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THE CIRCULAR ECONOMY VS THE SUSTAINABLE DEVELOPMENT APPROACH TO PRODUCTION AND CONSUMPTION: THE CASE OF THE EUROPEAN UNION COUNTRIES

Production and consumption are both monitored in the context of progress toward a circular economy and sustainable development. In each case, the number and types of the implemented indicators are different. Thus, it is reasonable to ask about the comparability of information produced by two composite measures for equivalent research subjects: production and consumption. This is a thematic area of the EU Action Plan for the Circular Economy, as well as for responsible consumption and production, which is the 12th goal of the UN Agenda 2030. To scrutinize this problem in the European Union, this research aims to test statistically the similarity between the production and consumption composite indicators (based on Circular Economy Action Plan measures), and the responsible consumption and production composite indicators (based on the UN Agenda 2030 measures). The thesis that the application of the composite indicators generates significantly different results is not proved.

Keywords: circular economy, sustainable development, production and consumption, hierarchical linear modeling, SDG, management, European Union.

1. INTRODUCTION

Sustainable development (SD) and circular economy (CE) are related concepts. One of their common goals is concentration on production and consumption systems. For monitoring them, the United Nations' Agenda for sustainable development (in short: Agenda 2030) implemented goal 12 – Ensure sustainable consumption and production patterns. Similarly, the European Union's Action Plan for the Circular Economy (in short: CEAP) included a thematic area called production and consumption. Both goal 12 of the

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Agenda 2030 and the mentioned thematic area of the CEAP are used in the assessment of the EU's countries' progress towards CE and SD goals. It is interesting, however, that these two approaches to production and consumption are based on different sets of indicators. Thus, the question of *how different are the results after measuring production and consumption according to Agenda 2030 and CEAP* is reasonable. Understanding this problem is crucial for decision-makers in creating development policy. Their conclusions determine managing the challenges of SD and CE, so the more robust and harmonized indicators the more effective the decision-making process. It is worth mentioning the earlier research arguing that at the EU level, the absence of a full harmonization between the policy on CE and sustainable consumption and production (Marrucci et al., 2019) causes also low integration between their tools. To scrutinize the integration of CE and SD indicators in the sphere of production and consumption of the European Union, this study aims to the identification of comparability of outcomes produced by the two mentioned approaches. The thesis of this paper assumes that *measuring production and consumption according to the methodology of the Agenda 2030 and CEAP generates significantly different results*. For the research purpose of this study, the following synthetic indicators were designed: production and consumption composite indicator (based on the Eurostat sub-indicators for Circular Economy Action Plan of the EU) as well as responsible consumption and production composite indicator (calculated upon the basis of the Eurostat sub-indicators for the UN Agenda 2030). We present the data regarding the hierarchical linear modelling (HLM) methodology. In the section Research results, we analyze and interpret the statistical results. Finally, we discuss our findings and the possibilities of future research.

2. CIRCULAR ECONOMY TOWARDS PRODUCTION AND CONSUMPTION

The long-lasting anthropopressure of the traditional consumption and production models put under discussion the paradigm of industrial civilization (Ziółkowski, 2021). The growing acceleration of the environmental burden ignited reflection on the depletion of natural resources which are required to support the social, economic and demographic existence of humans (Sariatli, 2017). Due to the fact that natural resources are only partially renewable, they should be saved by extending their usage in supply chains. This is the core of the circular economy concept which assumes closing the production and consumption loops (Szczygieł, 2021). A circular economy is defined as an economic system which replaces the linear model of the economy with a circular one (Szczygiel, Kowalska, 2021). From its beginnings, the essential part of this circularity is based on the implementation of the 3R's concept (Manickam & Duraisamy, 2019) which assumes reusing, recycling and recovering materials in production, distribution and consumption processes (Kirchherr et al., 2017). R-imperatives create the circular economy system (Ziolkowski, 2021) and their number is still evolving.

The circular economy is defined also as an industrial system which "replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models" (Ellen MacArthur Foundation, 2013). Among the broad spectrum of CE strategies, the most prominent ones are focused on waste management and innovations (Bartoszczuk, 2021).

The progress towards the circular economy is assessed by different types of indicators, regarding various typologies. In one approach, life cycle thinking is used to measure the

environmental impact of materials, products and services, defined as environmental problems (Moraga et al., 2019; Ziółkowski, Wyrwa, 2021). The assessment of their impact embraces the sphere of resource consumption and the sphere of pollution generated in production (Kayo et al., 2014). For monitoring CE progress in the European Union, the set of main and sub-indicators is used, as presented in Table 1.

Table 1. Indicators measuring the progress towards the circular economy in the European Union

Circular economy indicators	Circular economy sub-indicators
Production and consumption (cei_pc)	• EU self-sufficiency for raw materials (cei_pc010) • Material footprint (cei_pc020) • Resource productivity (cei_pc030) • Generation of municipal waste per capita (cei_pc031) • Generation of waste excluding major mineral wastes per GDP unit (cei_pc032) • Generation of waste excluding major mineral wastes per domestic material consumption (cei_pc033) • Waste generation per capita (cei_pc034) • Generation of packaging waste per capita (cei_pc040) • Generation of plastic packaging waste per capita (cei_pc050)
Waste management (cei_wm)	• Recycling rate of municipal waste (cei_wm011) • Recycling rate of all waste excluding major mineral waste (cei_wm010) • Recycling rate of packaging waste by type of packaging (cei_wm020) • Recycling rate of e-waste (cei_wm050) • Recycling of biowaste (cei_wm030) • Recovery rate of construction and demolition waste (cei_wm040)
Secondary raw materials (cei_srm)	• Contribution of recycled materials to raw materials demand - end-of-life recycling input rates (EOL-RIR) (cei_srm010) • Circular material use rate (cei_srm030) • Trade in recyclable raw materials (cei_srm020)
Competitiveness and innovation (cei_cie)	• Private investments, jobs and gross value added related to circular economy sectors (cei_cie010) • Patents related to recycling and secondary raw materials (cei_cie020)

Source: Own presentation based on the: Eurostat, Database [Access: 28.01.2023]. Access on the internet: https://ec.europa.eu/eurostat/web/main/data/database.

The production and consumption indicators in the EU methodology are considered essential to understanding progress towards the CE (European Commission, 2018). When reporting some aspects of waste generation and resource efficiency of the economy these indicators support acquiring economic and environmental benefits, which are the chief determinants of CE adoption (Yazan et al., 2018).

The circular economy addresses many sustainability challenges (Markard et al., 2012) in various sectors (e.g. agriculture, construction and tourism[4]) therefore it is considered in the European Union as a pathway for sustainable development (Marrucci et al., 2019; Ziółkowski, Wyrwa, 2021).

3. ASSUMPTIONS OF THE SUSTAINABLE DEVELOPMENT

Circular economy strategies respond to selected challenges of sustainable development on three dimensions: economic, environmental and social. All dimensions of sustainability have been defined by 17 factors named the Sustainable Development Goals (SDGs) and introduced by the United Nations' Agenda 2030 (Fidlerova et al., 2022). The Sustainable Development Goals of Agenda 2030 embrace (United Nations, General Assembly, 2015):

- "Goal 1. End poverty in all its forms everywhere,
- Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture,
- Goal 3. Ensure healthy lives and promote well-being for all at all ages,
- Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all,
- Goal 5. Achieve gender equality and empower all women and girls,
- Goal 6. Ensure availability and sustainable management of water and sanitation for all,
- Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all,
- Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all,
- Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation,
- Goal 10. Reduce inequality within and among countries,
- Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable,
- Goal 12. Ensure sustainable consumption and production patterns,
- Goal 13. Take urgent action to combat climate change and its impacts,
- Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development,
- Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss,
- Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels,
- Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development".

The global interest in sustainability was actively shaped during the last 36 years. According to the first contemporary definition of sustainable development, from the year 1987, this concept describes such a new model of development "that meets the needs of

[4] You can read more about solutions in this field of circular economy on TOUCAN websites (ERASMUS+, The future of tOUrism without a CArbon footprint (TOUCAN), 2021-1-PL01-KA220-VET-000025053, 2022-2023): https://www.linkedin.com/company/toucan-erasmus-project/, https://toucan.erasmus.site/pl/.

the present without compromising the ability of future generations to meet their own needs" (United Nations, General Assembly, 1987). Many international institutions and scholars developed their interpretations of that notion (Tsalis et al., 2020), although, the most prevailing one is three-dimensional approach. Next to the basic components of sustainable development (social, economic and ecological/environmental) the technical and institutional-political (Banse, 2014) as well as spatial ones are also mentioned in the scientific debate (Borys, 2005, 2011; Burchard-Dziubińska, 2010; Ziółkowski, 2014) – both as separate and included into the basic components. Despite the long dissemination of this issue, its diversity caused the understanding of sustainable development is often different within equal sectors of the economy (Ziółkowski, 2013). This can create problems in unambiguous assessment of progress towards sustainability in some areas (Matusiak et al., 2020).

The search for sustainability stems from the goal of humanity to develop an environment that enhances individual freedom, but also improves the range of choices associated with having a longer and healthier life (Boozer et al., 2004; Le Caous, Huarng, 2020; Mustafa et al., 2017). This is nevertheless the first principle of the Rio Declaration on Environment and Development from the year 1992 (Ziółkowski, 2012), which stated that "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature" (United Nations, General Assembly, 1992). In this context, sustainability is one of the essential backbones of human development, assessed by the human development index in the five domains: equity, productivity, empowerment, cooperation, and security (Shah, 2016). The use in production companies of various instruments supporting comprehensive decision-making allowed to increase the level of product quality and strengthen the pro-ecological impact of products on the natural environment (Hajduk-Stelmachowicz et al., 2022).

The European Union implemented the goal of sustainable development of Europe in its establishing document, i.e., the Treaty on European Union (aka the Maastricht Treaty from 1992). The resulting strategies and regulations of the EU focused on fulfilling the internationally promoted by United Nations sustainable development goals, first of all by the Agenda 21 from 1992, Millennium Declaration from 2000 and Agenda 2030 from 2015. The United Nations Resolution called "Transforming our world: the 2030 Agenda for Sustainable Development" (i.e., Agenda 2030) comprises 17 Sustainable Development Goals and 169 targets.

One of the prominent goals of the Agenda 2030 is *SDG 12. Ensure sustainable consumption and production patterns*, which embrace 11 targets (United Nations, General Assembly, 2015):

- "12.1 Implement the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries,
- 12.2 By 2030, achieve the sustainable management and efficient use of natural resources,
- 12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses,
- 12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international

frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment,

- 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse,
- 12.6 Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle,
- 12.7 Promote public procurement practices that are sustainable, in accordance with national policies and priorities,
- 12.8 By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature,
- 12.a Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production,
- 12.b Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products,
- 12.c Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities".

Production and consumption patterns are the key issues in discussion on "resource productivity as a key element of sustainable development and especially for reducing environmental impact" (Lebel, Lorek, 2010; Liedtke et al., 2014). SDG 12 is considered also a major contributor to the protection and enhancement of natural resources, although its measures are assessed as relatively weak when considering the four decades of lasting international policy discourse (Schröder et al., 2019). Employing the target 12.5 ("by 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse") SDG 12 includes also the circular economy approach "that combines both the technical-managerial efficiency aspect of recycling and the systemic approach to reduce overall consumption and waste generation" (Schröder et al., 2019).

The pursuit of sustainability is a never-ending story (Lebel & Lorek, 2010), however, the better the measurement system in this sphere the easier identification of SDGs achievements and the more accurate harmonization of policy plans.

4. RESEARCH METHOD

To describe the contribution to the SDGs and CEAP, different sets of indicators were developed by independent organisations. Similarly, in the EU evolved the Eurostat measures too. The research aim of this study is the identification of similarity between the outcomes of production and consumption indicator (used by the Circular Economy Action Plan) as well as responsible consumption and production indicator (used by the UN Agenda 2030). To investigate the problem, the hierarchical linear modelling (HLM) methodology was introduced. For this purpose, the destimulants were replaced with stimulants. The arithmetic mean was then used to calculate the synthetic meter values for the two rankings

separately. Based on data taken from Eurostat databases, two rankings were created, as presented in Tables 3 and 4. The first one concerns the variables from goal 12 of the Agenda 2030. The second one was created of the variables from consumption and production taken from the Eurostat database for circular economy indicators. The set of variables used for the analysis included:

A. Responsible production and consumption (variables measuring goal 12 of UN Agenda 2030):
   1. Circular material use rate (cei_srm030)
   2. Energy productivity (sdg_07_30)
   3. Raw material consumption 2019 (RMC) (sdg_12_21)
   4. Consumption of chemicals by hazardousness - EU aggregate (sdg_12_10) there is no data available
   5. Average CO_2 emissions per km from new passenger cars (source: EEA, DG CLIMA) (sdg_12_30)
   6. Gross value added in environmental goods and services sector (sdg_12_61) there is no data available
   7. Generation of waste excluding major mineral wastes by hazardousness (sdg_12_50)

B. Production and consumption (variables for monitoring CE Action Plan):
   1. EU self-sufficiency for raw materials (cei_pc010) - there is no data available
   2. Material footprint 2019 (cei_pc020)
   3. Resource productivity (cei_pc030)
   4. Generation of municipal waste per capita (cei_pc031)
   5. Generation of waste excluding major mineral wastes per GDP unit (cei_pc032)
   6. Generation of waste excluding major mineral wastes per domestic material consumption (cei_pc033)
   7. Waste generation per capita (cei_pc034)
   8. Generation of packaging waste per capita (cei_pc040)
   9. Generation of plastic packaging waste per capita 2019 (cei_pc050)

To identify the similarity between the two sets of measures, two composite/ synthetic indicators were developed.

The year of analysis was 2020, but for some variables, values from 2019 have been used, as they were not yet available for 2020.

5. RESEARCH RESULTS

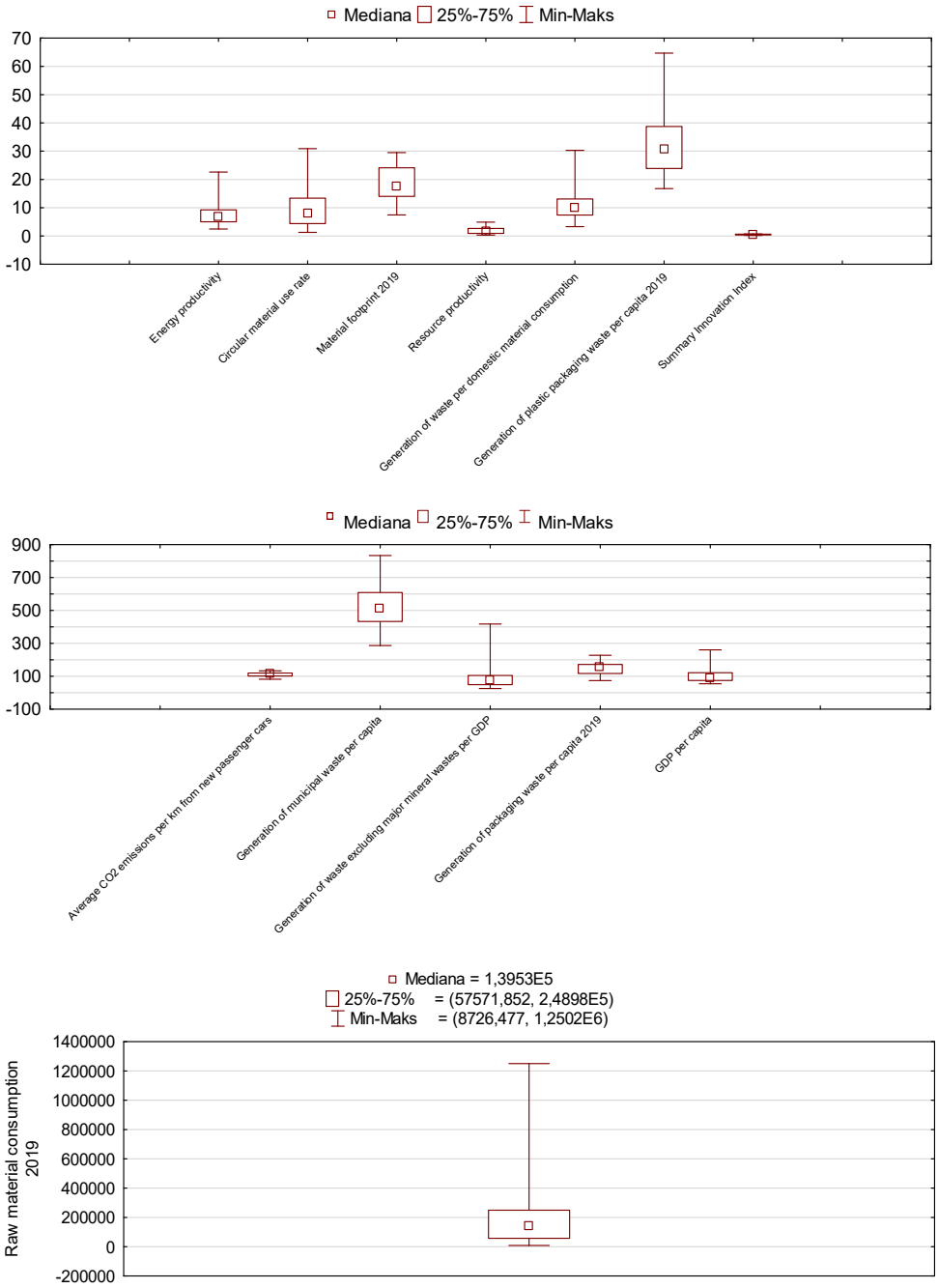
One could expect that the application of similar thematic measures should deliver comparable information. Thus, when measuring the production and consumption area there is a question about the similarity of outcomes after the application of two different composite indicators of production and consumption area. Every synthetic indicator consists of different numbers and types of sub-indicators, so the final result of their application is an intriguing issue.

Table 2 presents statistical measures for selected variables. Figures 1–4 show the analyzed variables in box charts.

Table 2. Descriptive statistics of analyzed variables

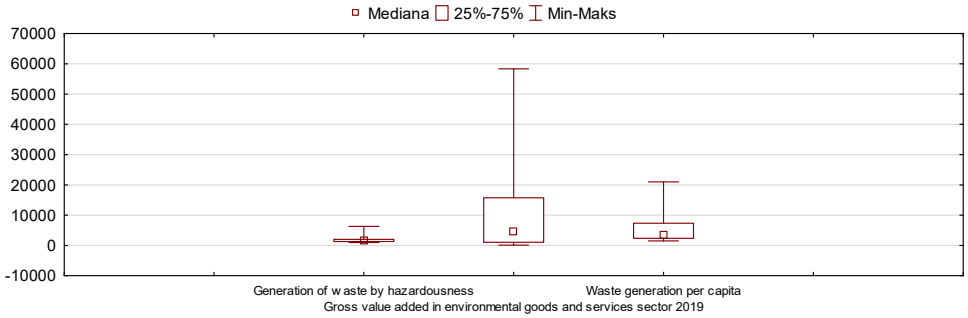
Variable	Descriptive statistics								
	Mean	Median	Min	Max	Q1	Q3	s	V	Asymmetry
Energy productivity	7,87	6,77	2,47	22,61	5,02	9,24	4,30	54,71	1,91
Raw material consumption 2019	252902,68	139526,51	8726,48	1250158,3	57571,85	248982,2	307195,9	121,47	1,96
Average CO_2 emissions per km from new passenger cars	111,14	113,00	82,30	133,00	101,40	119,80	11,53	10,38	-0,53
Circular material use rate	10,19	7,90	1,30	30,90	4,40	13,40	7,46	73,21	1,13
Generation of waste excluding major mineral wastes by hazardousness	1846,48	1517,00	962,00	6291,00	1311,00	2003,00	1070,20	57,96	3,06
Gross value added in environmental goods and services sector 2019	9923,72	4457,17	101,00	58358,8	704,76	14245,1	14476,1	145,87	2,07
Material footprint 2019	18,72	17,55	7,45	29,50	14,02	24,13	6,19	33,06	0,11
Resource productivity	1,85	1,58	0,34	4,92	0,94	2,68	1,19	64,09	1,00
Generation of municipal waste per capita	533,37	513,00	287,00	834,00	433,00	609,00	139,40	26,13	0,71
Generation of waste excluding major mineral wastes per GDP	96,93	74,00	26,00	418,00	49,00	105,00	95,92	98,97	2,95
Generation of waste excluding major mineral wastes per domestic material consumption	11,98	9,80	3,30	30,30	7,40	13,10	6,71	56,05	1,51
Waste generation per capita	5985,52	3598,00	1483,00	20993,00	2340,00	7338,00	5272,88	88,09	1,55
Generation of packaging waste per capita 2019	148,92	153,70	74,03	227,98	117,44	172,19	44,07	29,59	0,11
Generation of plastic packaging waste per capita 2019	31,65	30,57	16,76	64,67	23,90	38,75	9,97	31,51	1,31

Source: own calculations.



Figures 1–3. Box-plot of analyzed variables

Source: own calculations.



Figures 4. Box-plot of analyzed variables (cont.)

Source: own calculations.

The results obtained should help the authorities of the countries belonging to the European Union to make appropriate decisions regarding the objectives of the 2030 Agenda. According to the first ranking (Table 3), the best-performing countries are: the Netherlands, Denmark, Malta, France and Slovenia. The following countries are the worst performers: Poland, Slovakia, Hungary, Cyprus and Greece.

Table 3. Ranking of the European Union countries concerning variables from Goal 12 (Agenda 2030)

Country	Energy productivity	Raw material consumption 2019	Average CO_2 emissions per km from new passenger cars	Circular material use rate	Generation of waste excluding major mineral wastes by hazardousness	Synthetic measure	Ranking
Netherlands	10	12	1	1	24	9,47	1
Denmark	2	14	3	15	16	10	2
Malta	26	1	7	14	1	10,17	3
France	7	26	5	3	14	10,75	4
Slovenia	15	4	16	9	9	10,89	5
Luxembourg	3	2	21	6	22	10,94	6
Croatia	17	7	12	20	3	12,03	7
Ireland	1	10	8	26	15	12,08	8
Italy	4	24	11	4	19	12,14	9
Spain	9	22	13	11	11	12,94	10
Belgium	14	13	10	2	26	12,97	11
Sweden	8	21	2	16	21	13,39	12,5
Portugal	12	18	4	25	8	13,39	12,5
Austria	6	20	14	10	18	13,42	14

Table 3 (cont.). Ranking of the European Union countries concerning variables from Goal 12 (Agenda 2030)

Country	Energy productivity	Raw material consumption 2019	Average CO_2 emissions per km from new passenger cars	Circular material use rate	Generation of waste excluding major mineral wastes by hazardousness	Synthetic measure	Ranking
Germany	5	27	15	7,5	17	13,93	15
Latvia	19	5	19	22	7	14,61	16
Finland	16	17	6	18	23	15,81	17
Lithuania	21	8	20	21	13	16,64	18
Czechia	24	19	22	7,5	12	16,82	19
Romania	18	23	17	27	2	17,22	20
Estonia	25	6	23	5	27	17,25	21
Bulgaria	27	15	27	24	25	18,02	22
Greece	13	11	9	19	6	18,41	23
Cyprus	11	3	25,5	23	5	18,80	24
Hungary	22	16	18	13	4	19,19	25
Slovakia	20	9	24	17	10	19,58	26
Poland	23	25	25,5	12	20	20,74	27

Source: own calculations.

According to the second ranking (Table 4), the highest positions were obtained by the following countries: Croatia, Cyprus, Greece, Slovakia and Slovenia. The worst performers were: Germany, Austria, Poland, Luxembourg and Estonia. In this division, it can be seen that the more industrialized countries fared worse. It turns out that they should allocate more resources to fight for environmental issues (analyzing data related to production and consumption).

The comparison of national results after the calculation of composite indicators for Agenda 2030 and CEAP presents Figure 5.

The statistical analysis of the correlation coefficient between the two analysed composite indicators is p=0,56 (at the significance level of 5%). This delivers evidence which does not prove the thesis of this paper that *measuring production and consumption according to the methodology of the Agenda 2030 and CEAP generates significantly different results.* Finally, the informative power of two analysed composite indicators can be assessed as similar. This indicates that if decision-makers tend to build their conclusions regarding the progress towards CE in the field of production and consumption, by means of calculated composite indicators, they can rely equally on the methodology of Agenda 2030 and CEAP.

Table 4. Ranking of the European Union countries concerning variables from production and consumption (CEAP)

Country	Material footprint 2019	Resource productivity	Generation of municipal waste per capita	Generation of waste excluding major mineral wastes per GDP	Generation of waste excluding major mineral wastes per domestic material consumption	Waste generation per capita	Generation of packaging waste per capita 2019	Generation of plastic packaging waste per capita 2019	Synthetic measure	Ranking
Croatia	8	19	5	19	12,5	1	1	1	8,31	1
Cyprus	19	16	21	4	2	9	4	2	9,63	2
Greece	4	13	15	15,5	19	6	3	3	9,81	3
Slovakia	7	15	7	20	18	7	6	9	11,13	4
Slovenia	10	14	13	13	16	13	7	6	11,44	5
Hungary	11	22	4	17	6	4	13	18	11,88	6
Sweden	22	11	6	5,5	9,5	25	10	7	12	7
Spain	2	8	9	11,5	23	5	19	20	12,19	8,5
Latvia	15	21	10	22,5	11	2	12	4	12,19	8,5
Malta	13	12	23	5,5	8	18	14	15	13,56	10
Netherlands	1	1	16	11,5	27	20	20	13	13,69	11
Lithuania	17	24	11	21	7	8	11	12	13,88	12
Ireland	21	4	19	2	3	10	27	27	14,13	13
Italy	3	3	13	14	25	11	24	21	14,19	14
Czechia	14	18	18	18	14	14	8	10	14,25	15
France	6	5	17	7	22	16	23	19	14,38	16
Denmark	20	9	26	3	5	12	18	23	14,5	17,5
Romania	26	27	1	24	1	21	5	11	14,5	17,5
Portugal	12	20	14	15,5	9,5	3	22	24	15	19
Finland	27	17	20	10	4	27	9	8	15,25	20
Belgium	5	6	24	22,5	26	19	16	14	16,56	22
Bulgaria	18	26	8	27	20,5	26	2	5	16,56	22
Germany	9	7	22	9	20,5	17	26	22	16,56	22
Austria	23	10	27	8	12,5	22	17	16	16,94	24
Poland	16	23	2	25	17	15	21	17	17	25
Luxembourg	24	2	25	1	15	24	25	25	17,63	26
Estonia	25	25	3	26	24	23	15	26	20,88	27

Source: own calculations.

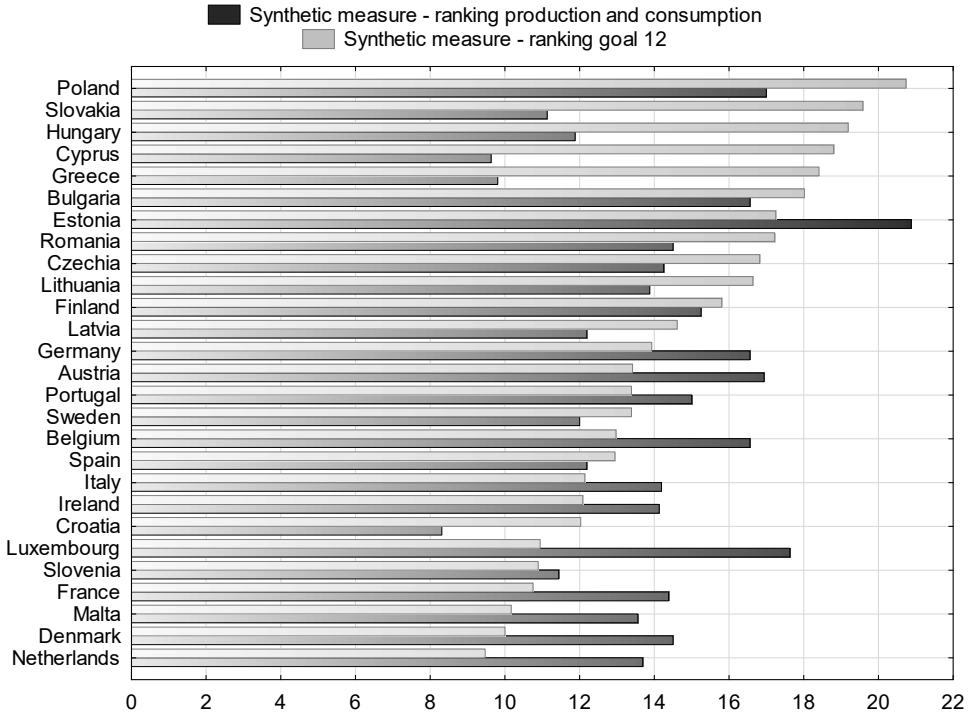


Figure 5. Composite indicators for Agenda 2030 and CEAP

Source: own calculations.

6. CONCLUSIONS

The shift to the circular economy is determined by the need to reduce reliance on non-renewable natural resources by decoupling economic growth from the environment. For assessing the achievements of such policy, different sets of indicators evolved globally. Because of the knowledge gap on their informative power, this paper aimed to explore the comparability of two composite measures for production and consumption area. The first one was production and consumption indicator - used for measuring progress in EU Action Plan for the Circular Economy. The second one was responsible consumption and production indicator – used for monitoring advances in the realization of sustainable development goals of the UN Agenda 2030. The hierarchical linear modelling (HLM) methodology highlighted some differences between these two composite indicators. Nevertheless, the correlation coefficient between the two composite indicators was not statistically significant. Thus, the presented results did not support the conclusion formulated by the earlier study on the low level of integration between CE and sustainable consumption and production tools "caused by the absence of a full harmonisation between the two policies at EU level" (Marrucci et al., 2019).

The results of this study might be useful for scientists and practitioners under certain conditions. The assessments based on synthetic indicators orients on similar conclusions. For this reason, one could recommend using the composite indicators interchangeably when describing the advancement in production and consumption policy. The calculated

results should help the authorities of the countries belonging to the European Union to make appropriate decisions regarding the objectives of the 2030 Agenda. From the results of the rankings, the evidence shows that the following countries are doing the best: the Netherlands, Denmark, Malta, France and Slovenia. The worst performers in the analysed issue are the following countries: Poland, Slovakia, Hungary, Cyprus and Greece. This aspect demonstrates the division into 'old EU' countries and countries that joined the EU after the year 2004. The revealed gap should be addressed by the European Commission when creating appropriate policy instruments to support countries that do not meet the conditions for achieving the goals of the 2030 Agenda.

It is important noticing some limitations resulting from the lack of data on the CE indicator *EU self-sufficiency for raw materials (cei_pc010)* for the year of analysis 2019. This could determine to some extent the final results of the analysis, therefore the updating of results in the time of data availability is a justified recommendation for future research. Investigation of the correlation between the synthetic indicators of CE and Agenda 2030 indicators could be also the recommended subject of future research.

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