

MACROECONOMIC DETERMINANTS OF CIRCULAR ECONOMY INNOVATION ACTIVATION IN CENTRAL JAVA

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Abstract

Climate change is a threat to future economic growth due to environmental damage caused by unmanaged waste generation. The circular economy plays an important role because it can be a solution to increase economic growth by managing waste as a production material. However, in Indonesia, the circular economy has not been running optimally, so encouragement is needed to innovate and implement the circular economy from a macroeconomic point of view. This study examines the impact of macroeconomic factors on the adoption of the circular economy, which aims to increase local revenue and reduce environmental damage in Central Java Province. This study uses per capita income, Human Development Index (HDI), Domestic Direct Investment (DDI), and Government Expenditure as proxies for macroeconomic variables, while using Environmental Quality Index (EQI) as a proxy for circular economy. This study utilizes the quantitative methodology of panel data regression analysis. The research findings show that the HDI variable provides a significant positive influence. In contrast, government expenditure has a negative influence on EQI, although income per capita and DDI do not have a significant influence on EQI. The implications of this study are expected to provide information to relevant stakeholders in developing appropriate policies to encourage innovation in the implementation of the circular economy in Central Java Province. The government is expected to assist stakeholders in developing policies to improve the implementation of the circular economy, especially by focusing on areas with low DDI but high per capita income and DDI and accompanied by increasing public knowledge about waste management.

Keywords: Circular Economy, Human Development Index, Sustainable Economic Development.

INTRODUCTION

The economy views climate change as a big rust that is slowly creeping towards an economic crisis (Wallace, 2019). Climate change can be indicated by the increasing average temperature of the Earth due to the high concentration of greenhouse gases in the atmosphere (D'Amato & Akdis, 2020). Concerns and awareness of the impacts of climate change due to global warming have always been masked by the illusion that economic growth is the cause of global warming. An increase in the average temperature of warmer regions of the Earth can reduce economic growth by an average of one percent due to reduced labor productivity and higher intensity of extreme weather (Hsiang et al., 2017). The impact can be felt on agricultural production, resulting in crop failure and food crises that can cause hunger that threatens tens of thousands of lives every year (Pun et al., n.d.).

Economic growth is based on linear economic activities, namely extraction, production, consumption, to disposal, which produces waste and waste (Ewijk, 2018). Linear economic activities in the economy often ignore environmental conditions on the grounds of increasing economic growth, accompanied by population growth (Esther & Suparyati, 2023). Looking at the environmental quality data presented by the World Bank (2022), it shows that the world's population is growing and increasing by 4.99 percent, meaning 7.753 billion people per year, which has an impact on production and consumption activities that continue to increase, thus causing high negative externalities to the environment. The increasingly massive population growth contributes

to carbon emission waste of 353 million tons from a total of 40,172 tons per year. Uncontrolled carbon emission waste conditions can significantly degrade the environment and threaten the economy and human survival (Ferronato & Torretta, 2019). There are several specific cases where CO₂ emission waste has doubled by 460 million tons, greater than the previous year.

Contributing to climate change, Indonesia ranks below Brazil as one of the top contributors to CO₂ emissions based on land use change. Indonesia released 243.3 thousand TgC/year of carbon emissions into the atmosphere due to land use change in 2022. This amount accounts for 20.7 percent of the world's total carbon emissions of 1173,661 thousand TgC/year based on land use change.

Issues regarding the environment and economy cannot be separated from Kuznet's theory, namely the Environmental Kuznet Curve (EKC). In Kuznet's theory, it states that environmental degradation increases along with economic growth. However, at a certain point (turning point) in economic growth will make the level of environmental degradation will decrease along with the increase (Leal & Marques, 2022). One way to accelerate the process of reaching and passing the turning point is through sustainable economic development. Sustainable economic development can be done through the concepts of green economy, carbon tax, and circular economy.

Circular economy can be defined as a restorative and regenerative economic model that provides insights into managing to reduce waste production and consumption based on sustainable economic development (Modarress & Ansari, 2020). The way a circular economy works technically involves the 4R 1S concept of reducing, reusing, recycling, repairing, and sharing. The circular economy also plays a role in spurring economic growth because, in its implementation, it maintains the value of a material in the market in the long term, which can reduce the level of environmental and social damage (Sari et al., 2023). The Ministry of National Development Planning/Bappenas (2023) has shown that the circular economy in Indonesia has the potential to generate revenues ranging from IDR 593 trillion to IDR 638 trillion to the Gross Domestic Product, with an estimated contribution of IDR 312 trillion across various sectors that contribute to carbon dioxide emissions in the country. The gains could lead to a reduction of 126 million tons of CO₂ emissions, representing a reduction of 18% to 52%, across the five contributing sectors, while simultaneously creating 4.4 million job opportunities in Indonesia.

The problem that needs to be faced by the circular economy is that it has not been heard of as popular in Indonesian society. Responding to this challenge, the Central Java Provincial Government (2023) has committed to making the development of a circular economic system and energy transition one of the ten priority regional programs. The basis for implementing this policy is the concern of the Central Java Provincial Government, as a province with 5.3 millions tons of waste per year, and produce 145 thousands GgCO₂e which can degrade the environment and the second largest in Indonesia.

The plan already has positive opportunities, so acceleration is needed, which is seen through macroeconomic factors in Central Java Province. Macroeconomic factors for accelerating the circular economy must be inclusive according to the principles of sustainable development. Macroeconomic factors in the circular economy include the roles of consumers, producers, and the government. The role of related sectors is a major factor in accelerating the circular economy, which is seen as a new industrial concept (Manik, 2022). Consumer behavior influences people's purchasing power for environmentally friendly goods and services (Sharma et al., 2023). On the other hand, producers with large capital can innovate to create environmentally friendly goods and services. The role of the government is to plan and implement the construction of facilities to support economic activities while being aware of the importance of environmental sustainability. The factor that can reflect the circular economy in Indonesia today is the environmental quality index, because it can see the impact of the rate of waste and waste generation (Musyarofah et al., 2023).

Based on the background analysis that has been explained, this study focuses on looking at the influence of macroeconomics on the acceleration of the circular economy in the Central Java economy. Things to note in this study lie in three aspects. First, this study clarifies the influence of

macroeconomic indicators that can increase the acceleration of the circular economy from an industrial perspective. Second, Central Java Province is in second place based on the data in Figure 1.2, which has a waste generation of 5.3 tons/year, making the study an interesting discussion for the community and related stakeholders, especially the Central Java Provincial Government, regarding the issue of circular economic development. Third, there is an inconsistent relationship between variables and environmental quality, so it is necessary to re-test how the related variables affect the circular economy.

LITERATURE REVIEW AND HYPOTHESIS FORMULATION

Environmental Kuznets Curve

Simon Kuznets (1995) in Sarkodie & Strezov (2019) explained that economic growth and income inequality have a strong relationship. The theory continues to develop and is adapted to the context of environmental economics, so it is known as the Environmental Kuznets Curve (EKC). Kuznets' theory describes the relationship between economic growth and environmental damage in the form of an inverted U-shape. The shape explains that at the beginning of economic development, the environment will be degraded as per capita income increases. Development in this phase relies heavily on cheap, non-renewable energy, and there is no demand for environmentally friendly products.

Circular Economy

The circular economy is designed to replace the linear economic model, which designs products to be sustainable making producers assume unlimited natural resources and continue to make new products (Suchek et al., 2022). In contrast, the circular economy considers that products can continue to be utilized and extend the value of products in the market for as long as possible. Another definition explains that the circular economy is an economic model that is restorative and regenerative, and provides insight into managing resources to reduce waste production and consumption based on sustainable economic development (Modarress & Ansari, 2020).

Environmental Quality Index (IKLH)

The Ministry of Environment and Forestry, (2019) explains that the quality of life index is a tool used to simplify a large amount of data and information while maintaining its essence. According to the United States environmental agency, the Environmental Protection Agency (EPA) explains that the Environmental Quality Index (IKLH) provides a quick overview of the condition and quality of the environment in a certain area and period of time. Conceptually, the IKLH value is comparative, which means comparing the performance of one province with another. In addition, each province contributes to the national value proportionally according to the demography and geography of Indonesia. IKLH not only provides a ranking, but also reflects the efforts that have been made to improve the quality of the environment both at the provincial and national levels.

Per Capita Income

Per capita income can be used as a fundamental economic indicator, because it is a measure of the average income of people in a region in a certain period (Abbood et al., 2024). Per capita income is obtained by dividing the total gross domestic product of a region by the total population. This makes the relationship between labor productivity and people's purchasing power to per capita income which is then interrelated with economic growth.

Per capita income can be used to understand income distribution and economic disparities between regions. It reflects the level of living standards and economic welfare of people in a region. Low per capita income in a region can indicate poverty and underdevelopment of facilities, so productivity and purchasing power in a region tend to be weak. Areas with high per capita income often correlate with better development and living standards (Zotikov, 2023).

Human Development Index

The human development index (HDI) is a composite statistic that describes the level of human development in each country. The index was introduced by the United Nations Development

Programme (UNDP) in 1990 to provide a broader measure of development by including additional dimensions such as health and education. There are three main dimensions that make up the HDI, namely; life expectancy, years of schooling, and per capita expenditure.

The Human Development Index can reflect the overall quality of life of the community, not only showing the success of a region in providing access to health, education, and the economy for the community, but also an indicator of increased awareness of important issues such as the environment. Awareness related to the environment will encourage more proactive in determining sustainable behavior by protecting ecosystems and the negative impacts of human activities (Wu & Cao, 2023).

Domestic Investment

Explained in law No. 25 of 2005, domestic investment is an investment activity to do business domestically carried out by investors with capital sourced from within the country. The investors in question are individuals and business entities registered and recognized by the Republic of Indonesia as well as the central or local government that make domestic investments. Domestic investment can be a factor in improving people's welfare and supporting equity in economic development and economic growth (Pratama & Rofiuddin, 2023).

Producers who have large capital can increase the production of goods and services and increase income, which increases economic growth (Mustika, 2021). The role of domestic investment is very important in encouraging producers to implement sustainable development that is oriented towards environmental sustainability. Domestic investment not only serves as a source of financing for economic development but also as a driver for producers to switch to environmentally friendly products and production (Bekoe & Chen, 2022).

Government Spending

Fiscal policy has several instruments, one of which is a deficit budget, which is a condition where government spending is greater than local revenue, which is useful in stimulating economic growth. The contribution of government spending in stimulating the economy includes routine spending, mandatory spending, and spending on development and services for the public. The role of government spending has three main functions: allocation, distribution, and stabilization. Within the local government environment, the focus is primarily on the allocation function, as it considers local needs, social conditions, and potential (Nofrita et al., 2024).

HYPOTHESIS FORMULATION

Kuznets' hypothesis states that increasing economic growth can degrade the environment, at a certain point economic growth will reduce the level of environmental degradation due to various factors, one of which is the circular economy approach. The practical implementation of circular economy needs to pay attention to macroeconomic factors to provide considerations in stakeholders' policy making. Circular economy as a business model is inseparable from three sectors of economic actors, namely consumers, producers, and government. Therefore, variables from each sector are needed to test the implementation of circular economy. Households are depicted through per capita income and HDI, in Kuznets' theory an increase in per capita income will degrade the environment, but up to a certain point makes environmental degradation decrease.

People with high income and ecological awareness have low marginal utility due to the desire for a better standard of living. Ecological awareness is the understanding and behavior of humans towards environmental sustainability obtained from the education process. Companies are reflected through domestic investment which can see the contribution of domestic investment in promoting sustainable development. Domestic investment is an important instrument in business development for a company, including in increasing innovation capacity for the production of low-emission goods and services.

Government is a sector that can be a catalyst in the implementation of circular economy represented through government spending. In order to optimize the business model of circular economy, government intervention can include green infrastructure, low-emission public services,

and market intervention. These forms of intervention can be observed fundamentally through government spending.

RESEARCH METHODS

Research Methods

This research applies quantitative methods that are processed using panel data analysis. This research applies a quantitative method which in proving its hypothesis is closely related to the use of data in the form of numbers in all stages of research, at the initial stage related data is collected then interpreted and conclusions are drawn (Machali, 2021).

The data source used in this study is data for a period of 3 years, namely 2021-2023 from 35 cities / districts in Central Java province. The data used is sourced from the official website data.jatengprov.go.id in the form of environmental quality index data as the dependent variable, the official website of the Central Java statistical agency in the form of data on income per capita, HDI, domestic investment, and government expenditure as independent variables.

Data Analysis Technique

Panel data regression analysis is the analysis technique used in this study. Panel data is a combination of cross section and time series data that are jointly used in an analysis (Mubarak, 2021). The equation model above is written in the basic panel data regression equation as below:

$$EQI_{it} = \beta_0 + \beta_1 PKI_{it} + \beta_2 HDI_{it} + \beta_3 DI_{it} + \beta_4 GE_{it} + \epsilon_{it}$$

Description:

EQI	= Environmental Quality Index (Index)
PCI	= Per Capita Income (Million Rupiah/Year)
HDI	= Human Development Index (Index)
DI	= Domestic Investment (Tens of Billion Rupiah/Year)
GE	= Government Expenditure (Hundred Billion Rupiah/Year)
A	= constant.
β	= Elasticity Coefficient
ϵ	= Error
i	= 35 Regency Cities in Central Java Province
t	= Range of data used 2021-2023

Identify variability both between subjects and within the same subject over time. This contributes to more precise estimation by accommodating individual differences and time-related effects. CEM can be said to be one of the easiest approaches in panel data analysis to understand, because it combines time series data and cross section data with no regard to time or individual dimensions. FEM is an approach to panel data analysis where variation between individuals can be explained by differences in intercepts. REM plays a role in estimating in this model used to analyze panel data when there is a relationship between disturbance variables across periods and individuals.

RESULTS AND DISCUSSION

The results of the panel data model estimation test in this study determine the Fixed Effect Model method. Model determination in panel data regression analysis is proven by a series of two test steps, namely the Chow test and the Hausman Test with the following results:

Table 1. Chow Test

Effects Test	Statistic	d.f.	Prob.
Cross-section F	3,460126	(34,66)	0,0000

Cross-section Chi-square	107,451311	34	0,0000
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Source: Output Eviews, 2024

According to Table 1, the model used is FEM because the cross-section F probability value is 0.0000 and the cross-section chi-square probability value is 0.0000, each less than 0.05.

Table 2. Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	26,614267	4	0,0000

Source: Output Eviews, 2024.

In Table 2, the cross-section probability value is 0.0000, or less than 0.05, so H_0 is rejected, as shown in Table 4.6. So, it shows that the FEM model used is the right one.

Based on the Chow Test and Hausman Test in this study the Fixed Effect Model (FEM) was chosen to be used. The panel data regression results using random effects are presented in Table 3.

Tabel 3. Panel Data Regression with *Fixed Effect Model (FEM)*

Variabel	Coefficient	Std. Error	t-Statistic	Prob.
C	-86,62354	60,78014	-1,425195	0,1588
PK	0,354429	0,402999	0,87948	0,3823
IPM	1,879806	0,937002	2,006192	0,0489
PMDN	0,006971	0,005964	1,168815	0,2467
PP	-0,03727	0,209232	-1,73727	0,0311
Adjusted R-Squared	0,552041	-	-	-
F-statistik	4,372738	-	-	0,00000

Source: Output Eviews, 2024

The Adjusted R-Squared value is 0.552041, or 55.20%, and the last 44.8% is explained by other variables not included in the regression model, such as local government policies, benchmark interest rates, and foreign investment.

The F-statistic value is 4.372738 and the F-table value is 0.1170, which indicates that the F-statistic > F-table, and the F-statistic probability value is 0.000000, which indicates that the F-statistic probability is less than 0.05, which indicates that H_0 is rejected. It is possible that the environmental quality index variable is significantly influenced by the use of all independent variables in this study simultaneously.

The t-test results are used to show the significance level of each independent variable on the dependent in this study. The test explanation on the t test results is as follows:

1. The Per Capita Income (PK) variable is not significant to the environmental quality index at the $\alpha = 5\%$ significance level.
2. The Human Development Index (HDI) variable has a positive and significant effect on the environmental quality index at the $\alpha = 5\%$ significance level.
3. The Domestic Investment (PMDN) variable is not significant to the environmental quality index at the $\alpha = 5\%$ significance level.
4. The government expenditure variable (PP) has a negative and significant effect on the environmental quality index at the $\alpha = 5\%$ significance level.

The results of panel data regression testing using the Fixed Effect Model (FEM) can be interpreted as follows:

A. The effect of per capita income on environmental quality index

Based on statistical tests, the hypothesis in this study cannot be accepted. The findings in this study state that per capita income in Central Java does not significantly affect circular economy activation. One of the reasons is the inequality of per capita income between districts/cities in Central Java that changes in per capita income are not directly proportional to improvements in environmental quality. This statistical data is one of the indicators showing that the environmental quality index is not significantly influenced by per capita income.

B. The effect of human development index on environmental quality index

Based on the statistical test, the hypothesis in this study can be accepted. The findings of this study state that the human development index in Central Java has a significant effect on circular economy activation. This indicates that human development can play an important role because it creates a society that is more aware of the importance of efficient natural resource management.

Communities with a good standard of living, high level of education, and better access to health have more concern for the environment and realize to be more proactive in adopting environmentally friendly practices, including those related to circular economy.

C. The effect of domestic investment on environmental quality index

Based on the statistical test, the hypothesis in this study cannot be accepted. The findings in this study state that domestic investment in Central Java does not significantly affect the activation of the circular economy. There are findings that show domestic investment is more focused on achieving economic growth in the short term, without considering environmental impacts. For example, in the transportation sector, telecommunications warehouses, housing, industrial estates and offices (Central Java Provincial Government, 2024). Thus, in practice the industry has not fully implemented green economic practices.

D. The effect of government spending on the environmental quality index

Based on statistical tests, the hypothesis in this study can be accepted. The findings of this study state that government spending in Central Java has a significant effect on the activation of the circular economy. government spending is allocated to other sectors that do not support environmental sustainability. There are several programs that worsen environmental conditions, such as infrastructure development such as the Construction of Steam Power Plants (PLTU) which risks damaging the environment, or other unsustainable projects.

Improper budget management that is not prioritized in the implementation of environmental programs can reduce the expected positive impact. To encourage the activation of circular economy, local governments need to re-evaluate their spending allocation and management, focusing on sectors that support sustainability, waste management, renewable energy use, as well as environmentally friendly infrastructure development.

CONCLUSION

This study aims to see how the relationship between per capita income, HDI, PMDN, and government spending on circular economy activation in 35 districts / cities of Central Java Province in 2021-2023. Per capita income has no influence on circular economy activation. This is due to income inequality between districts/cities so that it has not proven Kuznets' theory. The human development index has an influence on the activation of the circular economy. People who have a high level of understanding, guaranteed health, and a decent standard of living and have an awareness of the sustainability of the environment in which they live.

Domestic investment has no influence on the activation of the circular economy. The focus on short-term economic development is the main reason for this finding. It is also indicated that there is a reliance on conventional economic sectors and limited physical and non-physical infrastructure in encouraging environmentally friendly practices and sustainable development. Government spending has a significantly negative influence on circular economy activation. This is because

improper budget management due to unproportioned implementation of environmental programs can reduce the expected positive impact.

The Central Java provincial government needs to improve education to encourage people to perform pro-environmental behaviors that can influence decisions and actions to be environmentally sustainable. Then, emphasize the practice of 4R 1S so that there is continuity, the community has gained an understanding of pro-environmental behaviours in formal education. Thus, it can encourage the influence of other variables in this study that have in the quality of human capital.

District / city governments in Central Java province need to make spending on the environment and sustainability as one of the priorities. Then, the government can also encourage sustainable development by making policies. Policies can be made such as providing incentives and guidance to industrial sectors that have the potential to increase regional income if they implement a circular economy. In addition, it can act as an initiator by building public facilities such as Integrated Waste Disposal Sites (TPST), which are able to manage waste and waste into products that have economic value. By doing so, the government can encourage the community to practice environmental stewardship through the circular economy.

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