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THE IMPACT OF PRIVATE INVESTMENT IN THE CIRCULAR ECONOMY ON EU GDP

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Abstract: *The main purpose of this research is to analyze the Impact of Private Investments in the Circular Economy on EU GDP for the period 2010-2020. This research has a sample of 28 EU Member States and analyzes a 10-year period. The scientific methodology applied in this study is the quantitative method. The data used in this research are secondary and are generated from official data published by Eurostat and the World Bank. Based on the results of this research, we may conclude that there is a negative relationship between private investments in the Circular Economy and the GDP of the European Union countries for the period 2010-2020. During the period 2010-2020, some EU countries experienced problems in attracting private investments due to difficult economic and political conditions, they had influenced private investments to have a negative effect on GDP.*

Keywords: *Circular Economy, GDP, Private Investments.*

1. INTRODUCTION

This research will discuss the impact of private investments in the circular economy on the GDP of the European Union countries for the period 2010-2020. The main variables of this research are: Gross Domestic Product (GDP), Private Investments and Gross Value Added of the Circular Economy (IPEC), Persons Employed in the Circular Economy Sectors (PPEC), Final Consumption Expenditure (SHKF), and Inflation (INFL).

The inclusion of all EU Member Countries will make the research even more qualitative because it will present a real overview of the impact of these circular economy indicators on the GDP of all EU countries. The indicator of private and gross added values in the circular economy is an indicator that is used to monitor the progress of the economy in the field of competition and innovation. Through these indicators, the circular economy contributes significantly to economic expansion and the creation of new jobs.

The circular economy may make a significant contribution to the creation of new places of jobs and economic growth. Eurostat, on an annual basis, gathers information on the number of employees in the circular economy. This indicator determines if the shift from the traditional economy to the circular economy is producing the desired results by examining the growth of other sectors and the creation of new jobs.

On the other hand, the improvements in the productivity of the material as well as the efficiency of the use of the material, are otherwise known as the productivity of the resources.

According to Eurostat, productivity growth in recent years has been significantly slower than that of labor and energy productivity.

The key conclusions indicate that while investment plays a crucial role in enhancing resource efficiency, the combination of innovation and investment significantly contributes to the reduction of environmental degradation (Lehmann, Cruz-Jesus, Oliveira, & Damásio, 2022). The purpose of this article is to understand the significance of the impact of private investment in the circular economy on the GDP of EU countries, considering the importance of the transition from a linear economy to a circular one, where resources are not discarded but reused. This research also aims to provide recommendations for policymakers in order to create a more favorable environment for private investment in the circular economy.

2. LITERATURE REVIEW

The research conducted by Hondroyiannis et al. (2024) analyzes the relationship between a macro-level Turnover Rate and various macroeconomic variables in a sample of 28 European countries using panel data. The findings suggest a strong positive relationship between real GDP and the turnover rate in the long run, while higher environmental taxes are associated with an increase in the turnover rate.

According to Hysa et al. (2020), developed economies are innovating to spur growth and are providing government support to manufacturers in order to transition from linear to circular economies. As a result, waste materials in industrial systems are being recycled or reused, improving the efficiency of resource use through a zero-waste approach. The results of both econometric models showed a strong and positive correlation between the circular economy and economic growth, emphasizing the crucial role of sustainability and innovation.

According to Kaivo-Oja, Vehmas, and Luukkanen (2022), a well-functioning circular economy brings benefits to businesses, people, and the environment. It is described as a systems-based solutions framework designed to tackle global challenges such as climate change, biodiversity loss, waste, and pollution. A key finding of their research is that, within the European Union, the levels of synergy between economic indicators, such as GDP and GNI, and core variables of the circular economy do not consistently align and may differ significantly from one another.

According to Brussels et al. (2022), the impact assessment was conducted using a computable general equilibrium (CGE) model, as this approach allows for the quantification of both direct and indirect economic and environmental impacts of the simulated shocks. The results indicate that different types of fiscal policies can guide an economy toward a more circular model.

Research carried out by Robaina, Villar, and Pereira (2020) contrasts the circular economy with the traditional linear economy, emphasizing its potential as a sustainable model for producing goods and services and fostering economic development. With this aim, a series of determinants for a circular economy in Europe were analyzed for the period between 2000 and 2016. A cluster analysis was implemented and complemented by three econometric evaluation methods: panel unit root tests, panel co-integration, and a vector autoregression model. The main findings allowed European countries to be grouped into three distinct clusters based on the growth rate of their resource productivity and the explanatory factors selected.

According to Hysa et al (2020), industrialized economies are leveraging innovation to stimulate economic growth while also providing governmental support to manufacturers transitioning from linear to circular economic models. As a result, waste products within industrial systems are increasingly being recycled or repurposed, enhancing the efficiency of zero-waste strategies and the sustainable use of limited resources. The results of both econometric models used in their study demonstrated a strong and positive relationship between circular economy practices and economic growth, highlighting the essential role of sustainability, innovation, and investment in zero-waste programs in promoting overall prosperity.

The study carried out by Lehmann et al. (2022) used data from Eurostat and the United Nations, spanning 28 European nations from 2011 to 2017, to determine the two primary aspects of the circular economy, which are resource efficiency and environmental degradation. Additionally, using dynamic panel models, an analysis is conducted to compare the effects of investment, human capital, innovation, and past turnover levels on each identified feature of the circular economy. The results demonstrated that, as the investment by itself has a substantial role in enhancing resource efficiency, innovation, and investment together greatly minimize environmental degradation, whereas only the investment is also important in the promotion of resource efficiency.

The research carried out by Nedelea et al. (2018) conducted an empirical study between 2008 and 2015 using cross-sectional analysis applied to the interrelationships between data concerning the EU-28 member countries. The study's focus is on the effect of the bio-economy on economic growth. In the framework of the bio-economy, three econometric models based on ordinary least squares regression are created to emphasize the connections between economic growth, the circular economy, and intellectual capital. The circular economy's added value is positively correlated with the export of recyclable raw materials, employment within the sector, and the rate at which municipal garbage is recycled.

On the other hand, the research carried out by Bianchi and Cordella (2023) suggests that, while encouraging a shift toward more circular economic systems can contribute to reducing the extraction of primary resources, the overall effect of such initiatives remains relatively limited. Their estimates show that the amount of primary resources extracted annually due to economic growth is approximately four times greater than the amount saved through circular economy (CE) initiatives.

3. METHODOLOGY

The primary goal of this research is to examine how private investments and the circular economy's gross added value affect the GDP of EU member states between 2010 and 2020. Thus, this study demonstrates the effects of private investments and the circular economy's gross added value on the GDP of the 28 EU member states. Inclusion of all EU member states, the research will be even more qualitative as it will give a true picture of how these circular economy metrics affect each nation's GDP.

The main variables of this research are: Gross Domestic Product (GDP), Private Investments and Gross Value Added of the Circular Economy (IPEC), Persons Employed in

the Circular Economy Sectors (PPEC), Final Consumption Expenditure (SHKF), and Inflation (INFL).

The scientific methodology that has been applied in this study is the quantitative method, applying the deductive approach, which uses the existing theory to prove the hypotheses and draw conclusions. The data that will be used in the research are secondary data and will be generated from official data published by Eurostat and the World Bank. These data are mainly annual data presented also in the form of time series expressed in percentages. The results of this study will be analyzed through the Stata program. The research questions of this study are:

1. How does the change in private investments and gross added values of the circular economy affect the growth of the GDP of the European Union countries for the period 2010-2020?
2. How does the change in the number of employees in the circular economy affect the GDP of the European Union countries for the period 2010-2020?
3. What is the relationship between inflation, final consumption expenditure, resource productivity, and GDP for the countries of the European Union for the period 2010-2020?

The timeframe 2010-2020 was chosen for this study because it encompasses a complete decade and provides for a thorough examination of patterns and implications of private investments in the circular economy across European Union countries. This timeline encompasses the post-global financial crisis recovery phase, an increased policy emphasis on sustainable development, and significant progress in circular economy projects. Data availability and trustworthiness are also important factors in this decision, as official statistics and economic indicators for this time are comprehensive and consistent across countries. Although extending the period to 2025 would provide more recent insights, data for years after 2020 are sometimes tentative or unavailable at the time of the study, thereby affecting the robustness and comparability of conclusions. As a result, focusing on 2010-2020 assures that the research has a solid empirical foundation and that the policy implications are based on finished and validated facts.

The main hypothesis of this research is:

H_1 - Private investments and gross added values in the Circular Economy affect the GDP of the European Union countries.

Table 1: *Description of variables included in econometric models*

Variables	Variable review	Date of source
Dependent Variable (Y)	Gross Domestic Product (GDP)	Annual reports of the World Bank, time series (2010-2020) (https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG, 2024)
Independent Variable (X1)	Private Investments and Gross Value Added in the Circular Economy (IPEC)	Eurostat annual reports on circular economy indicators, time series (2010-2020) (https://ec.europa.eu/eurostat/web/circular-economy/database, 2024)
Independent Variable (X2)	Persons employed in the	Eurostat annual reports on circular economy indicators, time series (2010-2020)

	Circular Economy sectors (PPEC)	(https://ec.europa.eu/eurostat/web/circular-economy/database, 2024)
Independent Variable (X3)	Final Consumption Expenditure (FCF)	Annual reports of the World Bank, time series (2010-2020) (https://data.worldbank.org/indicator/NE.CON.TOTL.KD.ZG, 2024)
Independent Variable (X4)	Inflation (INFL)	Annual reports of the World Bank, time series (2010-2020) (https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG , 2024)
Independent Variable (X5)	Productivity of resources in the circular economy	Eurostat annual reports on circular economy indicators, time series (2010-2020) (https://ec.europa.eu/eurostat/web/circular-economy/database, 2024)

Source: Data processing by authors (2024)

To test the hypotheses of this study, the econometric model must be built to prove these hypotheses. This econometric model will look like the following:

$$GDP = \beta_0 + \beta_1 IPEC + \beta_2 PPECit + \beta_3 INFLit + \beta_4 SKF + \beta_5 Prod.Resit + \gamma it$$

Where:

GDP - Gross Domestic Product

IPEC - Private Investments and Gross Value Added in the Circular Economy

PPEC - Persons employed in the Circular Economy sectors

INFL - Inflation

SHKF - Final Consumption Expenditures

Prod, Res - Resource Productivity

Stochastic variables (other factors not considered in the model), I-code, and t–time period

4. RESULTS OF THE ECONOMETRIC MODEL

In this section, the results of descriptive analysis, correlation analysis, and the hypotheses of this study will be tested to test the research questions. The data used in this study are secondary data processed in the STATA program and are presented within the panel data. These data are obtained from the World Bank and Eurostat databases. The time period along which this study extends is the period 2010-2020. Here, the results of descriptive statistics, correlation analysis, and hypothesis testing will be analyzed.

This testing will be done using standard multiple regression analysis, fixed effect model, random effect model, Hausman Taylor Estimation, GMM Model, Arellano Bond Estimation, and GEE model.

Table 2: *Descriptive statistics for the variables included in the study*

Variable	Obs	Mean	Std. Dev.	Min	Max
IPEC	307	.670684	.3352697	.1	1.7
PPEC	307	1.787296	.5853898	.4	3.6

INFL	308	1.415045	1.416978	2.09	6.09
SKF	308	1.063534	2.828701	-12	10.1
Prod. Res	307	1.792713	1.162285	0.29	4.5
MNE	306	1.513337	3.546917	11.16	24.4

Source: Author's own calculations using STATA (2024)

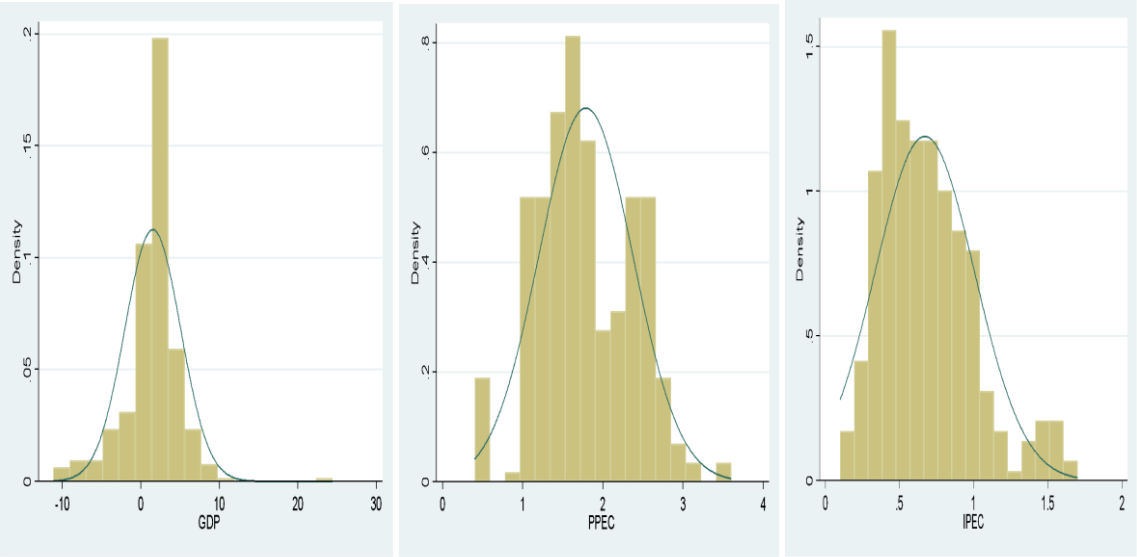
From the descriptive statistics, we can see that the research has 307 observations. The IPEC variable has a mean of 0.67, a minimum value of 0.1, and a maximum value of 1.7.

The PPEC variable has an average of 1.78, a minimum value of 0.4, and a maximum value of 3.6. Whereas INFL has an average of 1.41, a minimum value of -2.09, and a maximum value of 6.09.

The SHKF variable has 308 observations; an average of 1.06, a minimum value of -12, and a maximum value of 10.1, so the standard deviation is quite high. Prod. Res has an average value of 1.79, a minimum value of 0.29, and a maximum value of 4.5.

The GDP variable has 306 observations, an average of 1.51, a minimum value of -11.16, and a maximum value of 24.4.

Figure 1. *A graphic representation of GDP, PPEC, and IPEC*



Source: Author's own calculations using STATA (2024)

From the graphical presentation of the histogram, we can see that between GDP as a dependent variable and private investments and gross added values of the Circular Economy, as well as persons employed in the Circular Economy as independent variables, a normal distribution exists.

5. EMPIRICAL SUMMARY OF ECONOMETRIC MODEL RESULTS

The following section presents and interprets the summarized results of the econometric model.

Table 3. *Summary of empirical results from the econometric model*

Variables	Linear Regression	Random Effects Generalized Least Squares (GLS) Regression	Fixed Effects Regression	Haussmann Taylor Regression	GEE Model	GMM Model
MNE	-	-	-	-	-	-
IPEC	-1.112109 (0.009) ***	-1.2 (0.02) **	-1.604146 (0.063) *	-1.839911 (0.019) **	-1.280126 (0.021) **	-.5413688 (0.638)
PPEC	-.1421379 (0.546)	-.0843017 (0.805)	.0202363 (0.979)	.3863939 (0.588)	-.0828484 (0.808)	1.876413 (0.100) *
INFL	.1694437 (0.06) *	.2166044 (0.015) **	.2625833 (0.005) **	0.2421285 (0.007) ***	.2171025 (0.014) **	.2650805 (0.012) **
SKF	.9977681 (0.000) **	.985045 (0.000) ***	.9792111 (0.000) **	0.9876457 (0.000) ***	.9849271 (0.000)***	1.034553 (0.000) ***
Prod. Res	.2939534 (0.02) **	.3481249 (0.06) *	1.134713 (0.01) *	0.5240353 (0.038) **	.3495123 (0.060) *	.4058518 (0.685)
R Square	0.5989					
Adj. R 2	0.5922					

Source: Author's own calculations using STATA (2024)

*significance level 10%

** significance level 5%

*** 1% significance level

Based on the results of the standard multiple regression analysis and the equation of regression, we understand that all the variables of this study are significant at a reliability level of 10%, except for the variable of Persons Employed in the Circular Economy, which exceeds the allowed significance. The coefficient of correlation between dependent and independent variables is 59.89%. So there is an average correlation or connection between the variables of this study. The coefficient of determination between the independent and dependent variables is on average high in value, 59.22%, so for 59.22%, the independent variables explain the dependent variable. These results prove that this model is statistically sustainable.

β_0 - whether all factors ARE constant, then the value of GDP is 0.68.

β_1IPEC - If Private Investments in the Circular Economy increase by one unit while keeping other factors constant, then GDP will decrease by 1.11 units. This finding is real because the level of significance IS $0.009 < 0.05$.

β_2PPEC - if the number of Employed Persons in the Circular Economy per unit increases, keeping the other factors constant, then the GDP will decrease by 0.14 units. This statement is not true because the significance level exceeds the 10% significance level, i.e., $0.54 > 0.05$

β_3INFL - if inflation increases by one unit, keeping it constant with other factors, then the GDP will increase by 0.16 units. This statement is true at a significance level of 10%, thus $0.06 < 0.10$.

β_4SHKF - If final Consumption Expenditure increases by one unit while keeping other factors constant, then GDP will grow by 0.9 units. This finding is real because the level of significance is 0.000 < 0.05.

β_5Prod.Res - if the Productivity of resources increases by one unit while keeping other factors constant, then GDP will grow by about 0.29 units. This finding is because the level of significance is 0.02 < 0.05.

Therefore, it can be concluded that all independent variables are significant and statistically significant and prove the validity of the hypotheses of this study, with the exception of the variable of employed Persons in the Circular Economy, which is not significant at the 10% confidence level.

Based on the generated results, we can conclude that there is a positive relationship between Inflation, final consumption expenditures, and GDP.

The main hypotheses of this research are:

H_1 - Private investments and gross added values in the Circular Economy affect the GDP of European Union countries.

Based on the results, we can conclude that private investments and gross added values of the Circular Economy affect the GDP of the European Union countries for the period 2010-2020.

6. DISCUSSIONS/CONCLUSIONS

The literature research shows that the shift to a circular economy can have a brief negative impact on economic growth and GDP, particularly during the transition phase. However, all studies underline that this can have long-term benefits for economic growth and sustainable development if implemented carefully and with the assistance of suitable regulations.

In the study conducted by Kirchherr et al. (2018), the barriers of the circular economy in the EU were examined with 208 respondents and 47 expert interviews. The study finds that cultural barriers, especially a lack of consumer interest and awareness, as well as a reluctant company culture, are considered the main barriers to the circular economy by businesses and policymakers. These are driven by market barriers, which, in turn, are caused by the lack of synergistic government interventions to accelerate the transition to a circular economy. The study highlights that while the circular economy can bring long-term benefits, implementation can cause economic growth to slow down in the initial stages.

Despite the circular economy focusing on redesigning processes and recycling materials, providing opportunities for more sustainable business models, this article has also identified several tensions and limitations. These include the lack of the social dimension of sustainable development, which limits ethical impacts, as well as unforeseen consequences. The study concluded that the circular economy can contribute to economic growth, but this requires a period of transition and adaptation to achieve positive results (Murray, A., Skene, K., & Haynes, K., 2017).

Another study examines the macroeconomic consequences of moving to a circular economy. This research suggests that the impact on GDP may vary in the short and long term and highlights the need for supportive policies to aid this transition, supporting our conclusions

on the negative impact of private investment in the circular economy on GDP, especially during the transition period (McCarthy, A., Dellink, R., & Bibas, R., 2018).

Based on the statistical data obtained by Stata calculations and the fixed effect, we can conclude that changes in private investments and gross added values of the circular economy hurt the GDP of European Union countries between 2010 and 2020. In the period 2010-2020, some EU countries experienced problems in attracting private investments due to difficult economic and political conditions, which influenced private investments to have a negative effect on GDP. In countries that fail to create a favorable environment for private investment, GDP growth may be halted or limited. In cases where private investment is limited or negatively affects investor confidence due to factors such as political instability, lack of legal certainty, or insufficient market conditions, it can have a negative impact on economic growth.

One of the most important practical implications of this study is the need to improve the private investment climate in the circular economy and comprehend the necessity to migrate to a circular economy.

To ensure that private investment has a positive impact on European Union countries, the EU needs to improve the investment climate to make private investment more attractive. This can be achieved by improving fiscal and financial policies, providing lower-interest loans to investors, adjusting taxes and fees reasonably, as well as creating a more conducive environment for doing business. Furthermore, free and fair competition should be promoted, and more investment should be made in infrastructure and energy to support sustainable development.

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