Green Economic Transformation in Driving Green Economic Growth in Indonesia

Rizka Fadillah, Andria Zulfa, Rusiadi, Lia Nazliana Nasution

Abstract

This study aims to determine the transformation of the green economy in driving green economic growth. The variables in this study are Carbon Emissions, Green Investment, Labor and GDP. The analysis method used in this study is Vector Auto Regression (VAR) with the Impulse Response Function (IRF) test, Forecast Error Variance Decomposition (FEVD), stationarity test, cointegration test, lag structure stability test, and optimal lag length test. The results of the Vector Autoregression study using the lag 2 basis show that there is a contribution from each variable to the variable itself and other variables. The results of the Vector Autoregression analysis also show that the past variable (t-1) contributes to the current variable both to the variable itself and other variables. From the results of the analysis, there is a reciprocal relationship between one variable and another. Response Function analysis shows the response of other variables to changes in one variable in the short, medium and long term, and it is known that the stability of the response of all variables is formed in the short, medium and long term. Variance AnalysisDecomposition shows the existence of variables that have the largest contribution to the variable itself in the short, medium and long term such as Green Investment and GDP. While other variables that have the greatest influence on the variable itself and are supported by other variables in the short, medium and long term are Carbon Emissions which are most influenced by GDP.

Keyword: Green Economy, Var, Green Growth,GDP

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Introduction

Green economic transformation is one of the crucial issues in the context of sustainable development, especially in Indonesia which is rich in natural resources and biodiversity. In facing the challenges of climate change and environmental degradation, an approach is needed that focuses not only on economic growth, but also on sustainability and resource conservation. Green economy seeks to create inclusive and sustainable growth, by utilizing environmentally friendly technologies and responsible business practices.

In Indonesia, this transformation is particularly relevant given the country's position as one of the largest carbon emitters due to deforestation, fossil fuel use, and unsustainable agricultural practices. Therefore, efforts to drive green economic growth need to be encouraged through policies that support investment in the renewable energy sector, sustainable management of natural resources, and the development of innovative technologies. By integrating green economy principles into various sectors, Indonesia can not only increase its economic competitiveness but also contribute to global efforts in mitigating climate change. This transformation is expected to create new jobs, improve people's welfare, and maintain the ecosystem that is the foundation of life. In this context, it is important to explore the strategies and concrete steps needed to drive sustainable green economic growth in Indonesia.

Green economy is a human activity that produces less carbon in the use of resources that is more efficient and socially exclusive. In a green economy, the addition of jobs and increased community income is driven by government and private investment in the form of productive activities,development of infrastructure and assets that will reduce carbon emissions (CO2) and pollution, increase the efficiency of energy and resource use and prevent the loss of biodiversity and ecosystem degradation. In Indonesia, the green economy is a new step in the economic field where in the process it prioritizes efforts for efficiency and effectiveness in the use of sustainable resources and maintaining environmental sustainability.(Aisah, 2023).

Carbon emission reduction is also a key focus in this transformation. By adopting cleaner technologies and environmentally friendly industrial practices, Indonesia can contribute to global efforts to address climate change. Leveraging natural resources, such as forests and agricultural land, to absorb carbon can be an effective strategy in improving air quality and the environment.

Increased public and private investment in green sectors, increased quantity and quality of green sector jobs, increased GDP from green jobs, decreased resources and energy per unit of production, decreased levels of pollution and CO2 or GDP, and decreased energy consumption that generates a lot of waste are some of the evidences of green economy implementation. created the Green Economy Index to help countries transform their economies to be greener by focusing government policies, investments, and spending on specific areas such as clean technology, renewable energy, green transportation, sustainable agriculture, and forestry.(Makmun, 2015).

Green Economic Transformation

Green Economy seeks to drive GDP and employment growth through a shift in investment towards clean technologies, natural capital, human capital, and social institutions. It focuses on shifting public and private investment as the primary instruments for achieving growth, environmental improvement, poverty reduction, and social equity, with policy reforms supporting this shift. Green economy sees social aspects as a changing target for investment. (Mubarak, 2023).

Green economic growth in Indonesia is defined as an economic development model to support sustainable development that focuses on investment, capital, infrastructure, jobs, and skills to achieve sustainable social and environmental welfare.then narrowed down to increase economic growth while prioritizing environmental sustainability and community welfare.(Suryandari, 2024).

The green growth program is mainly based on the idea that sustainable development can be achieved through a more integrated and holistic approach, where environmental and social factors are integrated into the economic process. During the process of sustainable development, we cannot ignore its main driving factors, namely the green economy and green growth. Green growth or green growth is defined as growth in the economic sector through contributions to the responsible use of natural capital, pollution reduction and prevention, and enforcement. As a result, these three ideas are green growth, green economy, and sustainable development.is something that cannot be separated(Wulandari, 2021).

The green growth scenario shows that Indonesia's economy experiences a reduction in resource intensity as its economy grows rapidly. By gradually adopting best practices, Indonesia can reduce environmental degradation while maintaining rapid economic growth. The result is a stronger economy with improved well-being for more people. Increases in income, health, food security, energy, and sustainability are all driven substantially by reduced environmental and ecosystem degradation, which together drive sustainable development. Investments are needed for green growth. These investments are made to avoid the higher costs associated with maintaining current conditions. A green growth approach can significantly reduce these costs. These include lower health costs due to poorer air and water quality; food insecurity due to soil erosion, subsidence, and uncertain water availability; the negative effects of destructive mining, forestry, and fishing, and high levels of greenhouse gas emissions. A green economy offers a new way to increase prosperity without the negative impacts.(Bappenas, 2020).

Economic growth in the context of a green economy is not only measured by GDP figures, but also by the quality of that growth. Sectors such as sustainable tourism and organic farming have the potential to become new drivers of the economy, reducing dependence on environmentally damaging industries. In this way, inclusive and sustainable growth can be achieved. On the other hand, this transformation also has an impact on the workforce. Many new jobs will emerge, especially in sectors that are oriented towards sustainability. To ensure that the workforce is ready for this change, governments need to invest in training and education programs. This is important so that they have the skills that match the new market needs.

METHOD

The approach taken by quantitative researchers is based on secondary data from the period 2005-2022 through the Worldbank. The conceptual framework of the research is as follows:

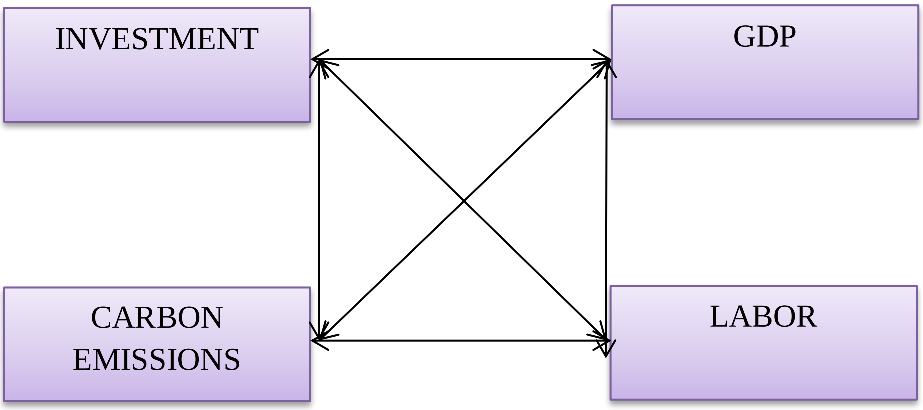


Figure 1 Conceptual Framework of VAR

The conceptual framework image explains the model used is the Vector Autoregression (VAR) test to analyze monetary policy in strengthening economic fundamentals in Indonesia by looking at the formation of vectors that influence each other between variables. According to Manurung (2009) it is impossible to distinguish between endogenous and exogenous variables if simultaneity between several variables is true. Testing simultaneous relationships and degrees of integration between variables in the long term using the VAR method is used because it is easier to use and to empirically prove the complex long-term reciprocal relationship of endogenous variables. The VAR analysis model consists of the following formula:

$$INV_t = \beta_{10}\, INV_{t-p} + \beta_{12}\, PDB_{t-p} + \beta_{13}\, EC_{t-p} + \beta_{14}\, TK_{t-p} + \beta + e_{t1}$$

$$PDB_t = \beta_{10}\, INV_{t-p} + \beta_{12}\, PDB_{t-p} + \beta_{13}\, EC_{t-p} + \beta_{14}\, TK_{t-p} + \beta + e_{t1}$$

$$EC_t = \beta_{10}\, INV_{t-p} + \beta_{12}\, PDB_{t-p} + \beta_{13}\, EC_{t-p} + \beta_{14}\, TK_{t-p} + \beta + e_{t1}$$

$$TK_t = \beta_{10}\, INV_{t-p} + \beta_{12}\, PDB_{t-p} + \beta_{13}\, EC_{t-p} + \beta_{14}\, TK_{t-p} + \beta + e_{t1}$$

Where :

INV = Investment

GDP = Economic Growth

EC = Carbon Emissions

TK = Labor

p = length lag

Next is the analysis of the Impulse Response Function (IRF) model, conducted to understand how each variable affects the standard deviation of innovation. Ariefianto (2012) explains that IRF conducts a search related to the impact of shocks or shocks on a variable in the system within a certain period of time. The purpose of the IRF analysis is to determine whether each transmission variable is cointegrated in both the short and long term. Manurung (2005) stated that IRF is an indicator of changes in the direction of movement of transmission variables as a result of changes in other transmission variables. To find out how important various shocks are to the variable itself and other variables, the Forecast Error Variance Decomposition (FEVD) is used. Manurung (2005) stated that the purpose of the FEVD analysis is to determine the contribution or influence between transmission variables.

Further analysis is carried out with the Assumption test consisting of the Data Stationarity Test (Unit Roots Test) and the Johansen Cointegration Test. Data stationarity can be obtained from data that is initially non-stationary through testing the degree of integration or stationarity at the level of data differentiation. This process involves testing the availability of data stationarity at one level and then repeating the test at the differentiation level until it reaches a stationary condition. Dickey-Fuller recommends applying certain regression models to determine the presence of unit roots in the data, as follows:

$\Delta Yt = \theta Yt\text{-}1 + et$ (1)

$\Delta Yt = \beta 1 + \theta Yt\text{-}1 + et$ (2)

$\Delta Yt = \beta 1 + \beta 2t + \theta Yt\text{-}1 + et$ (3)

In equation (1), the variable that shows the difference in time trend is denoted as t, and there are two additional regressors that include constant and time trend variables. Each model has two hypotheses considered: the null hypothesis $\Theta = 0$, which indicates the non-stationarity of the data, and the alternative hypothesis $\Theta < 0$, which indicates that the data is stationary. The DF statistic, represented by the t value of the coefficient $\Theta Yt\text{-}1$, is compared with its critical value; the rejection of the null hypothesis occurs if the absolute value of the DF statistic exceeds the critical value, indicating that the observed data is stationary. Conversely, if the value of the DF statistic is smaller than the critical value of the t distribution, then the data is considered non-stationary. The residuals et and autocorrelation elements are often related and interrelated according to the assumptions in equations (1) and (2). Dickey Fuller then included the autocorrelation element into his model, known as the Augmented Dickey-Fuller (ADF) to develop the unit root test. This ADF test is commonly used to assess the stationarity of data. The formulation of the ADF test can be explained as follows:

$\Delta Yt = \gamma Yt - 1 + \sum \beta \Delta Yt - 1 + 1n\ t - 1 + et$(4)

$\Delta Yt = \alpha 0 + \gamma Yt - 1 + \sum \beta \Delta Yt - 1 + 1n\ t - 1 + et$(5)

$\Delta Yt = \alpha 0 + \alpha 1T + \gamma Yt - 1 + \sum \beta \Delta Yt - 1 + 1n\ t - 1 + et$(6)

Where: Y = Research variable Yt = Yt – Yt-1 T = Time trend N = lag value The process of assessing whether the data is stationary or not involves comparing the ADF statistic value with the Mackinnon critical distribution value. The t statistic value of the coefficient γYt-1 is given in equations (4 to 6). If the absolute value of the ADF statistic exceeds its critical value, then the observed data shows a stationary nature. Conversely, if the absolute value of the ADF statistic is smaller than its critical value, then the data is considered non-stationary. It is also important to determine the length of the lag in the ADF test, and the Aikake Information Criterion (AIC) or Schwarz Information Criterion (SIC) can be used for this purpose. The model with the lowest AIC and SIC values is considered the most appropriate model. After knowing that the Export and Import data are stationary, the next step will determine whether there is a long-run equilibrium relationship between the two. There is one direction of Granger causality that is most uncertain if the two variables are integrated to degree one, I (1) and cointegrated. Based on the representation theorem, it is said that if a vector n/ (1) of time series data Xt is cointegrated with the cointegration vector, then there is an error correction representation, which can be mathematically represented by: A (L).Xt = -yaXt-1 + β(L) εt (7) Where: A(L) is a polynomial matrix.in the lag operator with A(0) = I; Y is (nx1) a constant vector that is not equal to zero; β(L) is a polynomial scalar in L; and εt is a vector of error variables that are white noise. In the short term, any deviation from long-term equilibrium (a'X=0) will affect the change in Xt and will adjust back towards equilibrium. The cointegration test that will be used here uses a test procedure.

Results and Discussion

The results of Vector Autoregression (VAR) show that with a lag of 1, the vector autoregression analysis shows the contribution of each variable to the variable itself and other variables, which is more clearly described in the following table:

Table 1 Vector Autoregression Results

Lag 1	Lag 2
Vector Autoregression Estimates Date: 09/21/24 Time: 10:34 Sample (adjusted):2 17 Included observations: 16 after adjustments Standard errors in()&t-statistics in[] Determinant resid covatiance (dofadj.) 4.65046. Determinant residual covariance 1.0046 Log likelihood -938.2021 Akaike informationcriterion 119.7753 Black criterion 120.7410 Number of coefficients 20	Vector Autoregression Estimates Date: 09/21/24 Time: 10:35 Sample (adjusted):3 17 Included observations: 15 after adjustments Standard errors in()&t-statistics in[] Determinant resid covatiance (dofadj.) 3.6945 Determinant residual covariance 9.4643 Log likelihood -844.5722 Akaike informationcriterion 117.4096 Black criterion 119.1089 Number of coefficients 36

Source: Author's Processed Data, 2024

In Table 1. above, the VAR results show the Lag 1 AIC value of 119.7753 < Lag 2 AIC value of 117.4096 also shows that the past variable (t-1) contributes to the current variable, both to the variable itself and to other variables. The analysis results show that there is a reciprocal relationship between the variables. Next is the Impulse Response Function (IRF) analysis with the results described as follows:

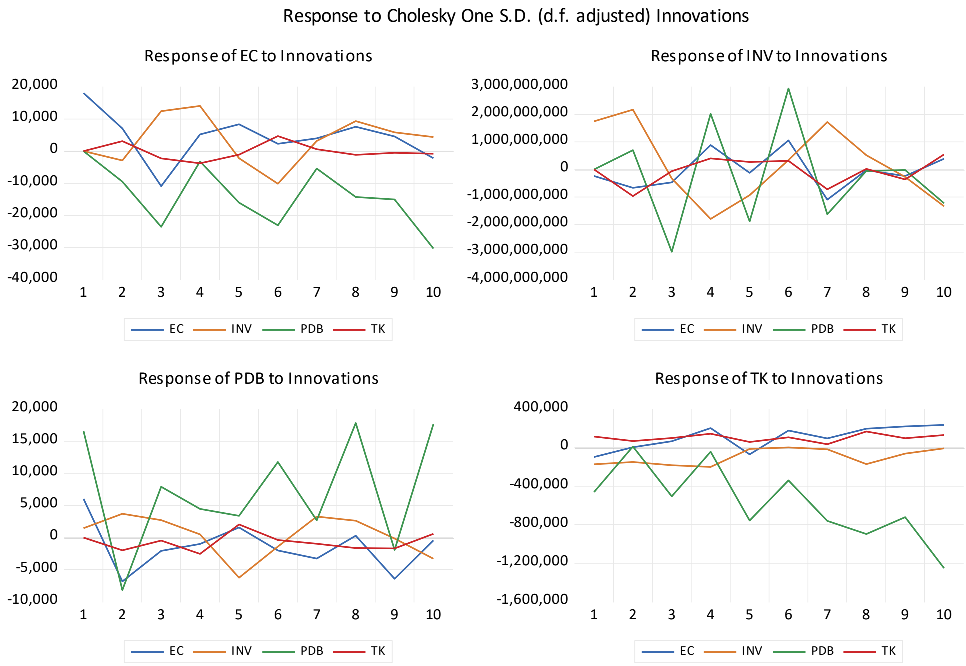
Table 2. Summary of Impulse Response Function (IRF) results

Response from EC: Period	E.C.	INV	GDP	Kindergarten
1	18077.21	0.000000	0.000000	0.000000
5	8334.137	-2228.959	-16026.73	-1096,582
10	-2223.395	4403.188	-30356.22	-831.1685
Response from INV: Period	E.C.	INV	GDP	Kindergarten
1	-2.40E+08	1.75E+09	0.000000	0.000000
5	-1.20E+08	-9.33E+08	-1.89E+09	2.74E+08
10	3.91E+08	-1.34E+09	-1.22E+09	5.48E+08
Response of PDB: Period	E.C.	INV	GDP	Kindergarten
1	6027.173	1441.535	16591.62	0.000000
5	1584.613	-6242.969	3387.346	2040.998
10	-433.3918	-3307.621	17693.61	583.4024
Response from TK: Period	E.C.	INV	GDP	Kindergarten
1	-96452.43	-173425.9	-460258.7	115852.1
5	-69442.91	-12565.50	-756772.9	58351.77
10	234833.4	-6911.388	-1250813.	131021.0
Cholesky Ordering: EC INV GDP TK				

Source: Author's processed data, 2024

Based on Table 2. Above, the results obtained state that the carbon emission variable is responded positively in both the short and medium term but in the long term it is responded negatively. Then for the green investment variable it is responded positively in the short term but in the medium and long term it is responded negatively. After that for the economic growth variable it is responded positively in both the short, medium and long term and for the workforce variable it is responded positively in the short, medium and long term.

Figure 2.Impulse Response Function (IRF) graph



Source: Author's processed data, 2024

Based on Figure 2 above, it is known that changes to one standard of division between variables can be responded to by other variables, namely carbon emissions, green investment, economic growth, and labor. The analysis in the figure above shows that the stability of the response of all variables is formed in the long term.short or period 1(one) and medium term or period 5(five) and long term or period 10(ten). Stable response stability is caused by the movement behavior between variables that are responded to by all variables almost the same as the movement in the short, medium and long term periods that have been analyzed. Next are recommendations for green economic transformation in driving green economic growth

Table 3. Green Economy Recommendations in Green Economic Growth

Period	GDP	Biggest 1	Biggest 2
Short-term	87.75%	GDP 87.75%	INV 98.15%
Medium term	72.20%	GDP 72.20%	INV 37.73%
Long-term	82.29%	GDP 82.29%	INV 32.25%

Source: Author's processed data, 2024

Table3. shows that the GDP variable itself is responsible as a green economy in driving green economic growth in the short, medium, and long term. Furthermore, GDP control is responsible for other variables that can be used to control short, medium, and long-term INV.

According to the analysis results*Forecast Error Variance Decomposition*(FEVD), there are many relationships between variables as a green economy in driving green economic growth. The most effective green economic variables on green economic growth are determined by this Forecast Error Variance Decomposition. Here is an example of a relationship as a green economic variable in driving green economic growth in Indonesia:

Table 4. Interaction of Green Economy in Driving Green Economic Growth

Variables	Green Economy in Driving Green Economic Growth				Period
	E.C.	INV	GDP	Labor	
Carbon Emissions	100.0%	0.00%	0.00%	0.00%	Short-term
	31.11%	19.28%	48.02%	1.57%	Medium term
	16.59%	14.77%	67.34%	1.29%	Long-term
Green Investment	1.84%	98.15%	0.00%	0.00	Short-term
	4.81%	37.73%	53.74%	3.70%	Medium term
	7.85%	32.25%	55.95%	4.16%	Long-term
GDP	11.58%	0.66%	87.75%	0.00%	Short-term
	15.02%	10.33%	72.20%	2.43%	Medium term
	9.95%	6.27%	82.29%	1.47%	Long-term
Labor	3.51%	11.36%	80.04%	5.07%	Short-term
	4.66%	9.87%	81.38%	4.07%	Medium term
	4.69%	3.10%	89.87%	2.32%	Long-term

Source: Author's processed data, 2024

: Largest 1

: Largest 2

Based on Table 4 above, it is known that all variables, namely carbon emissions, green investment, GDP and Labor, in the 1-year period (Short term), against shocks or changes in the model through the energy consumption variable are only influenced by carbon emissions themselves, namely (100.0%). In the 5-year period (48.02%) and the 10-year period (67.34%) it is more effective or can be used as a recommendation for taking through green economic control in driving green economic growth in the Carbon Emission variable. Furthermore, for green investment in the medium term period (19.28%) long-term funds (14.77%) can be used as a recommendation for taking through green economic control in driving green economic growth in the carbon emission variable. Furthermore, the Green Investment variable in the short term (98.15%) is more effective as a recommendation, then for the medium term (53.74%) and long term (55.95%) it is very effective to be used as a recommendation for taking through controlling the green economy in driving green economic growth in the green investment variable, then green investment can also be recommended both in the medium term (37.73%) and long term (32.25%) and is more effective for the investment variable itself. The green economy through the GDP variable obtained short, medium and long term results more effectively controlled by GDP itself, namely (87.75%), (72.20%), and (82.29%). Furthermore, the influence of the GDP variable is the carbon emission variable both in the short term (11.58%), medium term (15.02%) and long term (9.95%) can also be used as a recommendation in taking a green economy through controlling the carbon emission variable in the GDP variable. After that, for the labor variable that is influenced by the variable itself only in the long term (4.69%), then the more recommended is the GDP variable both in the short term

(80.04%), medium term (81.38%) and long term (89.87%) this is more effectively controlled by the labor variable. Then the green investment variable can also be recommended for the short term (11.36%) and medium term (9.87%).

CONCLUSION

Based on the analysis that has been done in Indonesia with the main focus on Green Economic Transformation in Driving Green Economic Growth in Indonesia with Vector Autoregression (VAR) analysis, the results of the VAR analysis used the lag 2 basis. Where according to the lag 2 basis, the contribution of each variable to itself and other variables can be seen clearly. Vector autoregression analysis also reveals that there is not only the influence of past variables (t-1) on the current variables, but the influence can also be felt both on the variables themselves and on other variables. Therefore, the results of the analysis confirm the existence of a significant reciprocal relationship between the various variables, illustrating the complexity and interconnectedness in the system. The results of the Impulse Response Function (IRF) test show that increasing carbon emissions provide a positive response in the short and medium term, but in the long term it is responded negatively. The Green Investment variable provides a positive response in various short terms, but there is a negative response in the medium and long term. From the GDP and Labor variables, it provides a positive response in both the short, medium and long term. Changes in one standard deviation variable between variables can be responded by other variables. Response stability is formed in the short term (period 1), medium term (period 5) and long term (period 10). Forecast Error Variance Decomposition (FEVD) analysis shows the relationship between variables and determines the most effective for green economy and economic growth, namely in the short term the variables of carbon emissions, green investment and GDP contribute significantly to temporary changes for the medium term, namely the GDP variable is more effective as a recommendation for green economy development and green economic growth. then for the long term, namely the most effective GDP variable involves carbon emissions, green investment and labor in the short, medium and long term. The overall results of FEVD provide in-depth insights for green economy development in driving green economic growth.

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