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PROGRESS TOWARDS A CIRCULAR ECONOMY AT THE EU LEVEL AND ITS IMPACT ON ECONOMIC DEVELOPMENT

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Methods. The research is devoted to the study of the circular economy and the establishment of its impact on socio-economic development. To obtain the results, methods of scientific abstraction, analysis and synthesis were used, which allowed us to consider the essence of the circular economy and establish its advantages for ensuring the sustainable development of the countries of the European Union. Factor analysis was used to identify factors that influence the functioning of the circular economy. Methods of mathematical statistics allowed us to establish the dependence of economic growth on resource productivity. The analysis is based on three statistical hypotheses tested through a panel data model using the EViews 14.0 statistical software.

Results. Based on the results of economic studies on the consequences of industrialization in emerging economies, the paper identifies the economic drivers underlying the development of the European Union's circular economy. It discusses the European Commission's Circular Economy Monitoring Framework (CEMF), which focuses on the European circular economy..

The study was conducted on a sample of 27 European Union countries for the period 2012–2023, during which the positive effects of the implementation of circular economy models were identified, namely: an increase in the level of employed labor, an increase in municipal revenues and profits of enterprises providing environmental infrastructure. The article emphasizes that the circular economy model is determined by resource productivity, labor involved in environmental protection, the level of household waste recycling and the use of renewable energy

Novelty. The results of the study confirm the statistical hypothesis, which is mainly related to the strong and significant effect of resource productivity on economic growth, which confirms the European point of view that a 30% increase in resource productivity by 2030 could lead to an increase in GDP of almost 1%.

Practical value: A linear regression model is presented that can be effectively used in the development and implementation of circular economy models.

Keywords: circular economy, renewable energy, economic growth, sustainable development.

Statement of problem. The use of limited resources is a major concern for governments and researchers as they try to find the best solutions to meet the growing demands of consumer economies and the challenges of climate change. Several institutions have recently provided information on the current state and future prospects of the circular economy in Europe, examining progress, challenges and recommended actions for further mainstreaming circular practices. There is a consensus on recognising some progress, together with a clear need for stronger policy implementation, financial support and scaling up circular business models and consumption patterns. The European Environment Agency's 2024 report, Accelerating the circular economy in Europe, highlights the same balance between recognising positive progress and the need for bolder action.

Unlike the traditional model, this model is linked to the unsustainable use of resources, which is a major driver of the current triple crisis of climate change, biodiversity loss and pollution.

Europe's response to the abuse of natural resources is to take steps to transition to a circular economy, which involves moving from

linear production and consumption models to circular ones. This transformation is detailed in the Circular Economy Action Plan (CEAP).

Currently, the real challenge is how to transform the current structure of the consumption model, based on the production-consumption-waste model, into a circular economy (CE), which is by definition regenerative. According to Kirchherr et al, CE is most often depicted as a combination of reduction, reuse, and recycling activities [1]. Thus, an essential role in a circular economy is to invest in innovative environmental protection equipment.

The economic literature of the past decades is rich in econometric and economic studies that estimate the impact of environmental management programs and waste on the economic development of countries, according to a general equilibrium model.

McDonogh and Browngart introduced the Cradle to Cradle (C2C) concept, which refers to the recycling of waste and its transformation into new products [2]. It is used in economic analyses that evaluate renewable and clean energy production, ecosystem diversity, and the use of green energy sources [3]. The paper presents an analysis of key CE indicators at the EU level, describing a multiple linear regression model.

Analyses of recent papers. Many aspects of the EU economy need to be transformed to successfully implement the principles of a circular economy and achieve a measurable impact on Europe's resource use and waste generation. This includes comprehensive policy frameworks, the creation of circular economy knowledge, new sets of jobs and skills, the development and scaling up of circular business models, changing consumption habits and rethinking the relationship with materials and waste.

An enabling framework that not only enables circularity but also supports the approach. This means strong policies; adequate financing for the transition should be provided through both public and private financial institutions, and research and innovation should support the transition process.

Businesses should adopt more circular models for the supply of goods and services that help reduce resource consumption. There are currently several monitoring frameworks focused on the European circular economy, including the European Commission's Circular Economy Monitoring Framework (CEMF). Existing frameworks provide an effective understanding of macro-phenomena related to the flow of materials into and out of the EU economy.

These aspects are crucial for a circular economy, where material flows have a low virgin resource content and waste is recycled. However, other elements of the circular economy are less well monitored, often because the data flows to understand them are fragmented or non-existent. By combining a wide range of new sources and perspectives, the EEA's Circular Metrics Lab (CML) complements existing initiatives by compiling data on the growth of the circular economy [4].

The most important prerequisite for a circular economy in the EU is the support of EU and national policies that promote circularity in various aspects of the economy. Another important factor for circularity is the importance of ensuring adequate financing. According to recent estimates, the financing needs for the circular economy in the EU are €55 billion per year [5]. Encouraging signs of adequate financing for the circular economy come, for example, from the fact that the European Investment Bank's lending for circular projects is steadily increasing and reached €3.8 billion in 2019–2023.

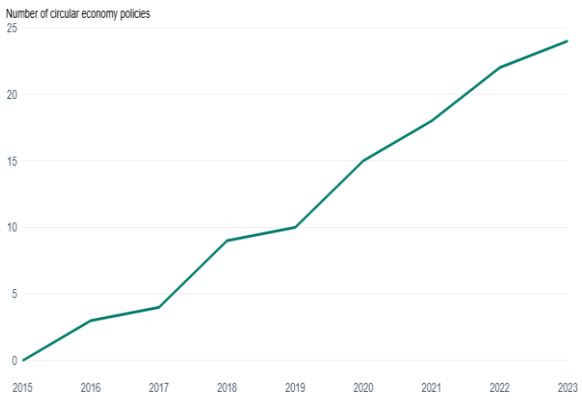

Figure 1. Number of national circular economy policies among EU Member States. Sources: National circular economy policies, European Environment Agency (EEA)

Knowledge creation and innovation are essential pillars to support circularity. If this is approximated by academic publications, the circular economy contributes to the formation of a growing knowledge base. In 2023 alone, almost 4,000 scientific articles on the circular economy were published; this shows the growing level of research and innovation activity for circularity.

However, looking at absolute numbers rather than trends reveals that circular economy-minded businesses still remain somewhat niche and further efforts are needed to mainstream circular practices across the business sector. The literature and case studies on circular business models – which refers to models that aim to offer the same product or service with lower material consumption, such as Product Service Systems (PSS) – indicate that such models have not yet scaled up to have an impact on the EU economy.

Aim of the paper. Based on the results of economic studies on the consequences of industrialization in emerging economies, this study aims to present the economic factors underlying the development of a circular economy at the European Union level. The European Commission's Circular Economy Monitoring Framework (CEMF), which focuses on the European circular economy, is discussed.

Materials and methods. The relationship between circular economy and economic growth has been analyzed by many researchers. It has been shown that there is a strong relationship between the use of circular economy and economic growth.

Moreover, while some researchers [6] argue that the use of renewable energy has a strong impact on economic growth, other economists' Innovative new products with environmental benefits for the market have a greater impact on economic growth [7]. Nevertheless, Giorgi et al, argued that resource productivity and recycling rates have a direct and significant impact on economic growth. [8].

We identify several independent factors that have the most significant impact on the regression model. These include, for example: labor productivity, labor involved in the production of environmental goods, municipal waste recycling rate, the share of innovative enterprises that have introduced innovative new products with environmental benefits to the market, and the use of renewable energy.

According to the studies mentioned above, these exogenous variables are some of the key important factors in describing the circular economy. To quantify this impact analysis, three statistical assumptions were made, as shown in Table 1.

Table 1

Hypotheses of the research study

Hypothesis 1	European Union (EU) member states with a higher number of employees in the field of the production of goods for environmental protection have higher economic growth.
Hypothesis 2	Renewable energy use at the EU level has a significant and strong impact on economic growth.
Hypothesis 3	Innovative enterprises with big market shares in the EU member states which have brought innovative new products with environmental benefits to the market have a greater impact on economic growth.

This study used several economic indicators that describe CE with a direct impact on economic growth and they were used as proxy variables in the regression model.

According to Blomsma, an important indicator of CE is «resource productivity» [9]. This is defined as the ratio of a country's GDP to its domestic material consumption and shows the efficiency of the economy in the 27 EU member states in using materials to create wealth.

According to the study, the most efficient EU member states in terms of material consumption were the Netherlands (€4.30/kg), Luxembourg (€4.20/kg) and the United Kingdom (€3.80/kg), while the least efficient were Poland (€0.45/kg), Romania (€0.42/kg) and Bulgaria (€0.42/kg). According to Lundvall, another important indicator of CE is the workforce involved in the production of environmental goods. [10].

According to Eurostat, we can conclude that the EU countries with the highest recycling rates for municipal waste were Sweden

(54.9%), Denmark (52.4%) and Hungary (48%). The countries with the lowest recycling rates were Romania (19.6%), Cyprus (13.3%) and Malta (12.1%) [11].

Descriptive statistics (e.g., mean, median, maximum, minimum, and standard error) related to the variables used in the analysis are given in Table 2. The mean and median values of the descriptive statistics for the variables in the model given in Table 2 indicate how close the data are to a normal distribution. In cases where the data have a standard normal distribution, the mean and median values are close to each other [12]. Table 2 also shows that the mean and median values of all variables were very close to each other. For this reason, it was assumed that all variables in the model were close to a standard normal distribution.

Table 2

Statistical description of variables in the model

Variable	Mean	Median	Standard Deviation	N
Y	0.2014	0.1942	0.1043	27
X_1	8.9432	8.9753	3.3022	27
X_2	0.1520	0.2013	0.0834	27
X_3	0.6012	0.7021	0.1027	27
X_4	0.9021	0.8042	0.0702	27
X_5	0.8124	0.9324	0.0987	27

According to Urban, To test the validity of the combined model from planned static panel data models with a fixed effects model [13], we developed a restricted model:

$$\delta = x\alpha + \epsilon_i \; i=\overline{1N} \qquad (1)$$

We examine the performance of the regression equations used to test three statistical hypotheses, using the pooled least squares method. This method was used to estimate performance-based economic growth and circular economy adoption at the EU level in the period 2012–2023.

Table 3

Impact of resource productivity, recycling rate, consumption, environment innovation, and recycling rate of correlations on GDP per capita growth at the EU level

Dependent Variable: GDP_CAPITA_GROWTH				
Method: Pooled least squares				
Sample: 2008–2017				
Total panel observations: 270 GDP_CAPITA_GROWTH = C (1) + C(2) × ROD_OF_RES + C(3) × ENVIRON_EMPL + C(4) × REC_RATE + C(5) × ENVIRON_INNOV + C(6) × RENEWABLE				
	Coefficient	Std. Error	t-Statistic	Prob.
C	−1.2453	1.245	3.252243	0.0084
Prod_of_res	2.324 X_1	1.430	3.58543	0.0045
Environ_Empl	2.389X_2	1.320	4.188850	0.0053
Rec_Rate	1.658X_3	1.012	4.821022	0.0047
Environ_Innov	1.476X_4	0.795	3.328985	0.0310
Renewable	1.493X_5	1.768	4.567883	0.0210
R-squared	0.798652	Mean dependent var		8.7892
Adjusted R-squared	0.824678	S.D. dependent var		0.6043
S.E. of regression	0.098723	Akaike info criterion		1.8023
Sum squared resid	1.408763	Schwarz criterion		1.7098
Log likelihood	119.3076	Hannan–Quinn criter.		1.6987
Durbin–Watson stat	2.088790			

According to the table above, we get the regression equation:

$$\delta = -1.2453+2.324X_1+2.389X_2+1.658X_3 +1.476X_4+1.493X_5 \qquad (2)$$

where:

- δ = GDP per capita growth;
- X_1 = labor productivity;
- X_2 = labor force engaged production of environmental goods;

- X_3 = recycling rate of municipal waste;
- X_4 = The share of innovative enterprises, by showcasing innovative products with environmental benefits on the market;
- X_5 = use of renewable energy.

Analyzing the evolution of economic growth in the 27 EU member states in 2008–2017 through independent variables the following results were obtained through the analysis of multifactorial regression (Table 2.): $\delta = -1.2453 + 2.324X_1 + 2.389X_2 + 1.658X_3 + 1.476X_4 + 1.493X_5$, with standard error coefficients (1.245), (1.430), (1.012), (0.795), and (1.768).

Conclusions. The European Commission's report on environmental policy indicates increasing rates of resource reuse in EU countries. The level of implementation of the CE model requires continued and significant investments in environmental infrastructure in order for EU countries to progress towards achieving the EU's environmental objectives.

This paper presents the advantages of using a conceptual model based on the efficient and responsible use of resources for sustainable economic growth.

Studies conducted in developed EU economies have shown various benefits based on environmental education programmed for civil society, as well as investments in infrastructure for collection, sorting and recycling. The positive effects of implementing circular economy models increase the level of employed labor, municipal revenues and profits earned by entrepreneurs providing environmental infrastructure.

The multiple regression analysis conducted in this study reveals the impact of independent CE factors on dependent economic growth.

The results of the study confirm the statistical hypothesis, which is mainly related to the strong and significant effect of resource productivity on economic growth, which confirms the European point of view that a 30% increase in resource productivity by 2030 could lead to an increase in GDP of almost 1% (European Union 2020). [14].

In conclusion, after the analysis, we can say that the economic model of economic growth was valid and well specified and that renewable energy factors, resource productivity, recycling rate, green employment and innovation were important factors of economic growth at the EU level.

References

1. Kirchherr, J., Reike, D., and Marko, Hekkert. (2020). Conceptualizing the circular economy: An analysis of 114 definitions. Resources. *Conservation and Recycling* 127: 221-32. https://doi.org/10.1016/j.resconrec.2017.09.005
2. McDonough, William, and Michael Braungart. (2013). *Cradle to Cradle: Remaking the Way We Make Things*. New York: North Point Press.
3. Browne, D., Bernadette O'Regan, and Moles R,. (2009). Use of carbon footprinting to explore alternative household waste policy scenarios in an Irish city-region. *Resources, Conservation and Recycling* 54: 113-22. https://doi.org/10.1016/j.resconrec.2009.07.003
4. EEA. (2022). Monitoring the circular economy using emerging data streams. https://www.eea.europa.eu/publications/monitoring-the-circular-economy-with)
5. Trinomics. (2024). Study supporting EU green investment needs analysis.
6. Su, Biwei, Almas Heshmati, and Yong Geng. (2013). A review of the circular economy in China: Moving from rhetoric to implementation. *Journal of Cleaner Production* 42: 215-27. https://doi.org/10.1016/j.jclepro.2012.11.020
7. Cotae, E.. (2015). Regional performances in the context of a transition towards the circular economy: Structuring the assessment framework. *Ecoforum Journal* 4. Retrieved from http://ecoforumjournal.ro/index.php/eco/article/view/222
8. George, D., Brian A., Chi-ang Lin, and Chen Y.,. (2015). A circular economy model of economic growth. *Environmental Modelling & Software* 73: 60-63. https://doi.org/10.1016/j.envsoft.2015.06.014
9. Blomsma, Fenna, and Geraldine Brennan. (2017). The emergence of circular economy: A new framing around prolonging resource productivity. *Journal of Industrial Ecology* 21: 603-14; https://doi.org/10.1111/jiec.12603
10. Lundvall, Bengt-Ake. (1996). The Social Dimension of the Learning Economy. Retrieved from https://pdfs.semanticscholar.org/202b/775ebcdbcaf8fd7c052f9a37a23776a3ea13.pdf
11. Eurostat. (2020). Eurostat. Your Key to European Statistics. Retrieved from http://ec.europa.eu/eurostat
12. Geng Yong, Jia Fu, Joseph Sarkis, and Bing Xue. (2012). Towards a national circular economy indicator system in China: An evaluation and critical analysis. *Journal of Cleaner Production* 23: 216-24. https://doi.org/10.1016/j.jclepro.2011.07.005
13. Urban, M. (2015). The Influence of Blockholders on Agency Costs and Firm Value an Empirical Examination of Blockholder Characteristics and Interrelationships for German Listed Firms. Berlin and Heidelberg: Springer.

https://doi.org/10.1007/978-3-658-11402-2
14. EU. (2020). Regulation (EC) No 2150/2002 of the European Parliament and the Council on Waste Statistics. Retrieved from http://www.kluwerlawonline.com/abstract.php?id=EELR2003019

ПОСТУП ДО ЦИРКУЛЯРНОЇ ЕКОНОМІКИ НА РІВНІ ЄС ТА ЙОГО ВПЛИВ НА ЕКОНОМІЧНИЙ РОЗВИТОК

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Методологія дослідження. Дослідження присвячено вивченню циркулярної економіки та встановлення її впливу на соціально-економічний розвиток. Для отримання результатів були використані методи наукового абстрагування, аналізу й синтезу, які дозволили розглянути сутність циркулярної економіки та встановити її переваги для забезпечення сталого розвитку країн Європейського Союзу. Факторний аналіз було застосовано для виокремлення чинників, які впливають на функціонування циркулярної економіки. Методи математичної статистики дозволили встановити залежність економічного зростання від продуктивності ресурсів. Аналіз базується на трьох статистичних гіпотезах, перевірених за допомогою моделі панельних даних за допомогою статистичного програмного забезпечення EViews 14.0.

Результати. На основі результатів економічних досліджень наслідків індустріалізації в країнах з економікою, що розвивається, в роботі виокремлено економічні чинники, що лежать в основі розвитку циркулярної економіки Європейського Союзу. Обговорюється Система моніторингу циркулярної економіки Європейської комісії (CEMF), яка зосереджується на європейській циркулярній економіці. Дослідження проводилося на вибірці із 27 країн Європейського Союзу за період 2012–2023 рр., під час якого було виокремлено позитивні ефекти від впровадження моделей циркулярної економіки, а саме: збільшення рівня зайнятої робочої сили, зростання муніципальних доходів та прибутків підприємств, що забезпечують екологічну інфраструктуру. У статті підкреслюється, що модель циркулярної економіки визначається продуктивністю ресурсів, працею, залученою для захисту навколишнього середовища, рівнем переробки побутових відходів і використанням відновлюваної енергії.

Новизна. Результати дослідження підтверджують статистичну гіпотезу, яка пов'язана з сильним і значним впливом продуктивності ресурсів на економічне зростання. Доведено, що збільшення продуктивності ресурсів на 30% до 2030 року може призвести до зростання ВВП майже на 1%.

Практична значущість. Представлена модель лінійної регресії, яка може бути ефективно використана при розробці та впровадженні моделей циркулярної економіки.

Ключові слова: циркулярна економіка, відновлювана енергетика, економічне зростання, сталий розвиток.

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