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DIGITAL ECONOMIC TRANSFORMATION IN SUPPORTING AND ACCELERATING ENVIRONMENTALLY FRIENDLY ECONOMIC GROWTH IN INDONESIA

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Abstract

This study investigates the relationship between digital economy factors and environmentally sustainable economic growth in Indonesia. Variables include Internet Users (IU), Carbon Emissions (CE), Green Investment (GI), Energy Consumption (EC), and Gross Domestic Product (GDP), using 2006–2024 World Bank data analyzed through the Vector Autoregression (VAR) method. Tests conducted include unit root, Johansen cointegration, impulse response (IRF), and variance decomposition (FEVD). Results show that internet usage significantly influences green investment, energy consumption, and GDP, especially in the long term. The positive impact of IU on GDP grows over time, highlighting the role of digitalization in improving efficiency and promoting green systems. While carbon emissions were initially driven by traditional activities like exports and energy use, they are increasingly shaped by digital economy growth and green investment. Energy consumption and green investment also demonstrate a two-way relationship with technology adoption and economic growth. The findings confirm that the digital economy can accelerate sustainable development. Leveraging technology, boosting green sector investment, and managing energy use effectively can help Indonesia achieve inclusive, low-carbon growth. Policy integration between digital transformation and green development is vital to expedite the country's progress toward the Sustainable Development Goals (SDGs).

Keywords: Digital Economy, Carbon Emissions, Green Investment, Energy Consumption, GDP, VAR, Sustainable Development

INTRODUCTION

In recent decades, the development of digital technology has brought significant changes to various aspects of life, including the economic sector. Economic digitalization not only creates efficiency in business and trade activities but also opens opportunities for more inclusive and sustainable economic growth. In Indonesia, digital economic transformation has become a key

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element in driving innovation and enhancing national competitiveness, particularly in the context of environmentally friendly development. Digital economic transformation can accelerate the implementation of green economy principles through various mechanisms. The utilization of digital technology enables energy efficiency, waste reduction, and the optimization of natural resources in production and distribution processes. For example, Internet of Things (IoT) and Artificial Intelligence (AI)-based systems can be applied to improve energy efficiency in the industrial and transportation sectors. In addition, the use of blockchain technology in supply chains can ensure the transparency and sustainability of raw materials used by industries, thereby promoting more environmentally responsible business practices

The number of internet users in Indonesia is projected to continue increasing in line with various government programs aimed at ensuring that all Indonesian citizens are digitally literate. The large internet user base in Indonesia has prompted the government to initiate the transformation of traditional systems into those utilizing digital technology. Such digital technology innovations are expected to position Indonesia on par with other countries that are shifting away from traditional methods toward the digital era (Wajuba et al., 2021). The following figure presents data on internet users, carbon emissions, and GDP in Indonesia from 2005 to 2023.

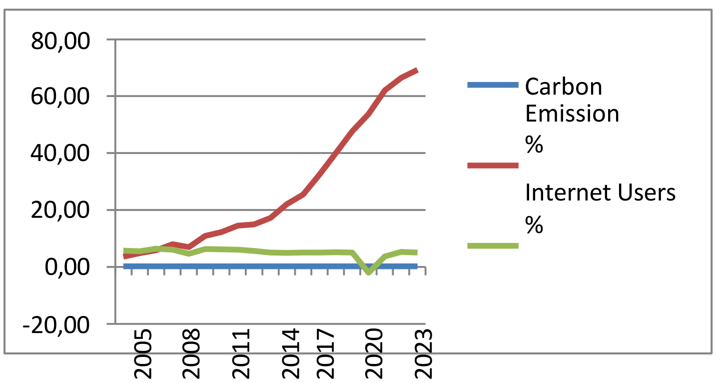


Figure 1. Carbon Emission Graph, GDP, and Internet Users 2005-2023 in Indonesia
Source: Author's Data, 2025

This graph illustrates the trends of three variables—carbon emissions, internet users, and GDP—in percentage terms from 2005 to 2023. The blue line, representing carbon emissions, exhibits a relatively flat pattern throughout the period, indicating that the percentage change in carbon emissions remained low without significant spikes. This may reflect efforts in emission mitigation or improvements in energy efficiency that kept emission levels under control despite changes in other factors. The red line, representing internet users, shows a very sharp upward trend, particularly since 2010. Over time, the number of internet users continued to grow exponentially, reaching approximately 70% in 2023. This rapid growth was likely driven by broader access to digital infrastructure, increased penetration of information and communication technology, and changes in societal behavior that increasingly relied on internet-based services across various aspects of life, including the economy, education, and social interactions. Meanwhile, the green line, representing GDP, displays a relatively stable pattern with minor fluctuations over the period. However, there was a noticeable sharp decline around 2020, most likely associated with the economic impact of the COVID-19 pandemic. Following this downturn, the graph shows a gradual recovery, reflecting the efforts of various sectors to restore economic stability in the post-pandemic period.

At the same time, the increasing use of the Internet in the economy presents promising opportunities, as unlimited, fast, and interactive access makes it easier for consumers to purchase the goods they need. The fundamental restructuring of the global economy is driven by the rapid growth of information and communication technology in the current era of digitalization, a phenomenon also experienced in Indonesia as a developing country with an open economic system. Moreover, technological advancements provide nations with opportunities to improve their economies. One of the key components influencing the overall well-being of society is economic growth. Due to significant economic differences in growth rates and growth patterns across the world, people in different countries experience varying standards of living. Numerous factors influence a country's economic growth, and technology plays a role in expanding employment opportunities (Simangunsong & Rozaini, 2023).

The digital economy offers new opportunities for sustainable growth as a result of globalization and increasing connectivity. The digital economic ecosystem is supported by technology-driven industries such as fintech and e-commerce. Growth in this sector creates new jobs and expands public access to financial services, education, and global markets. One of the positive impacts of the digital economy on green development is the emergence of the sharing economy and the circular economy concepts. Digital platforms enable communities to share resources, such as electric vehicles and co-working spaces, thereby reducing excessive consumption and lowering carbon emissions. In addition, digital technology accelerates the transition to renewable energy by supporting the integration of solar and wind power systems into the national grid through smart energy management systems.

One of the countries expected to undergo the most significant transformation is Indonesia, particularly in the economic sector. This means that Indonesia is committed to reducing carbon emissions by 29% before 2030. In 2019, the largest contributor to greenhouse gas emissions was the energy sector at 45.7%, followed by electricity at 35%, and transportation and industry each at 27%. The government continues to pursue economic and manufacturing progress while taking environmental considerations into account. It is expected that the development sector will contribute to reducing carbon emissions in Indonesia and encourage the transition toward a greener economy and more environmentally friendly green energy (Aisah et al., 2023).

Investment in green sectors, such as renewable energy, green transportation, and waste management, can help promote sustainable and environmentally friendly economic growth. Green economic growth supported by such investments can also yield significant benefits. Investment in green sectors and green economic growth are mutually reinforcing, as each positively influences the other (Wajuba et al., 2021). Green growth serves as a more sustainable and environmentally friendly alternative to conventional growth models. Green growth policies have been adopted by both developed and developing countries to mitigate the long-term negative impacts of business-as-usual economic growth caused by industrial projects. Industrial projects often utilize large quantities of certain substances in production processes that have environmental impacts. Moreover, excessive investment in natural resource–based sectors, if not accompanied by principles of transparency and accountability, can trigger ecological events that lead to increased social and environmental costs. Such outcomes would hinder the achievement of the 2030 Sustainable Development Goals (SDGs), which aim, among other objectives, to reduce the percentage of carbon emissions (Dewi Ayu Marchela Putri & Langgeng Rachmatullah Putra, 2024)

The implementation of a green economy can be observed through increased public and private investment in green sectors, growth in the quantity and quality of jobs within the green economy, an increase in GDP generated from green-sector employment, a reduction in energy or resource use per unit of production, a decrease in CO_2 emissions and pollution per unit of GDP, and a reduction in energy consumption that generates significant waste. Developing a green economy is designed to support countries in "greening" their economies through the formulation and targeting of policies, investments, and government spending toward sectors such as clean technology, renewable energy, green transportation, and sustainable agriculture and forestry (Rizka Fadillah et al., 2025). By optimizing the potential of the digital economy, Indonesia has a significant opportunity not only to enhance its competitiveness in the global economic era but also to realize more sustainable and environmentally friendly development. This transformation is not merely a necessity but also a strategic step toward ensuring an inclusive, efficient, and environmentally sustainable economic future.

LITERATURE REVIEW

Digital Economy

The transition toward a sustainable digital economy requires substantial investment and support in information and communication technology (ICT). Globally, governments and corporations are formulating strategies to harness the potential of this transformation to stimulate economic growth and generate new opportunities for individuals and businesses (Bakhri, 2020). The term "digital economy" generally refers to the influence of rapid advances in data and communication technologies on global socioeconomic conditions. It explores how innovation and technological progress shape economic activities—both in large and small markets—covering the creation, production, distribution, and delivery of goods and services in line with technological evolution (Kumala, 2022).

Environmentally friendly technologies, including renewable energy sources (solar, wind, bioenergy), waste management systems, and sustainable transportation, contribute to lowering carbon emissions and enhancing energy efficiency. Moreover, ICT tools such as big data, blockchain, and the Internet of Things (IoT) enable more transparent and efficient resource management, foster technological innovation, and stimulate industries that create green employment. The capital market also plays a crucial role in sustainable development by ensuring the effective allocation of capital (Nurmala Galuh Pramesthi et al., 2024)..

Green Economic Growth

The green economy system, also known as green growth, focuses on the relationship between natural ecosystems and human resources, based on technological and knowledge advancements. This system promotes rapid economic growth while reducing dependence on fossil fuels, thereby mitigating the effects of human economic activities on global warming and climate change. Under a new global agreement referred to as the "Global Green New Deal," the United Nations Environment Programme (UNEP) states that governments should support an economic shift from a primary focus on financial gain and welfare toward a green economy that places greater emphasis on environmental sustainability. The green economy is expected to address current environmental issues, particularly climate-related challenges. Maintaining the relationship between the economy and regions can provide various benefits, such as the revitalization and expansion of regional manufacturing industries and increased efficiency through more intensive trade and competition (Rany et al., 2020).

The green growth concept expands upon Solow's theory by highlighting the importance of incorporating environmental factors into economic growth models, such as minimizing pollution, optimizing the use of natural resources, and promoting investment in renewable energy. Since its inception, green growth theory has underpinned economic policies in many countries committed to sustainable and eco-friendly development. Integrating this framework with other economic theories allows for a more holistic evaluation of policy impacts on both internal and external balances, as well as environmental outcomes, thereby guiding the creation of strategies that foster sustainable and inclusive economic growth (Aprillia et al., 2024).

Green economic growth in Indonesia is defined as an economic development model that supports sustainable development by focusing on investment, capital, infrastructure, employment, and skills to achieve sustainable social and environmental well-being. This approach is further refined to enhance economic growth while prioritizing environmental preservation and societal welfare (Adolph, 2016). The concept of green growth and environmentally friendly practices can provide insights into how to stimulate a country's economic growth while benefiting from relatively strong financial performance (Rusiadi & Djannah, 2024).

Energy Consumption

Energy is a crucial component of economic activity, and almost all economic activities in Indonesia today involve it in one or more aspects. If left uncontrolled, energy use—especially from non-renewable sources—can exacerbate environmental degradation. Environmental exploitation during resource extraction and air pollution during processing are inevitable. Therefore, renewable energy must play a role in supporting the economy through the implementation of a green economy (Firmansah, 2023). Energy consumption plays a vital role in supporting economic growth. It is a fundamental input for nearly all economic activities, from industrial production to transportation and household use. Rapid economic growth is often accompanied by increased energy consumption, as higher levels of economic activity require more energy to sustain operations and expansion. However, rising energy consumption also presents significant environmental challenges, particularly when the energy comes from non-renewable and polluting sources. Greenhouse gas emissions from the combustion of fossil fuels, for example, are a major contributor to global climate change (Lutfiatun Qoriah et al., 2025).

Carbon Emissions

Carbon emissions refer to the release of carbon compounds such as carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4) into the Earth's atmosphere. These emissions originate from various human activities, including the combustion of carbon-containing compounds for production processes, the burning of fossil fuels for electricity generation and transportation, and deforestation. Carbon emissions contribute to the greenhouse effect (GHG), which in turn leads to climate change across all regions of the world. This phenomenon directly affects the environment as well as economic stability. Research has shown that carbon emission disclosure has a positive impact on a company's financial and operational performance. Companies are therefore required to pay greater attention to their relationship with environmental sustainability, rather than focusing solely on economic performance (Maulidio et al., 2024).

Rising consumption and production have driven significant CO_2 emissions, negatively affecting human life, economic stability, and social well-being. Advances in information and communication technology (ICT) have accelerated decarbonization (DE), marked by innovation, broad adoption, and global dissemination, reshaping economic structures, competition, and resource allocation—though its environmental impact remains uncertain. DE supports low-carbon development through improved government oversight, corporate transformation, and integration of data and technical resources to enhance CO_2 monitoring and governance. It also fosters green innovation, boosts production and carbon efficiency, and drives the transition to a low-carbon economy. However, the surge in digital activities such as cloud computing and cashless payments has increased energy demand, with projections indicating that the ICT sector's share of global emissions could rise from 1%–1.6% in 2007 to over 14% by 2040, making digital technology a growing source of CO_2 emissions (Wang et al., 2024).

Green Investment

Green investment is essential to prevent environmental damage caused by environmentally unfriendly economic activities, including non-green investments. However, the growth of green investment in Indonesia remains slow. In addition to renewable resources, Indonesia still heavily relies on non-renewable resources. Due to its high dependence on non-green investments, Indonesia still struggles to increase the use of green investments. The government has made various efforts to promote green investment, such as through green programs and legislation, but the funds allocated for green investment are smaller than those allocated for non-green investment. The government must implement appropriate green policies so that green investment in Indonesia can grow well (Pramana & Dewi, 2023). Green investment is a long-term, sustainable, and socially responsible investment model. At present, Indonesian legislation on green investment has provided legal guarantees to prospective investors, particularly in the Investment Law and the Presidential Regulation on the General Investment Plan. However, this is considered not yet fully implemented (Sari & Setiyono, 2022).

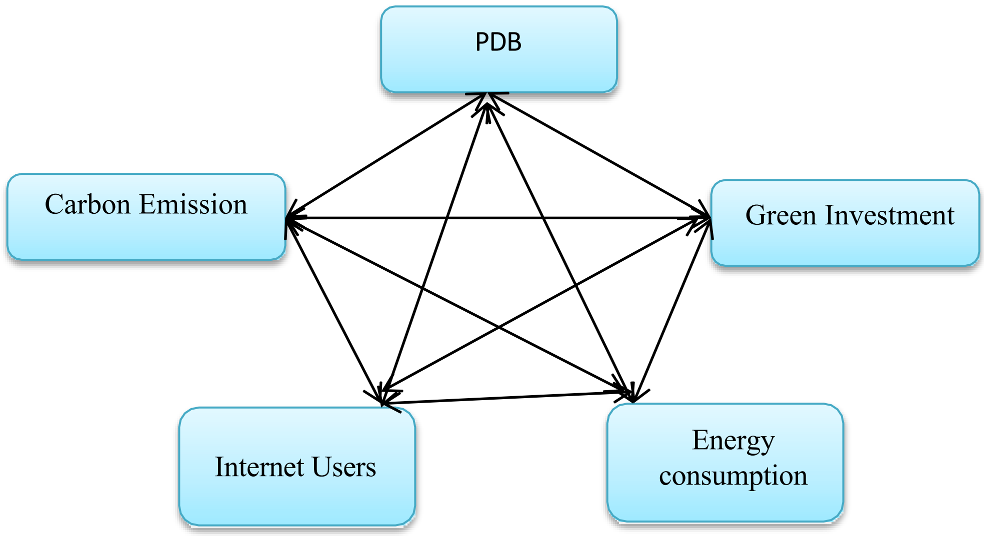
Economic Growth

One of the main focuses of a country's economy, especially in the long term, is economic growth, which is defined as the growth of per capita output over a longer period of time. According to the neoclassical or Solow growth theory, economic growth depends on technological development, labor, and capital. Although considered exogenous, technology is one of the components that drive a country's economic growth. Technology is highly important for a nation's social life. Communication technology is particularly vital. At present, technology can meet society's need for information. The digital economy, also known as the "digital economy," is one area that may have the capacity to drive economic growth closely related to technology (Duwi Wahyuningtias et al., 2019). Economic growth is a long-term issue, and the world has recently witnessed an important phenomenon. Modern growth is defined as a process of increasing per capita output over the long term, which means that an increase in per capita output will improve welfare while providing more options to purchase goods and services as well as enchancing the purchasing power of the economy (Sri Hartati, 2021).

Internet Users

Internet users have changed the way they shop. For example, they have begun choosing to shop online rather than in person, driven by the variety and convenience of available products. Through digital platforms, small businesses can reach a wider market thanks to the internet, but they still face challenges in terms of access and competition. People who frequently access the internet tend to have access to bank accounts, loans, and investments. In addition, internet usage increases public awareness of financial products through the provision of online information (Baroto, 2024).

Vector Autoregression Conceptual Framework



Hypothesis

H1: Energy consumption, carbon emissions, green investment, PDB, and internet users have a significant effect on the digital economy.

H2: Energy consumption, carbon emissions, green investment, PDB, and internet users have a significant effect on green economic growth.

RESEARCH METHODOLOGY

This method employs EViews and VAR for analysis. According to Manurung (2009), if there is indeed simultaneity among several variables, it is not possible to distinguish which are endogenous variables and which are exogenous variables. Therefore, the VAR method can be used to examine the simultaneous relationships and the degree of integration among variables in the long term. Based on the above statement, the author employs this method to empirically and more comprehensively demonstrate the long-term reciprocal relationships. The equation model used in applying the VAR technique is as follows:

$PDB_t = \beta 10 PDB_{t-p} + \beta 11 INV_{t-p} + \beta 12 EC_{t-p} + \beta 13 CO2_{t-p} + \beta 14 PG_{t-p} + et1$ $INV_t = \beta 10 PDB_{t-p} + \beta 11 INV_{t-p} + \beta 12 EC_{t-p} + \beta 13 CO2_{t-p} + \beta 14 PG_{t-p} + et1$ $EC_t = \beta 10 PDB_{t-p} + \beta 11 INV_{t-p} + \beta 12 EC_{t-p} + \beta 13 CO2_{t-p} + \beta 14 PG_{t-p} + et1$ $CO2_t = \beta 10 PDB_{t-p} + \beta 11 INV_{t-p} + \beta 12 EC_{t-p} + \beta 13 CO2_{t-p} + \beta 14 PG_{t-p} + et1$ $PG_t = \beta 10 PDB_{t-p} + \beta 11 INV_{t-p} + \beta 12 EC_{t-p} + \beta 13 CO2_{t-p} + \beta 14 PG_{t-p} + et1$

Where :

PDB/GDP = Gross Domestic Product (GDP) (%)

INV = Green Investment (US $)

EC = Energy Consumption (US $)

CO_2 = Carbon Emissions (%)

PG = Internet Users (Percentage%)
et = Random Shock (*random disturbance*)
p = Long Again

Model *Impulse Response Function* (IRF)

Ariefianto (2012) stated that the Impulse Response Function (IRF) traces the impact of shocks, or disturbances, to a variable on the system over a certain period of time. According to Manurung (2005), the IRF is a measure of the direction of movement of a transmission variable as a result of changes in other transmission variables. The purpose of IRF analysis is to determine whether each transmission variable is cointegrated in both the short term and the long term.

Model *Forecast Error Variance Decomposition* (FEVD)

Forecast Error Variance Decomposition (FEVD) is conducted to determine the relative importance of various shocks to a variable itself as well as to other variables. According to Manurung (2005), FEVD analysis aims to identify the influence or contribution among transmission variables. The FEVD equation can be derived and illustrated as follows:

EtX t + 1 = A0 + A1X1

his means that the values of A0 and A1 are used to estimate future values Xt + 1 Et Xt+n = et + n + A1

2et+n-2 +....................... + A1

n-1 et+1

This means that the FEVD value is always 100 percent, and a higher FEVD value indicates a greater contribution of the variance of one transmission variable to another transmission variable.

Unit Roots Test

The Augmented Dickey-Fuller (ADF) unit root test is used to examine the stationarity of the data. When the DF and ADF statistics, which represent the t-statistic values of the autoregressive coefficient, are calculated, it can be determined whether the time series data used contain unit roots (non-stationary) or are free from unit roots (stationary). If the DF value is greater than the critical value in the MacKinnon table, it indicates acceptance of H0, or stationarity. The estimation results show that all variables are at the first-difference stage, as indicated by ADF statistic values lower than the critical values and supported by significant ADF probability values.

Johansen Cointegration Test

The purpose of this test is to determine whether there is a long-term relationship in the analysis model. Therefore, regression at the level stage will not produce a valid regression if the variables used are cointegrated. The cointegration test is also used to determine whether the residuals are stationary. The ADF will be used to estimate this test.

RESULTS AND DISCUSSION

Results of the Unit Root Test

The following is table 4.1 which is the unit root test using the augmented Dickey-Fuller (ADF):

Table 1. Unit Root Test with *Augmented Dickey Fuller* (ADF)

Variable	Augmented Dickey Fuller	
	t-statistic	Stasioneritas
Carbon Emissions	**0.0052*** **	**1 (I)**
Green Investment	**0.0049*** **	**1(I)**
Energy Consumption	**0.0031*** **	**1(I)**
PDB	**0.0326*** **	**1(I)**
Internet Users	**0.0001*** **	**2(II)**

Source: Data analysis, eviews 10

Note: ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

Results of the Johansen Cointegration Test

Table 2. Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.980890	142.9607	69.81889	0.0000
At most 1 *	0.914073	75.68261	47.85613	0.0000
At most 2 *	0.634961	33.96026	29.79707	0.0157
At most 3 *	0.517351	16.82850	15.49471	0.0313
At most 4 *	0.230063	4.444597	3.841466	0.0350

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.980890	67.27813	33.87687	0.0000
At most 1 *	0.914073	41.72235	27.58434	0.0004
At most 2	0.634961	17.13177	21.13162	0.1659
At most 3	0.517351	12.38390	14.26460	0.0971
At most 4 *	0.230063	4.444597	3.841466	0.0350

Source: Data analysis, eviews 10

Table 2 above shows that the results of the cointegration test using the Johansen method are lower than the critical value. The trace statistic value and the maximum eigenvalue statistic at r = 0 are lower than the critical value. This indicates that there is no cointegration. The results suggest that the cointegration among the variables of Carbon Emissions, Green Investment, Energy Consumption, GDP, and Internet Users has a stable and consistent relationship.

Table 3. Results of Lag 1 and Lag 2 Test

Vector Autoregression Estimates LAG 1	
Akaike information criterion	94.68723
Schwarz criterion	96.17118
Number of coefficients	30
Vector Autoregression Estimates LAG 2	
Akaike information criterion	91.23501
Schwarz criterion	93.93070
Number of coefficients	55

Source: Data analysis, eviews 10

The optimal lag length is determined using the Schwarz Criterion (SC) and Akaike Information Criterion (AIC), with lower values indicating a better fit. As shown in Table 3, the AIC at lag 2 (93.93079) is lower than at lag 1 (65.32997), suggesting that lag 2 is more suitable. Consequently, the subsequent analysis will employ lag 2. The next stage involves evaluating the VAR model's stability through the lag structure stability test, as illustrated in the following table and figure.

Table 4. Results of Lag Structure Stability Test

Roots of Characteristic Polynomial
Endogenous variables: PI EK IH KE PDB
Exogenous variables: C
Lag specification: 1 2
Date: 07/29/25 Time: 19:07

Root	Modulus
0.991979 - 0.171615i	1.006715
0.991979 + 0.171615i	1.006715
0.150059 - 0.912644i	0.924898
0.150059 + 0.912644i	0.924898
-0.812392	0.812392
-0.237285 - 0.765716i	0.801639
-0.237285 + 0.765716i	0.801639
0.404390 - 0.662198i	0.775911
0.404390 + 0.662198i	0.775911
-0.629117	0.629117

Warning: At least one root outside the unit circle.

VAR does not satisfy the stability condition.

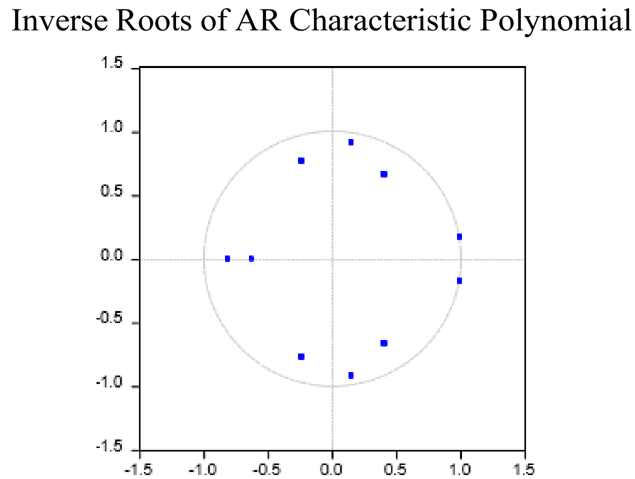


Figure 3. Inverse Roots Graph of AR Characteristic Polynomial Source: Data Analysis, Eviews 10

As shown in Table 4 and Figure 3, the modulus root values are all below 1, with the roots positioned inside the circle. This confirms that, based on the Roots of the Characteristic Polynomial and the Inverse Roots of the AR Characteristic Polynomial, the model is stable.

Impulse Response Function (IRF) Results

The IRF measures how one variable responds to shocks in another variable over different time horizons. The summary table below outlines the impact of changes in one variable on another across various periods.

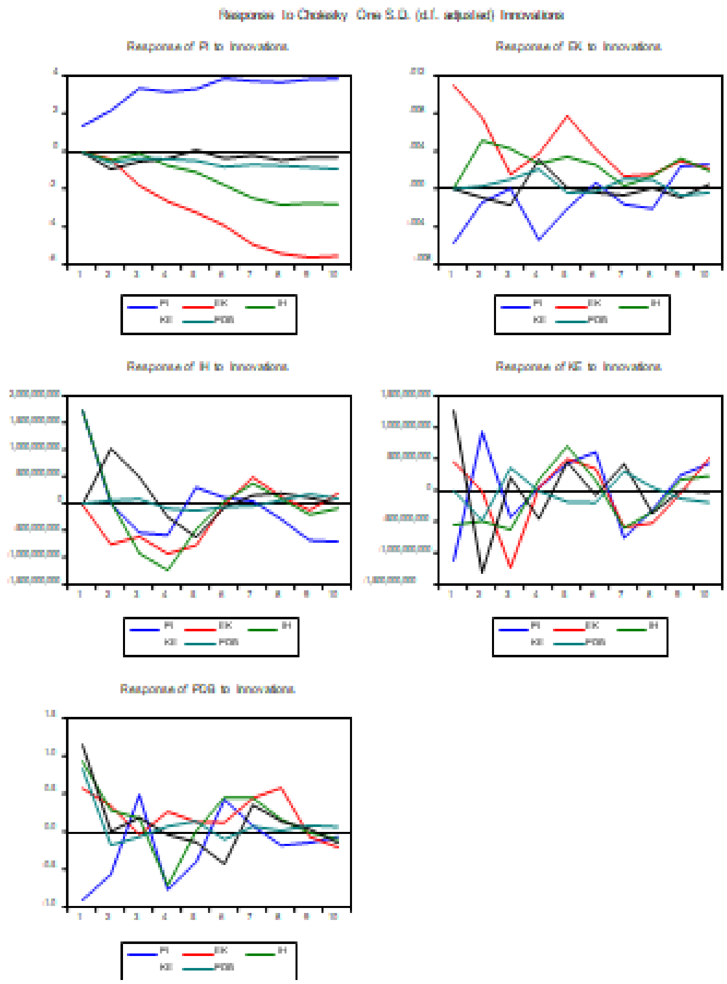


Figure 4. Impulse Response Function (IRF) Graph Source: Data analysis, Eviews 10

Based on the impulse response function graph, it can be observed that each variable responds differently to shocks from one another. When a shock occurs in the Internet Users (PI) variable, the Carbon Emissions (EK) and Energy Consumption (KE) variables exhibit sharp fluctuations at the beginning of the period before starting to stabilize. GDP shows a relatively consistent increase in response to shocks in PI and Green Investment (IH), although it experiences some fluctuations. The response of IH to other shocks also displays a dynamic up-and-down pattern, while the response of PI to other variables such as EK and KE tends to fluctuate but moves toward stability in the long run. Overall, the relationships among the variables indicate indirect effects and dynamic movements over time.

The following

Table 5. presents the results of the impulse response function (IRF) model, which can be explained as follows:

Period	Short Term (Period 1)	Medium Term (Period 5)	Long Term (Period 10)
KE it self	1.27%	4.43%	47.88%
Biggest 1	KE 1.27%	4.43%	4.78%
Biggest 2	PDB 0.84%	PDB 0.134%	PDB 0.055%

Source: Data analysis, Eviews 10

Based on the table, the largest contribution to the Energy Consumption (KE) variable comes from itself, which increases over time. In the short term (period 1), KE is influenced by itself by 1.27%, then rises to 4.43% in the medium term (period 5), and increases significantly to 47.88% in the long term (period 10). The second largest contributor is the GDP variable, which has an influence of 0.84% in the initial period, but its contribution decreases in the medium and long term, to 0.134% and 0.055%, respectively.

Results of the Forecast Error Variance Decomposition (FEVD) Model Test

Table 6. Digital Economic Interaction in Supporting and Accelerating Environmentally Friendly Growth

Variable	**Table 4.7 Digital Economic Interaction in Supporting and Accelerating Environmentally Friendly Growth**					Period
	PI	EK	IH	KE	PDB	
Internet users	100.00%	-	-	-	--	Short term
	61.79%	32.23%	2.80%	2.00%	1.16%	Medium term
	36.92%	50.10%	11.14%	0.58%	1.24%	Long term
Carbon Emissions	21.87%	78.12%	-	-	-	Short term
	17.21%	62.93%	14.88%	3.48%	1.47%	Medium term
	18.49%	59.78%	16.65%	3.2%	1.82%	Long term
Green Investment	49.61%	0.09%	50.37%	-	-	Short term
	27.52%	17.54%	41.86%	12.80%	0.26%	Medium term
	31.56%	17.48%	38.43%	11.96%	0.55%	Long term
Energy Consumption	36.63%	6.26%	9.23%	47.85%	-	Short term
	24.46%	20.01%	14.18%	37.32%	4.16%	Medium term
	27.80%	22.53%	14.89%	30.32%	4.43%	Long term
PDB	20.77%	8.46%	21.50	31.87%	17.37%	Short term
	34.31%	8.87%	23.61%	21.14%	12.04%	Medium term
	30.17%	14.67%	24.19%	21.11%	9.84%	Long term

Source: Processed data by the author, 2025

: Biggest 1

:Biggest 2

The table shows the contribution or interaction among variables within the framework of the digital economy that supports and accelerates environmentally friendly growth, observed over three time periods: short term, medium term, and long term. In the short term, the internet users variable is entirely influenced by itself, at 100 percent, without contribution from other variables. Moving into the medium term, the self-influence decreases to 61,79 percent, while the contribution of carbon emissions increases substantially to 32,23 percent. Green investment, energy consumption, and GDP begin to exert influence, although small, at 2, 80 percent, 2,00 percent, and 1,16 percent, respectively. In the long term, the influence of carbon emissions becomes dominant over internet users, at 50,10 percent, while self-influence declines to 36,92 percent. Green investment rises to 11,14 percent, whereas energy consumption and GDP continue to provide low contributions. The findings of this study align with previous research, indicating that abundant resources have the potential to drive digital economic growth, with one key factor supporting Indonesia's internet economy being its large number of internet users. While the growth of Indonesia's digital economy offers many benefits, it also poses challenges for the government, particularly in developing policies to ensure that technological advancement does not entirely replace human labor with automated systems (Purba et al., 2025).

Access to internet services has a monumental impact on economic growth, enabling business transformation and reshaping global interactions through rapid information access, online collaboration, and efficient business operations (Lela et al., 2023). In the short term, carbon emissions are most influenced by their own contribution (78.12%), with internet users contributing 21.87%. In the medium term, carbon emissions' contribution decreases to 62.93%, while other factors, such as green investment (14.88%), begin to play a role. In the long term, the pattern remains relatively stable, with carbon emissions still dominant at 59.78%, followed by green investment (16.65%), internet users (18.49%), and small contributions from energy consumption and GDP. Previous studies also indicate that severe environmental damage in Indonesia has recently led to climate change, largely attributed to greenhouse gas emissions from mining industry activities, often blamed for exploiting natural resources excessively (Hariswan et al., 2022). Information technology can have both positive and negative impacts on the environment—while electricity consumption from IT use can increase CO_2 emissions, information sharing can also help reduce them (Moddilani & Irwandi, 2021). Initially, green investment is driven almost equally by its own contribution (50.37%) and internet users (49.61%), showing that digitalization provides a strong initial push. In the medium term, internal influence decreases to 41.86%, while internet users still contribute significantly (27.52%), with energy consumption (12.80%) and exports (17.54%) starting to play a role. In the long term, green investment remains dominant (38.43%), followed by internet users (31.56%), energy consumption (~12%), and carbon emissions (~17%). This supports earlier findings that in the rapidly evolving digital era, financial technology (fintech) significantly impacts various sectors, including investment, by accelerating access, expanding financial inclusion, and facilitating sustainable investment transactions (Pratama et al., 2025). Energy is a crucial component of economic progress, and it is impossible to separate energy from economic growth.

The level and scale of energy openness and consumption are shaped by economic growth conditions, and by identifying energy consumption turning points, this study examines the relationship between energy use and economic growth, illustrating the energy Kuznets curve (Ulfa & Efendi, 2024). The digital economy can deepen capital production structures and expand business opportunities using innovative technologies, though inherent risks require special attention. Increased efficiency calls for multidisciplinary expertise between the digital economy and green finance, making it essential for educational institutions to develop relevant training programs. By promoting sustainable lifestyles and adopting green technologies, the digital economy can create a more dynamic and environmentally friendly market (Septrianti & Miftahuddin, 2024). In the short term, energy consumption is most influenced by itself (47.85%), followed by internet users (36.63%). In the medium term, carbon emissions (20.01%) and green investment (14.18%) play greater roles, though energy consumption still leads (37.32%). In the long term, energy consumption stabilizes, with self-influence declining to 30.32%, internet users maintaining strong influence (27.80%), and increases in exports and green investment, while GDP's influence remains small. This aligns with previous studies showing that digital businesses can collect climate change data, share solutions and technologies to reduce carbon emissions, and identify new business opportunities to mitigate environmental damage (Maulidio et al., 2024). High consumption levels can boost GDP, reflecting healthy economic growth, driving production, job creation, and household income, while also strengthening investor confidence due to strong domestic demand. In the short term, GDP is influenced relatively evenly by various factors, with energy consumption (31.87%) and green investment (21.50%) being the largest contributors (Rusiadi et al., 2024).

In the medium term, internet users dominate (34.31%), while green investment and energy consumption contribute 23.61% and 21.14%, respectively. In the long term, the pattern is similar, with internet users still dominant (30.17%), green investment increasing to 24.19%, energy consumption at 21.11%, exports rising to 14.67%, and GDP's self-influence declining to just 9.84%. This is consistent with prior research highlighting that green investment aims to sustain economic and social well-being, ensure proper governance, and serve as a regulatory and economic driver for sustainable growth (Rosyid & Mulatsih, 2024). Economic growth can be achieved through a balance between population growth, increased productive capacity, and investment availability (Sidiq & Rizqi, 2023). Expanding internet access has significantly boosted the e-commerce sector, creating new opportunities for online trade and digital business growth, while the adoption of financial technology and digital financial services promotes financial inclusion, broadening access to financial services for previously underserved communities and contributing to economic growth in Indonesia (Lela et al., 2023).

CONCLUSION

Based on the results of the IRF and FEVD analysis, it can be concluded that the interaction among variables within the framework of digital economic transformation plays a crucial role in supporting and accelerating environmentally friendly economic growth in Indonesia. Initially, the internet user variable (PI) is entirely influenced by itself; however, in the medium and long term, contributions from other variables such as carbon emissions (EK), green investment (IH), and energy consumption (KE) begin to have a significant impact. This indicates that digitalization does not progress in isolation but also drives dynamics across other sectors. Digital economic transformation plays a vital role in fostering environmentally friendly economic growth in Indonesia, with internet users (PI) serving as a key factor in strengthening the role of green investment (IH), energy consumption (KE), and carbon emission reduction (EK). Over time, PI's influence on other variables, particularly GDP, becomes more prominent. Carbon emissions, which were initially dominated by external factors, begin to be affected by digitalization and green investment, while energy consumption and IH show strong interconnections with digital development. Overall, the digital economy has proven capable of accelerating sustainable economic growth through energy efficiency, green investment, and emission control.

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