sciendo

The Impact of Circular Economy on Economic Development A Review of EU`s Countries

Alin-Cristian MARICUȚ[*]
Bucharest University of Economic Studies, Bucharest, Romania
[*]*Corresponding author, alin.maricut@csie.ase.ro*

Giani-Ionel GRĂDINARU
Bucharest University of Economic Studies, Bucharest, Romania
National Institute of Economy, Romanian Academy, Bucharest, Romania
giani.gradinaru@csie.ase.ro

Abstract. *Over time, the concept of economic development has been the cause of debates in the research environment. Some of the researchers consider the level of economic development of a country to be characterized by high levels of the main macroeconomic aggregates, while another part supports the idea of uniform economic development with a high level of social inclusion. Regardless of the definition of the concept of economic development, it has been proven that a major positive impact is generated by the sustainable development strategy, especially in the light of the concept of circular economy. Therefore, the study addresses the level of economic development of the member states of the European Union based on the impact generated by the circular economy. In addition, based on the analysis carried out, the paper aims to identify the dependency ratio between the variables associated with the circular economy concept and the level of economic development. In order to achieve these goals, a panel regression model was estimated, for all member states of the European Union, on the time horizon 2011-2020. The model used as dependent variable "the level of economic development", and the independent variables were made up of variables associated with the circular economy. The results of this analysis reveal that there are individual effects on both dimensions associated with the analysis (cross-sectional, time series), which leads to the idea that each country is influenced in the process of economic development through the circular economy by its own specificities.*

Keywords: **circular economy, sustainable development, poverty, economic growth, recycling**

Introduction

The level of economic development of the EU`s countries can be viewed from several angles. Most scientific researches consider the level of Gross Domestic Product per capita to be the standard variable for analyzing the level of economic development. However, the concept of economic development means a set of inter-connected elements. A high value of Gross Domestic Product per capita does not necessarily mean a high level of economic development. For example, there is a possibility that at the aggregate level a high value of gross domestic product per capita will be reached, but the territorial distribution of this aggregate is not a uniform one. Therefore, it can be stated that gross domestic product per capita is not an infallible element of measuring the economic development of a country.

According to the European Union's desiderates, economic development must take into account a number of essential aspects, such as the concept of sustainable development. This concept promotes the idea of developing an economic system by analyzing the impact on 3 dimensions essential for human development (environment, social, economic). Thus, the economic component must be seen from the perspective of the impact it generates on the social

DOI: 10.2478/picbe-2023-0134
© 2023 A. C. Maricuț; G. I. Grădinaru, published by Sciendo.
This work is licensed under the Creative Commons Attribution 4.0 License.

and environment. The best concept that incorporates the aforementioned point of view is the 'circular economy'. The circular economy has the merit of making the consumption, especially of natural resources, more efficient, but also of producing added value in the economy based on the reuse of the collected waste, and then recycled.

Starting from these hypotheses, the paper aims to identify the impact of the circular economy on the level of economic development of EU`s countries. In addition, based on the analysis carried out, another objective of the paper is to identify the main variables associated with the concept of "circular economy" that have a significant effect on the level of economic development.

In order to achieve all the objectives of this research, a panel regression model was estimated at the level of the 27 member states of the European Union, during the period 2011-2020. The element of originality of this work is constituted by the use of the variable "Share of population with income below the level of 60% of the national median income", as a representative variable for the level of economic development. The reason why this variable has been chosen as characteristic of the level of economic development is the importance it attaches, on the one hand, to the Strategy of Sustainable Development (Goal 1- "No poverty"), but also the increase of social inclusion, a healthy developed economy having a low rate of poverty and social exclusion. This variable associated with the level of economic development is analysed in the light of the variation of some variables associated with the concept of the circular economy (Material Import Dependency, Recycling rate of municipal waste, Investments in durable goods, Air pollution, Domestic Material Consumption and Resource Productivity).

Literature review

Skare & Prziklas Druzeta (2016) states that there is a causal relationship between the poverty line and the level of economic development. Moreover, they say that a high level of economic development can contribute to reducing the level of poverty, but this is not enough to increase social inclusion. Dubey & Tiwari (2018) studied the relationship between economic growth and reducing urban poverty in India. Their results reveal that through sustained economic growth, the urban poverty rate is significantly reduced, but not evenly reduced, with declining rates varying according to geographical location. However, the poverty rate is influenced by several factors outside of economic growth. Definitely, economic growth is inversely correlated with the level of poverty and social exclusion, only if the level of economic growth is evenly distributed, otherwise the poverty rate may increase (Michalek & Vybostok, 2019; Singh, 2021).

Zhang et al. (2022) define multidimensional poverty as social, economic and ecological poverty. At the same time, they identified three types of multidimensional poverty as opportunities for reducing the general phenomenon of poverty and social exclusion. Totuși, există posibilitatea unui fenomen de sărăcie tranzitorie, ca urmare a unor evenimente, precum: pandemia, dezastre naturale, stare de război, etc.. Această stare tranzientă se diferențiază de definiția de bază a sărăciei și excluziunii sociale prin faptul că nu are un caracter permanent. This phenomenon of transient poverty can be overcome through 3 directions of sustainable development: multidisciplinary approach, the action of the civilian community in ensuring a strong ecosystem and adjacent aspects related to the social environment (health, justice system, education, political aspects) (Leal et al, 2022). Poverty eradication and sustainable development are in a close symbiosis, even one of the desiderates of sustainable development is 'No poverty'. Cheng et al. (2018) argue that the eradication of poverty can be achieved through the sustainable development strategy, if the strategy takes into account the impact of the economic model on the environment.

The concept of sustainable development is a cross-disciplinary concept that incorporates aspects with a direct impact on three dimensions: economic, environmental, social. The main instrument of the sustainable development strategy is the circular economy, which incorporates aspects with a direct impact on all three dimensions of sustainable development (Sauve et al., 2016). Over time, the concept of the circular economy has been defined by researchers in different manners. Kirchher et al. (2017) gathered 114 definitions of the concept of circular economy, which they classified into 17 dimensions. The results of their research concluded that this concept, of the circular economy, is defined mainly on the basis of 3 R (reduce, reuse, recycle). In addition, another of their findings is the existence of an association link between the concept of circular economy and the concept of sustainable development, the circular economy having as main purpose economic prosperity in the context of a quality environment, but also of social fairness. The circular economy leads to the decrease and minization of the generation of waste by providing a closed loop of raw materials and natural resources (Ogunmakinde et al., 2022). Moreover, Ogunmakinde et al. (2022) state that the circular economy plays a fundamental role in the deploymnet of the 2030 Sustainable Development Agenda through the positive impact it can generate on waste management in the construction industry. Skvarciany et al. (2021) studied the direct impact of the circular economy on achieving the targets of the Sustainable Development Strategy for the 32 OECD member countries. The results of this study reveal that in 20 of the 32 states the circular economy had a direct impact on achieving the targets of the Sustainable Development Strategy. In addition, perhaps the most important result of the study conducted by Skvarciany et al. (2021) is the positive aspect that the inclusion of circular economy indicators in the Sustainable Development Strategy can generate.

Methodology

Reliable data, appropriate to the purpose of the research, were used to achieve all the objectives of the research, and subsequently processed using methods appropriate to statistical analysis.

The data were extracted from Eurostat's interactive database for all member states of the European Union, at the level of the time horizon 2011-2020. The principles underlying the extraction of statistical data are: indicators appropriate to the purpose of the research, accuracy, relevance, completeness and comparability. In order to obtain an analysis appropriate to the purpose of this scientific research, following the data quality principles listed above, variables have been selected to capture the level of economic development of countries, the sustainability of countries, air quality or the rate of recycling. In the table below, the variables used in this study are presented in detail (Table 1).

Table 1. Variables of research

Indicator	Dissagregation	Unit of measure	Acronym
Severe housing deprivation rate by poverty status	Below 60% of median equivalised income	Percentage	Poverty
Resource productivity	Total	Purchasing power standard (PPS) per kilogram	RP
Purchasing power parities (PPPs), price level indices and real expenditures for ESA 2010 aggregates	Real Expenditures-Durable goods	Purchasing power parities	RE_DG

Indicator	Dissagregation	Unit of measure	Acronym
Recycling rate of municipal waste	Recycling	Percentage	Rec
Material import dependency	Fossil energy materials/carriers	Percentage	MID
Material flows for circular economy - Sankey diagram data	Imports of waste for recovery - recycling	Tonnes per capita	MFCE
Air emissions intensities by NACE Rev. 2 activity	Greenhouse gases (CO2, N2O in CO2 equivalent, CH4 in CO2 equivalent, HFC in CO2 equivalent, PFC in CO2 equivalent, SF6 in CO2 equivalent, NF3 in CO2 equivalent)	Index, 2008=100	AE
Domestic material consumption	Total	Tonnes per capita	DMC

Source: Authors` own research

In order to achieve all the desiderates of this research, the data were analyzed by using a panel regression model. This model was used because it allows the analysis of variables from a two-dimensional perspective (cross-sectional, time series), thus the analysis and, implicitly, its results become more relevant. By using this panel regression model, the model's estimators become more conscientious (Porter et al., 2019). Therefore, the panel linear regression model is described by the following equation:

$$Y_{it} = \alpha + \beta_1 x_{1t} + .. + \beta_n x_{nt} + e_i \quad \text{(Eq.1)}$$

Where:
t = time series (2011-2020)
i = datele cross-sectional (Eu`s countries)
α = Intercept
x_{it} = regressors
e_{it} = residuals
y_{it} = dependent variable

Subsequently, to identify the best model, the Hausman test was used. It is based on two hypotheses:
H0: random effects (RE)
H1: fixed effects (FE)

Random effects imply the absence of a correlation relationship between regressors and the term errors, both for the cross-sectional dimension and for time series. Thus, by using random effects, which occur as a result of the "sampling" operation, the term error is decomposed into two other endings: the first represents the term of the specific error for the cross-sectional dimension and another error term associated with the combination of the time series component and the cross-sectional component (Gujarati, 2004). On the other hand, Gujarati (2004, pp. 650-651) defines fixed effects as a correlation between regressors and the term residual. Thus, based on the estimation of the model, it is concluded that there are significant differences at the individual level, therefore, the intercept will be different depending on the individual effects that occur.

All data processing was carried out in R, using packages such as: tidyverse, readxl, plm, foreign.

Results and discussions

In order to identify the relationship of determination between the level of economic development, represented by the share of the population that is below 60% of the median income and the other variables used in this study, variables that characterize the circular economy, a model of multiple linear regression was estimated in a first phase, based on the following relationship:

Dependent variable: Poverty

Independent variables: RP, RE_DG, Rec, MID, MFCE, AE, DMC

Therefore, the regression equation becomes:

$$Poverty_i = \alpha + \beta_1 RP_i + \beta_2 RE_DG_i + \beta_3 Rec_i + \beta_4 MID_i + \beta_5 MFCE_i + \beta_6 AE_i + \beta_7 DMC_i + e_i \quad \text{(Eq. 2)}$$

By estimating the regression model based on the least squares method, the results are as follows:

Table 2. Significance level of multiple regression model

Indicator	Value
R-Squared	45%
p-value	2.2e-16

Source: Authors' own research.

By using a probability of 95%, it can be argued that the model is statistically valid. Therefore, the share of the population on the threshold of poverty is influenced by 45% of the evolution of explanatory variables (Table 2). However, in order to have a clearer idea of the factors of influence, it is important to test the estimated coefficients.

Table 3. Coefficients of multiple regression model

Indicator	Coefficient	p-value
Intercept	59.53	2e-16
RP	-8.22	1,34e-12
RE_DG	0.000006158	0.6886
Rec	-0.05723	0.1640
MID	-0.1356	5.79e-10
MFCE	3.030	6.50e-07
AE	-0.07301	0.0471
DMC	-0.9513	2e-16

Source: Authors' own research.

Of the 8 coefficients, with a probability of 95% it can be stated that only six of them are significantly different from zero, thus statistically significant (Table 3). The equation becomes:

$$Poverty_i = \alpha + \beta_1 RP_i + \beta_2 MID_i + \beta_3 MFCE_i + \beta_4 AE_i + \beta_5 DMC_i + e_i \text{ (Eq.3)}$$

In other words, using a probability of 95%, it can be said that the poverty threshold is 45% influenced by: Resource Productivity (RP), Material Import Dependency (MID), Imports of waste for recovery – recycling (MFCE), Air Emissions (AE), Domestic Material Consumption (DMC).

Further, in order to have a complete analysis, from a two-dimensional perspective, both cross-sectional and time series, the next step consists in estimating a linear regression model, having as category variable the member state of the European Union.

Table 4. Significance of dummy regression model

Indicator	Value
R-Squared	96%
p-value	2.2e-16

Source: Authors' own research.

For the analyzed period, with a probability of 95% it can be stated that at least one coefficient of the model is statistically significant, the variation in the level of economic development (poverty threshold) is influenced at a rate of 96% by explanatory variables, which have associated significant coefficients different from 0 (Table 4).

Table 5. Coefficients of regression model

Indicator	Coefficient	Significant
RP	0.7702	No
RE_DG	-4.346e-05	No
Rec	-0.2686e	Yes
MID	0.1083	No
MFCE	1.21	No
AE	0.01678	No
DMC	-0.6547	Yes
Factor(Country)	Different for each country	Yes

Source: Authors' own research.

The category variable "Country" is statistically significant, therefore it can be stated that during the analysis period there are individual effects at the level of the member states of the European Union (Table 5). Also, the level of economic development is influenced in a inverse proportionality relationship by the Recycling Rate (Rec) as well as by the Domestic Material Consumption (DMC). Another important clue, obtained by estimating this model, is the existence of individual effects, therefore, we will state that there are fixed effects on the cross-sectional dimension, regressors being correlated with the series of residues. However, to demonstrate this claim to the end, several panel regression models will be estimated, either with fixed effects or random effects.

In order to identify the best panel regression model that can be estimated on this data series, the Hausman test was used.

Hypotheses:

H0: random effects

H1: fixed effects

Since the p-value associated with the Hausman test is equal to 0.02992, for a probability of 95% it can be stated that the most suitable model is the fixed effects panel model. Based on this result, the next step involves testing the fixed effects on the two dimensions (cross-sectional, time-series). The Breusch-Pagan statistics test was used for this test.

Hypotheses:
H0: No effects
H1: Significant effects

Table 6. Breusch-Pagan Test

Dimension	P-Value	Significant
Individual	0.039	Yes
Time	2.2e-16	Yes

Source: Authors' own research.

For a probability of 95% it can be stated that the fixed effects are significant on both dimensions, cross-sectional and time series. Next, the fixed effects that appear on the temporal dimension (Table 6) will be analyzed in detail.

Table 7. Individual effects for time series

Year	Coefficient	p-value
2011	-7.15	0.44
2012	-1.70	0.08
2013	-1.87	0.07
2014	-1.99	0.07
2015	-2.03	0.09
2016	-2.21	0.09
2017	-3.08	0.02
2018	-3.71	0.01
2019	-4.37	0.01
2020	-5.14	0.00

Source: Authors' own research.

Using a probability of 95%, it can be stated that fixed effects make their mark on the years 2017, 2018, 2019 and 2020 (Table 7). Interesting to note is that during this period, where fixed effects are present, there is a downward trend, a sign that the share of the population with incomes below 60% of the national median income is decreasing in the EU`s countries. Also, the presence of fixed effects for these four years opens the premise of some peculiarities at the level of public policies, either European or national, which have led to the decrease of the population on the threshold of poverty.

Given that the fixed effects are significant on both dimensions (cross-sectional, time series), a "two-ways effects" model of panel regression has been estimated.

Table 8. Significance of two-ways effects regression model

Indicator	Value
R-Squared	0.21
P-value	1.337e-10

Source: Authors' own research.

For a probability of 95%, it can be stated that the model is valid. Unfortunately, the quality of the model is not very high, only at a rate of about 21% of the variation in the rate of poverty and social exclusion is explained by the estimated model (Table 8). This result confirms the assumption supported by Skvarciany et al. (2021) that variables associated with the circular economy have a major impact on sustainable development for most of the countries included in the analysis, but not

for all countries. Further, a particularly important aspect is the identification of regressors that explain 21% of the variation in the phenomenon of "the rate of the population with incomes below 60% of the median level".

Table 9. Coefficients of two-ways effects regression model

Indicator	Coefficient	P-value
RP	2.5156	0.07
RE_DG	-0.000018	0.75
Rec	-0.21849	5.453e-07
MID	-0.081776	0.18
MFCE	0.49891	0.74
AE	-0.048568	0.18
DMC	-0.5403	0.0004416

Source: Authors' own research.

Using a probability of 95%, only two estimators are significantly different from 0. The statistically significant variables are "Recycling rate of municipal waste" and "Domestic Material Consumption". In other words, it can be stated that 21% of the variation in the "Share of people with income below 60% of the median income at national level" is influenced by the trajectory of the "Recycling rate of municipal waste" and "Domestic Material Consumption" (Table 9).

When the "Recycling rate of municipal waste" increases by one unit, the "share of people with incomes below 60% of median income" decreases, on average, by 0.22, while the level of Domestic Material Consumption remains constant.

On the other hand, when "Domestic Material Consumption" increases by one unit, "The share of people with incomes below 60% of the median income" decreases, on average, by 0.54, given that the "Recycling rate of municipal waste" remains constant.

Starting from the results of the "two-ways effects" panel regression model, it can be stated that the level of economic development of EU`s countries is influenced in a proportion of 21% by the evolution of waste recycling and by the management of the consumption of national raw materials. This result confirms the theory supported by Kirchher et al. (2017) and Ogunmakinde et al. (2022). In addition, it can be concluded that the circular economy, through the recycling process and a rational model of consumption of natural resources, can bring added value to the process of eradicating the phenomenon of poverty and social exclusion. Therefore, the member states of the European Union should take into account the integration of circular economy indicators in the monitoring process of the Sustainable Development Strategy 2030 (Skvarciany et al. (2021). In addition, by integrating the circular economy indicators in the monitoring process of the National Strategy for Sustainable Development and the results of this study, the idea stated by Cheng et al. (2018) according to which the eradication of poverty can be achieved through the sustainable development strategy is confirmed, if the strategy takes into account the impact of the economic model on the environment.

.

Conclusion

Starting from the hypothesis that economic growth does not uniformly reduce the risk of poverty and social exclusion, the results of the study bring to the fore the dependency relationship between the risk of poverty and social exclusion, the recycling rate of municipal waste and Domestic Material Consumption. The results of the research confirm the existence of a dependency relationship between these three variables, the recycling rate and the DMC explaining at a rate of

about 21% the variation in the share of people with income below 60% of the median income. The deterministic relationship between the two explanatory variables and the explained variable is inverse proportionality. In other words, the increase in the recycling rate and the increase in the DMC contribute 21% to the reduction of poverty and social exclusion, at the level of the EU`s countries, during the period 2011-2020. However, it is important to note that this deterministic relationship is significantly influenced by the individual effects present both among the member states of the European Union and among the time series. It can, therefore. be said that, at the level of the EU`s countries, the reduction of poverty and social exclusion is not a uniform process, being influenced by the particularities of each country, but also by the particularities of the period under review.

Unfortunately, the time series is not very long, since the main criteria in the process of selecting the data were the completeness and comparability of the data. Thus, the time series was limited in order to fully meet the two data quality criteria. An extended time series could draw with a greater degree of accuracy the deterministic type relationship between the variables used.

Therefore, the expansion of the time series, as well as the expansion of the cross-sectional series, can significantly help the quality criteria of the results, such as: relevance, opportunity and accuracy. In addition, in the future, the reasearch will be expended to the impact of the circular economy on the private sector, given the 17 sustainable development goals.

References

Cheng, X., Shuai, C., Wang, J., Li, W.-J., Shuai, J., & Liu, Y. (2018). Building a sustainable development model for China's poverty-stricken reservoir regions based on system dynamics. Journal of Cleaner Production, 176, 535-554. doi:10.1016/j.jclepro.2017.12.068

Dubey, A., & Tiwari, S. (2018). Economic Growth and Urban Poverty in India. Environment and Urbanization Asia, 9(1), 18-36. doi:10.1177/0975425317748451

Gujarati, D. (2004). Basic Econometrics. The McGraw-Hill Companies.

Kirchher, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources Conservation and Recycling, 127, 221-232. doi:10.1016/j.resconrec.2017.09.005

Leal, W., Eustachio, J., Dinis, M., Sharifi, A., Venkatesan, M., Donkor, F., Vargas-Hernandez, J. (2022). Transient poverty in a sustainable development context. International Journal of Sustainable Development and World Ecology, 29(5), 415-428. doi:10.1080/ 13504509.2022.2029612

Michalek, A., & Vybostok, J. (2019). Economic Growth, Inequality and Poverty in the EU. Social Indicators Research, 141(2), 611-630. doi:10.1007/s11205-018-1858-7

Ogunmakinde, O., Egbelakin, T., & Sher, W. (2022). Contributions of the circular economy to the UN sustainable development goals through sustainable construction. Resources Conservation and recycling, 178, Article Number 106023. doi:10.1016/j.resconrec.2021.106023

Porter, C., Outlaw, R., Gale, J., & Cho, T. (n.d.). The Use of Online Panel Data in Management Research: A Review and Recommendations. Journal of Management, 45(1), 319-344. doi:10.1177/0149206318811569

Sauve, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. Environmental Development, 17, 48-56. doi:10.1016/j.envdev.2015.09.002

Singh, T. (2021). Economic growth and the state of poverty in India: sectoral and provincial perspectives. Economic Change and Restructuring, 55(3), 1251-1302. doi:10.1007/s10644-021-09345-5

Skare, M., & Prziklas Druzeta, R. (2016). Poverty and Economic Growth: A review. Technological and Economic Development of Economy, 22(1), 156-175. doi:10.3846/20294913.2015.1125965

Skvarciany, V., Lapinskaite, I., & Volskyte, G. (2021). Circular economy as assistance for sustainable development in OECD countries. OECONOMICA COPERNICANA, 12(1), 11-34. doi:10.24136/oc.2021.001

Zhang, X., Sun, Y., Gao, Y., & Dong, Y. (2022). Paths out of poverty: Social entrepreneurship and sustainable development. Frontiers in Pshychology, 13, Article Number 1062669. doi:10.3389/fpsyg.2022.1062669