

Original Article

Analysing the Effect of Climate Change and Green Stocks on Economic Growth: Evidence from Indonesia and Malaysia

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Abstract: Contemporary economic growth shows a direct correlation between energy consumption and productivity. As economic development and technological advancements enhance living standards, the demand for natural resources and energy has concomitantly increased. This investigation examines the impact of climate change and green stocks on economic growth and the causal relationships among these variables in Indonesia and Malaysia over short- and long-term periods. Climate change has resulted in a downward trend in economic growth fluctuations, underscoring the necessity for green finance to mitigate the effects of climate change. The study employs the Autoregressive Distributed Lag (ARDL) model and Granger Causality test, analysing data on carbon emissions, green stocks, and gross domestic product from 2016-2022 (quarterly). The findings indicate that, in the short term, only green stocks positively influence economic growth in Indonesia and Malaysia. In the long run, climate change and green stocks positively affect economic growth in these countries. Economic growth demonstrates a unidirectional causal relationship with climate change, whereas climate change exhibits a unidirectional causal relationship with green stocks. This implies that green stock can mitigate climate change risks in Indonesia and Malaysia. It is recommended that the central bank consider implementing an environmentally sustainable financial system to promote economic growth.

Keywords: Climate change; Economic growth; Green stock; Autoregressive Distributed Lag approach



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1. Introduction

Today's economic growth has a direct energy-productivity relationship. As the cycle of economic growth and technological progress improves living standards, the demand for natural resources and energy increases. However, as long as energy comes from fossil fuels that produce carbon emissions, atmospheric concentrations of carbon dioxide and other greenhouse gases will increase, and climate breakdown will worsen (Rezai et al., 2018). Economic growth experiences significant changes from the many factors that influence it. Fluctuations in economic growth are influenced by external factors such as climate change,

which impacts the global stock market. Climate change is also a serious problem that affects economic growth in Indonesia and Malaysia (Naeem et al., 2021). In principle, mitigation efforts can generate energy without carbon dioxide emissions and other greenhouse gases. Mitigation efforts also impact employment levels and income distribution. Therefore, through sustainable investment, such financing can boost a country's economic growth. The world agreed to the Paris Agreement in December 2015, committing governments worldwide to work together to preserve and protect the planet from the catastrophic effects of climate change (Khan et al., 2020). Climate change can cause a decline in agricultural production and impact economic growth. One indicator of climate change is temperature and rainfall. Changes in temperature and rainfall patterns can disrupt the process of plant growth, causing production to decline (Boakye & Paper, 2014). Climate change is closely related to the economy, so there is a need for policies that can suppress climate change.

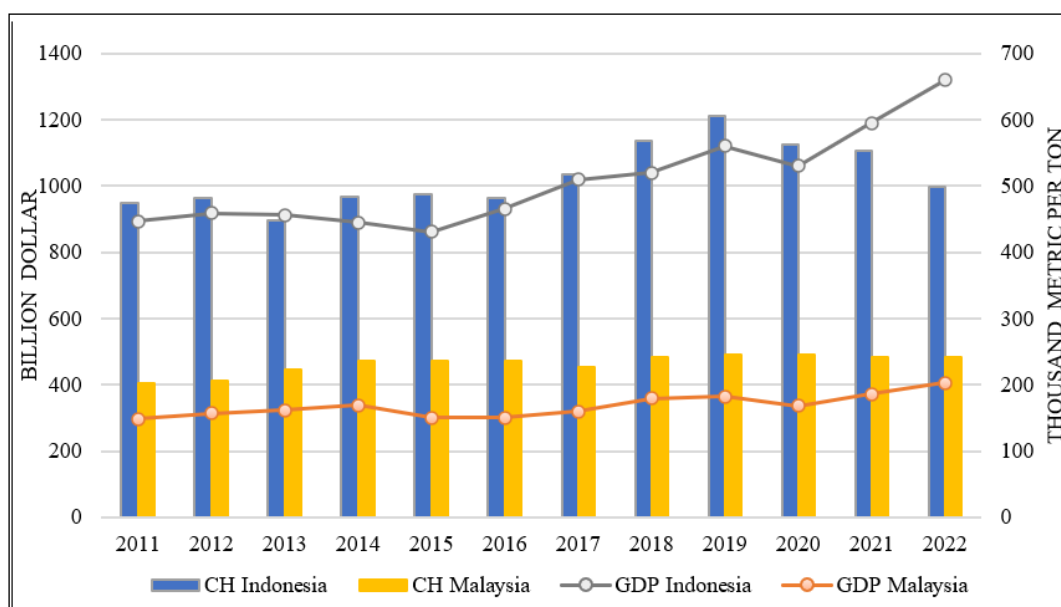


Figure 1. Gross Domestic Product and Climate Change in Indonesia and Malaysia for 2011-2022

Source: World Bank (2023)

Figure 1 shows that Indonesia and Malaysia's gross domestic product development fluctuates. Each country experiences different increases in real GDP, but when climate change is highest in 2019, the impact of real GDP in the following year tends to decrease. When climate change decreases in 2022, real GDP experiences a significant increase. This shows that climate change can affect economic activity. Climate change can reduce the economic output of the two countries as climate change affects the prospects for trade and economic development in Indonesia and Malaysia. Climate change reduces agricultural production and impacts economic growth. Extreme weather can disrupt supply chains, damage transport infrastructure necessary for the trade of goods, and limit the scope of people's ability to conduct economic activities. Based on Figure 1, Indonesia is the country that experiences the highest climate change for the period 2011-2022. If this condition is left unchecked, it will impact economic growth, which will be unbalanced (Ardiaa et al., 2021). Therefore, the government issued a policy to reduce the rate of climate change by implementing sustainable economic growth. Policy expenditures are made by investment for additional costs for the government today to generate savings in the future so that economic growth continues to increase.

Sustained economic growth is costly, so the investment can help with government spending. Investment is the main driver in increasing economic growth (Akpokerere, 2024). Such investments through the stock market can provide long-term funding focused on curbing climate change (Trisnowati et al., 2022). The stock market used in this study is the Green Stock Index. This green stock is a benchmark for investors who have good performance in running their business according to ESG (Environment, Social, and Good Governance) principles. Green stocks are issued as one of the innovations of green financial instruments. Innovations that have been implemented for environmentally friendly funding. The number of green stock issuances continues to increase yearly, and the green stock index is well-developed (Sakuntala et al., 2022). This shows how quickly developed and developing countries are paying attention to environmental damage that can disrupt economic balance.

Adaptation to climate change is inevitable, especially in developing countries where the adaptation deficit is often larger than in developed countries (Bhave et al., 2016). Research results Park & Jang (2021) show that institutional investors prioritise environmental and governance factors over social ones. Performance in innovation is very important for global success, so innovation is necessary to increase economic growth. Nasir & Zhang (2024) research investigated the relationship between GII (Global Innovation Index), input, output and efficiency with creative performance. Conceptualising prosperity regarding ecological sustainability, social inclusion, and quality from a global perspective can increase economic growth in every country that implements economic sustainability (Fritz & Koch, 2016). Reducing the impact of damage due to climate change on financial asset prices and the financial position of companies and banks must be carried out to improve the economy (Dafermos et al., 2018).

Green stocks continue to increase to create an environmental balance that controls climate change. Economic growth can also increase with environmentally friendly financing. Therefore, green stocks can reduce energy costs and increase efficiency (Ardiaa et al., 2021). Mitigation can potentially reduce the growth rate, whereas decarbonisation of energy generation can avoid carbon emissions and reduce the negative impacts of climate change triggered by growth. Therefore, climate change, green stocks and economic growth are interrelated. Therefore, everything is interconnected and influences economic growth. The transition to a green economy requires expensive investments. To overcome these obstacles, the government can utilise the capital market to obtain additional funds from investors interested in green assets (Ning et al., 2022). Capital markets can mobilise funds to achieve sustainable development goals.

Thus, this study identified that no study looks at the relationship between climate change and economic growth in Indonesia and Malaysia in the long term or short term. Indonesia and Malaysia are developing countries that already have green stocks. This research focuses on these two countries because green stocks owned by Indonesia and Malaysia continue to grow rapidly so that these two countries can reduce climate change. Indonesia's economy is rich in natural resources, including petroleum, natural gas, and coal. The mining and plantation sectors are significant contributors to the country's economy. Malaysia's economy is showing resilience and performing strongly. Growth is running above potential, fuelled by strong global demand for electronics and better terms of trade for commodities, such as oil and gas. If both countries experience increased climate change, it will impact the economy as it may reduce the supply of goods in Indonesia and Malaysia. This makes it urgent to investigate appropriate policies to reduce the impact of climate change and economic growth. Also, this research aims to prove empirically that green investment through green stocks has a very important role in developing environmentally friendly technology so that it can increase sustainable economic growth and prevent environmental damage. Therefore, this research is novel. It aims to fill the gap in previous literature and prove the relationship between climate change, green stocks, and economic growth in Indonesia and Malaysia.

2. Materials and Methods

2.1. Materials

This study analyses the influence of climate change and green stocks on economic growth in Indonesia and Malaysia. This research focuses on these two countries because green stocks owned by Indonesia and Malaysia continue to grow rapidly so that these two countries can reduce climate change. This research is included in quantitative research to analyse the influence between independent and dependent variables to answer this research question in the problem formulation. The scope of this research includes the dependent variable, namely economic growth, while the independent variables consist of climate change and green stocks. Climate change is proxied in carbon emissions, green stocks of the two countries, Indonesia and Malaysia, and economic growth seen from total gross domestic product. Indonesia and Malaysia are the objects of research. This research uses secondary data in the form of quarterly data and panel data consisting of two countries during the 2016-2022 period. The data used is secondary data sourced from each country's World Bank and the Stock Exchange.

2.2. Methods

The data analysis method used in this research is the Autoregressive Distribution Lag (ARDL) analysis method. The ARDL model is a method in econometrics that can estimate any linear regression model when analysing long-term relationships, including cointegration tests between the variables to be estimated. Using the ARDL approach requires a lag, namely the time required for a reaction to occur due to a movement and a decision to be concluded from the results. The short-term model can be tested once the cointegration test results are confirmed. Silva et al. (2018) suggest that with the help of the ARDL model framework, the

parameters in the estimation of short-term time period relationships can become stable, and the coefficients in the long-term time period estimation can become very stable on a small scale. The ARDL approach is a model type of approach that has been widely used by several researchers who have studied previously. The first condition for using the ARDL method is that the data must be stationary at the level or stationary at the first difference, and it is not recommended to be stationary at the second difference only (Wang & Huang, 2022). Pattern measurements and ARDL versions can simultaneously accurately examine residuals and problems with endogenous variables. According to Khan et al. (2020), the model can be used in the ARDL approach to test short-term and long-term relationships (see equation 1 and 2)

$$\Delta Y_t = \beta_0 + \sum_{t=1}^p \beta_1 \Delta Y_{t-1} + \sum_{t=1}^p \delta_1 \Delta X_{t-1} + \varphi_1 Y_{t-1} + \varphi_2 X_{t-1} + \varepsilon_t, \quad (1)$$

To explain the variables of economic growth, climate change, and green stocks in this research. Based on equation (1) above, the ARDL equation model is as follows:

$$\Delta GDP_t = \beta_0 + \sum_{t=1}^p \beta_1 \Delta GDP_{t-1} + \sum_{t=1}^p \delta_1 \Delta CH_{t-1} + \sum_{t=1}^p \delta_2 \Delta GS_{t-1} + \varphi_1 GDP_{t-1} + \varphi_2 CH_{t-1} + \varphi_3 GS_{t-1} + \varepsilon_t, \quad (2)$$

Where GDP is economic growth in billion dollars, CH is climate change in thousand metrics per ton, and GS is green stock in point. , GDP_{t-1} is the value of the ratio of gross domestic product at t-1 ; CH_{t-1} is the value of the climate change at t-1 ; GS_{t-1} is the value of the green stock at t-1; β_0 is constant ; $\beta_1, \delta_1, \delta_2$ are short-run coefficients ; $\varphi_1, \varphi_2, \varphi_3$ are Long term coefficients ; ε_t is error correction term.

3. Results

3.1. Stationary Test

When processing time-series data, the initial step in determining a model from this data is known as a data stationarity test or unit root test. If the mean remains constant over time or if the data exhibit stability, the data are considered to have a stable mean. Preliminary steps were undertaken prior to conducting the ARDL test. The stationarity test employs the unit root test, specifically the common unit root test.

Table 1. Result of Stationary Testing

Variable(s)	Levels	First Difference
GDP	Stationary	-
Log (CH)	Not Stationary	Stationary
GS	Stationary	-

Table 1 shows the GDP and GS are stationary at level I(0) while CH is stationary at the first difference (1).

3.2. Cointegration Test

The cointegration test in this study uses the Kao (Engle-Granger) test. The results of the Kao test show that cointegration has occurred.

Table 2. Result of Cointegration Testing

Cointegration Test	Statistics	Prob.
ADF	1.9722	0.0243
Residual Variance	26.3001	
Group ADF-Statistics	40.5191	

Table 2 displays that all variables in this study show that they have long-term or short-term relationships or experience cointegration. The next step after the cointegration test is analysing the ARDL model formed either in the short or long term.

3.3. Long-Term Estimation

The results of estimating ARDL have obtained two models to describe the relationship between variables in the short and long term. Table 3 regresses the estimation results using the long-term ARDL method. The results of the long-term estimation in the model can be depicted in Table 3 below.

Table 3. Result of ARDL Estimation in Long Term

Variable(s)	Coefficient	Std. Error	t-statistics	Prob.
Log (CH)	27.968	6.4419	4.3415	0.0001
GS	0.3496	0.0894	3.9068	0.0003

Table 3 shows the long-term estimation results. The result indicates that climate change positively and significantly influences economic growth in the long term. Climate change has a regression coefficient value of 27,968 and a probability of $0.0001 < 0.05$, which means that if climate change increases the value by 1 thousand metric per tons, economic growth will increase by 27,968 billion dollars. Meanwhile, green stocks positively and significantly influence economic growth in the long term. Green stocks have a probability of less than 0.05, which is 0.0003 and has a regression coefficient of 0.3496. This shows that climate change and green stocks are important in maintaining stable economic growth. This study's results align with the research of Barberà *et al.* (2023), who stated that climate change can affect economic growth. To support sustainable economic development as evidenced by increased economic growth, it must be balanced with increased issuance of global green stock financing issues to reduce the negative impacts of climate change in Indonesia and Malaysia (Agustia *et al.*, 2022).

3.4. Short-Term Estimation

Climate change and green stocks also have a short-term relationship with economic growth in Indonesia and Malaysia. The results of the short-term ARDL estimation analysis can be seen in Table 4 as follows:

Table 4. Result of ARDL Estimation in Short-Term

Variable(s)	Coefficient	Std. Error	t-statistics	Prob.
D(GDP(-1))	0.6088	0.00422	144.257	0.0000
D(GS)	0.0384	0.018402	2.0893	0.0428
D(GS(-1))	0.0057	0.003883	1.4818	0.1458
DLOG(CH)	192.5532	178.1475	1.0808	0.2859
DLOG(CH(-1))	-111.364	114.1976	-0.9751	0.3351
COINTEQ01	0.0986	0.100259	0.9838	0.3308

Table 4 indicates that the results estimate ARDL in the short term to illustrate the short-term relationship between the variables studied. In general, green stocks influence economic growth in the short term. Green stocks show a positive and significant influence on economic growth in the long term and short term. A coefficient value in the regression of 0.0384 and a probability of $0.0428 < 0.050$ means that an increase of 1 point in green shares will increase economic growth by 0.0384 billion dollars. If green shares increase, it will increase financing to suppress climate change so that it can impact the economy. This shows that green stocks are important in boosting economic growth in Indonesia and Malaysia. Based on the estimation results, it can be seen in Table 4 that it is concluded that climate change has a positive and insignificant effect on economic growth in the short term. This interprets that climate change in the short term cannot affect the economy. Climate change continues to increase in the long term. It will disrupt the economy, so there is a need for policy regulations to suppress climate change so that economic growth in Indonesia and Malaysia remains stable. Increased economic growth occurs during climate change because international trade processes increase (Fitrah & Soemitra, 2022). When every country tries to suppress climate change but must meet its survival needs, countries that do not have a supply of raw materials due to extreme climate change will experience international trade so that economic growth can increase. This climate change has a very negative impact on economic growth.

3.5. Causality Test

The Granger causality test is an analysis method that describes whether variables are related (have a two-way relationship) or only have one direction. The causality test is designed to see how the past influences the current situation, so the data used is time series data (Yii & Geetha, 2017). The presence or absence of a causal relationship can be tested with an F-test or confirmed with probability.

Table 5. Result of Granger Causality Testing

Hypothesis	F-Statistic	Prob.
LCH does not Granger Cause GDP	0.93960	0.398
GDP does not Granger Cause CH	3.89175	0.0273
GS does not Granger Cause GDP	0.46231	0.6327
GDP does not Granger Cause GS	2.17095	0.1254
GS does not Granger Cause LCH	1.94186	0.1548
LCH does not Granger Cause GS	4.28479	0.0195

Table 5 shows that after testing the variables that have a causal relationship, the variables have a probability value smaller than the alpha value of 0.05. Therefore, it can be seen from Table 5 that GDP significantly influences CH with a probability of $0.0273 < 0.05$, but CH does not significantly influence GDP with a probability of $0.3980 > 0.05$. It can be concluded that CH and GDP only have a one-way causal relationship. Meanwhile, GS and GDP do not have a causal relationship. CH has a one-way causal relationship with GS because CH can influence GS with a probability of 0.0195, meaning that CH and GS have a significant one-way causal relationship. The relationship between climate change, green stocks, and economic growth is related, so if one of these variables is not controlled, it will impact the economy. This climate change occurs naturally, but human activities can also produce climate change. Burning fossil fuels such as coal, gas and oil (Reddy, 2015). Therefore, all human activities must prevent environmental damage to protect the earth and preserve the environment. The interrelationship between these research variables will impact the progress of economic growth in Indonesia and Malaysia.

4. Discussion

This study found that economic growth in Indonesia and Malaysia can increase towards sustainable and environmentally friendly economic growth. The existence of environmentally friendly investments such as green shares can increase investors' willingness to invest their shares to protect the environment. Investment in the form of green shares has a positive impact on economic growth as well as a good impact on the environment. The estimation results that green stocks support economic growth theory which emphasises increasing technological innovation, are also supported by research from Sakuntala *et al.* (2022) and Pertiwi *et al.* (2020), who mentioned that foreign investment affects the economies of Indonesia and Malaysia. The existence of technological innovation in the form of a green stock market based on ESG means that companies producing goods and services still pay attention to environmental balance. Research by Park & Jang (2021) shows that institutional investors prioritise environmental and governance over social factors. Economic growth in Indonesia and Malaysia can improve by paying attention to environmental sustainability so that the productivity of natural resources is not disrupted (Hassan *et al.*, 2019). If resources do not work efficiently, the economy in Indonesia and Malaysia can worsen.

Research by Fang *et al.* (2021) provide empirical evidence that green industrial stocks in the Chinese stock market, have higher average returns. The green risk factor significantly captures excess stock returns after controlling for firm characteristic, institutional, and economic risk factors. Research by Nasir *et al.*, (2019) shows that the results of economic growth, financial development and FDI lead to increased environmental degradation. Meanwhile, research by Loiseau *et al.*, (2016), monetary policy and global uncertainty influence green stocks using the ADRL model. Extreme climate change can reduce the supply of raw materials, damage infrastructure due to weather, and even tourism will also decrease (Khan *et al.*, 2019). In this condition, every country will carry out international trade to continue to meet its needs so that the exchange of export and import goods continues to occur despite high climate change (Mangunjaya, 2015). Research by Rasiyah *et al.* (2018) Climate change has had a huge impact on the economy of ASEAN countries. Climate change is a big problem in the balance of environmental ecosystems which can affect economic growth in every country. Climate change and green stocks on economic growth in Indonesia and

Malaysia. The results of this research can become a policy reference so that sustainable economic growth can maintain sustainability in Indonesia and Malaysia.

5. Conclusions

This study concludes that climate change and green stocks affect short- and long-term economic growth. In the long term, climate change and green stocks positively affect economic growth in Indonesia and Malaysia. In the short term, climate change has a positive and insignificant effect, while green stocks have a positive and significant effect on economic growth in Indonesia and Malaysia. This research has a causal relationship between the independent and dependent variables. Climate change and economic growth have a one-way causal relationship. Climate change and green stocks have a one-way causality relationship. Green stocks and economic growth have no causal relationship. As the controller of monetary policy, central banks must be wise in controlling a sustainable financial system that prioritises environmental sustainability in increasing economic activity. Apart from that, stock exchanges in Indonesia and Malaysia continue to increase green stocks to develop and increase economic growth efficiently.

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