TRANSITION TO BIOECONOMY: PERCEPTIONS AND BEHAVIORS IN CENTRAL AND EASTERN EUROPE

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Abstract
The implementation of bio-economy, respectively the transition from a fossil fuel-based development to an economy that uses biological resources and innovation in biological sciences requires the formulation of new strategies and policies focused on comprehensive analyzes. The aim of this study is to contribute to a better understanding of the concept and policies of bioeconomy and to analyze citizens' behaviors and perceptions about the development of bioeconomy in the countries of Central and Eastern Europe. The comparative vision has the role ~~to~~ in identifying differences and similarities between national systems and is captured by applying a cluster analysis. The data are from European official statistics – EUROSTAT, plus data collected under Eurobarometer 88.1, from the European Commission and European Parliament. The analysis of the data shows that there are differences between the countries considered, from the perspective of the socio-economic context and also in terms of behaviors that support the bioeconomy. Further efforts are needed in the development of the bioeconomy to achieve both economic growth and employment opportunities as well as the development of behavior centered on the sustainability and resource efficiency of the resource.

Keywords: bioeconomy, transition, social preference, human behaviour, cluster analysis.

JEL Classification: J10, D19, O13.

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Introduction

Bioeconomy is seen as a comprehensive societal transition in order to achieve a sustainable and resource-efficient economy that enjoys a great deal of attention at a global level. The objective of this transition is to achieve a low-carbon innovative economy that reconciles the demands for sustainable agriculture and fisheries, food security and the sustainable use of renewable biological resources for industrial purposes, while ensuring biodiversity and environmental protection. The involvement of stakeholders and the general public in the development of bio-economy strategies and policies are key elements. Sociological investigations have the role of informing, educating, communicating with the general public about the complex topics of the bioeconomy in order to highlight the priorities of the bioeconomy research agenda and to engage / involve in this field in order to maximize the impact of development, research and innovation policies. Behavioural analyses conducted on the basis of the results of sociological investigations can provide diverse perspectives allowing better alignment of innovations and policies with the needs of society.

The first two sections of the article illustrate the conceptual and political complexity of the bioeconomy as well as the importance given in the literature to the development of this strategy, from the perspective of the theoretical context under consideration. The multivariate analysis based on socio-economic and behavioural indicators undertaken in Section 3 of the article has the role of detecting similarities and differences between 11 EU states on the development of the knowledge-based bioeconomy. Analyses undertaken may identify certain bottlenecks or success factors and may constitute important knowledge bases for designing policy tools that encourage the transition to this new way of economic development.

1. Policies on bioeconomy

Bioeconomy is a complex and multidisciplinary concept, a new approach to economic growth centered on research, development and inovation policy that addresses the challenges facing our society, namely climate change, energy and resource efficiency, health and demographic change. In the Europe 2020 Strategy, in the "Innovation Union" Flagship Initiative is highlighted the launching of European partnerships between the EU and the national innovation levels to create the bio-economy until the year 2020. Also, in the "resource-efficient Europe-Flagship initiative" is mentioned establishing a vision of the structural and technological changes needed to make the transition to a resource-efficient economy (EC, Europe 2020 Strategy). In this regard, the European Commission launched in 2012 the Bioeconomy Strategy entitled "Innovation for Sustainable Growth: A Bioeconomy for Europe", which has a global approach to societal challenges and which is divided into two documents: 1) a communication that includes the strategy and action plan and 2) the working document which provides details for previous document. The action plan focuses on three main aspects: 1) investing in research, innovation and skills; 2) increased interaction between policy makers and stakeholder involvement, and 3) market development and increased competitiveness in the bioeconomic field (European Commission, 2010; 2011; 2012a; 2012b).

In Romania there is not yet an official bioeconomy strategy as it exists in other countries, such as for example Germany (Bundesministerium für Bildung und Forschung, 2011) and Sweden (FORMAS, 2012). However, bioeconomy is mentioned as one of the four areas of

intelligent specialization foreseen in the National Strategy for Research Innovation Development in Romania (Ministry of National Education, 2020). This new field supports the reorientation of RD&I policies towards achieving important results from economic point of view, given the increased potential of Romanian agriculture, horticulture, forestry, zootechnics and fish sectors, of valorisation of biomass and fuels as well as high food demand, respectively for increasing the food safety and optimization.

Bioeconomy enjoys special attention in the literature, with different definitions having broader or narrower approach angles, but with common elements, such as: "an economy that uses biological resources from the soil and sea, as well as waste, as raw materials for food, feed and industrial and energy production "(European Commission, 2012a); bio-economy defined in a narrow sense as biotechnology – "bioeconomy can be understood as a world in which biotechnology contributes to a considerable extent to economic results" (Organisation for Economic Cooperation and Development, 2009). Şerban, (2013) defines bioeconomy as the "science of the dynamic integration of mankind into the environment" and also mentions the uses of the term: a progressive branch of social sciences, meant to integrate economics and biology; an activity of studying market dynamics through the perspective of evolutionary biology; a complex of economic activities designed to optimize the production and use of biological products. Priefer, Jörissen and Frör (2017) draws on the idea that bio-economy aims to facilitate the gradual replacement of fossil fuels as a result of excessive reduction with renewable raw materials; that it is a complex field that includes a variety of sectors, actors and interests and that it is linked to profound changes in today's production systems.

Due to the fact that there is no clear definition, universally accepted for bioeconomy, there is no obvious difference between the concepts of "bioeconomy" and "bio-based economy", but there is a tendency in the literature to consider the first term as general, including the second one (Staffas, Gustavsson and McCormick, 2013). The concept of "knowledge-based biotechnology" launched by Urmetezer and Pyca (2014) underlines the importance of knowledge and innovation in starting and advancing the biotechnology sector that involves changes in technology, markets, politics, culture and institutions.

The key priority areas identified by the analysis of 12 bio-economy development strategies produced by governments, regional agencies and industrial groups are: stimulating research and innovation, especially in the field of biotechnology; promoting collaboration between industry, businesses and research institutions; prioritization of optimized use of biomass through the implementation of the "cascade" principle and the use of waste residue streams; and providing financial support for the development of biology-based activities (Besi and McCormick, 2015). Bugge, Hansen and Klitkou (2016) identified in their researches three visions of the bioeconomy: 1) the biotechnology vision that underlines the importance of research, application and marketing of bio-technology in different sectors of the economy (Hansen and Winther, 2011; Richardson 2012; McCormick, Kautto, 2013; Zilberman et al., 2013); 2) the bio-resource vision that focuses on the processing and upgrading of raw materials as well as the establishment of new value added chains (Duchesne and Wetzel, 2003; Ponte, 2009; Keegan et al., 2013; Ollikainen, 2014) and 3) bio-ecology vision that highlights the sustainability and ecological processes to optimize the use of energy and nutrients, promoting biodiversity and avoiding monocultures and soil degradation (Levidow, Birch and Papaioannou, 2013; Staffas, Gustavson and McCormick, 2013).

2. The theoretical context of analysis

The social and ecological impact of the bio-economy has as objectives to address the societal challenges, namely: ensuring food security; sustainable management of natural resources; reducing dependence on non-renewable resources; mitigating and adapting to climate change; creating jobs and maintaining European competitiveness (European Commission, 2012a; 2012b). A responsible bio-economy must initially address the sustainable use of resources, recognizing the importance of knowledge of resources, the potential of farmers and SMEs to contribute to innovation, in order to increase local capacity (Schmid, Padel and Levidow, 2012; Gârdan et al., 2018). In order to ensure food security, it is proposed to redesign the global food governance by setting up an international platform and an international panel for alimentation, nutrition and agriculture (Braun and Birner, 2016; Candel, 2014) and the sustainability of certification, an instrument addressing environmental and social issues (Azhar, Prideaux and Razi, 2018). On the other hand, replacing fossil fuels with biomass could lead to a reduction in CO2 emissions, which will help address global climate change (Cudlínová, Lapka and Vávra, 2017). The impact of the bio-economy on job creation and economic growth has been assessed by the European Commission's Knowledge Centre for Bioeconomy (2018) for the period 2009-2015, which concludes that bio-economy generated 4.2% of EU GDP in 2015 and committed 8.2% of the workforce.

Given the wide variety of industries covered by biotechnology and the interweaving of natural sciences and technology, much of the research in the field focuses on studying the link between bioeconomy and societal and economic implications (BioSTEP, 2018; Stern et al., 2018; Urmetezer and Pyca, 2014). Therefore, research regarding public opinion and social preferences in advancing the bioeconomy and societal changes through the behaviour of everyday citizens, workplaces, food and education are very important in shaping the economic and social development strategies in the context of redefining to some sectors of activity and technological advancement. Involvement of the public can be done through a multitude of ways and different levels of coverage. Rowe and Frewer (2013) argue that there is a growing trend of public participation in the development of science and technology policies needed to reflect and recognize democratic ideas and to increase confidence in regulators and transparency of regulation systems.

In order to facilitate the involvement of stakeholders and the general public in the field of bioeconomy were experimented, in the 2015-2018 period, the various participatory tools including workshops work, laboratory activities and exhibitions. Studies has shown that a first initial online survey can be an effective tool to start involving stakeholders at a very early stage. Engagement activities should be tailored to the national / regional context and should take into account the "culture of participation" (BioSTEP, 2018). German Bioeconomy Council (2018) recently investigated the vision of 4,331 experts from 46 countries on future opportunities and developments on topics from bioeconomy, such as: success stories about bioeconomy, promising technological areas, notable technological features, potentially conflicting objectives, necessary policy measures, communication measures and educational measures, important future investments. The results of the study indicate that bio-economy is seen as a central element in achieving many sustainable development goals, innovation being the key to this. Besides satisfying food and energy security, bio-economy is considered a central element in climate protection and innovative industrial transformation, also assuming a shift to sustainable consumption. Following the

revision of the literature, criticism of this concept is also made (Priefer, Jörissen and Frör, 2017), which refers to: the strong emphasis on technology, the lack of attention paid to alternative ways of implementation, the insufficient differentiation of the underlying sustainability requirements, and the inappropriate participation of stakeholders society. There is also criticism of the national methods used to measure, monitor and report the contribution of the bio-economy to the overall economy, noting that comprehensive approaches to measuring and monitoring progress in bioeconomy are often lacking (Bracco et al., 2018). Most countries measure only the contribution to gross domestic product (GDP), turnover and employment of the sectors covered by the bio-economy definition, which could provide an incomplete picture without taking into account objectives such as the social impact and ecological aspects of bio-economy. It is therefore suggested to strengthen the sustainable monitoring of the bio-economy. Eposti (2012) which focuses on the link between the national innovation systems and the bio-economy, describes the transition to the new form of economy as an ongoing process.

3. Methodological approach

The Strategy and Action Plan on bioeconomy, documents issued by the European Commission, were made in the context of the Europe 2020 strategy which considers this area a key to sustainable growth, smart and green Europe (European Commission, 2017; Ministry of Foreign Affairs, 2010). Citizen involvement in bioeconomic progress is thus an important element of any strategy. A first step in this approach is to capture the incidence of pro-bioeconomy behaviors among citizens. Recent studies (German Bioeconomy Council, 2018) show that the future bioeconomy will meet primary human needs, being driven by technology and taking into account the environment. In order to ensure the success of the actions design to stimulate the bioeconomy, policies and strategies will need to pay more attention to the transfer of knowledge and adequate funding. The method used in this article to explore the citizens' behaviors and perceptions regarding the development of bioeconomy, was previously applied by Urmetezer and Pyca (2014) on an expanded set of indicators (grouped in five dimensions) and a country sample that included all EU countries and four OECD countries.

3.1. Objectives and indicators

Bioeconomic research (Urmetezer and Pyca, 2014) show that there are a multitude of factors that may influence a country's capacity to develop bio-economic activities, and these factors are determined both by geographic, political and historical conditions and by the socio-economic characteristics of each country. Other comparative studies (BioSTEP, 2018) highlight the importance of involving citizens in bioeconomy activities, but even in this case, the level of involvement depends on the national and cultural context. Within this section, we aim to identify the similarities and differences between 11 European Union (EU) member countries with regard to the development of knowledge-based bioeconomics. The countries included in the analysis are Romania, Bulgaria, the Czech Republic, Hungary, Slovenia, Slovakia, Estonia, Lithuania, Latvia, Poland and Croatia. To achieve the objective, we have selected a series of indicators considered relevant to the measurement. The following three dimensions were defined by the authors in order to group the indicators used to identify the predispositions of the citizens from the countries in the analysis (CEE countries) to the pro – bioeconomy behaviours: (1) *Opinions on environmental protection*: it

captures attitudes expressed by citizens about the protection of the environment; (2) *Pro Bioeconomy Behaviours*: it captures the pro bioeconomy behaviours of citizens; (3) *The socio-economic context*: it captures the specificities of the different economies of the CEE countries included in the analysis. There are a number of differences in this context that can influence the overall performance of their development towards the bio-economy, including different attitudes of the population. Sources for the selected indicators are Eurobarometer 88.1 (European Commission and European Parliament, 2018) Section D. The Attitudes of European Citizens towards the Environmental Issues and the European Statistical Database, EUROSTAT (2015; 2016; 2017).

In order to examine the predisposition of the 11 CEE countries to the adoption of pro-bioeconomy behaviors by their own citizens, for each of the three proposed dimensions were identified indicators that are listed in the table below (table no.1):

Table no. 1: Indicators for the analysis of the predispositions of the citizens from the CEE countries to the pro – bioeconomy behaviors

Dimensions	Code	Name of the indicator	Year	Source
Opinions on environmental protection	1.1	Opinions on the role of the individual in environmental protection (% of those who agree with the statement)	2017	Eurobarometer 88.1
	1.2	Impact of plastic on the environment (% of those who say they have concerns about this)	2017	Eurobarometer 88.1
	1.3	Impact of plastic on health (% of those who say they have concerns about this)	2017	Eurobarometer 88.1
	1.4	Impact of chemical products on health (% of those who say they have concerns about this)	2017	Eurobarometer 88.1
	1.5	Impact of chemical products on the environment (% of those who say they have concerns about this)	2017	Eurobarometer 88.1
	1.6	Air quality (% of those who say that air quality has improved in the last 10 years)	2017	Eurobarometer 88.1
Pro-bioeconomy behaviours	2.1	Cut down water consumption in the last 6 months (%)	2017	Eurobarometer 88.1
	2.2	Cut down energy consumption in the last 6 months (%)	2017	Eurobarometer 88.1
	2.3	Avoided single- use plastic goods other than plastic bags in the last 6 months (%)	2017	Eurobarometer 88.1
	2.4	Avoided buying over- packaged products in the last 6 months (%)	2017	Eurobarometer 88.1
	2.5	Chosen the public transport/bicycle/ walking for the past 2 years to reduce harmful air emissions (%)	2017	Eurobarometer 88.1
	2.6	Changed the home heating system to a lower emission one in the last 2 years (%)	2017	Eurobarometer 88.1
	2.7	Replaced the older energy-intensive equipment with newer equipment with a better energy efficiency rating in the last 2 years (%)	2017	Eurobarometer 88.1

Dimensions	Code	Name of the indicator	Year	Source
Socio-economic context	3.1	GDP per capita in PPS	2017	Eurostat
	3.2	Employment rate (20-64 years old) (%)	2017	Eurostat
	3.3	Educational level: at least upper secondary educational attainment (25-64 years old) (%)	2017	Eurostat
	3.4	Organic crop area by agricultural production methods and crops	2016	Eurostat
	3.5	Urban population exposure to air pollution (%)	2015	Eurostat
	3.6	Agricultural area under organic farming (%)	2016	Eurostat
	3.7	Opinions regarding the importance of environmental protection (% of those who declare the environmental protection is important)	2017	Eurobarometer 88.1

3.2. Method

The method chosen to explore the perceptions and behaviours favourable to the bio-economy of the citizens from the Central and Eastern European countries was the cluster analysis. Cluster analysis is a multivariate analysis technique that includes a number of algorithms for classifying objects (in our case, countries) into homogeneous groups (Cornish, 2007; Urmetezer and Pyca, 2014; Yim and Ramdeem, 2015). The variables or cases are sorted into clusters so that between the members of the same cluster to be more similarities and between the members of different clusters to be weaker similarities. The clusters were formed on each of the three dimensions presented in the previous subsection, following the approach of Urmetezer and Pyca (2014). In order to identify relatively homogeneous clusters of countries (based on distances or differences between them) hierarchical cluster analysis was used given that the number of clusters was not known in advance. This statistical method approaches each country as a separate cluster, and then combines the groups successively, reducing the number of clusters until the maximum amount of heterogeneity between the groups is reached, while remaining within an acceptable level of homogeneity within each group.

Cluster coherence and cluster diversity were determined by calculating distance values between countries based on measured characteristics, the calculation method being the Euclidean distance (data are scale and continuous). In order to measure similarity between groups of countries, the average-link method was used because this procedure measures cluster averages and is therefore only slightly affected by extreme values. The purpose of this method is also to create clusters with small variations within the group Cornish, 2007; Filho et al., 2014; Urmetezer and Pyca, 2014). Due to the different scales and sizes of variables, the original data was standardized by converting variables to standard scores (also known as *Z scores*) before grouping the countries, to eliminate the influence that large values may exert on the distance between groups (Everitt et al., 2011). As a result of the applied algorithm we obtain the grading trees (dendrograms) which are actually a synthesis of the classification that has emerged. The data was analysed and processed using IBM SPSS 19.

3.3. Results and discussions

3.3.1. Opinions on environmental protection

The most optimistic about the role they can play in environmental protection in their own country have proven to be the Slovenes (51.7% total expressed agreement), followed by the Romanians (41.7% total expressed agreement) and the Croats (41,2% total expressed agreement). The most pessimistic are the Lithuanians (28.8% total expressed agreement) and the Poles (27.1% total expressed agreement) (table no. 2).

Table no. 2: The percentage of respondents who have expressed total agreement on the statement "As an individual, I can play a role in protecting the environment in my country

RO	HR	BG	LV	SI	HU	LT	PL	SK	CZ	EE
41.7%	41.2%	37.2%	32.6%	51.7%	31.3%	28.8%	27.1%	34.7%	29.6%	34.3%

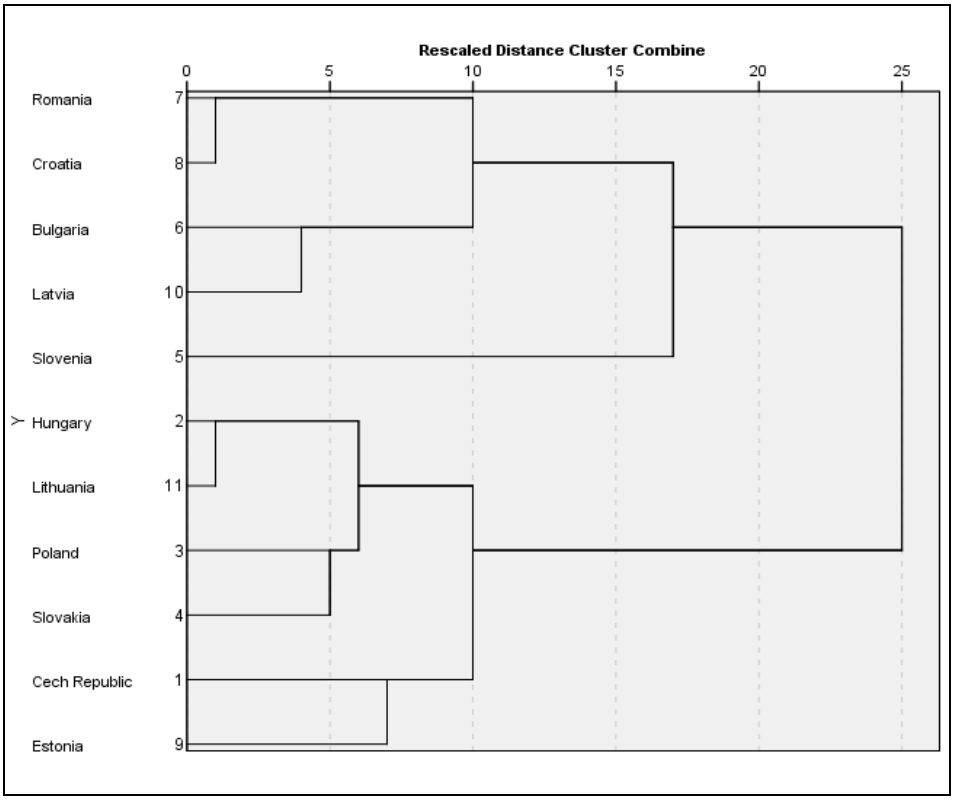

Figure no. 1: Clusters according to the opinions on environmental protection indicators

In terms of environmental concerns, there are no significant differences among the countries considered. Countries focus mainly in two clusters (figure no. 1): the first cluster (Hungary, Lithuania, Poland, Slovakia, Estonia, Czech Republic) comprises most of the countries. On the one hand, there are countries like Poland where citizens have the lowest interest in the impact of plastic on health and on the environment, but also countries (the Czech Republic, Poland, Estonia, and Hungary) where citizens share the positive opinion that air quality improved in the last decade. The second cluster (Bulgaria, Romania, Croatia, and Latvia) includes countries whose citizens are more concerned about the impact of chemicals and plastic on health than on the environment. The citizens of the countries in this group are the ones who appreciate the least that air quality has improved over the past ten years. Within the group, Bulgarian citizens are the ones who appreciate to the least that the quality of the air has improved in the last decade. In case of Slovenia, the opinions expressed by citizens exceeded the average of responses for all indicators analyzed within this dimension.

3.3.2. Pro-bioeconomy behaviors

The second dimension taken into account for the hierarchical grouping of the CEE countries is the behavior adopted by citizens to reduce harmful emissions into the air (actions undertaken over the past 2 years), respectively to contribute to the protection of the environment (initiatives taken over the last 6 months). The analysis of the countries led to the emergence of three clusters (figure no. 2). This dimension expresses in the most suggestive manner the influence of historical, geographic and cultural factors on the behavior of citizens. The first cluster (Czech Republic, Hungary, Slovakia) includes countries where citizens have mostly adopted behaviors aimed at avoiding products with too many packages and replacing heating systems. In the second cluster (Romania, Croatia, Bulgaria, Poland) citizens have chosen to avoid the purchase of products with too many packages, to reduce the energy consumption and to use public transport/bicycle/walking as main actions to contribute to the protection of the environment and to the reduction of harmful emissions into the air. The third cluster (Estonia, Lithuania, Latvia) includes countries where citizens have chosen to reduce energy consumption, to replace old household appliances with ones with higher energy efficiency, to use public/bicycle/walking and to avoid plastic single items use with the exception of plastic bags, as main actions to reduce harmful air emissions and to protect the environment. Similar to the opinions expressed with regard to the importance of environmental protection, in Slovenia citizens have preferred to replace heating systems in homes and to avoid too many packaging products, as the main ways to help protect the environment.

Analyses has underlined that there are countries that tend to be part of the same cluster, and this can be explained by the fact that they share similar geographic, historical, cultural or economic characteristics. This is the case of Romania and Bulgaria which tend to group together in all three analyzed dimensions, but another example is Estonia and Latvia. These results are supported by other studies that have been carried out to group European countries in the field of bioeconomy, innovation and national production systems (Lundvall et al., 2002; Urmetezer and Pyca, 2014), studies showing that such countries usually have a greater potential to learn effectively by taking the positive experiences of similar countries than by adopting countries' behaviors with different historical, political, and economic systems.

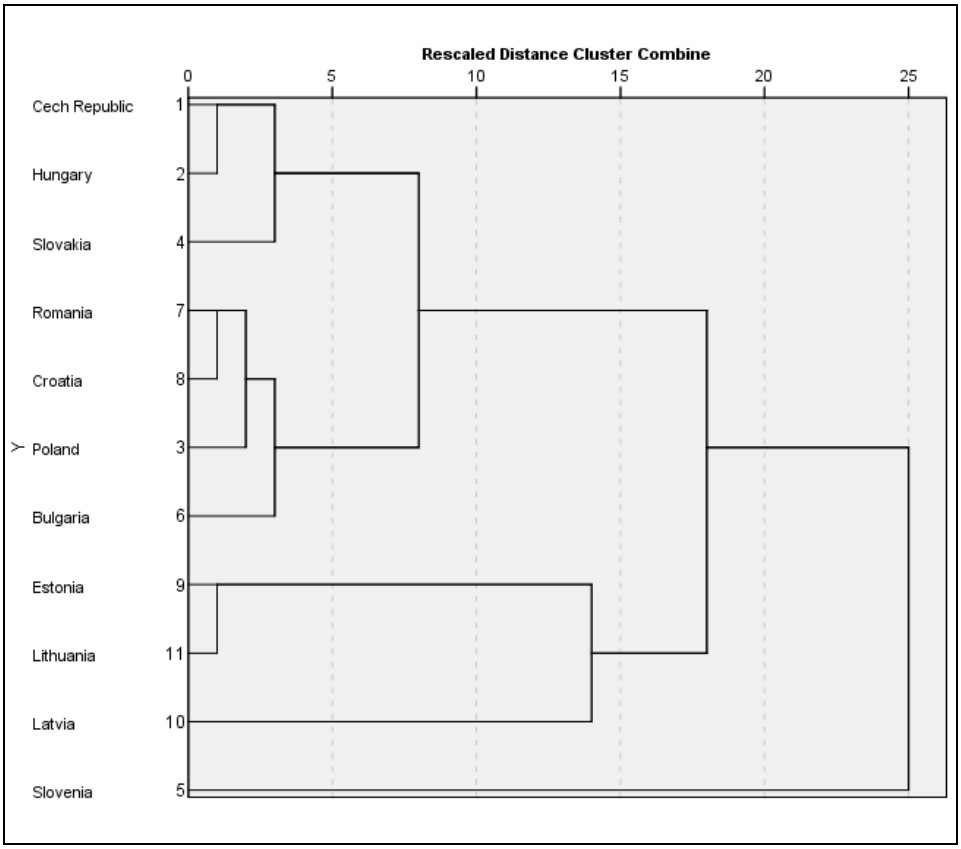

Figure no. 2: Clusters by pro-bioeconomy behaviors indicators

3.3.3. The socio-economic context

Applying the hierarchical grouping procedure according to the selected indicators for the socio-economic context has led to the emergence of three clusters with two groups concentrating more than a half of the CEE countries. The socio-economic context captures the specificities of the economies of the countries included in the analysis, the differences in social and economic conditions, and may exert an influence on the performance of their development towards bioeconomy, generating different attitudes of the citizens. The characteristics of the groups identified within the first dimension are presented in the figure no. 3.

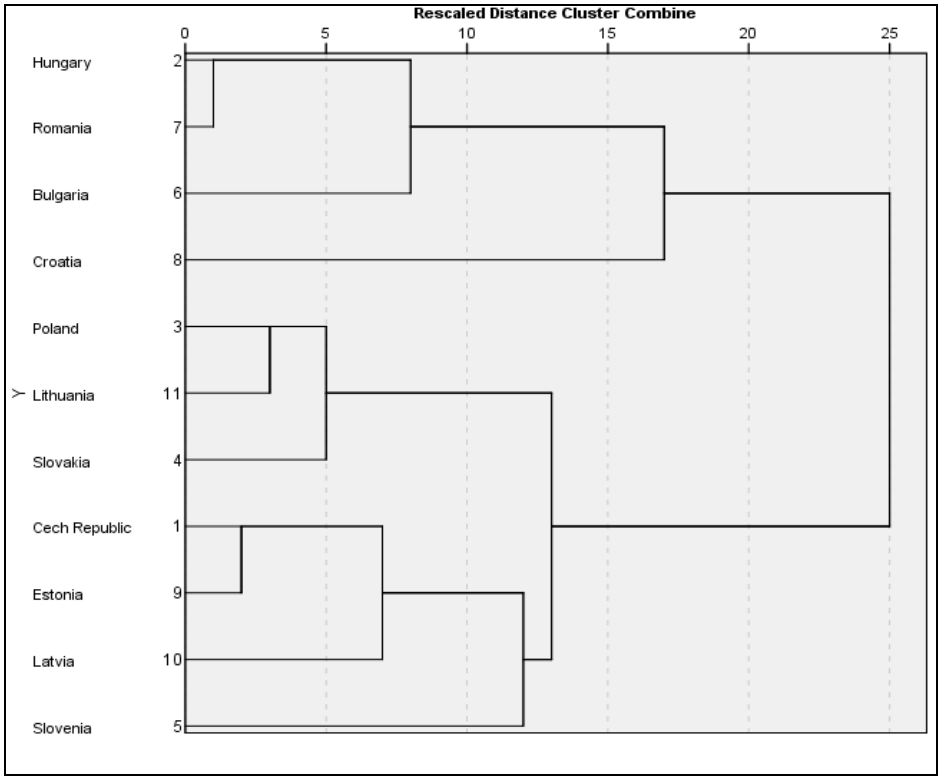

Figure no 3: Clusters according to the socio-economic context indicators

The characteristics of the identified groups are:

- Cluster 1 (Hungary, Romania, Bulgaria) countries with lower values for gross domestic product (under the average of the countries included in the analysis), in particular Bulgaria, lower employed population sizes (20-64 years) and average values of the number of households exposed to pollution. Within the group (but also compared to all countries included in the analysis), Romania has the lowest share of the population who have completed at least the upper secondary level of education (77.9%). The indicator is important because it expresses the proportion of the population that has the minimum qualifications required in order to be able to participate in economic and social life. Compared with the countries from other clusters, Hungary, Romania and Bulgaria have the lowest shares of areas under organic farming in total utilized agricultural area. The level of awareness concerning the importance of environmental protection is relatively high for the countries in this cluster, lower values being recorded in case of Bulgaria.

- Cluster 2 (Poland, Lithuania and Slovakia) gathers countries with high values of GDP, employment rates and the share of the population with at least upper secondary level of education. Instead, these countries have levels of awareness concerning the importance of environmental protection below the views expressed by the citizens of the first group of countries. This lower level of awareness may explain the lower interest in expanding

agricultural areas cultivated with different organic crops (for example in Poland and Lithuania).

- Cluster 3 (Estonia, Czech Republic, Latvia and Slovenia) comprises countries with high employment rates and GDP. Although the awareness of the importance of environmental protection is lower compared to the countries of the previous groups, the share of organic crop is the highest among the countries included in the analysis.

Apart from the clusters, Croatia has the lowest share of households exposed to pollution and above average values for GDP, employment rate and share of the population with at least upper secondary education.

Conclusions

The purpose of this research was to analyze the opinions and behaviors of the citizens of the Central and Eastern European countries favorable to bioeconomy. The method used to achieve this goal was cluster analysis, as it is a multivariate analysis technique that allows the classification of objects into homogeneous groups. The indicators considered relevant for clustering have been chosen to illustrate three areas of bioeconomics in line with similar approaches of Urmetezer and Pyca (2014), namely the socio-economic context, the citizens' views on environmental protection and the bioeconomy behaviors adopted during the last 6 month and 2 years respectively. Applying the multivariate cluster analysis, we identified similarities and differences between the analyzed countries for all the indicators.

The results are consistent with Urmetezer and Pyca (2014) underlying that historical, geographic and cultural factors influence the pro-bioeconomic behaviors adopted by citizens. The size of the socio-economic context has highlighted the most visible differences between countries, leading us to the conclusion that CEE countries are in different stages of development. Concerning the opinions on environmental protection, the analysis revealed that there are no significant differences between the countries. Similarities are important because models of similar bioeconomic behavior facilitate mutual learning between countries. The pro-bioeconomic behaviors adopted by citizens have highlighted the influence of historical, geographic and cultural factors. There are a number of limits of the research conducted in this article that results from the lack of detailed statistical data on bioeconomic activities so that we could conclude on the influence of social, economic and cultural factors that determine the views and behavior of citizens in CEE countries. To these, are added those limits resulting from the variables included in the instrument applied at the level of the citizens of the EU countries under Eurobarometer 88.1.

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