Chapter 17
Circular Economy Performance at Regional Level in European Union

Victor Platon, Simona Frone, Andreea Constantinescu, and Sorina Jurist

Abstract Circular economy represents the reuse of products that have reached the end of their life cycle by repairing them or transforming them into recycled raw materials. This way, the consumption of resources and energy needed for the production of new equipment can be diminished and in time waste generation can be reduced. The main objective of this research is to identify a regional hierarchy of the EU member states according to the circular economy indicators. Several relevant monitoring indicators for the circular economy evolution were analyzed, namely generated municipal waste, circular material use rate, packaging recycling rate, biodegradable waste recycling rate, circular economy investment, circular economy innovation, and rate of WEEE recycling. The methodology used includes a literature review, former research outputs analyzed for the objective of this research, and dynamic and comparative statistical analysis on the evolution of relevant indicators at the level of five EU geographical regions. The results of the research highlighted the fact that, at regional level, the circular economy has a fragmented distribution. Consequently, a number of regions, and implicitly the member states that form that region, recorded higher values for some indicators and lower or average values for other indicators.

Keywords Circular economy · Regional change · Circular economy indicators · Statistical dynamic analysis

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L. Chivu et al. (eds.), *Constraints and Opportunities in Shaping the Future: New Approaches to Economics and Policy Making*, Springer Proceedings in Business and Economics, https://doi.org/10.1007/978-3-031-47925-0_17

17.1 Introduction

This article represents the preliminary findings of a research work carried out by a collective of researchers within the Institute for National Economy. The research is not finalized, so the research will continue with more elaborate analysis techniques and more indicators of the circular economy topic.

Circular economy is increasingly studied and implemented worldwide nowadays, since helping preserve the natural resources and encouraging reuse and recycle of products at their end-of-life moment (Noja et al., 2022). European Union is one of the main promoters of circular economy concept, creating and implementing policies through all member states.

The main objective proposed by this research paper is to bring some insight regarding the circular economy performance at regional level, throughout the European Union member states using a limited number of indicators. The methodology used was a simple analysis that took into consideration, as main hierarchization criterion, the member states affiliation to five geographical regions within the European Union. The geographical situation has a significant influence on transition to the circular economy model, and this may be observed in the comparative evolution of the selected circular economy indicators.

17.2 Literature Review

There is a consistent background literature on the subject of circular economy, focusing on different indicators from different points of view. Therefore, in this paper, we will only mention briefly some of the latest papers on the subject.

Mihai et al (2018) is an interesting and influential research with insights into the circular economy and renewable energy correlations and developments in the EU is Mihai et al. (2018). Another important research work is by Hysa et al., 2020, who used five major CE indicators to model and measure the effect of circular economy innovation on economic growth. The study strongly confirmed the importance of environmental, economic, and social components of the CE to economic growth and underpins the necessity of innovation in the core of circular economy for EU28.

The authors of the current paper have some previous research on aspects concerning eco-innovation and recycling. One paper focuses on measuring the intensity of influence of innovation on recycling within EU member states. One of the indicators analyzed is the circular material use rate (CMUR). The findings highlight that CMUR, taken as a dependent variable, is highly and positively impacted by Euro area membership— countries belonging to Euro area have +2.3% higher CMUR rate compared with countries that are not yet using Euro as currency (Platon et al., 2022). Another recent paper analyzes the evolution of WEEE within EU member states and how it impacts the implementation of circular economy on regional and national level (Constantinescu et al., 2022). A previous approach of the circular

economy indicators highlights the need for better policy and economic instruments in order to create a positive framework at national level (Platon et al., 2020). However, many research papers highlight that there is a lot to improve regarding the waste management in Romania, and it represents a topic of further research (Frone et al., 2020; Constantinescu & Frone, 2015).

In an interesting recent paper, authors revised the circularity of materials under linear and circular models. They examine the recycling of different waste types and present the results for various activity sectors. The results of the research results show that the most important factor affecting the circularity of materials is represented by private investments in recycling, in particular the municipal waste and the WEEE recycling (Burinskiene et al., 2022).

The factors that influence implementation of circular economy innovation by firms in European Union are analyzed in this paper. The analysis stated showed a positive correlation between recycling activity and product redesign (Triguero et al., 2022). Another paper presents strategic directions within EU toward raw material management, with a special approach to circular material use. The authors emphasize the importance of mineral resources management in order to promote circular economy and thus the importance of circular material use (Smol et al., 2020).

The synthesis and importance of business models in implementing and performing the circular economy worldwide are analyzed by Foroozanfar et al. (2022). The most significant drivers are emphasized and discussed for future research.

A recent paper discussed the degree of regulation in the EU WEEE recycling industry. The research highlighted the fact that the impact of competition on the economic performance is rather positive (Favot et al., 2022). Analyzing the recycling situation in EU, a new research used a regression analysis to identify what factors influence most the European waste management policies. Different circular economy indicators (trade in secondary raw materials, circular material use rate, and waste recycling rate) vary, being influenced by general indicators—national GDP, human resources, investments in innovation, and technology (Sultanova et al., 2021).

The objective and findings of our research are closer to the outcomes of a very recent study (Drăgoi et al., 2021). In this study, the results showed that CE within the European Union as aggregate is on the sustainable and circular path of development. Nevertheless, the study did mention that the situation of the member states varies significantly requiring adjustments to be made by national and EU authorities.

17.3 Methodology

The research work that is going to continue took into consideration 28 EU countries for the period 2000–2018 and only seven indicators out of 11 indicators that are included in the circular economy section. At this stage of the research, a simplified methodology was used taking into account only the average values for the seven indicators selected for a period of 19 years. The number of observations is large for

each indicator. In theory, we have available a maximum of 532 data points for each indicator. In some cases, when some data are missing, the data available were reduced to 380–400 entries.

As stated before, the EU member states were clustered using the geographical criterion. Countries were clustered in five regions, as follows (see Fig. 17.1):

1. Center region comprises Austria, Czech Republic, Hungary, Poland, Slovakia, Slovenia, and Germany; this group of countries is well known to belong to the Central European cluster.
2. North region comprises Denmark, Estonia, Finland, Leetonia, Lithuania, and Sweden; this region includes mainly Nordic countries and Baltic states.
3. West region comprises Belgium, France, Ireland, Luxembourg, Holland, Portugal, and UK. In the case of Portugal, the fact that Portugal has the time zone aligned with that of UK and not with Spain was considered. As well, in many analyses, southern countries group does not include Portugal but only Mediterranean countries. So, we allocated Portugal to the west region.
4. South region comprises Cyprus, Greece, Italy, Malta, and Spain; all these countries have in commune the Mediterranean Basin.

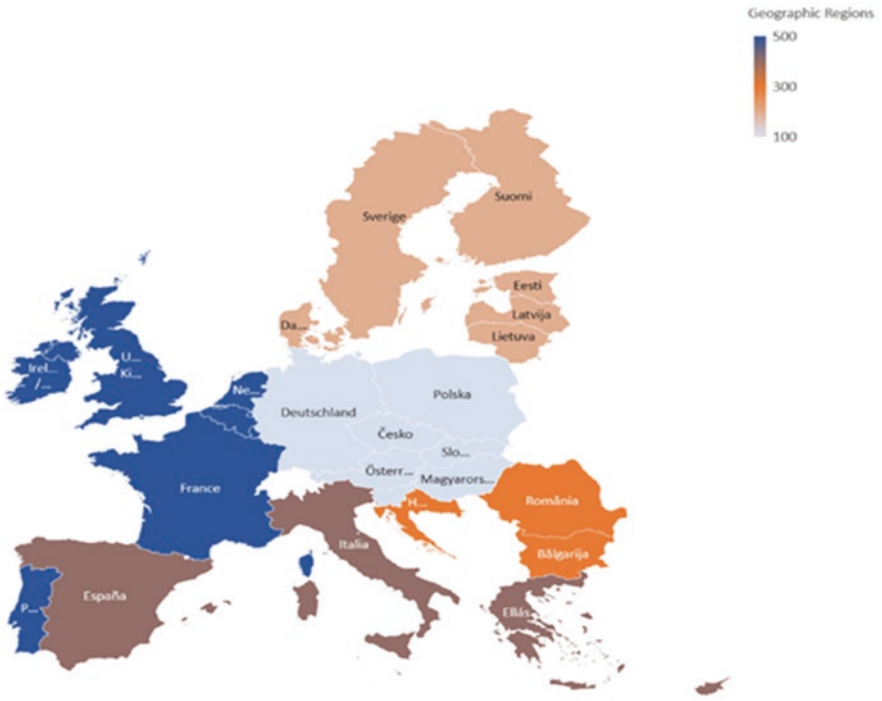


Fig. 17.1 Regional clusterization of EU member states, using geographical criterion. (Source: Authors' own research)

5. Southeast region comprises Bulgaria, Croatia, and Romania; this region includes Balkan countries.

It is important to clarify that UK was included, even if it is no longer a member state, because the analyzed statistical data cover the period 2000–2018, when UK was still part of EU. Nevertheless, it must be stated that indicators analysis covers slightly different periods of time because of the lack of data. Several research methods have been used in this paper, namely desk research, data processing, interrogating available databases, and comparative analysis of data.

As it was said, the methodology is based on data provided by Eurostat database.[1] The indicators of the circular economy taken into account in this preliminary stage were the next:

1. Packaging recycling rate.
2. Municipal waste recycling rate.
3. Biodegradable waste recycling.
4. Circular economy investments.
5. Circular economy innovation (patents).
6. WEEE recycling rate.
7. CMUR—circular material use rate.

The processing method was a simpler one involving only hierarchies of the average values of the indicators selected for this preliminary analysis. A next step of the methodology will be to take into account all indicators describing circular economy and to make use of a more complex processing methods.

17.4 Analysis/Result Interpretation

The indicators chosen to be analyzed are some of the most important ones for circular economy evaluation.

(a) The packaging recycling rate, at regional level, is shown in Fig. 17.2.

The highest average value of the packaging recycling rate is registered by the countries situated in region west of EU (67.1%). The countries in the north and center regions registered almost similar values of the analyzed indicator (61%). The lowest values are recorded in south and southeast region of EU around 56%.

(b) The municipal waste recycling rate is presented in Fig. 17.3.

The highest municipal waste recycling rate is registered by the west region (38.0%).

[1] Each indicator has its own detailed explanation at the Eurostat site (https://ec.europa.eu/eurostat/data/database)

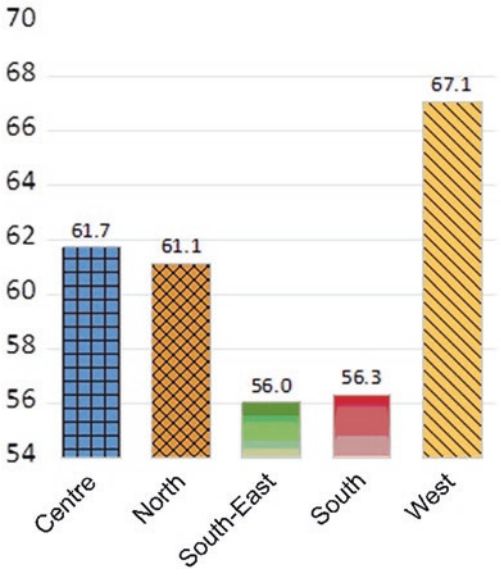


Fig. 17.2 Packaging recycling rate at regional level (%, average of the period 2000–2018). (Source: Authors' own calculations)

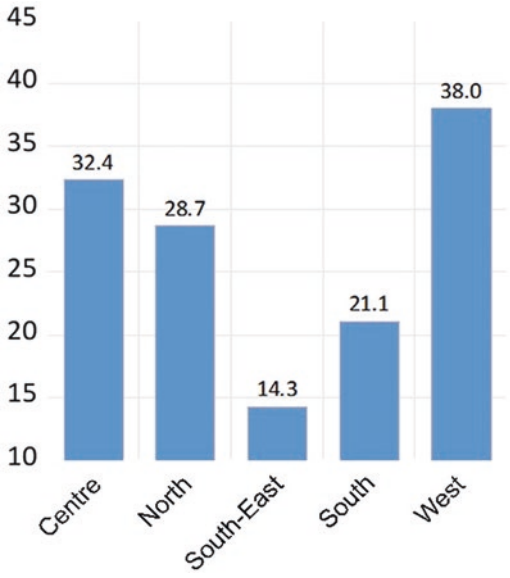


Fig. 17.3 Municipal waste recycling rate at regional level (%, average for the period 2000–2018). (Source: Authors' own calculations)

The center region, with a rate of 32.4%, ranks second followed by the north region with 28.7%.

The lowest values are recorded in the south region (21.1%) and the southeast region, with an average rate of only (14.3%).

(c) Figure 17.4 presents the evolution of indicator "biodegradable *waste recycling*." It is expressed in kg/inhabitant and also as an average value for the time period 2000–2018.

The member states located in the west of EU region recycle the largest amount of biodegradable waste (82.9 kg/inhabit.).

In second place, according to the geographical criterion, are the states in the center region, with an average value of 52.9 kg/ inhabit.

The states in the north and south regions of the EU recycle similar amounts of biodegradable waste (46–48 kg/inhabit.), also similar to the European average.

The lowest amounts of biodegradable waste are recycled in the countries in southeast region (15.7 kg/inhabit.)— Romania, Bulgaria, and Croatia.

(d) The next indicator, presented in Fig. 17.5, is circular economy investments, expressed in million Euro and as yearly average for the time period 2000–2018.

The average of circular economy investments for the analyzed period (2000–2018) had the highest value in the west region of EU—11330.3 mil. Euro.

In second place are the countries of the south region, with an average CE investment of 8000 mil. Euro.

In the center region, average values of 5000 million Euros were recorded for investments in the circular economy, in the period 2000–2018.

The north and southeast regions recorded the lowest values for investments in circular economy, in the analyzed period: 1608.5 million Euros in the north region and only 764.4 million Euros in the southeast region.

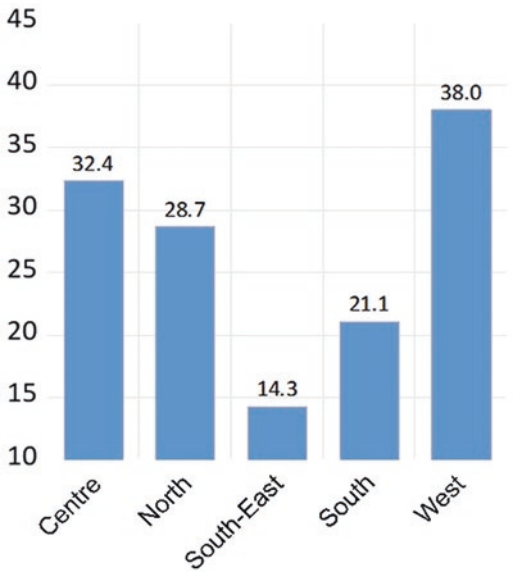


Fig. 17.4 Biodegradable waste recycling, at regional level (kg/inhabit. Average for the period 2000–2018). (Source: Authors' own calculations)

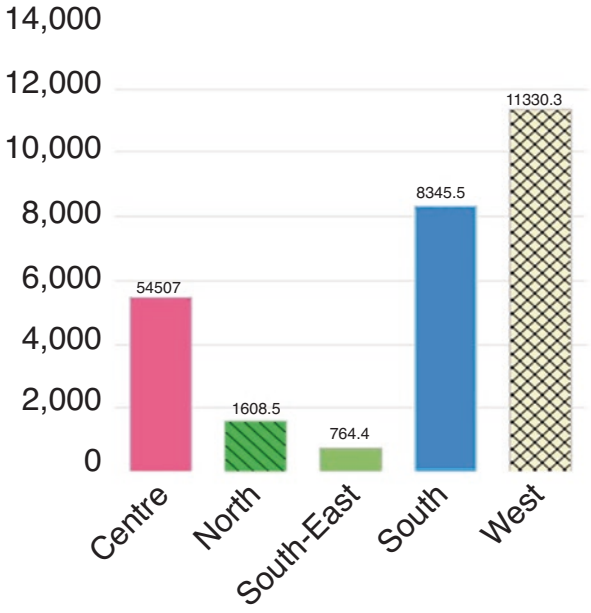


Fig. 17.5 Circular economy investments at regional level (mil. Euro yearly average 2000–2018). (Source: Authors' own calculations)

(e) Another significant indicator for the circular economy implementation at EU level is circular economy innovation, evaluated by the number of registered patents. The evolution, presented in Fig. 17.6, illustrates the average trend for the time period 2001–2016.

The countries in the center region registered, in the analyzed period, the highest number of patents—22.1 patents/year, followed at a long distance by the countries in the west region—12.6 patents/year.

The countries in the south and north regions registered average values of the annual number of patents—7.7 patents/year in the south region and 3.6 patents/year in the north region.

The countries in the southeast region registered, for the analyzed period, the lowest number of circular economy patents, only 1.2 patents/year.

(f) Figure 17.7 presents the evolution of one of the most followed indicators nowadays, namely the recycling of waste of electric and electronic equipment (WEEE). It is expressed in kg per inhabitant, and the figures represent average data for the time period analyzed, 2009–2018.

The north region has the best results with 7.5 kg/inhabit. of WEEE recycled in the analyzed period.

The west region is in second place, with 6.9 kg/inhabit. of recycled WEEE.

The center region with 5.3 kg/inhabit. of recycled WEEE is in third place.

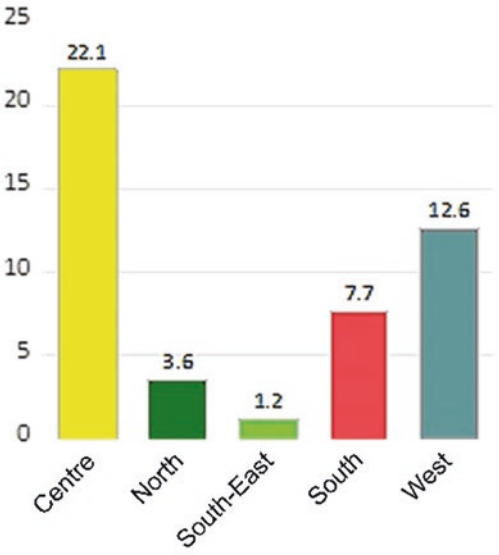


Fig. 17.6 Innovation in circular economy at regional level (number of patents, average for the period 2001–2016). (Source: Authors' own calculations)

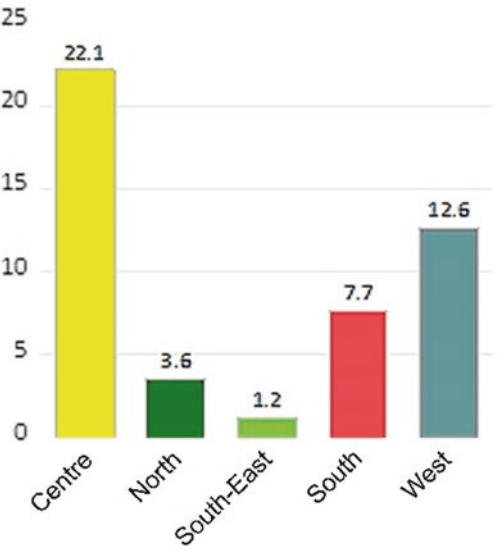


Fig. 17.7 WEEE recycling at regional level (kg/inhabit. Average for the period 2009–2018). (Source: Authors' own calculations)

The south and southeast regions have the lowest (almost similar) levels of WEEE recycling—4.1 kg/inhabit. and 4.2 kg/inhabit.

(g) Fig. 17.8 presents the last and most important indicator for circular economy evolution and circular material use rate. It is analyzed as percentage and also as average for the time period 2010–2020.

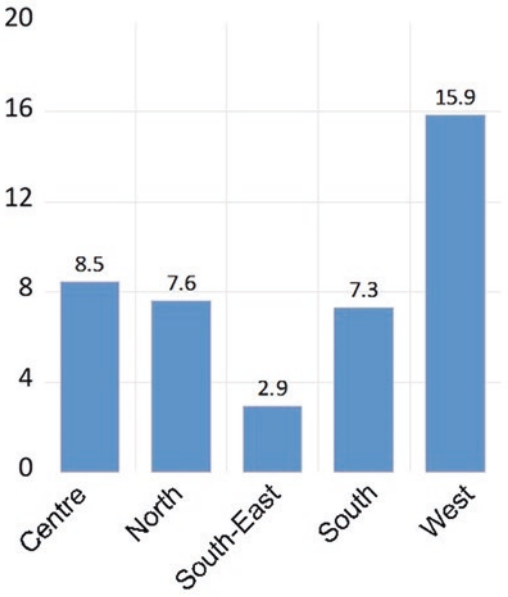


Fig. 17.8 CMUR—circular material use rate, at regional level (%, average for the period 2010–2020). (Source: Authors' own calculations)

Table 17.1 Circular economy indicators in EU at regional level

CE indicator/region	Center	North	Southeast	South	West
Packaging recycling rate (% average 2000–2018)	61.7	61.1	56.0	56.3	67.1
Municipal waste recycling rate (% average 2000–2018)	32.4	28.7	14.3	21.1	38.0
Biodegradable waste recycling (kg/inhabit. average 2000–2018)	52.9	48.6	15.7	45.9	82.9
Circular economy investments (mil. Euro yearly average 2000–2018)	5450.7	1608.5	764.4	8345.6	1130.3
Circular economy innovation (no. of patents 2001–2016 average)	22.1	3.6	1.2	7.7	12.6
WEEE recycling (kg/inhabit. average 2009–2018)	5.3	7.5	4.1	4.2	6.9
CMUR—Circular material use rate (% average 2010–2020)	8.5	7.6	2.9	7.3	15.9

Source: Authors' own research

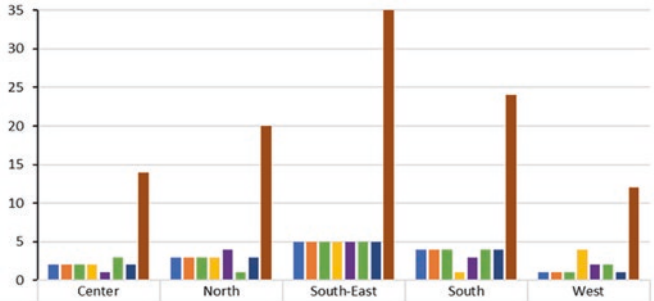
The west region, which includes the Netherlands and Belgium, has the highest value of the CMUR indicator (15.9%).

In second place is the center region with a CMUR rate of 8.5%.

The north and south regions have average and close values (7.6% and 7.3%).

The lowest value for CMUR evolution is recorded in the southeast region (2.9%).

In the following analyses, Table 17.1 is a compilation of all the analyzed indicators for the five geographical regions in the European Union, according to the proposed methodology.



	Center	North	South-East	South	West
Packaging recycling rate	2	3	5	4	1
Recycled municipal waste rate	2	3	5	4	1
Biodegradable waste recycling rate	2	3	5	4	1
Circular economy investments	2	3	5	1	4
Circular economy innovation (patents)	1	4	5	3	2
WEEE recycling	3	1	5	4	2
CMUR – circular material use rate	2	3	5	4	1
TOTAL	14	20	35	24	12

Fig. 17.9 Circular economy indicators in EU hierarchy

Figure 17.9 presents the hierarchical approach of each indicator for the circular economy performance of each region. Each region received a mark (1–5) in accordance with the place in the hierarchy of each indicator. All indicators were considered having equal importance. Simple hierarchies were established, based on the mentioned indicators: 1st place in the hierarchy gets 1 point, and 5th place in the hierarchy gets 5 points. The first in hierarchy are the regions with the lowest number of total points.

First place, with the highest circular economy performance, is occupied by west region (12 points), followed by center region (14 points), in second place. Next places, third and fourth, belong to north and south regions. The last place in this hierarchization, with the poorest circular economy performance, is occupied by southeast region (35 points).

17.5 Conclusions

From the research developed in this chapter, several conclusions may be drafted. Using a simplified methodology and only seven indicators, a picture of the circular economy was outlined.

The main conclusion is that, in the EU, circular economy has a fragmented distribution at regional level. The best performers are the countries from west regions (with 12 ranking points) followed by countries in center region (with 14 points). These two regions have the lowest number of hierarchy points; thus, they have the best values for every indicator analyzed. Regions, north (with 20 ranking points) and south (with 24 points), have mediocre performance in promoting circular economy; they are situated in the middle of the hierarchy.

The southeast region has the last position in every hierarchy of indicators and consequently for the overall ranking (35 points).

Therefore, the most advanced countries in promoting circular economy are in the west of EU, while the east are the feeblest ones. With average performance in CE, there is small difference between northern and southern countries. Their performance is quite similar.

As for the limits and future directions of research, it should be mentioned that, in this analysis, not all CE relevant indicators were taken into account. Consequently, further and recent data should be added, for 2019–2021 period. A new influx of data may change the ranking but not in a significant manner. Therefore, the next research analysis will employ updated information and more advanced methodology.

There is another future research direction that explains what causes this fragmentation. As the legislation regarding CE is consistent across EU member states, there are some ideas to be taken into account: main drivers (eco-investment, eco-innovation), economic instruments for recycling, stable legislative framework, etc.

It is obvious that there is still required a broad range of economic policies and investments for the improvement of circular economy performance. This is mainly needed in the countries located in the southeast and some countries of the south regions of the EU. These are countries also covered by the convergence objective of the Maastricht Treaty.

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