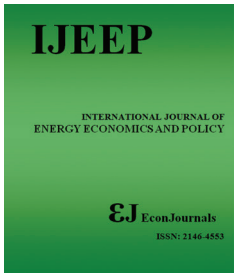
Suriani, Suriani; Masbar, Raja; Agustina, Maulidar et al.

Article

Do Global Green Sukuk affect on climate change? : evidence in issuing countries

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Suriani, Suriani/Masbar, Raja et. al. (2024). Do Global Green Sukuk affect on climate change? : evidence in issuing countries. In: International Journal of Energy Economics and Policy 14 (1), S. 98 - 107. https://www.econjournals.com/index.php/ijeep/article/download/14987/7653/35752. doi:10.32479/ijeep.14987.



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2024, 14(1), 98-107.

Do Global Green Sukuk affect on Climate Change? Evidence in Issuing Countries

Suriani Suriani*, Raja Masbar, Maulidar Agustina, Athalla Daffa Khairul

Faculty of Economics and Business, Universitas Syiah Kuala, Indonesia. *Email: suriani@unsyiah.ac.id

Received: 11 July 2023 **Accepted:** 24 November 2023 **DOI:** https://doi.org/10.32479/ijeep.14987

ABSTRACT

Uncertain climate change as a result of technological developments, often has a negative impact on the environment. This is shown by the number of carbon emissions that are continuously increasing. As a sovereign country, the issuing country of Green Sukuk Global strives to increase investment to support a sustainable development process. This study aims to analyze the effect of green finance, specifically on global green sukuk, on the adverse effects of climate change. Using time series data in four issuing countries (from January 2018 until December 2022) with an autoregressive distributed lag in the panel model approach. The findings show that in the long and short term, global green sukuk can reduce the adverse effects of climate change in the issuing country. However, economic growth affects increasing carbon emissions in the issuing country in the long term, while trade openness has no effect on climate change. To support sustainable economic development as evidenced by increased economic growth, it must be balanced with increased issuance of global green sukuk financing issues to reduce the adverse effects of climate change in issuing countries.

Keywords: Green Economy, Climate Change, Global Green Sukuk, Economic Growth, Trade Openness
JEL Classifications: C33, E44, F43, G31, Q01, Q56.

INTRODUCTION

Maintaining sustainable development can be achieved through eco-friendly development methods. The seventeen Goals targets, which take into account the priorities of each existing indicator, unequivocally demonstrate that each nation has sustainable development goals. Several countries around the world have begun to fully support the development of infrastructure projects and all sectors with environmentally friendly funding (*green finance*) in order to ensure that the macroeconomy as a whole is better protected against climate change, which is uncertain and does not support economic growth (Oktaviani et al., 2011).

A substantial investment is required to achieve the goal of a green economy (Niyazbekova et al., 2021; Chang and Fang, 2023; Naeem et al., 2021), especially for renewable energy initiatives. As a result of this issue, stakeholders are encouraged to develop financial instruments with the main objective of funding projects that promote sustainable development (SDGs). Issuing green financial instruments such as Green Sukuk is one of the environmentally friendly funding innovations that has been implemented (Grahesti et al., 2022; Fitrah and Soemitra, 2022; Suherman et al., 2019). The number of issuances each year, which keeps rising in four issuing nations and one multilateral development bank (Indonesia, Malaysia, Saudi Arabia, and the UAE), demonstrates how quickly the global green sukuk market has grown. Malaysia was the first country to issue Green Sukuk in 2017. Then followed by Indonesia in 2018, the United Arab Emirates, and Saudi Arabia in 2019.

Indonesia dominates the issuance of global green sukuk (international standard). The Indonesian government's dedication to preventing the detrimental effects of climate change is proven by its ratification of the Paris Agreement through Law No. 16/2016. This commitment requires a large amount of funds. However, over the years 2018-2020, Indonesia was able to fulfill this

commitment. This is reinforced by Ramadhan and Wirdyanigsih (2020), which state that Indonesia, as the country with the largest Muslim population, has the potential to lead the world in funding ecologically environmentally friendly projects by issuing the first sovereign green sukuk.

Green sukuk studies are in the spotlight because they are one of the green funding innovations that support a green economy in the process of sustainable development (Musari, 2022; Pathan et al., 2022; Rahman and Hanife, 2022; Boukhatem, 2022; Ramadhan and Wirdyanigsih, 2020; Anindito Mujizat, 2021; Risanti et al., 2020; Abdullah and Nayan, 2020; Fitrah and Soemitra, 2022). In order to achieve the SDGs with adequate consideration for the environment and to realize a better economy in the future, Suwanan et al. (2022) emphasize the significance of continuing sustainable development from the MDGs to SDGs.

The macroeconomy is the main factor that is anticipated to support changes in every economic activity engaged in by each country (Alves et al., 2020; Ausloos and Lambiotte, 2007). Exchange rate policy, trade openness, inflation, and economic growth in the issuing country. The difference between this study and previous research is the inclusion of environmental indicators as proxies for changes in environmental conditions or climate change as the dependent variable. The goal of this study is to determine whether Global Green Sukuk can help to reduce carbon emissions brought on by environmentally harming technological advancements.

This study was conducted with the goal of addressing a worldwide problem, specifically the sustainable future of environmentally friendly development. Disaster prevention due to climate change, which threatens the existence of the global population. The implementation of a green economy demands significant funding. One of the financial instruments offered by a number of nations globally is the global green sukuk, which is used to finance specific development activity projects that adhere to environmentally friendly standards (low carbon emissions). Despite being relatively new, Indonesia's sovereign global issuance of Green Sukuk has been spread throughout many issuance periods, and demand for Green Sukuk around the world is growing every year. Therefore, specific research is required to assess the impact of this green financial instrument (global Green Sukuk) on sustainable development.

2. LITERATURE REVIEW

2.1. Green Finance and Sustainable Development

Green finance is a form of financing that is used to increase financial flows (from banking, micro-credit, insurance, and investment) from the public, private, and non-profit sectors which are prioritized for sustainable development (Adamowicz, 2022). It can be interpreted that green financing is an investment made to support development by taking into account environmental aspects. This green financing activity has become a global movement to facilitate and allocate resources through sustainable investment so that it can protect and improve the environment in the midst of economic development (Ng, 2018). In contrast to traditional financing, green financing places an emphasis on environmental conservation and benefits (Wang and Zhi, 2016). The growth of green financing is consistent with the public's increasing awareness of the value of environmental preservation in the process of environmentally friendly economic development, or sustainable development (SDGs).

Green financing consists of the issuance of green loans, green securities, and green investments that can be applied to promote sustainable development, such as the development of energy-efficient technologies, utilization of energy-saving resources, transition to clean energy consumption, implementation of environmentally friendly business processes, and reduction of hazardous waste (Zhou and Li, 2022). In carrying out green financing to support sustainable development, the involvement of institutions is crucial, both government and private institutions, to ensure the effective implementation of green financing and sustainable development, in line with the expected outcomes.

Research by Ronaldo and Suryanto (2022) explains that green finance has a big role in achieving the SDGs in the category of environmental sustainability and economic sustainability. This green finance can promote green technology and green micro businesses that lead to the achievement of the SDGs through environmental sustainability and economic sustainability. In addition, Wang et al. (2022) assessed the causal relationship between green finance and sustainable development on a global scale using a bootstrap rolling window granger causality test. Empirical results show that green finance has a positive impact on sustainable development in several sub-periods.

Cui et al. (2020) proved that the integrity of the green financial system has a positive impact on sustainable development. To uphold this integrity, cooperation is required among the government, financial institutions, companies, and consumers. Wang and Wang (2021) conducted a study in China using the grey correlation analysis method to empirically test the relationship between green finance and industrial structure improvement in China. The study employed the GMM method to determine the direction and level of impact of green finance on industrial structure improvement in China. The results of this study indicate that China's green finance has a strong effect on the tertiary industry and leads to rapid development, which drives the improvement of the industrial structure. The steps in green finance policy, such as enhancing green technology innovation, strengthening green finance cooperation and reserves, providing professional training in green finance, and implementing green financial infrastructure, are crucial in promoting sustainable development.

The research conducted by Azad et al. (2022) demonstrates that the central bank of Bangladesh has made significant achievements in greening the country's financial system through the implementation of green policies and regulatory measures. The total achievement of the targets set by the central bank and non-bank financial institutions (NBFIs) is 3.16% out of the 5% target for green financing and 9.32% out of the 20% target for sustainable finance. However, these figures still fall short of the SDGs (Sustainable Development Goals) that need to be achieved by 2030.

The research conducted by Ibrahim et al. (2022) in China, using the ARDL method, reveals that renewable energy and technological innovation are fundamental factors that cannot be ignored if other indicators are to generate the desired and consistent economic growth while supporting sustainable development. Another study by Zhou and Li (2022) in China, also utilizing the ARDL method from 1986 to 2019, demonstrates that green finance and renewable energy have a positive relationship with sustainable development and a negative relationship with carbon emissions in China.

2.2. Global Green Sukuk and the Environment

Indonesia launched sovereign green sukuk in 2018 to finance green projects that contribute to addressing climate change and achieving the Sustainable Development Goals. This issuance also marked the world's first sovereign green sukuk. Since then, Indonesia has issued five sovereign green sukuk and mobilized $3.23 billion from these issuances. The funds raised from these green sukuk have been directed toward five eligible sectors: sustainable transportation, energy efficiency, renewable energy, waste-to-energy and waste management, and climate resilience for disaster-prone areas (Anindito Mujizat, 2021).

In recent years, the world has realized the importance of a healthy environment in reducing natural disasters. Consequently, green bonds were introduced in 2007, followed by the issuance of green sukuk in 2017. Malaysia took the lead in issuing green sukuk and issued ten green sukuk in 2020 (Liu and Lai, 2021). Subsequently, Indonesia took the initiative to issue five green sukuk in 2018. Additionally, Saudi Arabia issued two green sukuk, and the United Arab Emirates also issued two green sukuk in 2019 (Rahman and Hanife, 2022). The issuance of green sukuk in various sectors of sustainable development in the issuing countries can bring about changes for stakeholders, particularly the government, to enact new policies and regulations that support environmentally friendly development. The issuance of green sukuk in various sectors of sustainable development in the issuing countries may impact stakeholders, especially the government, to implement new policies and regulations that promote environmentally friendly development.

Previous research on Green Sukuk has examined various aspects. Abdullah and Nayan (2020) discuss suitable contracts for green sukuk issuance and the available project categories to instill confidence and enhance investor trust in green sukuk financing. It is important to consider fund instability concerning energy consumption (Safi et al., 2021).

The relationship between CO_2 emissions and economic growth provides the rationale for policy choices that aim to reduce emissions by imposing constraints on economic growth. Considering the fact that there is a two-way causality, as economic growth increases or decreases, CO_2 emissions are further stimulated at higher or lower rates, and as a result, emission reduction potential should have an adverse impact on economic growth (Mardani et al., 2019).

Another study examining the dynamic causal relationship between economic growth, carbon emissions, and energy consumption for 116 countries during the period 1990-2014 at the regional and global levels was conducted by Acheampong (2018). The results of the study explain that: First, at the global and regional levels, economic growth does not cause energy consumption. Second, with the exception of the global and Latin America-Caribbean region, economic growth does not have a causal impact on carbon emissions. However, economic growth negatively affects carbon emissions at the global and Latin America-Caribbean levels. Third, carbon emissions positively cause economic growth. Fourth, energy consumption positively causes eco-economic growth in sub-Saharan Africa while negatively affecting economic growth globally, in the Middle East and North Africa (MENA), the Asia-Pacific, and Latin America-Caribbean. Fifth, energy consumption positively causes mobile carbon emissions in MENA but negatively affects carbon emissions in sub-Saharan Africa and Latin America-Caribbean. Finally, except for MENA and the global sample, carbon emissions do not cause energy savings. This confirms that the impact of energy consumption can vary across countries. Another study related to the environmental aspects of carbon emissions was conducted by Pao and Chen (2019), which explains that carbon emissions have an equilibrium relationship with economic growth.

2.3. Trade Openness, Environment, and Economic Growth

Every nation strives to achieve high economic growth since it improves the social well-being of the nation (Mensah, 2019). Trade openness is one factor that can stimulate economic growth in the long term. According to Adam Smith in the Ricardian model, trade openness can increase per capita income if a country specializes in an area where labor productivity is high (Ichvani and Sasana, 2019). In terms of specialization, especially in products traded through open trade, the level of growth obtained through open trade is determined. Huchet-Bourdon et al. (2018) explain that trade openness has a negative impact on economic growth for countries specializing in low-quality products.

In addition to directly affecting a country's economic growth, open trade activities also have an impact on the environment. According to Wang and Zhang (2021), trade openness can reduce carbon emissions in high- and upper-middle-income countries. However, different findings were observed in a study conducted by Jun et al. (2020) in China, which showed that trade openness has increased pollution in the country. Open trade activities can increase foreign export volumes in line with the growth of domestic industries, leading to an increase in carbon emissions.

3. RESEARCH METHODS

This study examines green financing for sustainable development processes in global green sukuk issuing countries. The focus of this research is on global green sukuk instruments issued by four countries (Indonesia, Malaysia, Saudi Arabia, and UAE) from their initial issuance in 2017 until 2022, using monthly data. The indicators of macroeconomic variables such as exchange rates and inflation limit the scope of this study, considering environmental conditions (carbon emissions) and economic growth.

The type of data used in this study is secondary data obtained from official institutions. The data utilized includes time series and cross-sectional data. Hence, the data used in this research is panel data from the four countries under investigation. Specifically, the data were obtained from relevant institutions, such as the Asian Development Bank (ADB) for global green sukuk data, the World Bank for carbon emissions data, and the central banks (BI and BPS) for economic growth, exchange rates, inflation, and trade openness data. These four nations were chosen as the research objects because they have issued a total of 11 global green sukuk from 2017 through the present (2022).

The Autoregressive Distributed Lag (ARDL) model was employed for regression analysis in this study. The regression analysis in this study is separated into two parts: the first addresses the research objectives using ARDL regression, and the second tests the causal linkages. The initial form of the ARDL equation is derived from research conducted by Zaretta and Yovita (2019).

$$\Delta Y_t = \beta_o + \sum_{i=1}^{n} \beta_1 \Delta y_{t-1} + \sum_{i=0}^{n} \delta_1 \Delta x_{t-1} + \varphi_1 y_{t-1} + \varphi_2 x_{t-1} + \mu_t \quad (1)$$

Where β_1 and δ_1 are Short-term Coefficients; ϕ_1 and ϕ_2 are Long-term ARDL Coefficients; and μ_t is the Disturbance error. Then, the Equation (1) model in this study is formulated as the Panel ARDL Model as follows:

$$\Delta EV_{it} = \alpha + \sum_{i,t=1}^{p} \delta_1 \Delta EV_{it-1} + \sum_{i,t=1}^{p} \delta_2 \Delta EG_{it-1} + \sum_{i,t=1}^{p} \delta_3 \Delta GS_{it-1} + \sum_{i,t=1}^{p} \delta_4 \Delta TO_{it-1} + \varphi_1 EV_{it-1} + \varphi_2 GS_{it-1} + \varphi_3 INF_{it-1} + \varphi_5 TO_{it-1} \quad (2)$$

Where *EV* is the environment (a proxy for carbon emissions), *EG* is economic growth, *GS* is global Green Sukuk, and *TO* is trade openness (a proxy for net exports). The testing stages conducted in this modeling include the data stationarity test, cointegration test, lag selection test, and regression of ARDL in panel data.

4. RESULTS AND DISCUSSION

4.1. Unit Root Test Re

The Augmented Dickey-Fuller (ADF), Phillips Peron (PP), and Levin, Lin and Chu (LLC) testing methods were used in this study to test stationarity (unit root) (Phillips and Perron, 1988). These methods were utilized for determining the unit roots of the observed variables in the study. Table 1 shows that the four observed variables in this study (EV, GS, EG, and TO) do not have unit roots and are stationary at the first difference. This indicates that the values of these variables do not tend to develop continuously and are not impacted by prior trends. Stationarity in this context refers to the fact that these variables' means, variances, and covariances remain constant across time. As a result, the variables EV, GS, EG, and TO in this study fulfill the stationarity assumption, and further cointegration testing can be performed (Syczewska, 2010).

4.2. Cointegration Test Result

The Kao cointegration test was used in this study to check whether there was a cointegration relationship between the variables. Table 2 reveals that the null hypothesis (H_0), which states no cointegration between the series, is rejected with a 5% significance level (evidenced by the probability value of 0.0319). This suggests that the variables under examination have a strong cointegration relationship. Cointegration is a long-term interaction in which the variables move together over time, showing a mutual dependence or equilibrium. In the context of this study, the cointegration analysis results show that EV, GS, EG, and TO exhibit a consistent pattern of movement in the long run. Accordingly, it is expected that changes or deviations in one variable will be compensated by corresponding changes in the other variables, maintaining their equilibrium relationship. In other words, variables are cointegrated, indicating that they share a long-term trend or equilibrium. As a result, further estimations can be conducted.

4.3. Lag Length Test Results

Lag testing is performed to determine the ideal lag length for the analysis before conducting the Panel ARDL (Autoregressive Distributed Lag) test. The lag length refers to the number of past time periods included as explanatory variables in the model. Lag testing is crucial to prevent problems with the model, such as autocorrelation and misspecification. We can accurately do the analysis and capture the important dynamics by choosing a suitable lag length. Based on the Akaike info criterion (AIC) as shown in Figure 1, the chosen lag in this study is ARDL (1, 2, 2, 2), which means that the current values of the variables are influenced by their values in the prior time period.

4.4. Panel ARDL Estimation Test Result

The panel ARDL model, applying the pooled mean group (PMG) method, assumes the presence of cointegration, necessitating the separate utilization of co-integration and unit root tests in panel data (Bergheim, 2008; Zaidi and Saidi, 2018). The PMG method demonstrates consistent and asymptotic properties in estimating two types of variables: stationary variables with

Figure 1: Lag length test results

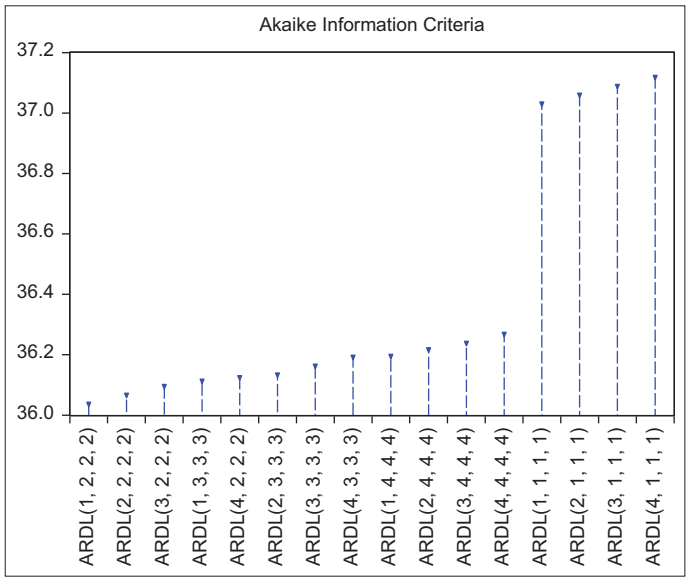


Table 1: Unit root test results

Variable	ADF test		PP test		LLC test	
	Statistic	P*	Statistic	P*	Statistic	P*
Level I(0)						
EV	3.735	0.880	5.151	0.741	0.159	0.563
GS	3.932	0.863	2.862	0.943	1.008	0.843
EG	1.681	0.989	0.843	0.999	1.141	0.873
TO	7.286	0.506	2.770	0.948	0.147	0.558
1st difference I (1)						
EV	18.390	0.018**	18.707	0.016**	−3.231	0.0006***
GS	36.251	0.000***	65.115	0.000***	−3.634	0.0001***
EG	14.234	0.076*	14.538	0.068*	−2.667	0.0038**
TO	14.338	0.073*	14.148	0.078*	−0.105	0.4583

*Significance at the 10% level, **Significance at the 5% level, ***Significance at the 1% level. ADF: Augmented Dickey-Fuller, PP: Phillips Peron, LLC: Levin, Lin and Chu, EV: Environment, TO: Trade openness, GS: Green sukuk, EG: Economic growth

I(0) and nonstationary variables with I(1) (Asteriou and Hall, 2007; Peiris and Saxegaard, 2007). The PMG method not only allows for estimating the long-term relationship among cointegration variables but also provides an error correction coefficient, ensuring the existence of long-term equilibrium. The lagged error correction coefficient measures how dependent variables adjust to changes in independent variables in order to converge toward their equilibrium (Apostolidou et al., 2014). The analysis results using panel ARDL in this study can be seen in Table 3.

Based on the panel ARDL estimation in Table 3, several conclusions can be drawn. First, in the long run, economic growth (EG) has a positive and significant impact on the environment (EV), as proxied by carbon emissions, at a 1% level of significance (0.0000 < 0.01) collectively in Indonesia, Malaysia, Saudi Arabia, and the UAE. These findings suggest that a rise in economic growth in these countries will result in an increase in carbon emissions in the long run. According to the findings, economic growth in these countries contributes to environmental degradation, as evidenced by increasing carbon emissions. The evidence shows that growth-related economic activities including industrial output, transportation, and energy consumption increase carbon emissions. In turn, these emissions lead to climate change and degradation of the environment. This research is supported by Schröder and Storm (2020), which demonstrates that an increase in economic growth will lead to an increase in carbon emissions. While in the short run, economic growth (EG) does not have a collective impact on the environment (EV), as proxied by carbon emissions, in Indonesia, Malaysia, Saudi Arabia, and the UAE. However, interestingly, Table 4 reveals different results when estimating the impact separately for each country. In Indonesia, Malaysia, Saudi Arabia, and the UAE, EG with a lag of D(EG) has a negative and significant effect on EV at a 1% level of significance (0.0000 < 0.01). This indicates that a rise in economic growth will result in a short-term decrease in carbon emissions. The relationship may be explained by a number of factors.

One possibility is that these nations have implemented policies and regulations that encourage the development of cleaner technologies, energy efficiency, and environmental sustainability. These policies could have resulted in a more decoupled link between economic growth and carbon emissions, allowing economic growth to occur without increasing the adverse environmental impact. Additionally, it's evident that investments in renewable energy sources and technological advancements have caused a change in the energy mix, reducing the need for fossil fuels and therefore lowering carbon emissions. Furthermore, changes in industrial structure, such as a shift towards carbon-intensive industries, may contribute to the observed negative relationship between economic growth and carbon emissions. Meanwhile, in the case of Lag D(EG[−1]), EG in Indonesia, Malaysia, Saudi Arabia, and the UAE has a positive and significant impact on carbon emissions at a significance level of 1% (0.0000 < 0.01). This indicates that an increase in economic growth will lead to higher carbon emissions in the short term. The findings of this research indicate that an increase in economic activity in Indonesia, Malaysia, Saudi Arabia, and the UAE will contribute to an increase in carbon emissions in the short term. It implies that there is an environmental consequence when these economies grow and develop, particularly in terms of higher carbon emissions.

Table 2: KAO cointegration test results

ADF	t-statistic (−1.8537)	P (0.0319)**
Residual variance	1.94E+12	
HAC variance	9.73E+12	

**Significance at the 5% level. ADF: Augmented Dickey-Fuller

Table 3: Panel autoregressive distributed lag estimation test results on environment

Variable	Coefficient	SE	t-statistic	P*
Long run equation				
EG	0.0008	3.11E-05	26.7777	0.0000***
GS	−0.0372	0.011593	−3.2117	0.0015***
TO	0.0002	0.000146	1.6037	0.1100
Short run equation				
COINTEQ01	−0.1568	0.0785	−1.9973	0.0469**
D(EG)	0.0001	0.0026	0.0537	0.9572
D(EG[−1])	9.47E-05	0.0026	0.0365	0.9709
D(GS)	0.2722	0.2171	1.2541	0.2110
D(GS[−1])	−0.0245	0.0108	−2.2697	0.0241**
D(TO)	0.0394	0.0243	1.6172	0.1071
D(TO[−1])	−0.0336	0.0224	−1.5002	0.1348
C	3,995,308	1,274,109	0.3136	0.7541
@TREND	−865,629.4	367,984.5	−2.3523	0.0194**

*Significance at the 10% level, **Significance at the 5% level, ***Significance at the 1% level. SE: Standard error, TO: Trade openness, GS: Green sukuk, EG: Economic growth

Table 4: Panel autoregressive distributed lagestimation test results in each country (cross-section)

Variables	Coefficient	SE	t-statistic	P*
Indonesia				
COINTEQ01	−0.198658	0.002505	−79.27915	0.0000***
D(EG)	0.007803	2.37E-06	3295.229	0.0000***
D(EG[−1])	−0.007522	2.28E-06	−3292.702	0.0000***
D(GS)	0.837321	0.015518	53.95946	0.0000***
D(GS[−1])	−0.030546	0.001278	−23.90223	0.0002***
D(TO)	0.096724	5.21E-05	1857.707	0.0000***
D(TO[−1])	−0.086380	8.31E-05	−1039.682	0.0000***
C	−17,727,695	2.44E+14	−7.25E-08	1.0000
@TREND	−1,324,029	3.98E+11	−3.33E-06	1.0000
Malaysia				
COINTEQ01	−0.358280	0.008418	−42.55897	0.0000***
D(EG)	−0.002342	2.59E-08	−90,435.95	0.0000***
D(EG[−1])	0.001869	8.32E-08	22,454.46	0.0000***
D(GS)	0.057629	0.001158	49.74774	0.0000***
D(GS[−1])	−0.051736	0.001331	−38.87163	0.0000***
D(TO)	0.043067	2.34E-07	184,253.5	0.0000***
D(TO[−1])	−0.027476	1.58E-05	−1743.277	0.0000***
C	−5,788,679	1.71E+13	−3.39E-07	1.0000
@TREND	−481,504.9	1.96E+10	−2.45E-05	1.0000
Saudi Arabia				
COINTEQ01	−0.067253	0.001508	−44.59177	0.0000***
D(EG)	−0.003597	2.26E-06	−1594.761	0.0000***
D(EG[−1])	0.004104	2.31E-06	1773.571	0.0000***
D(GS)	0.360282	0.009320	38.65715	0.0000***
D(GS[−1])	−0.014116	0.004532	−3.114540	0.0527**
D(TO)	0.040083	6.09E-05	658.2999	0.0000***
D(TO[−1])	−0.042703	6.05E-05	−706.1046	0.0000***
C	40,773,101	6.94E+14	5.88E-08	1.0000
@TREND	−1,623,637	3.78E+11	−4.29E-06	1.0000
UEA				
COINTEQ01	−0.003146	0.000295	−10.64925	0.0018***
D(EG)	−0.001307	4.51E-08	−28,961.22	0.0000***
D(EG[−1])	0.001927	4.62E-08	41,682.13	0.0000***
D(GS)	−0.166292	4.99E-05	−3335.041	0.0000***
D(GS[−1])	−0.001767	1.94E-05	−91.19063	0.0000***
D(TO)	−0.022363	5.39E-07	−41,487.19	0.0000***
D(TO[−1])	0.022181	6.80E-07	32,626.24	0.0000***
C	−1,275,497	4.02E+12	−3.17E-07	1.0000
@TREND	−33,346.75	5.75E+09	−5.80E-06	1.0000

*Significance at the 10% level, **Significance at the 5% level, ***Significance at the 1% level. SE: Standard error, TO: Trade openness, GS: Green sukuk, EG: Economic growth

Secondly, over the long term, global Green Sukuk (GS) has a significant and negative impact on the environment (EV) as measured by carbon emissions at a significance level of 1% (0.0000 < 0.01) collectively in Indonesia, Malaysia, Saudi Arabia, and the UAE. This indicates that an increase in the issuance of global Green Sukuk will lead to a long-term reduction in carbon emissions in these countries. This suggests that Green Sukuk-funded projects are environmentally friendly and contribute to reducing carbon emissions into the atmosphere. The findings have broader implications and shed light on the potential for reducing carbon emissions through increased Green Sukuk issuance in these countries. These nations could effectively tackle the issue of carbon emissions in the long run by increasing the issuance of global Green Sukuk. The Green Sukuk provides a mechanism for financing environmentally friendly projects that prioritize sustainability and emission reduction. As more projects are financed through Green Sukuk, such as renewable energy initiatives, sustainable infrastructure development, and carbon capture projects, the carbon footprint of these nations can be reduced significantly. Increased Green Sukuk issuance will result in a long-term decrease in carbon emissions, which is consistent with global efforts to fight climate change. The findings reveal that the use of financial instruments like Green Sukuk can help achieve climate goals and promote environmental sustainability as the world faces the urgent need to transition to a low-carbon economy. Furthermore, in the short term, global Green Sukuk at lag D(GS) does not have a significant impact on carbon emissions. However, separately, as shown in Table 4, lag D(GS) of Green Sukuk in Indonesia, Malaysia, and Saudi Arabia has a positive and significant effect on carbon emissions at a significance level of 1% (0.0000 < 0.01). This indicates that an increase in global Green Sukuk will lead to an increase in carbon emissions in the short term. The positive and significant effect of lag D(GS) on carbon emissions in these countries may appear counterintuitive, considering that Green Sukuk is often connected with financing environmentally friendly projects. However, it is essential to take into consideration the specific circumstances and aspects that contributed to this impact in the short term. Possible factors include the categories of projects financed, the stage of implementation, and the intricate relationship between economic growth and environmental concerns. Meanwhile, global Green Sukuk at lag D(GS[−1]) has a significant and negative impact on carbon emissions collectively in Indonesia, Malaysia, Saudi Arabia, and the UAE at a significance level of 5% (0.0241 < 0.05). Separately, according to Table 4, lag D(GS[−1]) of Green Sukuk in Indonesia and Malaysia has a negative and significant effect on carbon emissions at a significance level of 1%. In Saudi Arabia, lag D(GS[−1]) of Green Sukuk has a negative and significant impact on carbon emissions at a significance level of 10%. Lastly, in the UAE, both lag D(GS) and D(GS[−1]) of Green Sukuk have a negative and significant impact on carbon emissions at a significance level of 1%. This indicates that an increase in the issuance of global Green Sukuk will lead to a short-term reduction in carbon emissions in these countries. The findings show that the short-term reduction of carbon emissions in these nations is significantly supported by the increasing global issuance of Green Sukuk. These nations can significantly reduce their carbon footprints and contribute to a more sustainable future by funding environmentally friendly beneficial activities through Green Sukuk, such as renewable energy programs or energy-efficient infrastructure. This finding is supported by the research conducted by Abdullah and Nayan (2020), which indicates that green sukuk financing has an impact on the sustainable environment. The growth of the green sukuk market has the potential to foster environmentally-friendly initiatives and enhance the quality of life, thereby assisting Islamic finance in fulfilling its ethical objectives (Aassouli et al., 2018).

Lastly, both in the long and short term, trade openness (TO) does not collectively affect the environment (EV) proxied by carbon emissions in Indonesia, Malaysia, Saudi Arabia, and the UAE. However, separate testing in Table 4 reveals interesting results. TO in lag D(TO) in Indonesia, Malaysia, and Saudi Arabia, as well as TO in lag D(TO[−1]) in the UAE, have a positive and significant impact on carbon emissions at a significance level of 1% (0.0000 < 0.01). This indicates that an increase in trade

openness will lead to an increase in carbon emissions in the short term. The positive impact shows that when trade openness increases, allowing for more international trade and economic activity, it contributes to higher levels of carbon emissions. This result is consistent with a study conducted by Ansari et al. (2020), which discovered a significant positive relationship between trade openness and carbon emissions in the long run. Consequently, it is advisable to reduce the volume of trade in order to lower emissions. The increase in trade is found to be Granger-cause CO_2 emissions, particularly in the case of major carbon emitters such as the USA, Japan, Canada, Iran, Saudi Arabia, UK, Australia, Italy, France, and Spain. On the other hand, TO at lag D(TO[−1]) in Indonesia, Malaysia, and Saudi Arabia, as well as TO at lag D(TO) in the UAE, have a negative and significant impact on carbon emissions at a significance level of 1% (0.0000 < 0.01). This indicates that an increase in trade openness will decrease carbon emissions in the short term. The negative and significant impact suggests that higher levels of trade openness result in reduced carbon emissions. This study shows that there is a possibility for better environmental outcomes in terms of lower carbon emissions as these countries increase their involvement in international trade and open up their economies. One possible reason for the relationship is that increased trade openness can lead to the adoption of cleaner and more efficient production technology and practices. Countries that engage in international trade are frequently under pressure from their trading partners to adhere to environmental standards and regulations. This may encourage the use of greener technology and production techniques that aid in lowering carbon emissions. Furthermore, trade openness makes it easier for people to exchange goods and services across national boundaries, which enables nations to focus on markets where they have a competitive advantage. Specialization may result in better utilization of resources and production, which may help to reduce carbon emissions. One possibility is for a nation to produce clean energy technology with a focus on exporting them to other countries, thereby lowering their dependency on carbon-intensive energy sources. In addition, trade openness encourages the transfer of knowledge and technology across nations. Countries that trade with one another have the chance to share knowledge and adopt best practices for sustainable growth and environmental management. The application of successful policies and techniques to reduce carbon emissions may result from this knowledge exchange. These findings are in line with the research conducted by Gozgor (2017), which revealed that measures of trade openness have a negative association with carbon emissions in the long run among OECD countries.

4.5. Robustness Test Results

The results of the panel ARDL estimation presented in Tables 3 and 4 do not provide strong conclusions due to the possibility of outliers in the dependent and explanatory variables. Therefore, this study employs the robust least square regression technique to mitigate the potential influence of outliers on the model.

Table 5 presents robust regression estimates and reveals that both economic growth and trade openness have a positive and statistically significant impact on carbon emissions. This implies that as economic growth and trade openness increase, carbon emissions also tend to increase. On the other hand, the study finds that global green sukuk has a negative and significant effect on carbon emissions. Consequently, an increase in the issuance of global green sukuk is associated with a reduction in carbon emissions. These findings indicate that economic growth and trade openness play a role in shaping carbon emissions. As economies grow and trade becomes more open, the production and consumption of goods and services increase, leading to a rise in carbon emissions. This relationship is expected, considering the increased economic activity and corresponding energy consumption associated with economic growth and trade openness. However, the study also reveals the potential of global green sukuk in mitigating carbon emissions. Global green sukuk, which represents environmentally friendly investment instruments, demonstrates a negative influence on carbon emissions. This suggests that the issuance of global green sukuk contributes to environmentally sustainable practices and helps reduce carbon emissions. Overall, the results emphasize the complex relationship between economic factors, financial instruments, and environmental outcomes. While economic growth and trade openness tend to contribute to higher carbon emissions, the emergence of global green sukuk offers a promising avenue for mitigating the environmental impact associated with economic activities. These findings underscore the importance of considering sustainable financial mechanisms alongside economic growth and trade policies to address the challenge of reducing carbon emissions and promoting environmental sustainability.

4.6. Granger Causality Test Results

The Granger causality test is a statistical method for determining the direction of causality among variables in a study. The Granger causality test examines the one-way or two-way causal relationship between research variables (2012). Table 6 displays the results of the Granger causality test, which show a significant one-way causal relationship between the variables of economic growth and global green sukuk on carbon emissions. This indicates that changes in economic growth and the issuance of global green sukuk might be viewed as leading indicators that impact or result in changes in carbon emissions. In particular, the test results indicate that fluctuations in economic growth and global green sukuk precede and can be used to predict changes in carbon emissions. This shows that variables like economic growth and the adoption of environmentally friendly financing methods like the global green sukuk have an effect on carbon emissions. However, it is important to emphasize that the causal relationship is unidirectional, which means that carbon emissions do not necessarily drive economic growth or the issuance of global green sukuk. These findings have major implications

Table 5: Robust least squares test results on environment

Variable	Coefficient	SE	Z-statistic	P*
EG	0.000680	1.25E-05	54.27685	0.0000***
GS	−0.110498	0.010679	−10.34736	0.0000***
TO	0.000739	8.73E-05	8.467191	0.0000***
R^2			0.444352	
Rw^2			0.915511	
P (Rn^2 statistic)			0.0000	

*Significance at the 10% level, **Significance at the 5% level, ***Significance at the 1% level. SE: Standard error, TO: Trade openness, GS: Green sukuk, EG: Economic growth

Table 6: Granger causality test results

Null hypothesis	F-statistic	P*
EG does not granger cause EV	5.58396	0.0042***
EV does not granger cause EG	0.51545	0.5978
GS does not granger cause EV	3.51199	0.0312**
EV does not granger cause GS	1.55126	0.2138
TO does not granger cause EV	0.73351	0.4812
EV does not granger cause TO	0.39815	0.6719
GS does not granger cause EG	1.14290	0.3204
EG does not granger cause GS	0.43037	0.6507
TO does not granger cause EG	1.41395	0.2449
EG does not granger cause TO	1.68271	0.1878
TO does not granger cause GS	2.52111	0.0822*
GS does not granger cause TO	0.02079	0.9794

*Significance at the 10% level, **Significance at the 5% level, ***Significance at the 1% level. EV: Environment, TO: Trade openness, GS: Green sukuk, EG: Economic growth

for policymakers and stakeholders involved in environmental sustainability and economic planning. Recognizing the one-way causal relationship between economic growth, global green sukuk, and carbon emissions allows policymakers to design targeted actions and policies to alleviate the environmental impact of economic activity and encourage sustainable financing systems.

5. CONCLUSION

This study examined the relationship between economic growth, global Green Sukuk, trade openness, and carbon emissions in Indonesia, Malaysia, Saudi Arabia, and the UAE. The period under study is 2018-2022 in the form of monthly data. The reason for choosing this period is the 1st time that the four countries on average issued global green sukuk except for Malaysia in 2017. The panel ARDL estimation revealed several key findings. Firstly, in the long run, economic growth was found to have a positive and significant impact on carbon emissions in these countries. This suggests that as economic growth increases, carbon emissions also increase, contributing to environmental degradation. Industrial output, transportation, and energy consumption were identified as key drivers of carbon emissions. However, in the short term, economic growth did not have a collective impact on carbon emissions. Interestingly, when examining the impact separately for each country, it was found that economic growth with a lag of one period led to a short-term decrease in carbon emissions. This may be attributed to the implementation of policies and regulations promoting cleaner technologies, energy efficiency, and environmental sustainability, as well as investments in renewable energy sources and changes in industrial structure.

Regarding global Green Sukuk, it was found to have a significant and negative impact on carbon emissions in the long run. Increased issuance of global Green Sukuk was associated with a reduction in carbon emissions, indicating that these financial instruments support environmentally friendly projects and contribute to sustainability efforts. In the short term, the impact of global Green Sukuk on carbon emissions varied among countries, with both positive and negative effects observed. However, the long-term reduction of carbon emissions was significantly supported by increasing global Green Sukuk issuance. In terms of trade openness, this study found that it did not collectively affect carbon emissions in the long or short term. However, separate analyses revealed interesting results. In the short term, an increase in trade openness led to an increase in carbon emissions, while in some cases, it resulted in a short-term decrease in carbon emissions. The relationship between trade openness and carbon emissions is complex, influenced by factors such as the adoption of cleaner technologies, adherence to environmental standards, resource utilization, and knowledge exchange. Overall, the research highlights the complex relationship between economic factors, financial instruments, and environmental outcomes. While economic growth and trade openness tend to contribute to higher carbon emissions, the issuance of global Green Sukuk offers a promising avenue for mitigating environmental impact and reducing carbon emissions. The study emphasizes the importance of sustainable financial mechanisms alongside economic and trade policies to address the challenge of reducing carbon emissions and promoting environmental sustainability.

Furthermore, the Granger causality test demonstrated a significant one-way causal relationship between economic growth, global Green Sukuk, and carbon emissions. Changes in economic growth and the issuance of global Green Sukuk were identified as leading indicators that impact or result in changes in carbon emissions. Policymakers and stakeholders can utilize this knowledge to design targeted actions and policies to mitigate the environmental impact of economic activities and encourage sustainable financing systems.

In conclusion, this research provides valuable insights into the relationship between economic growth, global Green Sukuk, trade openness, and carbon emissions in Indonesia, Malaysia, Saudi Arabia, and the UAE. The findings underscore the importance of considering environmental sustainability alongside economic development and highlight the potential of global Green Sukuk as a tool for reducing carbon emissions. It is crucial for policymakers to recognize the causal relationships identified in this study to implement effective measures that address environmental concerns while fostering economic growth and trade.

REFERENCES

Aassouli, D., Asutay, M., Mohieldin, M., Nwokike, T.C. (2018), Green sukuk, energy poverty, and climate change: A roadmap for Sub-Saharan Africa. In: Policy Research Working Paper. United States: World Bank.

Abdullah, N., Nayan, M.A. (2020), Green sukuk: Financing the future to sustainable environment. International Journal of Zakat and Islamic Philanthropythropy, 2, 2672-7471.

Acheampong, A.O. (2018), Economic growth, CO_2 emissions and energy consumption: What causes what and where? Energy Economics, 74, 677-692. https://doi.org/10.1016/j.eneco.2018.07.022

Adamowicz, M. (2022), Green deal, green growth and green economy as a means of support for attaining the sustainable development goals. Sustainability (Switzerland), 14(10), 14105901

Alves, A.B., Wanke, P., Antunes, J., Chen, Z. (2020), Endogenous network efficiency, macroeconomy, and competition: Evidence from the portuguese banking industry. North American Journal of Economics and Finance, 52, 101114.

Anindito Mujizat, D. (2021), The Sovereign Green Sukuk: An Analysis of Its Process and Barriers to Funding Renewable Energy Projects in Indonesia. p1-61. Available from: https://www.geo.uu.se

Ansari, M.A., Haider, S., Khan, N.A. (2020), Does trade openness affects global carbon dioxide emissions: Evidence from the top CO_2 emitters. Management of Environmental Quality: An International Journal, 31(1), 32-53.

Apostolidou, I., Mattas, K., Loizou, E., Michailidis, A. (2014), Agriculture's role in economic growth: An exploratory study among southern and northern EU countries. Contributions to Economics, 208, 147-162.

Asteriou, D., Hall, S. (2007), Applied Econometrics: A Modern Approach Using Eviews and Microfit. United Kingdom: Palgrave Macmillan.

Ausloos, M., Lambiotte, R. (2007), Clusters or networks of economies? A macroeconomy study through gross domestic product. Physica A: Statistical Mechanics and Its Applications, 382(1), 16-21.

Azad, M.A.K., Islam, M.A., Sobhani, F.A., Hassan, M.S., Masukujjaman, M. (2022), Revisiting the current status of green finance and sustainable finance disbursement: A policy insights. Sustainability (Switzerland), 14(14), 1-14.

Bergheim, S. (2008), Long-run Growth Forecasting. Germany: Springer.

Boukhatem, J. (2022), How does financial risk affect sukuk market development? Empirical evidence from ARDL approach. Heliyon, 8(5), e09453.

Chang, C.L., Fang, M. (2023), Impact of a sharing economy and green energy on achieving sustainable economic development: Evidence from a novel NARDL model. Journal of Innovation and Knowledge, 8(1), 100297.

Cui, H., Wang, R., Wang, H. (2020), An evolutionary analysis of green finance sustainability based on multi-agent game. Journal of Cleaner Production, 269, 121799.

Fitrah, R., Soemitra, A. (2022), Green sukuk for sustainable development goals in Indonesia: A literature Study. Jurnal Ilmiah Ekonomi Islam, 8(1), 231.

Gozgor, G. (2017), Does trade matter for carbon emissions in OECD countries? Evidence from a new trade openness measure. Environmental Science and Pollution Research, 24(36), 27813-27821.

Grahesti, A., Nafii'ah, F., Pramuningtyas, E., Bisnis, F.E. (2022), Green sukuk: Investasi hijau berbasis syariah dalam mewujudkan ketahanan terhadap perubahan iklim di indonesia. Jurnal Ilmiah Ekonomi Islam, 8(03), 3374-3382.

Huchet-Bourdon, M., Le Mouël, C., Vijil, M. (2018), The relationship between trade openness and economic growth: Some new insights on the openness measurement issue. World Economy, 41(1), 59-76.

Ibrahim, R.L., Al-mulali, U., Ozturk, I., Bello, A.K., Raimi, L. (2022), On the criticality of renewable energy to sustainable development: Do green financial development, technological innovation, and economic complexity matter for China? Renewable Energy, 199, 262-277.

Ichvani, L.F., Sasana, H. (2019), Pengaruh korupsi, konsumsi, pengeluaran pemerintah dan keterbukaan perdagangan terhadap pertumbuhan ekonomi di Asean 5 [Effects of corruption, consumption, government spending and trade openness on economic growth in ASEAN 5]. Jurnal REP (Riset Ekonomi Pembangunan), 4(1), 61-72.

Jun, W., Mahmood, H., Zakaria, M. (2020), Impact of trade openness on environment in China. Journal of Business Economics and Management, 21(4), 1185-1202.

Liu, F.H.M., Lai, K.P.Y. (2021), Ecologies of green finance: Green sukuk and development of green Islamic finance in Malaysia. Environment and Planning A, 53(8), 1896-1914.

Mardani, A., Streimikiene, D., Cavallaro, F., Loganathan, N., Khoshnoudi, M. (2019), Carbon dioxide (CO_2) emissions and economic growth: A systematic review of two decades of research from 1995 to 2017. Science of the Total Environment, 649, 31-49.

Mensah, J. (2019), Sustainable development: Meaning, history, principles, pillars, and implications for human action: Literature review. Cogent Social Sciences, 5(1). https://doi.org/10.1080/23311886.2019.1653531

Musari, K. (2022), Integrating green sukuk and cash waqf linked sukuk, the blended islamic finance of fiscal instrument in Indonesia: A proposed model for fighting climate change. International Journal of Islamic Khazanah, 12(2), 133-144.

Naeem, M.A., Adekoya, O.B., Oliyide, J.A. (2021), Asymmetric spillovers between green bonds and commodities. Journal of Cleaner Production, 314, 128100.

Ng, A.W. (2018), From sustainability accounting to a green financing system : Institutional legitimacy and market heterogeneity in a global fi nancial centre. Journal of Cleaner Production, 195, 585-592.

Niyazbekova, S., Troyanskaya, M., Toygambayev, S., Rozhkov, V., Zhukov, A., Aksenova, E., Ivanova, O. (2021), Instruments for financing and investing the "green" economy in the country's environmental projects. E3S Web of Conferences, 244, 10054.

Oktaviani, R., Amaliah, S., Ringler, C., Rosegrant, M.W., Sulser, T.B. (2011), The Impact of Global Climate Change on the Indonesian Economy. IFPRI-Discussion Papers, 1148. p1-40.

Pao, H., Chen, C. (2019), Decoupling strategies : CO_2 emissions, energy resources, and economic growth in the Group of Twenty. Journal of Cleaner Production, 206, 907-919.

Pathan, D.M.S., Ahmed, D.M., Khoso, D.A.A. (2022), Islamic banking under vision of green finance: The case of development, ecosystem and prospects. International Research Journal of Management and Social Sciences, 3(1), 193-210.

Peiris, S.J., Saxegaard, M., editors. (2007), An estimated DSGE model for monetary policy analysis in low-income countries. IMF Working Paper 07/282; December 1, 2007.

Phillips, P.C.B., Perron, P. (1988), Testing for a unit root in time series regression. Biometrika, 75(2), 335-346.

Rahman, A., Hanife, M.A. (2022), The challenges of green sukuk policy implementation for achieving sustainable environment. Malaysian Journal of Social Sciences and Humanities, 7(11), e001987.

Ramadhan, I.A., Wirdyanigsih. (2020), Green sukuk issuance as an investment instrument for sustainable development. 413(Icolgis 2019), 95-98.

Risanti, M.A., Alwyni, F.A., Nadya, P.S. (2020), Peran Green Sukuk dalam Mewujudkan Pembangunan yang Berkelanjutan. In: Prosiding Konferensi Nasional Ekonomi Manajemen Dan Akuntansi (KNEMA). Vol. 1177. p1-13. Available from: https://jurnal.umj.ac.id/index.php/KNEMA/article/view/9072

Ronaldo, R., Suryanto, T. (2022), Green finance and sustainability development goals in Indonesian fund Village. Resources Policy, 78(2021), 102839.

Safi, A., Chen, Y., Wahab, S., Ali, S., Yi, X., Imran, M. (2021), Financial instability and consumption-based carbon emission in E-7 countries: The role of trade and economic growth. Sustainable Production and Consumption, 27, 383-391.

Schröder, E., Storm, S. (2020), Economic growth and carbon emissions: The road to "hothouse earth" is paved with good intentions. International Journal of Political Economy, 49(2), 153-173.

Suherman, N.I., Manzilati, A. (2019), Identifikasi potensi pasar green sukuk republik Indonesia. Human Falah: Jurnal Ekonomi Dan Bisnis Islam, 6(1), 37-53.

Suwanan, A.F., Munir, S., Merlinda, S. (2022), Analisis peran dan tantangan sukuk hijau bagi ketahanan perubahan iklim pada wilayah rentan selama pandemi Covid-19 [Analysis of the role and challenges of green sukuk for climate change resilience in vulnerable areas during the Covid-19 pandemic]. Al-Kharaj : Jurnal Ekonomi, Keuangan and Bisnis Syariah, 4(4), 978-989.

Syczewska, E.M. (2010), Empirical power of the Kwiatkowski-Phillips-Schmidt-Shin test. Department of Applied Econometrics Working Papers, 3, 21.

Wang, K., Zhao, Y., Jiang, C., Li, Z. (2022), Does green finance inspire sustainable development ? Evidence from a global perspective. Economic Analysis and Policy, 75, 412-426.

Wang, Q., Zhang, F. (2021), The effects of trade openness on decoupling carbon emissions from economic growth-evidence from 182 countries. Journal of Cleaner Production, 279, 123838.

Wang, X., Wang, Q. (2021), Research on the impact of green finance on the upgrading of China's regional industrial structure from the perspective of sustainable development. Resources Policy, 74, 102436.

ACKNOWLEDGEMENT

The authors would like to thank Universitas Syiah Kuala for funding this research. Full support from the Research and Community Service Institute (LPPM USK) with grant number: 181/UN11.2.1/PT.01.03/PNBP/2023 May 3, 2023. We would also like to thank the research team members who worked to complete this research.

Wang, Y., Zhi, Q. (2016), The role of green finance in environmental protection: Two aspects of market mechanism and policies. Energy Procedia, 104, 311-316.

Zaidi, S., Saidi, K. (2018), Environmental pollution, health expenditure and economic growth in the Sub-Saharan Africa countries: Panel ARDL approach. Sustainable Cities and Society, 41, 833-840.

Zaretta, B., Yovita, L. (2019), Harga saham, nilai tukar mata uang dan tingkat suku bunga acuan dalam model autoregressive distributed lag (Ardl). Jurnal Penelitan Ekonomi Dan Bisnis, 4(1), 9-22.

Zhou, M., Li, X. (2022), Influence of green finance and renewable energy resources over the sustainable development goal of clean energy in China. Resources Policy, 78, 102816.