D employment rates, therefore, and high innovation potential (not considering lower birth rates of small and medium-sized businesses in these regions).

2. Regions in economically developed countries that were covered in this research have very different resources for the bioeconomy development. Despite this fact, attempt to separate them into potential bioeconomy development 'losers' and 'winners', by integrating variables of biomass availability, bio-based business cluster and innovation potential, has failed. Nevertheless, several groups of regions with high potential were identified: 12 Finnish regions and 4 Norwegian regions with high potential to develop innovative forest biomass based bioeconomy, 6 Norwegian regions and 1 region in the United Kingdom with high potential for innovative blue bioeconomy development, as well as 12 Finnish regions, 4 Norwegian regions and 2 Estonian regions with high potential to develop knowledge-based circular bioeconomy. Of course, this potential can be utilised only if R&D specialisation will match needs of identified bioeconomy sectors and regional business cluster will take the lead.

3. In the reference year, the relationships between explored bioeconomy development factors (i.e. between biomass availability, bio-based business cluster and innovation potential) are rather weak in analysed regions. Taking into account potential risks related to coherent and balanced development of different bioeconomy parts in different EU territories, the research could be repeated at a later time to evaluate the progress towards EU goals of sustainable and inclusive bioeconomy development. Results of the research do not show structural problems (at least within covered regions), when particular regions would be trapped with great biomass availability, but poor business and innovation potential. Therefore, it would be recommended for European regions to focus on improving current bio-based value chains (e.g. developing competitive bio-based businesses around local biomass resources, including biological waste) and on specialisation in relevant areas of the bioeconomy (e.g. investing in those fields of R&D that match the potential of local business companies and prospects in the market).

4. There are several worthy to note limitations of this research. The size of bioeconomy business clusters was measured by indicators of the number of firms and the share of total employment. For instance, gross value added indicators would describe more precisely the weight of separate bioeconomy sectors in region's economy and its competitiveness in relation to other regions. The number of firms does not show their scope of activities, while high levels of employment may signal inefficiencies in business and production processes. Entrepreneurship measurement was also limited to SME birth rate, which does not reveal the sectors (high, medium or low-tech), in which these new enterprises operate.

References

Antonelli, C. (2003). The Economics of Innovation, New Technologies and Structural Change. – London: Routledge. 4–37 pp.

Baumol, W. J. (1996). Entrepreneurship: Productive, Unproductive, and Destructive // *Journal of Business Venturing*. Vol. 11. No. 1: 3–22.

BECOTEPS – Bio-Economy Technology Platforms. (2017). The European Bioeconomy in 2030 Delivering Sustainable Growth by Addressing the Grand Societal Challenges. – http://www.plantetp.org/system/files/publications/files/the_european_bioeconomy_brochure_web_final.pdf [04 12 2018].

BioEconomy Regional Strategy Toolkit (BERST). (2016). Open Access Database. – https://berst.databank.nl [23 11 2018].

European Commission. (2012). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Innovating for Sustainable Growth: A Bioeconomy for Europe. – https://ec.europa.eu/research/bioeconomy/pdf/official-strategy_en.pdf [23 11 2018].

European Commission. (2018). A Sustainable Bioeconomy for Europe: Strengthening the Connection between Economy, Society and the Environment. Updated Bioeconomy Strategy. – https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf [23 11 2018].

Eurostat. (2018). Glossary: High-tech Classification of Manufacturing Industries. – https://ec.europa.eu/eurostat/statistics-explained/pdfscache/6384.pdf [04 12 2018].

Evans, J. D. (1996). Straightforward Statistics for the Behavioral Sciences. – Pacific Grove: Brooks Cole Publishing, p. 146.

Galindo-Rueda, F., Verger, F. (2016). OECD Taxonomy of Economic Activities Based on R&D Intensity. OECD Science, Technology and Industry Working Papers, 2016/04. – Paris: OECD Publishing, p. 21.

Garson, G. D. (2015). Missing Values Analysis and Data Imputation. – Asheboro: Statistical Associates Publishers, pp. 10–16.

Kirzner, I. M. (1997). Entrepreneurial Discovery and the Competitive Market Process: An Austrian Approach // *Journal of Economic Literature*. Vol. 35. No. 1: 60–85.

Kritikos, A. S. (2014). Entrepreneurs and Their Impact on Jobs and Economic Growth. – Berlin/Bonn: University of Potsdam/IZA World of Labor, p. 7. – https://doi.org/10.15185/izawol.8.

Kuznets, S. (1955). Economic Growth and Income Inequality // *American Economic Review*. Vol. 45. No. 1: 1–28.

OECD. (2016). Better Policies for Sustainable Development. A New Framework for Policy Coherence. – Paris: OECD Publishing, pp. 181–212.

OECD. (2018). Meeting Policy Challenges for a Sustainable Bioeconomy. – Paris: OECD Publishing, pp. 11–12.

Overbeek, G., de Bakker, E., Beekman, V., Davies, S., Kiresiewa, Z., Delbrück, S., Ribeiro, B., Stoyanov, M., Vale, M. (2016). Review of Bioeconomy Strategies at Regional and National Levels. – http://www.bio-step.eu/fileadmin/BioSTEP/Bio_documents/BioSTEP_D2.3_Review_of_strategies.pdf [04 12 2018].

Piotrowski, S. (2018). State of Play of Central and Eastern Europe's Bioeconomies. Draft. – http://www.bioeast.eu/article/bioeastconference8november2018studies [04 12 2018].

Poschke, M. (2013). Who Becomes an Entrepreneur? Labor Market Prospects and Occupational Choice // *Journal of Economic Dynamics and Control*. Vol. 37. No. 3: 693–710. – https://doi.org/10.1016/j.jedc.2012.11.003.

Ronzon, T., Gurria P., Parisi C., Philippidis G., M'Barek R. (2018). Socio-economic Insights into the Bioeconomy in BIOEAST Countries. Research Brief. – http://www.bioeast.eu/article/bioeastconference8november2018studies [04 12 2018].

Ronzon, T., M'Barek, R. (2018). Socioeconomic Indicators to Monitor the EU's Bioeconomy in Transition // *Sustainability*. Vol. 10. No. 6: 1–22. – https://doi.org/10.3390/su10061745.

Ross, M. L. (2015). What Have We Learned about the Resource Curse? // *Annual Review of Political Science*. Vol. 18: 239–259. – https://doi.org/10.1146/annurev-polisci-052213-040359.

Sarstedt, M., Mooi, E. (2014). A Concise Guide to Market Research. – Berlin: Springer, pp. 273–324.

Schmidt, O., Padel, S., Levidow, L. (2012). The Bio-Economy Concept and Knowledge Base in a Public Goods and Farmer Perspective // *Bio-Based and Applied Economics*. Vol. 1. No. 1: 47–63.

Schumpeter, J. A. [1911] (2008). The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle. Translated by R. Opie. – New Brunswick and London: Transaction Publishers, pp. 57–94.

Sieger, P., Fueglistaller, U., Zellweger, T. (2016). Student Entrepreneurship 2016: Insights From 50 Countries. – St. Gallen/Bern: KMU-HSG/IMU.

Spatial Foresight, SWECO, ÖIR, t33, Nordregio, Berman Group, Infyde. (2017). Bioeconomy Development in EU Regions: Mapping of EU Member States' / Regions' Research and Innovation Plans and Strategies for Smart Specialisation on Bioeconomy for 2014–2020. – https://ec.europa.eu/research/bioeconomy/pdf/publications/bioeconomy_development_in_eu_regions.pdf [23 11 2018].

Teräs, J., Lindberg, G., Johnsen, I. H. G., Perjo, L., Giacometti, A. (2014). Bioeconomy in the Nordic Region: Regional Case Studies (Nordregio). – http://www.sureaqua.no/Sureaqua/library/NordRegio%20-%20Bioeconomy%20in%20the%20 Nordic%20Region%20Regional%20Case%20Studies,%202014.pdf [04 12 2018].

Timm, N. H. (2002). Applied Multivariate Analysis. – New York: Springer, pp. 445–459.

Vásáry, V., Dorottya, S. (2018). Characteristics of Sustainable Bioeconomy in the CEE Macro-region // *Central European Review of Economics & Finance*. Vol. 27. No. 5: 5–26. – https://doi.org/10.24136/ceref.2018.023.

Venables, A. J. (2016). Using Natural Resources for Development: Why Has It Proven So Difficult? // *Journal of Economic Perspectives*. Vol. 30. No. 1: 161–84. – https://doi.org/10.1257/jep.30.1.161.

Woźniak, E., Twardowski, T. (2018). The Bioeconomy in Poland within the Context of the European Union // *New biotechnology*. Vol. 40. Part A: 96–102.

BIOEKONOMIKOS PLĖTROS POTENCIALO VERTINIMAS INOVACIJŲ EKONOMIKOS ASPEKTU EUROPOS REGIONUOSE

***Virginija Kargytė[1], Rando Värnik[2], Vilija Aleknevičienė[3]**
[1, 3] Aleksandro Stulginskio universitetas, [2] Estijos gyvybės mokslų universitetas

Įteikta 2018 12 05; priimta 2018 12 20

Santrauka

Europos Komisija numato, kad bioekonomikos plėtra ES turėtų teigiamai paveikti kaimiškąsias ir pakrantės ekonomikas. Nors šios teritorijos turi palyginti gausius biomasės išteklius, jos būdingas mažesnis verslumo lygis bei mažiau išvystytomis mokslinių tyrimų ir technologinės plėtros veiklomis. Dėl šių priežasčių gali nutikti taip, kad labiau urbanizuoti ir pramonę išvystę regionai, turintys didesnį inovacijų potencialą, išplėtos aukštą pridėtinę vertę kuriančią biologiniais ištekliais grįstą ekonomiką, o kaimiškieji ir pakrantės regionai pasiliks arba taps dar didesniais biomasės tiekėjais. Straipsnyje siekiama nustatyti bioekonomikos vystymosi galimybes skirtingose regionų grupėse, ištiriant sąsajas tarp vietinės biomasės prieinamumo, regionų bioekonomikos verslo klasterio ir inovacijų potencialo. Tikslui pasiekti darbe išanalizuoti inovacijų ekonomiką apibūdinantys bioekonomikos plėtros veiksniai, panaudojant 237-ių NUTS 3 lygmens Šiaurės, Vakarų ir Vidurio Europos regionų 2016 m. duomenis. Tyrimo rezultatai parodė, kad pagal pasirinktus kriterijus analizuoti regionai negali būti suskirstyti į potencialius bioekonomikos plėtros „pralaimėtojus“ ir „laimėtojus“, tačiau keletas analizuotų regionų grupių išsiskiria didesniu potencialu tam tikrose bioekonomikos srityse.

Raktiniai žodžiai: inovacijų ekonomika, bioekonomikos plėtra, Europos regionai.
JEL kodai: O13, O14, O31, Q57, R11.

* *Autorius pasiteirauti*