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CIRCULAR ECONOMY: A GROWING MARKET FOR SUSTAINABLE INNOVATIONS

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Abstract. As a paradigm shift in sustainable development, a circular economy enabled by innovative business models ensures a competitive advantage by prioritising and improving resource efficiency, reducing waste and costs, creating value, and meeting sustainable demands. This paper explores the circular economy as a growing market for sustainable innovations, analysing key drivers, economic opportunities, and challenges for businesses and economies. The information base for the research is the Eurostat and World Bank panel data for the European Union (EU) countries covering the period from 2014 to 2020. The research aims to examine the impact of circular economy indicators (Private investment and gross added value in circular economy sectors; patents related to recycling and secondary raw materials; persons employed in circular economy sectors) on gross domestic product (GDP) per capita in the selected countries. The research results, obtained through descriptive statistics, correlation, and regression analysis, indicate a positive association between circular economy indicators and GDP per capita. By examining the circular economy indicators in the EU, the authors emphasise how economies and businesses can leverage circular strategies to enhance competitiveness and resilience. The research findings suggest that businesses embracing circular economy models benefit from increased profitability, reduced environmental impact, and enhanced consumer engagement, positioning sustainability as a core driver of long-term economic growth.

Keywords: Circular economy; EU countries; sustainable innovations; economic growth

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1. Introduction

In a world being faced with growing concerns regarding resource scarcity, climate change, and intensive resource consumption that induced many economic, social and environmental challenges over the recent decades, achieving and maintaining sustainable economic development has emerged as a priority goal for policy makers, governments and businesses (McDowall et al., 2017; Dantas et al., 2021). According to the Circle Economy report (2022), over the last decade, about 70% of the world's resources have been consumed faster than they could be safely replenished (Circle Economy, 2022). The overall consumption of resources has more than tripled since 1970, nearly doubled since 2000, and now totals 100 billion tons. This has resulted in 420 million hectares of land lost to deforestation, nearly 50% of the soil severely degraded, 85% of fish stocks in question, and 70% of wildlife populations declining over the last 50 years (Circle Economy, 2023). If this trend continues, together with an estimated increase in the human population, it could result in enormous resource depletion in the coming years, thus placing the concept of "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" at severe risk. In accordance

with such fast global changes, there has occurred a need for an economic model transformation, which would shift from a linear economy that is based on an unreasonable, by production maximisation justified, unsustainable resource exploitation towards a circular economy that is motivated with a waste reduction and an efficient resource usage (Moraga et al., 2019; Markovic et al., 2020; Neves & Marques, 2022).

Circular economy, that has occurred in 1970s as a response to the above revealed challenges, which through resource devastation, waste accumulation, pollution and related matters threaten to limit social welfare and business profitability, provides a range of opportunities for ensuring a sustainable development complying with both, environmental quality and economic prosperity goals and social equity across current and future generations (Weigend Rodriguez et al., 2020; Oberc et al., 2022). A concept of circularity, built as a new approach to economic development, which relies on the 7R principles (reduce, redesign, repair, reuse, recycle, recover, and renovate) and promotes a long-term product life cycle, brings many benefits on micro, meso and macro levels (Morseletto, 2020). The motivation behind such an extended lifespan of a product approach is found in preventing the unjustified exploitation of resources and thus increased efficiency of resource use, and minimising the waste where the product being in the ultimate stage of its life cycle, i.e. becomes a waste for a consumer, is brought back to a new product life cycle beginning stage through a recycling as a core operation under the circular economy (Morseletto, 2020). A new production and consumption paradigm, driven by technological advancements during the latest industrial revolution, offers a wide range of opportunities for innovation, job creation, and economic growth, thereby advancing all socio-economic aspects of society (Popovic, 2021). With a completely redesigned approach to economic development (relying on the 7Rs), the circular economy aims to regenerate finite resources, turning waste into a new resource. Thus, with an extended product life cycle, a more efficient and sustainable production model is designed, thereby diminishing the conflict between economic prosperity and sustainability goals (EMF, 2022).

Since a traditional linear model of production and consumption which dominated the world economy over the last two centuries, where the goods are produced, sold, exploited and discarded, could not any longer hold under the changed reality, the transition to a new economic model has become rather a necessity than an option in the world of increased economic volatility, resource depletion, and growing concerns over the preserving environment and future generations prosperity. Having recognised a new paradigm as the best available approach for achieving sustainability goals, both businesses and policymakers across the Globe have made the inclusion of the circular economy principles into their strategies and practices a priority in completing the agenda of social welfare and profit maximisation (Nikolaou & Tsagarakis, 2021; Suchek et al. 2022; Zeng et al., 2022). As such, through the decrease in the use of primary resources and exploiting full the materials being already in the system based on recycling and other circularity principles implementation, circular economy is expected to be a meaningful tool for triggering sustainable economic growth in the upcoming years being less dependent on raw materials and energy (Esposito et al., 2018; Geng et al., 2019; Androniceanu, et al., 2021). Despite promising results, not all countries and businesses have been equally successful in implementing circularity. This could be explained by the fact that some countries had a greater impact in increasing public awareness of the concept and its potential and/or were more effective at creating and implementing relevant laws and policies (Mazur & Wierzbicka, 2021). In line with that, the disparities in the circularity principle led to achievements across the countries, which are expected and certain.

The EU has demonstrated its commitment to promoting and implementing the new paradigm. Such a commitment could be understood given the European Commission (2020) report estimates which predict the creation of 1.2 million new jobs, mostly in the waste, recycling, repair and service sector, being followed by an annual increase of 600 billion euros in the manufacturing sector and respectively about 0.5% increase in EU economic growth by 2030, mostly arising from the transition to circular economy led business models and development of new innovative technologies. Nevertheless, such developments are expected not to be evenly distributed across the EU; Central and Eastern EU countries are expected to benefit more than Western Europe due to earlier investments in fossil fuel sectors (European Commission, 2020).

In line with these predictions, the European Union (EU) has taken several steps and introduced legislative and policy initiatives to embed the circularity paradigm into its economy better (Korhonen et al., 2018; EC, 2022).

Those initiatives started in 2015 with the Paris Agreement on the Sustainable Goals that was followed by the Circular Economy Action Plan which was based on the previous waste directives, being renewed and turned into the EU Green Deal in 2019 which focuses on regions, industries and workers affected by the new policies (European Commission, 2020; Fellner & Lederer, 2020; Kuo & Chang, 2021; Zeng et al. 2022). The results of such initiatives are expected to be measured by considering gross value added, private investment, and jobs created in the related sectors (European Commission, 2020). To ensure favourable outcomes in the full implementation of the circularity principles, the European Commission has established a monitoring body to assess progress along this path, evaluate the benefits and contributions of the new paradigm to achieving sustainability goals, and address potential risks to their realisation (Eurostat, 2025).

Given its identified relevance, the circular economy has also become an area of increasing interest among economics scholars in recent years (Korhonen et al., 2018; Alnajem et al., 2021). Accordingly, the Circular economy has been intensively addressed through both theoretical and empirical research aimed at assessing the potential, implications, effectiveness, advantages, and limitations of circular model implementation (Kirchherr et al., 2017; Geissdoerfer et al., 2017; Esposito et al., 2018; Korhonen et al., 2018; Martinho & Mourao, 2020; Markovic et al., 2020). In this sense, several attempts have been made to evaluate the effects of the new paradigm using relevant indicators, focusing only on specific aspects of this transformation, such as eco-innovation, waste management, or energy efficiency (Smol et al., 2017). Others conducted a more extensive analysis of the effects of the recent underlying shift in the world economy (Hysa et al., 2020; Karman & Pawlowski, 2022).

Even though more recent research has provided a better understanding of the new paradigm and the implementation of business models, the economic, social, and environmental effects at all levels, there is still a lack of conclusive evidence on its impact on economic growth in Europe. Moreover, the current findings rely heavily on ad hoc evaluation models and are often theoretical in nature, thus providing a range of opportunities for further research. Even though its implementation was expected to be associated with meaningful positive effects in terms of innovation and technological advances, job creation, and economic prosperity, there is still vague evidence to confirm this assumption (Chen et al., 2020; EMF, 2022).

In line with the above, this study aims to narrow the existing gap by deepening the understanding of the relationships between circularity principles and economic growth in the European Union (EU). More precisely, employing the Eurostat and World Bank panel data for a set of EU countries in the period from 2014 to 2020, correlation and regression analysis, this research aims to examine the impact of the set of circular economy indicators (Private investment and gross added value related to circular economy sectors, Patents related to recycling and secondary raw materials, Persons employed in circular economy sectors) on a gross domestic product (GDP) per capita in the selected EU countries. In this view, the study explores the circular economy as a growing market for sustainable innovations, analysing key drivers, economic opportunities, and challenges for businesses and economies. Accordingly, adopting a macro-level perspective, this research contributes to current knowledge on the circular economy's implications for national economic performance, aiming to provide useful insights into the effectiveness of circular economic models and the convergence of new-paradigm applications and their performance implications across EU countries. This way, the study provides further evidence on whether the new paradigm is intended to boost economic prosperity, as expected, which could be relevant to the business sector and policymakers who may be on the road towards "becoming circular". This is of particular importance for EU countries, which, being strongly concerned with resource availability, have implemented CE strategies earlier than other nations but are at different stages of implementation.

The rest of the paper is structured as follows. After introducing the theoretical background, a literature review of the economic implications of the CE concept is presented. After that, the methodology, applied data, and hypotheses are presented, followed by the research results and their discussion in the context of the existing literature. Lastly, concluding remarks are provided.

2. Literature Review

Despite the notion of circularity becoming a popular subject of scholarly discourse worldwide, the scientific research literature in this field remains vague, inconsistent, and unorganised. There have been studies that provide evidence of the positive impact of the principles of circularity on economic prosperity and sustainable development. Accordingly, some researchers point out the fundamental and increasing role of renewable energy for achieving economic sustainability and growth (Lee, 2019; Guney, 2021; Aboul-Atta & Rashed, 2021), which could be explained by the fact that their production costs have been decreasing over the recent period, making them much more attractive for efficiency goal achievement (Mukoro et al., 2021; Kostakis & Tsagarakis, 2022b). Similarly, a positive long-term association between renewable energy use and economic growth was identified for seven emerging countries (Cetin, 2016). In the same context, Lee (2019) has provided evidence of a positive relationship between the aforementioned variables within the EU framework. Following this approach, a few studies have found evidence on the positive impact of RE on the job creation worldwide (Johansson & Henriksson, 2020; Khobai et al., 2020).

Meaningful research evidence was provided regarding the relationship between the sharing and second-hand principles and economic benefits. Given that this policy implementation implies an increase in the product lifespan through multiple usage of the material resources, it therefore significantly contributes to properly managing the issue of overconsumption and resource savings, thus providing a huge potential for meeting sustainability goals (Mhatre et al., 2021; Munoz & Cohen, 2017; Jabour et al., 2020; Schwanholz & Leipold, 2020; Frenken, 2017). Moreover, the sharing principle is also seen as a factor that meaningfully contributes to economic prosperity through the job creation opportunities it brings (Cheng, 2016). Significant savings opportunities from sharing have been identified in energy use, building and infrastructure costs, and CO₂ emissions in the automobile industry, bringing both economic and environmental benefits (Schwanholz & Leipold, 2020).

Similarly, research examining the relationship between the repair and remanufacturing principles of the circularity framework and economic progress has provided significant evidence of a positive link. Seen as a means to extend the product's life and maintain its value for as long as possible, this principle is identified as an important tool for increasing resource efficiency, achieving resource savings, and lowering economic costs (Mhatre et al., 2021). The positive impact of this practice on economic benefits generation was confirmed by a number of studies, according to which this policy implementation leads to job creation, full product value exploitation, an increase in profit margins and social wealth (Matsumoto et al., 2016; Jansson, 2016; Llorente-González & Vence, 2020).

Similar to previous circularity principles, recycling was identified as an important contributor to achieving economic sustainability and progress targets. Prioritising the use of secondary raw materials reduces the need for primary raw materials and their exploitation, bringing many benefits, particularly for countries that depend on imports (Kostakis and Tsagarakis, 2022a). Nevertheless, empirical evidence of its positive impact on economic growth remains limited. While such a positive relationship was confirmed in some studies (Busu, 2019; Hysa et al., 2020; Kostakis & Tsagarakis, 2022a), Guoyan et al. (2022) found mixed evidence for this link, suggesting that the effects of the circularity principle differ over time. Nonetheless, substantial employment opportunities arising from recycling are evidenced by several studies (Ellen MacArthur Foundation, 2022).

Although the new circularity paradigm may seem driven by environmental motives, most related legislative documents and EU research reports are rooted in deeper reasons, many of which are economic in nature. Accordingly, such incentives were designed to promote circularity across industries, achieve relevant targets, and implement a circular economy as a new sustainable strategy defined for the EU (Siekelova et al. 2020; Mazzoni, 2020). Nevertheless, despite such strong incentives for the transition of the EU economy, some studies point to distinct outcomes regarding the success achieved on this path. A survey of European companies suggests that almost 95% have identified a new paradigm as an imperative for achieving competitiveness,

diversification, cost efficiency, and increased market share (Haller, 2020). Still, several factors are obstacles to the full adoption of the new economic model in the EU.

Some empirical studies aimed to assess the causality between circularity and economic development within the EU and the implications of implementing the circularity model have confirmed significant changes in EU economies and their outcomes due to the new paradigm's application.

In line with that, many studies have provided evidence of an association between economic growth and recycling efficiency. Androniceanu et al. (2021), who examined the circularity model and its relationship with economic development across EU economies in 2019, confirmed a strong correlation between GDP per capita and municipal waste recycling rates, thereby demonstrating that economic growth is closely associated with the adoption of a new economic model. Similarly, using the Granger causality test for panel data, Dumitrescu and Hurlin (2012) identified two-way associations between the same variables. Similarly, Razzaq et al. (2021) identified, using ARDL, that recycling solid municipal waste is an important driver of economic growth in both the short and long run. Tantau et al. (2018), who applied the Durbin-Wu-Hausman test to panel data for 28 EU members over the period 2010-2014, found that material resource utilisation and resource productivity were strongly correlated with municipal waste recycling rates. Aiming to assess the linkages between economic growth and specific circular economy indicators, Busu and Trica (2019) applied the pooled least squares (PLS) method, which identified labour productivity, followed by resource productivity and municipal waste recycling, as having the strongest impact on economic growth. Using the same methodological approach, Busu (2019) and Trica et al. (2019) identified a strong association between environment-relevant circularity indicators and economic growth. Following this view, Gardiner and Hajek (2020) applied a panel error-correction model to a dataset of EU countries' data, providing evidence of two-way causality between waste generation and economic growth. In line with this, Androniceanu (2021) have noted a strong association between employment after circularity implementation and socio-economic development indicators. In addition, the authors revealed one-way causality between circularity and employment. With an attempt to assess the socio-economic implications of the new concept on the linkages between material resource exploitation and economic growth in 28 European countries, Bianchi and Cordella (2023) provided evidence according to which the annual consumption of primary resources in relation to economic growth is about four times greater compared to the resources saved through the circularity concept implementation. Thus, the study has confirmed that the circular economy initiatives contribute to primary resource saving. Taking a similar approach, Knable et al. (2022) have annualised the impact of circular economy implementation on the three dimensions of sustainable development in 25 selected European countries. Their results suggest that, as expected, the new paradigm application has proven beneficial to the economic, social, and environmental aspects of sustainable development in the countries examined.

Many studies have assessed the linkages between the circularity concept, or its specific aspects, and economic prosperity. A meaningful portion of these studies provided evidence of a strong positive relationship between the variables examined, thus confirming their interdependence and supporting the implementation of the new paradigm as an inevitable step towards building a sustainable future for society (Busu & Trica, 2019; Radivojevic et al., 2024).

Nevertheless, some studies offer alternative evidence on the impact of circularity on a society's socio-economic prospects. Accordingly, Repp et al. (2021), who studied the value chains of EU clothing imports from large global exporters (China, Bangladesh, India, Turkey, and Cambodia) and worldwide employment trends, found that this new concept could have a significant negative impact on employment in non-EU upper-middle-income countries. In line with that, the authors conclude that the implementation of a new circularity paradigm may have uneven effects across the nations, with negative impacts being borne mainly by non-EU countries.

With the above in mind, the transition from the linear economy, which has been the dominant model since the start of the Industrial Revolution, does not seem to be an easy task. Such a substantial transformation implies radical shifts in consumption and production trends but also an in-depth understanding of circularity concepts, processes, and their power towards the creation of positive economic, social and environmental implications for

sectors and value chains to create and implement the proper incentives and policies for full exploitation of its potential (Rizos et al., 2017).

Despite a meaningful degree of convergence on the path toward "becoming circular" being noticed in the EU, but also worldwide over the recent decades, the lags and diversity in effects of the concept implementation are clear, which could be attributed to the fact that building a new approach to sustainability is still based on conceptual modelling and a few case studies. In addition, while defined circularity policies and goals may not be vague, their implementation requires greater awareness, participation, and coordination across all levels and stakeholders involved. To leverage circularity toward building a better future, companies need to redesign their business models and strategies, become more innovative in creating value, and better address environmental and social aspects (Sehnem, 2019).

3. Research Methodology

Based on well-elaborated theoretical insights into the circular economy and its significance for economic growth, this research focuses on circular economy indicators from the EU monitoring framework (Eurostat, 2025). The EU monitoring framework examines the circular economy in five areas: 1) *production and consumption*, 2) *waste management*, 3) *secondary raw materials*, 4) *competitiveness and innovation*, and 5) *global sustainability and resilience*. The list of variables used in the analysis falls under the fourth thematic area of the EU monitoring framework: competitiveness and innovation (Table 1). The independent variables used in the research are Private investment and gross added value related to circular economy sectors (PIGVA), Persons employed in circular economy sectors (PE), Patents related to recycling and secondary raw materials (PAT), while the dependent variable is GDP per capita in PPP constant 2021 international \$ (GDPpc)

Table 1. List of variables

Variable	Variable type
GDP per capita in PPP constant 2021 international \$ (GDPpc)	Dependent
Private investment and gross added value related to circular economy sectors (PIGVA)	Predictor
Persons employed in circular economy sectors (PE)	Predictor
Patents related to recycling and secondary raw materials (PAT)	Predictor

Source: Authors

The importance of circular economy indicators for competitiveness and innovation has already been recognised in numerous studies (D'Adamo et al., 2024; Grybaitė & Burinskienė, 2024; Lehmann et al., 2022; Fang et al., 2024). The indicator "Private investment and gross added value related to circular economy sectors" consists of gross investment in tangible assets and value added at factor costs across three sectors: recycling, repair & reuse, and rental & leasing (Eurostat, 2025). This indicator is crucial to the transition toward a circular economy, as it signals innovations and investments that reduce environmental strain. Thus, the authors expect a positive relationship between Private Investment and economic growth. The indicator "Persons employed in circular economy sectors" estimates the number of persons employed in the same three sectors as stated for the Private Investment. This indicator covers all persons employed by observation companies, as well as persons who work outside the companies but are affiliated with and financed by them (e.g., sales representatives) (Eurostat, 2025). Given the benefits of job creation for the overall economy, it is expected to boost economic growth. The third circular economy indicator in the competitiveness and innovation group is "Patents related to recycling and secondary raw materials", measuring the number of patents related to recycling and secondary raw materials (Eurostat, 2025). To avoid double counting, this indicator covers patent families, including all documents related to inventions submitted to different authorities. Encouraging research and development, new products and services, and thus leading to further economic development, the authors expect Patents to have a positive impact on economic growth.

To analyse the impact of circular economy indicators on economic growth and test the formulated hypotheses, the information base for the EU27 countries is applied in the research covering the period from 2014 to 2020. The information base sources are the Eurostat database for Circular Economy Indicators (Competitiveness and Innovation indicators) and the World Bank database for World Bank Indicators (GDP per capita).

The research investigates the following hypotheses:

H1: A positive correlation exists between Private investment and Gross added value related to circular economy sectors (PIGVA), Persons employed in circular economy sectors (PE), Patents related to recycling and secondary raw materials (PAT), and GDP per capita;

H2: Private investment and gross added value related to circular economy sectors (PIGVA), Persons employed in circular economy sectors (PE), Patents related to recycling and secondary raw materials (PAT) positively influence the GDP per capita.

To address the main research goal of evaluating the impact of circular economy indicators on GDP per capita for EU27 countries, correlation and regression analyses are applied. Given a sample of 27 EU countries (27 cross-sectional units) over 7 years (7 time periods), the panel data analysis will be employed. The normality of the database is assessed using the Shapiro-Wilk and Shapiro-Francia tests. The relationship between variables is tested using the Spearman correlation coefficient, which ranges from -1 to +1, where values close to ± 1 indicate a strong correlation. The correlation is very weak if the coefficient ranges from 0 to 0.19, weak from 0.20 to 0.39, moderate from 0.40 to 0.59, strong from 0.60 to 0.70, and very strong above 0.80 (Cohen, 2003).

Given the panel data in the research, the regression model was selected using the F-test, Breusch-Pagan LM test, and Hausman test. The F-test's null hypothesis approval proposes the Pooled Regression Model (Pooled), while its non-acceptance supports the Fixed Effects Model (FEM). The Breusch-Pagan LM test's null hypothesis is that the Pooled model is appropriate, while its non-acceptance supports the Random Effects Model (REM). Finally, the approval of the null hypothesis in the Hausman test suggests the REM test (Gujarati, 2004).

3. Findings and Discussion

The descriptive statistics are presented in Table 2. The average PIGVA in the EU27 countries is 3,525.249 million euros. The minimum value of 33 million euros was recorded in Cyprus in 2004, while the maximum value of 34,489 million euros was recorded in Germany in 2018. The average PE in the analysed countries is 150,152. The minimum PE value of 6,457 full-time persons employed was recorded in Luxembourg in 2015, while the maximum PE value of 764,026 was recorded in Germany in 2019. The average PAT value across the analysed countries is 11.84116. The minimum PAT value of 0 was recorded in several years in Bulgaria, Cyprus, Estonia, Croatia, Lithuania, Latvia, Malta, Poland, the Slovak Republic, Slovenia, and for one year in Greece (2018), Hungary (2020), Portugal (2014). The maximum PAT value, 103.78, was recorded in Germany in 2019. The average GDP per capita in the EU27 countries is 49,398.32 PPP (constant 2021 international \$), while the minimum value of 22,938.83 PPP (constant 2021 international \$) was recorded in Bulgaria in 2014, and the maximum value of 132,836.1 PPP (constant 2021 international \$) was recorded in Luxembourg in 2016.

Table 2. Descriptive statistics

Variable	Min	Max	Mean	SD
PIGVA	33	34489	3525.249	6094.25
PE	6457	764026	150152.6	185830.1
PAT	0	103.78	11.84116	185830.1
GDPpc	22938.83	132836.1	49398.32	21308.43

Source: Authors

Prior to the correlation analysis and to select an appropriate methodology, the Shapiro-Wilk and Shapiro-Francia normality tests are conducted on the sample data. The results of normality tests confirmed the non-normality of the data ($p < 0.05$) (Table 3). Thus, the correlation analysis has been performed using the nonparametric Spearman's correlation coefficient.

Table 3. Normality tests

Variable	Shapiro-Wilk		Shapiro-Francia	
	W	p-Value	W'	p-Value
PIGVA	0.59660	0.00000	0.59394	0.00001
PE	0.70242	0.00000	0.70376	0.00001
PAT	0.67858	0.00000	0.70223	0.00001
GDPpc	0.77784	0.00000	0.77726	0.00001

Source: Authors

The correlation analysis has been employed to test hypothesis H1. Namely, the correlation analysis will examine the relationship between the analysed indicators and the strength of their correlation. According to the correlation results from Table 4, there is a positive correlation between GDPpc and two circular economy indicators (PIGVA and PAT). The results indicate that the positive correlation between circular economy indicators (PIGVA and PAT) and GDPpc is moderate and statistically significant ($p < 0.01$). In addition, a positive correlation exists among circular economy indicators, and it is strong between PE and PIGVA (0.7222), between PE and PAT (0.6027), and very strong between PAT and PIGVA (0.8561). However, the correlation between GDPpc and PE is negative. The results of the research confirm a positive correlation between PIGVA, PAT, and GDPpc, but not between PE and GDPpc (hypothesis H1).

Table 4. Correlation results

Variable	PIGVA	PE	PAT	GDPpc
PIGVA	1			
PE	0.7222*	1		
PAT	0.8561*	0.6027*	1	
GDPpc	0.4672*	-0.1471*	0.4832*	1

Source: Authors

Note: *Correlation is significant at the 0.01 level (two-tailed).

Following the correlation analysis, three tests (F-test, Breusch-Pagan LM, and Hausman) were conducted to determine the appropriate panel data model. Based on the research data in Table 5, the fixed-effect model (FEM) is selected for the regression analysis. Specifically, the F-test results favour the FEM model, whereas the Breusch-Pagan LM results favour the REM model. The decision on the appropriate panel data model is based on the Hausman test results, which indicate the FEM model is preferred at the 1% significance level ($p = 0.0000$).

Table 5. Test results for the evaluation of the proper panel data model

Model	F-test H ₀ : Pooled, H ₁ : FEM	Breusch-Pagan LM H ₀ : Pooled, H ₁ : REM	Hausman H ₀ : REM, H ₁ : FEM
Model	99.82 (0.0000)	402.08 (0.0000)	45.81 (0.0000)

Source: Authors

Note: p values are given in ().

The proposed Fixed effect model (FEM) is employed to examine the impact of PIGVA, PAT and PE on GDPpc across 27 EU countries for the period 2014-2020. The obtained results show that Private investment and gross added value related to circular economy sectors (PIGVA) and Persons employed in circular economy sectors (PE) have a positive and significant impact on economic growth (GDPpc), while Patents related to recycling and secondary raw materials (PAT) has positive but not significant impact on GDPpc ($p = 0.875$) which can be explained by a low number of available data for this indicator. The estimated model explains a 98.41% change in GDPpc, and based on the F statistics is statistically significant at a 1% level of significance (see Table 6). If

Persons employed in circular economy sectors (PE) increase by 1%, GDPpc will increase by 0.19%, ceteris paribus. If Private investment and gross added value related to circular economy sectors (PIGVA) increase by 1%, GDPpc will increase by 0.12%, ceteris paribus.

Table 6. Regression results

	Constant	In PIGVA	In PAT	In PE	R ²	F statistics
In	7.67514	0.1287344	0.0000935	0.1925958	0.9841	42.33
GDPpc	[15.77] (0.000)	[8.59] (0.000)	[0.16] (0.875)	[4.26] (0.000)		(0.0000)

Source: Authors

Note: t values are given in [], p values are given in ().

The significance of competitiveness and innovation circular economy indicators on GDP growth was also examined in other studies (Hysa et al., 2020; Murray et al., 2020; Busu, 2019), but without statistical significance, while the importance of innovations as the significant driver of sustainable and economic development has been confirmed by Aid et al. (2016), and Lieder and Rashid (2016). Variables associated with the innovation capacities of the EU27 countries confirmed their positive and significant impact on GDP per capita, proving they are important dimensions of economic growth.

Conclusions

Given that, over the last decades, the traditional linear model of production and consumption, which dominated the world economy since the Industrial Revolution, could no longer hold in the changed reality, the transition to a new economic model has become imperative. Having recognised circularity as a promising approach to achieving sustainability goals, both businesses and policymakers worldwide have made the adoption of the circularity model a priority in their strategies and practices to advance the agenda of social welfare and profit maximisation. Despite the expected results, not all countries and businesses have been equally successful in benefiting from the concept of circularity.

In line with the above and given that scientific research in this field appears vague, cursory, and unorganised, this research aims to assess the assumed interdependence between circularity and economic prosperity in the EU. More precisely, by employing the Eurostat and World Bank panel data for a set of EU countries in the period from 2014 to 2020, correlation and regression analysis, this research examines the impact of the set of circular economy indicators (Private investment and gross added value related to circular economy sectors, Patents related to recycling and secondary raw materials, Persons employed in circular economy sectors) on a gross domestic product (GDP) per capita in the selected EU countries. In this view, the study explores the circular economy as a growing market for sustainable innovations, analysing key drivers, economic opportunities, and challenges for businesses and economies.

Accordingly, this research contributes to current knowledge on CE's implications for national-level economic performance, aiming to provide useful insights into the effectiveness of circular economic models and the relevant convergence among EU countries. This way, the study provides further evidence on whether the new paradigm boosts economic prosperity, as expected, which could be relevant to the business sector and policymakers who may be on the road towards "becoming circular". This is of particular importance for EU countries, which, being strongly concerned with resource availability, have implemented CE strategies earlier than other nations but are at different stages of implementation.

The study confirms that competitiveness and circular-economy innovation indicators positively affect economic growth in the analysed EU27 countries. Private investment and gross added value related to circular economy sectors (PIGVA) and Persons employed in circular economy sectors (PE) have an equally strong influence on economic growth. In contrast, Patents related to recycling and secondary raw materials (PAT) have a positive but not significant impact on economic growth. These results, confirming hypothesis 2 (H2), indicate that innovations play a crucial role in driving economic growth. However, while the importance of Patents related to recycling and secondary raw materials is positive, it should be further examined to substantiate its significance

by complementing it with additional data. Nonetheless, the findings of this study indicate that European countries differ meaningfully in the quality of their systems and in how they approach competitiveness and innovation related to circularity model implementation. The results also imply that Central and Western countries, which are considered traditionally competitive and innovative economies, have taken greater advantage of circularity principles than other countries.

Therefore, despite a meaningful degree of convergence on the path toward "becoming circular" being noticed in the EU, the lags and diversity in the effects of the concept implementation are clear, which could be attributed to the fact that building a new approach to sustainability is still based on conceptual modelling and a few case studies. In addition, while defined circularity policies and goals may not be vague, their implementation requires greater awareness, participation and coordination of all the levels and stakeholders involved, but also an in-depth understanding of circularity concepts, processes and its power towards the creation of positive economic, social and environmental implications for sectors and value chains. To take advantage of circularity to build a better future, companies need to redesign their business models and strategies, become more innovative in creating value, and better address environmental and social aspects. The major limitation of this study could be the narrow list of circularity indicators employed, largely due to a lack of available data, as the EU circular economy monitoring data sources cover a short, uneven period. Nevertheless, it would be useful to direct future research toward a broader set of circularity indicators when assessing the contribution of new economic models to the EU's economic prospects, even over shorter time periods. Comparing the interdependence among these variables across European regions, i.e., groups of countries, could be another approach worth future attention in this research field.

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