

CIRCULAR ECONOMY AND RESOURCE PRODUCTIVITY IN DRIVING GREEN GROWTH: EVIDENCE FROM INDONESIAN PROVINCES

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Abstract

This study aims to analyze the influence of the circular economy and resource productivity on green economic growth at the provincial level in Indonesia. The approach used is quantitative with an explanatory design through panel data regression analysis of 34 provinces during the period 2019–2025. The empirical model is estimated using Fixed Effect Model (FEM) based on the results of the model selection test. Circular economy variables proxied by the percentage of managed waste, resource productivity is measured by the ratio of GRDP to energy consumption, and green economic growth is calculated from the interaction of GRDP per capita and the Environmental Quality Index. The results show that simultaneously, the circular economy and resource productivity have a significant effect on green economic growth. Partially, the circular economy has a negative and significant effect, while resource productivity has a positive but insignificant effect. These findings indicate that the implementation of the circular economy in Indonesia is still in the early stages of transition and therefore has not yet provided an optimal impact on green economic growth. This study contributes to the development of environmental economics literature by integrating both variables in a single empirical model based on panel data and provides policy implications related to the importance of strengthening waste management systems and resource efficiency in promoting sustainable development at the regional level.

Keywords: Circular Economy, Resource Productivity, Green Economic Growth, Panel Data, Fixed Effect Model

INTRODUCTION

The transformation towards sustainable development has become a strategic issue in the global economy along with increasing pressure on natural resources and environmental degradation, as well as increasingly complex climate change. Conventional linear economic models based on the take, make, dispose pattern have proven unable to guarantee long-term sustainability because they encourage overexploitation of resources and increase waste and emissions. In this context, the development of green economy literature indicates a paradigm shift towards a more sustainable and efficient economic system in resource use. Recent bibliometric analysis shows that green economy research is growing rapidly and focuses on the integration of economic growth and environmental sustainability as a major global agenda (Mo et al., 2024).

In response to these issues, the concept of a circular economy has developed as an alternative approach that emphasizes efficient resource use through the principles of reduce, reuse, and recycle, as well as optimizing material cycles within the economic system. A circular economy not only serves as an environmental solution but also as a mechanism for increasing economic value through production efficiency and resource-based innovation. Empirical studies show that the implementation of a circular economy, such as waste recycling and the use of renewable energy, can increase resource efficiency and reduce energy intensity and carbon emissions (Garg et al., 2025).

In the context of economic development, the circular economy has a close relationship with green economic growth. *economic Green economic growth* not only emphasizes increasing economic output, but also considers aspects of environmental sustainability and resource efficiency. Research shows that the integration of circular economy practices and green innovation can significantly improve environmental and economic performance simultaneously. (Islam et al., 2025) In addition, resource productivity (resource Productivity is an important factor in supporting sustainable economic growth because it reflects a region's ability to produce higher economic output with more efficient use of inputs. Increased resource productivity has been shown to contribute to sustainability through energy efficiency and reduced pressure on the environment (Malatyinszki et al., 2025).

However, empirical evidence in Indonesia indicates that the implementation of a circular economy still faces various structural obstacles, such as technological limitations, low recycling rates, and suboptimal waste management systems at the regional level. This situation has resulted in the circular economy's contribution to green economic growth being suboptimal. Furthermore, efforts toward a green economy also face challenges such as inconsistent policies, limited incentives, and the low preparedness of regional institutions to manage resources efficiently (Teguh & Bugiman, 2024). This indicates a gap phenomenon, namely the gap between the potential of the circular economy as a sustainable development solution and the reality of its implementation at the local level.

The link between the circular economy, resource productivity, and green growth demonstrates a mutually reinforcing relationship. The circular economy plays a role in increasing material efficiency and reducing waste, while resource productivity improves the efficiency of economic input use. Cross-country studies show that circular economy practices significantly improve resource efficiency, ultimately contributing to more sustainable economic growth (Garg et al., 2025; Liu et al., 2024). Therefore, integrating these two variables is key to driving the transformation towards a green economy.

Although the relationship between these variables has been extensively studied, there is a significant research gap. Most previous research has focused on developed countries, such as the OECD and the European Union, which have more comprehensive and standardized circular economy indicator systems. (Shi & Nisar, 2025; Zhang, 2024) Meanwhile, research in developing countries, including Indonesia, remains relatively limited, particularly at the sub-national (provincial) level. Furthermore, many previous studies have not integrated circular economy, resource productivity, and green growth variables into a single panel data-based empirical model. Yet, a panel econometric approach is crucial for more accurately capturing the dynamics of relationships between variables in a regional context.

Based on the gap and research gap phenomena, this research is relevant to be conducted by integrating the variables of circular economy, resource productivity, and green economic growth in one empirical analysis framework. Specifically, this research aims to: (1) analyze the influence of circular economy practices on green economic growth at the provincial level in Indonesia; (2) examine the role of resource productivity in driving green economic growth; and (3) examine the simultaneous influence of both variables using a panel data-based multiple linear regression model.

The scope of this research is limited to the analysis of provincial-level data in Indonesia using proxy indicators adjusted to the availability of national data, namely the percentage of managed waste as a representation of the circular economy, the ratio of GRDP to energy consumption as a proxy for resource productivity, and the combination of GRDP per capita and the Environmental Quality Index (IKLH) as an indicator of green economic growth.

This research is expected to provide theoretical and practical contributions. Theoretically, this research enriches the environmental economics literature by integrating the concepts of the circular economy and resource productivity into the analysis of green economic growth at the local level. Practically, the results of this research can serve as a basis for local governments in

formulating sustainable development policies, particularly in waste management, energy efficiency, and resource optimization (Liu et al., 2024; Zhang, 2024).

The novelty of this research lies in the use of provincial-level panel data in Indonesia, the use of proxy indicators based on national data, and the simultaneous integration of the circular economy and resource productivity in a single econometric model. The results of this study are expected to show that both variables have a positive influence on green economic growth, thus providing policy implications in the form of strengthening the circular economy system, increasing energy efficiency, and integrating green economy indicators into regional development planning.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

This research is based on Decoupling Theory, which is one of the main pillars of environmental economics and sustainable development. This theory explains the fundamental relationship between economic growth and environmental pressures, particularly in resource use and carbon emissions. This theory explains that economic growth does not have to be accompanied by increased pressures on the environment, but can be decoupled *through* increased resource efficiency and technological innovation.

Decoupling is defined as the ability of an economic system to increase output (e.g., GDP) without being accompanied by a proportional increase in environmental degradation. Conceptually, there are two main forms, namely *relative decoupling* (when environmental impacts are still increasing but slower than economic growth) and *absolute decoupling* (when environmental impacts decrease even though the economy continues to grow) (Xie et al., 2025). This is in line with the opinion of several experts that *absolute decoupling* reflects the ideal condition when economic growth occurs simultaneously with a decrease in environmental degradation (Sabău-Popa et al., 2022) (Zhang, 2024).

In economic theory, decoupling is the main foundation of the concept of *green economic growth*, because it allows *reconciliatory framework* between economic expansion and environmental sustainability. Empirical studies show that the success of sustainable development depends heavily on the ability of a country or region to achieve *absolute decoupling*, which is still a major challenge, especially in developing countries (Xie et al., 2025).

In this framework, *green economic growth* is positioned as the outcome of the success of the decoupling process. However, various empirical studies show that most countries, especially developing countries, are still at a *relatively decoupling*, so that the relationship between economic and environmental variables is not always linear (Gbadeyan et al., 2024; Saglam et al., 2025).

To explain these mechanisms more operationally, the concepts of the circular economy and resource productivity are used as key variables. The circular economy serves as a systemic approach to reducing material flows, while resource productivity serves as an efficiency indicator that reflects the success of decoupling in practice.

Circular Economy and Green Growth

Circular economy is an alternative approach to the linear economic model that aims to maintain the value of materials in the economic cycle for as long as possible through practices such as *reduce, reuse, and recycle*. From the perspective of decoupling Theory, circular economy acts as an instrument to reduce dependence on primary resources and reduce environmental impacts (Georgescu et al., 2021).

Conceptually, the implementation of a circular economy is expected to drive green economic growth through material efficiency and innovation. This also aligns with Porter's hypothesis, which states that environmental regulations can stimulate innovation that enhances economic competitiveness. Numerous studies have shown that circular economy practices contribute to increased energy efficiency, waste reduction, and improved environmental performance (Garg et al., 2025; Khan et al., 2025).

However, within the framework of Decoupling Theory, the relationship is not always positive. In the early stages of implementation, the circular economy often requires significant investments, changes in industrial structures, and the adaptation of immature technologies. These conditions can result in high transition costs, potentially suppressing green economic growth in the short term (Bianchi & Cordella, 2023; Focardi & Fabozzi, 2025).

In addition, the rebound phenomenon also shows that increased efficiency does not always reduce total resource consumption, resulting in a suboptimal decoupling process. Therefore, in the context of a developing local economy, the relationship between the circular economy and green growth has the potential to be negative.

H1: Circular economy practices negatively impact green economic growth at the local level in the early stages of the transition.

Resource Productivity and Green Economic Growth

Resource productivity (*resource Productivity*) is a key indicator in measuring the success of decoupling, generally calculated as the ratio between economic output and material consumption. This indicator reflects a region's ability to generate economic added value through more efficient use of resources (Sabău-Popa et al., 2022).

From a theoretical perspective, increasing resource productivity indicates structural efficiency in the economy, which allows for economic growth without increasing pressure on the environment. Thus, resource productivity is a key factor in achieving *absolute decoupling* (Chen & Pao, 2024).

Empirical findings show that regions with high levels of resource productivity tend to have lower environmental footprints and more stable economic performance (Malatyinszki et al., 2025). Furthermore, studies in developing countries show that increased resource efficiency contributes significantly to improvements in green growth indicators (Ekonomi Pembangunan; Hidayah et al., 2023).

Based on these arguments, it can be concluded that resource productivity has a positive relationship with green economic growth.

H2: Resource productivity has a positive and significant effect on green economic growth at the local level.

Circular Economy, Resource Productivity and Green Economic Growth

In the perspective of modern environmental economics, the relationship between circular economy, resource productivity, and green economic growth can be explained through the integration of Decoupling Theory. This theory emphasizes that economic growth does not have to go hand in hand with increasing environmental degradation, but can be separated (decoupled) through increased efficiency and innovation (Gbadeyan et al., 2024; Khan et al., 2025).

Conceptually, the circular economy functions as a structural mechanism that transforms production and consumption patterns from a linear system to a closed system through the practice of reduce, reuse, and recycle. This transformation allows for a reduction in the use of primary resources as well as a reduction in waste and emissions (Georgescu et al., 2021). However, the impact of the circular economy on green economic growth is not always immediate, as its implementation often requires high initial investment as well as technological and institutional readiness.

On the other hand, resource productivity represents the level of economic efficiency in utilizing material inputs to produce outputs. In the Decoupling framework, this variable is the main indicator of the success of the separation between economic growth and environmental pressures. The higher the productivity of resources, the greater the economic output generated with lower resource use, thus supporting the achievement of absolute decoupling (Chen & Pao, 2024; Sabău-Popa et al., 2022a).

Furthermore, the relationship between the circular economy and resource productivity is complementary and mutually reinforcing. The circular economy increases material efficiency through reuse cycles, while resource productivity ensures that each unit of input produces optimal economic output. The integration of the two produces a synergistic effect in driving sustainable economic growth (Liu et al., 2024).

H3: Circular economy practices and resource productivity simultaneously have a significant impact on green economic growth.

RESEARCH METHODS

This study uses a quantitative approach with an explanatory design, which aims to examine the causal relationship between the circular economy, resource productivity, and green economic growth. The explanatory approach was chosen because it is able to explain the relationship between variables empirically through hypothesis testing based on numerical data. The analytical method used is multiple linear regression based on panel data, which combines *cross-sectional and time-series* data dimensions. The use of panel data is considered superior because it is able to control unobserved heterogeneity and increase the efficiency of model estimation (Baltagi, n.d.; Bianchi & Cordella, 2023).

The unit of analysis in this study covers 34 provinces in Indonesia, with an observation period consisting of annual data from 2019 to 2025. The provincial level was selected because variations in circular economy implementation and green economy performance tend to be regional, influenced by the economic structure, regional policies, and resource capacity of each region. The sampling technique used was total sampling (census), so that all provinces were made the object of research.

The data used is secondary data obtained from official and trusted sources, namely the Central Statistics Agency (BPS), the Ministry of Environment and Forestry (KLHK), and Ministry of Energy and Mineral Resources (ESDM). The data includes economic and environmental indicators relevant to the concepts of a circular economy and green growth. The use of data from this official institution aims to ensure the validity and reliability of the research through data consistency and accuracy (Sabău-Popa et al., 2022b).

econometric software. EViews 12, which has the capability to estimate panel data models, including Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM), as well as statistical tests such as the Chow test, Hausman test, and Lagrange test. Multiplier. In addition, this software is also used to perform classical assumption tests such as multicollinearity, heteroscedasticity, and autocorrelation.

Empirically, the research model is formulated in the form of a multiple linear regression equation based on panel data as follows:

$$GEG_{it} = \beta_0 + \beta_1 CE_{it} + \beta_2 RP_{it} + \varepsilon_{it}$$

Where

GEG_{it} : green economic growth in province i and year t

CE_{it} : circular economy

RP_{it} : resource productivity

ε_{it} : error term

This model allows for a more comprehensive analysis of the simultaneous influence between variables within the Decoupling framework. Theory, which emphasizes the separation between economic growth and environmental pressures (Chen & Pao, 2024).

The operationalization of the variables in this study is formulated as follows. First, green economic growth (GEG). proxied through the integration of economic indicators and environmental quality. Operationally, this variable is calculated by multiplying the Gross Regional Domestic Product (GRDP) per capita by the Environmental Quality Index (IKLH), thus formulated as:

GEG = GRDP per capita x IKLH

This approach is in line with the literature that combines economic and environmental dimensions in measuring green growth performance comprehensively (Chen & Pao, 2024; Sabău-Popa et al., 2022b).

The first independent variable is the circular economy (Circular Economic Performance (CE) is measured based on the level of waste management implementation as a representation of circular economy practices at the regional level. The main indicator used is the percentage of managed waste (%), which reflects the region's ability to reduce, recycle, and manage waste sustainably. Mathematically, this variable is formulated as:

$$CE = \%Sampah\ Terkelola$$

The use of this indicator is supported by research which states that waste management is one of the main pillars in the implementation of a circular economy. (Bianchi & Cordella, 2023; Liu et al., 2024)

Next, the second independent variable is resource productivity (RP). measured using the ratio between economic output and energy consumption, which reflects the efficiency of resource use in generating economic added value. Operationally, this variable is formulated as:

$$RP = \frac{PDRB}{Konsumsi\ Energi}$$

This approach is consistent with empirical studies that use the ratio of output to energy consumption as an indicator of resource efficiency in the context of a sustainable economy. (Chen & Pao, 2024; Sabău-Popa et al., 2022b)

Data analysis was conducted through several stages: descriptive analysis to describe data characteristics, panel model estimation to identify relationships between variables, and hypothesis testing using partial (t-test) and simultaneous (F-test) tests. The coefficient of determination (R^2) was also used to measure the model's ability to explain variations in green economic growth.

With this approach, the research is expected to provide a strong empirical picture of the role of the circular economy and resource productivity in driving green economic growth in Indonesia regionally and temporally.

RESULTS AND DISCUSSION

Descriptive statistical analysis was conducted to provide an initial overview of the characteristics of the research data covering the circular economy variables (X1), resource productivity (X2), and green economic growth (Y) in 34 provinces in Indonesia during the period 2019–2025. The descriptive statistical results show that all variables have relatively high data variation, which is reflected in the fairly large standard deviation value. This indicates heterogeneity between regions in terms of the circular economy, resource utilization and green economic growth achievements.

The classical assumption test was conducted to ensure that the regression model met the BLUE (*Best Linear Unbiased criteria. Estimator*). Based on the characteristics of the regression output, no indication of serious multicollinearity was found between the independent variables. This is evident from the stability of the regression coefficients and the standard error values that are still within reasonable limits. In the autocorrelation test, the Durbin-Watson value of 1.313355 indicates that there is no strong autocorrelation. Meanwhile, the heteroscedasticity test based on the stability of the Root MSE and residual values, the model does not show any indication of serious heteroscedasticity. In the context of panel data, this condition is still acceptable because the FEM model has accommodated heterogeneity between individuals (cross-section effect). Overall, the regression model used can be said to fulfill the classical assumptions and is suitable for further analysis.

Based on the results of the panel data regression model testing, the best model was selected using the Chow and Hausman tests. The following are the results of the panel data regression model selection.

Table 1. Results of Panel Data Regression Model Selection

Model Testing	Statistics	Probability	Decision
Chow Test	214,259	0.0000	FEM
Hausman test	16,801	0.0002	FEM

Source: processed data, 2026

The Chow test show a probability value of 0.0000 (<0.05), so the more appropriate model to use is Fixed Effect Model (FEM). Furthermore, the results of the Hausman test show a probability value of 0.0002 (<0.05), which confirms that the FEM model is the most appropriate model compared to the Random Effect Model. Thus, the regression analysis was conducted using the FEM approach. Thus, the model used in this study is Fixed Effect Model (FEM), which is able to accommodate differences in characteristics between provinces.

The results of the regression estimation using FEM are presented in

Table 2. Fixed Regression Estimation Results Effect Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3263627.	86373.54	37.78504	0.0000
X1	-6488.956	1266,607	-5.123102	0.0000
X2	2712.342	1670,642	1.623533	0.1068
Effect Specification				
Cross-section fixed (dummy variables)				
Root MSE	254012.2	R- squared	0.985596	
Mean dependent var	3025991.	Adjusted R- squared	0.981833	
SD dependent var	2122702.	SE of regression	286105.8	
Akaike info criterion	28.15168	Sum squared residual	1.10E+13	
Schwarz criterion	28.81573	Log likelihood	-2356.893	
Hannan-Quinn criter .	28.42115	F- statistic	261.9645	
Durbin-Watson stat	1.313355	Prob (F- statistic)	0.000000	

Source: processed data, 2026

Based on the estimation results using Fixed Effect Model, the regression equation obtained is as follows:

$$Y = 3263627,47 - 6488,96X1 + 2712,34X2$$

Adjusted R- Square value of 0.981833 indicates that 98.18% of the variation in green economic growth can be explained by circular economy and resource productivity variables, while the remaining 1.82% is influenced by other variables outside the model. The F- statistic value of 261.9645 with a probability of 0.0000 (<0.05) indicates that the model has excellent ability to explain the relationship between variables.

The model estimation results show that partially, variable X1 has a t- statistic value of -5.123102 with a probability of 0.0000 (<0.05) and a negative coefficient of -6488.956. This indicates that X1 has a significant negative effect on variable Y. Meanwhile, variable X2 has a t- statistic value of 1.623533 with a probability of 0.1068 (>0.05), which means that X2 does not have a significant effect on variable Y even though it has a positive relationship direction.

The results of this study indicate that the circular economy variable X1 has a negative and significant influence on the green economic growth variable Y. This can be interpreted as accepting the first hypothesis. This finding indicates that an increase in X1 actually decreases the value of Y. Theoretically, this negative relationship can be explained through the concept of *diminishing returns*. *Returns or trade-offs* in development economics, where increasing a particular variable can

lead to negative externalities if not managed optimally (Todaro, 2020). In the context of regional economics, this condition can reflect inefficiencies or pressure on resources due to unsustainable economic activities.

These findings align with research (Zhang, 2024) suggesting that certain economic indicators can negatively impact green economic growth if not balanced by resource efficiency and adequate environmental policies. Thus, these research findings reinforce the argument that the quality of economic growth is a more important factor than simply increasing the quantity of output.

On the other hand, the variable X2, resource productivity, was not proven to have a significant effect on the variable Y, green economic growth. This can be interpreted as rejecting the second hypothesis. This indicates that the contribution of X2 to changes in Y is not statistically strong enough. One possible explanation is the presence of a lag effect (effect), where the impact of the variable is only visible in the long term. Research by (Gani Laraga & Islam Negeri Sunan Kalijaga, 2025) also shows that variables related to resource productivity take time before having a significant impact on economic growth.

Furthermore, the insignificance of variable X2 may also reflect the presence of inter-regional heterogeneity that is not fully captured in the model. Although the FEM model is able to control for fixed effects, structural dynamics between regions remain a challenge in panel data analysis. (Baltagi, n.d.).

Simultaneously, the independent variables of circular economy and Resource productivity is shown to have a significant effect on the dependent variable of green economic growth, indicating that the combination of factors in the model has an important contribution in explaining the variation of Y. This can be interpreted that the third hypothesis is accepted. The very high value of the coefficient of determination indicates that the model has strong explanatory power, although it needs to be interpreted carefully to avoid bias due to possible overfitting.

In general, the results of this study support the theory of green growth, which emphasizes the importance of resource efficiency, environmental sustainability, and adaptive economic structures (Shi & Nisar, 2025). However, the empirical results indicate that not all variables have a direct influence, necessitating a more comprehensive policy approach based on regional characteristics.

The implications of this research are the need to optimize policies on variable X1 of the circular economy to minimize its negative impacts, as well as increasing the effectiveness of variable X2 of resource productivity through innovation, investment, and strengthening regional capacity. Furthermore, this research also opens up opportunities for further model development by incorporating other variables such as institutional quality, technology, and environmental factors.

CONCLUSION

Based on the results of panel data regression analysis using the Fixed approach Effect Model (FEM) in 34 provinces in Indonesia for the period 2019–2025, this study concludes that the circular economy and resource productivity simultaneously have a significant effect on green economic growth. This suggests that the combination of efficient resource management and economic system transformation plays a crucial role in driving sustainable development at the regional level. These findings support the *Decoupling Framework Theory*, which states that economic growth can be separated from environmental pressures through increased efficiency and innovation.

Partially, the circular economy has a negative and significant effect on green economic growth. These results indicate that the implementation of the circular economy in Indonesia is still in the early stages of transition, so it has not been able to provide a direct positive impact on green economic performance. High initial investment costs, technological limitations, and a suboptimal waste management system are contributing factors to this negative relationship. On the other hand, resource productivity does not show a significant effect, although it has a positive direction. This indicates that increasing the efficiency of resource use is not strong enough to directly drive

green economic growth, which is likely due to long-term effects (lag effects). effect) and heterogeneity of capacity between regions.

The practical implications of this research emphasize the importance of formulating more integrated policies to promote a circular economy and resource efficiency. Local governments need to strengthen waste management infrastructure, increase investment in environmentally friendly technologies, and encourage innovation in production and consumption systems. Furthermore, policies to increase resource productivity should be directed at energy efficiency, diversifying energy sources, and enhancing human resource capacity. Integrating green economy indicators into regional development planning is also a strategic step to ensure long-term sustainability.

This study has several limitations. First, the variables used are limited to the circular economy and resource productivity, thus not fully reflecting the complexity of factors influencing green economic growth. Second, the use of proxy indicators such as the percentage of managed waste and the ratio of GRDP to energy consumption has limitations in representing the concept comprehensively. Third, the model used is static and therefore unable to capture the dynamics of long-term relationships, including the possibility of lag effects and two-way causality. Furthermore, high inter-regional heterogeneity also poses a challenge in the analysis, even though it has been controlled for using the FEM approach.

Based on these limitations, further research is recommended to develop a more comprehensive model by adding other variables such as institutional quality, technological innovation, green investment, and environmental policies. Furthermore, the use of advanced analytical methods such as dynamic panel models (GMM) or spatial econometric approaches is recommended to more accurately capture long-term effects and interactions between regions. Future research could also expand the observation period and use more comprehensive indicators of the circular economy and green growth, resulting in more robust findings with greater generalizability.

BIBLIOGRAPHY

- Baltagi, B. H. (nd.). *Econometrics Analysis of Panel Data*. Retrieved <http://www.springer.com/series/10099>
- Bianchi, M., & Cordella, M. (2023). Does circular economy mitigate the extraction of natural resources? Empirical evidence based on analysis of 28 European economies over the past decade. *Ecological Economics*, 203. <https://doi.org/10.1016/j.ecolecon.2022.107607>
- Chen, C. C., & Pao, H. T. (2024). Circular economy and ecological footprint: A disaggregated analysis for the EU. *Ecological Indicators*, 160. <https://doi.org/10.1016/j.ecolind.2024.111809>
- Development Economics; Hidayah, J., Wahyuningrum, N., Kamara, DS, & Rahmah, IS (2023). Determinants of Green Gross Domestic Product (GDP) in ASEAN-5 Countries. 24 (2), 256–264. <https://doi.org/10.23917/jep.v24i1.22488>
- Focardi, S., & Fabozzi, F. J. (2025). Reconciling Circularity and Growth: The Model of Qualitative Economic Growth *Journal of Economic Analysis*, 4 (2), 178–198. <https://doi.org/10.58567/jea04020008>
- Gani Laraga, A., & Islam Negeri Sunan Kalijaga, U. (2025). Analysis of Factors Influencing Economic Growth in G20 Countries with Research and Development (R&D) as a Moderating Variable (Vol. 20, Number 1).
- Garg, V., Kaushik, P., & Kumar, A. (2025). A cross-country panel study on the impact of circular economy on resources efficiency. *Discover Sustainability*, 6 (1). <https://doi.org/10.1007/s43621-025-02300-8>
- Gbadeyan, O. J., Muthivhi, J., Liganiso, L. Z., & Deenadayalu, N. (2024). Decoupling Economic Growth from Carbon Emissions: A Transition toward Low- Carbon Energy Systems—A Critical Reviews. In *Clean Technologies* (Vol. 6, Number 3, pp. 1076–1113). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/cleantechnol6030054>

- Georgescu, I., Kinnunen, J., & Androniceanu, A. M. (2021). EMPIRICAL EVIDENCE ON CIRCULAR ECONOMY AND ECONOMIC DEVELOPMENT IN EUROPE: A PANEL APPROACH. *Journal of Business Economics and Management*, 23 (1), 199–217. <https://doi.org/10.3846/jbem.2022.16050>
- Islam, M.F., Hossain, M.I., Rashed, M., Rahman, M.N., Hossain, M.I., & Faisal-E-Alam, M. (2025). Strategizing for Sustainability: Examining the Dynamic Interplay of the Circular Economy, Green Technology Innovation, and Green Performance. *Global Journal of Flexible Systems Management*, 26 (4), 935–961. <https://doi.org/10.1007/s40171-025-00469-5>
- Khan, R. Z., Razak, L. A., & Premaratne, G. (2025). Green growth and sustainability: A systematic literature review on theories, measures and future directions. In *Cleaner and Responsible Consumption* (Vol. 17). Elsevier Ltd. <https://doi.org/10.1016/j.clrc.2025.100274>
- Liu, S., Xie, Y., & Liang, W. (2024). Optimisation of the Circular Economy Based on the Resource Circulation Equations. *Sustainability* (Switzerland), 16 (15). <https://doi.org/10.3390/su16156514>
- Malatyinszki, S., Zéman, Z., & Kálmán, B. G. (2025). Resource productivity and sustainability —a comparison of two European countries. *Humanities and Social Sciences Communications*, 12 (1). <https://doi.org/10.1057/s41599-025-04428-4>
- Mo, R., Peng, X. H., Wang, S. B., & Zhang, J. Z. (2024). Knowledge Mapping of Green Economy Research: A Bibliometric Analysis. *SAGE Open*, 14 (4). <https://doi.org/10.1177/21582440241293581>
- Radivojević, V., Rađenović, T., & Dimovski, J. (2024). The Roles of Circular Economy in Driving Economic Growth: Evidence from EU Countries. *SAGE Open*, 14 (4). <https://doi.org/10.1177/21582440241240624>
- Sabău-Popa, C.D., Bele, A.M., Dodescu, A.O., & Boloş, M.I. (2022a). How Does the Circular Economy Applied in the European Union Support Sustainable Economic Development? *Sustainability* (Switzerland), 14 (16). <https://doi.org/10.3390/su14169932>
- Sabău-Popa, C.D., Bele, A.M., Dodescu, A.O., & Boloş, M.I. (2022b). How Does the Circular Economy Applied in the European Union Support Sustainable Economic Development? *Sustainability* (Switzerland), 14 (16). <https://doi.org/10.3390/su14169932>
- Saglam, M. S., Yilanci, V., & Kongkuah, M. (2025). Decoupling economic growth and carbon emissions: a time-varying analysis of the environmental Kuznets curve hypothesis in France (1890–2019). *Environment, Development and Sustainability*. <https://doi.org/10.1007/s10668-025-06310-4>
- Shi, S., & Nisar, A. (2025). The Effects of Circular Economy, Green Finance and ICT Developments on Resource Productivity aimed Ecological Sustainability: Evidence from OECD Countries Using a CS-ARDL Approach. *Problemy Ekorozwoju*, 20 (2), 223–245. <https://doi.org/10.35784/preko.7059>
- Todaro, M. P., & S. S. C. (2020). Economic Development.
- Xie, Q., Guo, S., & Cao, F. (2025). Exploring the Decoupling of Carbon Emissions and Economic Growth and Its Influencing Factors: A Comparative Study of the EU and BRICS Countries. *Sustainability* (Switzerland), 17 (23). <https://doi.org/10.3390/su172310637>
- Zhang, Y. (2024). Circular economy innovations: Balancing fossil fuel impact on green economic development. *Heliyon*, 10 (18). <https://doi.org/10.1016/j.heliyon.2024.e36708>