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The Impact Of Islamic Finance, Economic Growth, And Globalization On CO2 Emissions

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Abstract: This paper examines the impact of Islamic finance, economic growth, and globalization (economic, social, political, and overall aspects) on carbon dioxide emissions in 4 countries for the period 2015-2020. Employing the System GMM estimation method, which fulfills criteria for model unbiasedness, validity, and consistency. Findings reveal that Islamic finance, economic growth, and globalization simultaneously contribute to increasing and decreasing carbon dioxide emissions with a significance level of 0.010. Partially, Islamic finance and globalization's overall aspect in short or long term contribute to a decrease in carbon dioxide emissions with a significance level of 0.010. Meanwhile, economic growth and globalization in economic, social, or political aspects in short or long term contribute to an increase in carbon dioxide emissions with a significance level of 0.010. This scientific article provides a new contribution to the research results that have been obtained with a significance level of 0.010 or 99 per cent confidence level.
Keywords: Islamic Finance; Economic Growth; Globalization; Carbon Dioxide Emissions.

Abstraks: Penelitian ini bertujuan untuk menganalisis pengaruh dari keuangan Islam, pertumbuhan ekonomi, dan globalisasi (aspek ekonomi, aspek sosial, aspek politik, dan aspek keseluruhan) terhadap emisi karbon dioksida di 4 negara dengan periode tahun 2015 sampai 2020. Penelitian ini menggunakan metode estimasi System GMM yang telah memenuhi kriteria model ketidakbiasan, validitas, dan konsistensi. Hasil yang diperoleh adalah keuangan Islam, pertumbuhan ekonomi, dan globalisasi secara simultan berkontribusi terhadap meningkatnya dan menurunnya emisi karbon dioksida dengan taraf signifikansi sebesar 0,010. Secara parsial, keuangan Islam dan globalisasi aspek keseluruhan dalam jangka pendek ataupun jangka panjang berkontribusi terhadap penurunan emisi karbon dioksida dengan taraf signifikansi 0,010. Sedangkan pertumbuhan ekonomi dan globalisasi aspek ekonomi, sosial, ataupun politik dalam jangka pendek ataupun jangka panjang berkontribusi terhadap peningkatan emisi karbon dioksida dengan taraf signifikansi 0,010. Pada artikel ilmiah ini memberikan kontribusi yang baru pada hasil penelitian yang telah diperoleh dengan taraf signifikansi 0,010 atau tingkat kepercayaan 99 persen.
Kata Kunci: Keuangan Islam; Pertumbuhan Ekonomi; Globalisasi; Emisi Karbon Dioksida.

INTRODUCTION

In recent decades, carbon emissions have posed a significant challenge to global economic expansion, known as global warming. World leaders, academics, and other stakeholders have widely discussed this matter because it impacts environmental degradation in both developed and developing countries. The Kyoto Protocol to the Paris Agreement is a statement of agreement from world leaders to work together to combat global warming by reducing carbon dioxide emissions.

Despite the commitment demonstrated through these agreements, environmental degradation continues to increase. Based on data from the International Energy Agency (IEA), one can prove that carbon dioxide emissions from energy combustion and global

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industrial activities will reach 36.800 gigatons in 2022. Where CO2 emissions increased by about 0.500 gigatons compared to 2021, as well as a new record high in history.

In Islam, all activities carried out in human life have been regulated, and one of them is how to preserve the environment. In the Al-Qur'an there is a clear warning to humans not to damage the natural environment, as Allah SWT says in the Al-Qur-an Surah Al-'Araf verse 56 below:

وَلَا تُفْسِدُوْا فِى الْاَرْضِ بَعْدَ اِصْلَاحِهَا وَادْعُوْهُ خَوْفًا وَّطَمَعًاۗ اِنَّ رَحْمَتَ اللّٰهِ قَرِيْبٌ مِّنَ الْمُحْسِنِيْنَ

Meaning: "And do not cause damage to the earth after it was (created) well. Pray to Him with fear and hope. Indeed, Allah's mercy is very close to those who do good."

Islamic finance, which is part of implementing the Islamic Sharia system, should pay attention to the impact of the surrounding environment. Researchers use various comparative methods to test how the main parameters of the Islamic financial market influence the intensity of carbon emissions, taking into account the different phases of Islamic finance development in various Islamic countries (Al-Silefanee et al., 2022). Countries that are members of the Organization of Islamic Cooperation (OIC), it shows that the development of Islamic finance has a significant influence in reducing CO_2 emissions (Setiawati & Salsabila, 2022). These results differ from what happened in 30 countries with Islamic banks, where the development of Sharia banking significantly increased energy intensity so that the quality of the environment became polluted (Ibrahim et al., 2021).

Apart from discussing the development of Islamic finance concerning environmental quality, scholars have also long-discussed economic growth in connection with ecological quality (Nengsih et al., 2023). Asian countries show that Gross Domestic Product (GDP) significantly influences increasing CO_2 emissions in the early stages, with Turkey, Thailand, Saudi Arabia, Qatar, Pakistan, Kuwait, Japan, and Indonesia producing higher CO_2 emissions (Adeneye et al., 2021). These results differ from those in countries that are members of the Organization of Islamic Cooperation (OIC), where GDP per capita in the initial stage does not significantly influence CO_2 emissions. However, in the long term, it contributes to higher environmental degradation (Shaari et al., 2020).

Apart from that, one topic that is a concern in the discussion about environmental degradation is globalization. Researchers are still debating the impact of globalization on environmental degradation, whether direct or indirect, as the effect of the globalization index on the environment remains uncertain (Muhammad & Khan, 2021). Countries that are members of economic cooperation and development organizations show that globalization has a significant influence in helping to reduce CO_2 emissions (Cao et al., 2021). These results are different from those that occur in 47 developing markets and countries where globalization has a significant impact on increasing CO_2 emissions, thereby worsening environmental quality (Le & Ozturk, 2020).

Because carbon dioxide emissions make a significant contribution to global warming, it is crucial to make efforts to overcome this problem. This research aims to make an effort to conduct empirical analysis. The results obtained through this research can serve as material for policymakers to consider in addressing the problem of global warming caused by carbon dioxide emissions.

Previous research investigating the influence of Islamic finance, economic growth, or globalization on carbon dioxide emissions still shows different results. In particular, investigations into the impact of Islamic finance on carbon dioxide emissions are still relatively small and still use the usual panel data regression estimation method, such as in the research of (Abduh et al., 2022) and (Nengsih et al., 2023). Therefore, this scientific

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article analyzes the influence of Islamic finance, economic growth, and globalization on carbon dioxide emissions in 4 countries for the period 2015-2020. The countries analyzed as samples in this research are Malaysia, Saudi Arabia, the United Arab Emirates, and Indonesia, which are the countries with the top rankings in the 2022 Global Islamic Economic Indicators Report.

This scientific article provides a new contribution to the research results that have been obtained with a significance level of 0.010 or a confidence level of 99 per cent using the System GMM (Sys-GMM) estimation method, which has the advantage of being able to see short-term and long-term contributions the length of the independent variable to the dependent variable. Whereas in previous studies, the results used a significance level of 0.050 or the level of confidence was only up to 95 per cent.

THEORITICAL REVIEW

The Relationship between Islamic Finance and Carbon Dioxide Emissions. Theoretically, Islamic finance should have a significant and positive relationship with environmental quality compared to conventional finance. Referring to Sharia objectives, Sharia financial institutions are prohibited from financing projects that can endanger or cause damage to the environment, both physically, such as the illegal felling of trees or in protected forests, mining exploration, and the use of machines that can pollute the air, as well as morally or socially, such as concerts and inappropriate events. By doing this, Islamic finance can preserve the environment and ultimately slow climate change better than conventional finance (Abduh et al., 2022).

Several studies have previously explored the relationship between Islamic finance and carbon dioxide emissions, including research conducted in Indonesia for the 2000-2018 period using Autoregressive Distributed Lag (ARDL) and Error Correction Model (ECM) testing, showing that the development of Islamic finance can help countries to adjust carbon dioxide emissions and play its role in protecting the environment by encouraging environmentally friendly and energy-efficient projects (Iskandar et al., 2020). These results are similar to research conducted in 12 member countries of the Organization of Islamic Cooperation (OIC) for the 2013-2018 period using the Panel Corrected Standard Error (PCSE) method, showing that the development of Islamic finance has a significant effect on reducing carbon dioxide emissions, namely by encouraging energy efficiency activities and producing or consuming renewable energy (Setiawati & Salsabila, 2022).

On the other hand, several other studies show different results, such as research conducted in 6 countries with the best Islamic finance with the research period 2013-2018 using the Fixed Effects Model (FEM) and Random Effects Model (REM) panel data regression approach. The development of Sharia finance has a significant effect on increasing carbon dioxide emissions. The financial intermediation function of Islamic commercial banks helps increase production capacity carried out by the business sector so that the amount of energy consumption increases (Abduh et al., 2022). These results are similar to research conducted in 30 countries where there are Islamic banks for the period 1999-2013 using the Fixed Effects Model (FEM) panel data, which resulted in the development of Islamic banking contributing significantly to increasing energy intensity, thereby causing environmental degradation, this is because Islamic banks have not financed environmentally friendly energy technology as a tool that can reduce energy intensity

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(Ibrahim et al., 2021). The author's hypothesis for the influence of Islamic finance on carbon dioxide emissions is:

H1: Islamic finance significantly reduces carbon dioxide emissions in the short and long term.

Relationship between Economic Growth and Carbon Dioxide Emissions. Generally, one can observe the relationship between economic growth (proxied by gross domestic product or GDP) and carbon dioxide emissions through the well-known Environmental Kuznets Curve (EKC) hypothesis. It explains an influence between these two variables, indicating that CO2 emission pollution increases along with a country's economic growth in the early stages. After reaching a specific turning point, increased economic growth will reduce CO_2 emissions in the long term. The country has obtained carbon-friendly technology, reducing environmental degradation more efficiently (Rahman & Alam, 2022).

Several studies have previously explored the relationship between GDP and CO2 emissions, including research conducted in member countries of economic cooperation organizations for the period 1990-2014 using the Fully Modified Ordinary Least Squares (FMOLS) method, showing that economic growth in the short term it causes an increase in CO_2 emissions, but in the long term or after reaching a turning point CO2 emissions decrease (Shabani et al., 2021). These results are similar to research conducted in Gulf Cooperation Council (GCC) member countries for the 1995-2018 period using the Cross-Sectionally Augmented Autoregressive Distributed Lag (CS-ARDL) approach, showing that economic growth increases CO2 emissions in the short term and reduces CO2 emissions in the long term (Baydoun & Aga, 2021).

On the other hand, there are several other studies that show different results, such as research conducted in Belt and Road Initiative (BRI) countries for the 1990-2017 period used the Dynamic Seemingly Unrelated Regression (DSUR) approach to reveal a significant relationship between economic growth and increasing environmental degradation in the long term (Zhuo & Qamruzzaman, 2021). The author's hypothesis for the influence of economic growth on carbon dioxide emissions is:

H2: Economic growth in the short term contributes significantly to increasing carbon dioxide emissions and, in the long term, contributes significantly to reducing carbon dioxide emissions.

The Relationship between Globalization and Carbon Dioxide Emissions. Over the years, there have been many studies on the relationship between globalization and carbon dioxide emissions. However, there is no consensus regarding the relationship between the influence of globalization and carbon dioxide emissions (Baydoun & Aga, 2021). Several studies have previously investigated the relationship between globalization and carbon dioxide emissions, including research conducted in Mexico, Indonesia, Nigeria, and Turkey for the period 2000-2020 using the Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) approaches, showing that globalization significantly improves environmental quality or reduces environmental degradation using renewable energy (Li et al., 2022). These results are similar to research conducted in 9 top globalized countries, and the data period is 1990-2019 using the Dynamic Ordinary Least

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Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) approaches, finding that globalization mitigates CO2 emissions, thereby contributing to environmental sustainability by importing and using energy-saving machines (Weimin et al., 2022).

On the other hand, several other studies show different results, such as research conducted in 5 South Asian countries for the period 1985-2018 using the Fully Modified Ordinary Least Squares (FMOLS) approach, which found that globalization had a significant effect on increasing CO2 emissions which caused environmental degradation because it was not yet operational using energy-saving technology with the integration of clean energy (Wen et al., 2021). These results are similar to research in South America for the 1995 to 2020 period using the Pooled Mean Group (PMG), Mean Group (MG), and Dynamic Fixed Effects (DFE) approaches, showing that economic globalization has a positive impact on environmental pollution because there is no pressure on trade environmentally friendly abroad (Ali et al., 2022). The author's hypothesis for the influence of globalization on carbon dioxide emissions is:

H3: Globalization (Economic Aspects, Social Aspects, Political Aspects, Overall Aspects), in the short term, contributes significantly to increasing carbon dioxide emissions, and in the long term, contributes significantly to reducing carbon dioxide emissions.

METHODS

In this article, the dependent variable is carbon dioxide emissions. At the same time, Islamic finance is proxied by Islamic bank financing of the private sector, and economic growth is proxied by gross domestic product, and globalization (economic aspects, social aspects, political aspects, and overall aspects) is the independent variable. The samples in this research are Malaysia, Saudi Arabia, the United Arab Emirates, and Indonesia, using data for the 2015 to 2020 period. The data comes from secondary data obtained from WDI or World Development Indicators, IFSB or Islamic Financial Services Board, and the KOF Globalization Index. The **Table 1** that explains the units and data sources for each variable in this article:

Table 1. Units and Data Sources for Research Variables

Variable	Unit	Data source
Carbon Dioxide (CO2) Emissions	Metric tons per capita	World Bank, World Development Indicators (WDI)
Islamic Finance (KI)	Million US$	Islamic Financial Services Board (IFSB)
Gross Domestic Product (GDP)	GDP per capita (constant 2015 US$)	World Bank, World Development Indicators (WDI)
Globalization (GLB)	Globalization Index of Overall aspect (GLB) Globalization Index of Economic Aspects (GLBE) Globalization Index of Social Aspects (GLBS) Globalization Index of	KOF Globalization Index

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The dynamic panel data model is one of the popular models for handling short-panel structures or the number of minor cross sections compared to the number of times series. The Generalized Method of Moments (GMM) approach is an approach for estimating parameters in statistical models. It is suitable for dynamic panel data models because it is appropriate for overcoming endogeneity problems and can see short-term and long-term contributions (Jahanger, 2022).

In this article, the estimation method used is System GMM (Sys-GMM) with One Step Estimator, which meets the model criteria of unbiasedness, validity, and consistency. This research employed a significance level of 0.010 or a confidence level of 99per cent. All data for research variables were transformed into natural logarithms to ensure consistent and reliable results. The research conducted the analysis using Stata version 17 software. Several previous studies addressed issues contributing to CO_2 emissions through a similar approach (Khan et al., 2021), (Jahanger, 2022), (Deka et al., 2023). Thus, the equation of this research model is as follows:

$$LnCO2_{i,t} = \beta_0 + \delta\, LnCO2_{i,t-1} + \beta_1\, LnKI_{i,t} + \beta_2\, GDP\, i_{,t} + \beta_3\, LnGLB_{i,t} + \beta_4\, LnGLBE_{i,t} + \beta_5\, LnGLBS_{i,t} + \beta_6\, LnGLBP_{i,t} + \varepsilon_{i,t} \quad \text{..... (1)}$$

Where i indicates the cross-section unit, namely the country (i of 1,2,3,4), t indicates the time-series unit (t of 2015 to 2020), β_0 indicates the constant value, $\beta_1\, \beta_2\, \beta_3\, \beta_4\, \beta_5\, \beta_6$ shows the coefficient value of the independent variable that contributes to the dependent variable, δ shows the scalar of the lag of the dependent variable at the position of the independent variable, and ε shows the error component.

RESULTS

Figure 1 displays the average value of research variables from 4 countries for 2015 to 2020.

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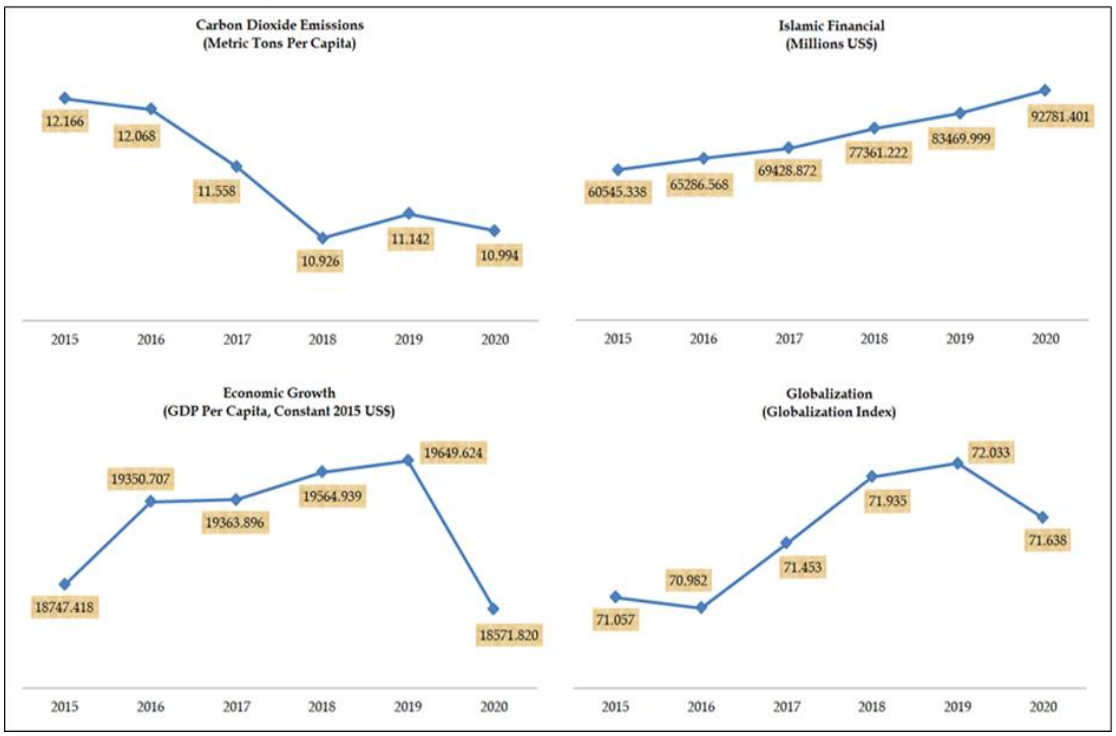

Figure 1. Average Value of Research Variables
Source: processed by the author

According to **Figure 1**, the average value of carbon dioxide emissions from 4 countries shows that 2015 was the highest in producing carbon dioxide emissions at 12,166 metric tons per capita.

Malaysia as one of the countries in Southeast Asia with a rapidly growing economy, has a significant level of CO2 emissions. The support of natural resource-based industries and transportation that rely on fossil fuels, such as motor vehicles and power generation, has been an important factor in the country's increasing per capita carbon dioxide emissions.

Saudi Arabia is known as the world's leading oil producer. Its economy relies heavily on the oil and gas industry, which produces high CO2 emissions. Although the country has a relatively small population, high levels of energy consumption and dependence on the oil sector lead to high per capita CO2 emissions.

The United Arab Emirates is one of the countries in the Middle East that has experienced rapid economic growth in recent decades. The construction of magnificent infrastructure, shopping malls, and a booming tourism industry have been major factors in the country's increasing per capita CO2 emissions.

Indonesia an archipelago with a large population and growing economy, faces similar challenges in controlling CO2 emissions. Rapid economic growth, along with a reliance on coal burning and deforestation, has led to an increase in the country's per capita CO2 emissions.

Based on **Figure 1**, the average value of carbon dioxide emissions from 4 countries shows that 2018 is the lowest in producing carbon dioxide emissions, which is 10,926 metric tons per capita.

Malaysia has a history of steady and rapid economic growth. However, stricter environmental policies and a transition to renewable energy have helped Malaysia lower its

CO2 emissions. Investments in green technologies, such as solar and wind power generation, have been a key driver in reducing the country's carbon footprint.

Saudi Arabia as the world's leading oil producer, has been faced with pressure to reduce its dependence on fossil fuels. While it still relies on oil as its main source of energy, Saudi Arabia is beginning to turn its attention to cleaner energy sources, such as nuclear and solar energy.

The United Arab Emirates is an important economic and financial center in the Middle East. Although famous for its oil and gas industry, the UAE has begun steps towards diversifying its economy and energy sources. Large investments in renewable energy, such as solar power plants and wind energy projects, have helped reduce the country's CO2 emissions.

Indonesia an archipelago with a large population, has unique challenges in managing its CO2 emissions. While it still relies on coal as its main energy source, Indonesia has taken steps to promote renewable energy and reduce deforestation. Tree planting programs and renewable energy development have been the main focus of efforts to reduce CO2 emissions in Indonesia.

As depicted in **Figure 1**, the average value of Islamic finance from 4 countries shows that 2020 is the highest in generating Islamic finance, amounting to 92781.401 million US dollars.

Malaysia as one of the leading centers of Islamic finance, has contributed significantly to this achievement. Various initiatives such as the establishment of Islamic financial institutions, the development of Islamic capital markets, and the promotion of Islamic-based financial products have driven the growth of this sector in Malaysia.

Saudi Arabia, as the host of Islam's two holiest sites, has an important role to play in strengthening Islamic finance. Investments in large infrastructure projects and Islamic economic development initiatives are the main drivers of Islamic finance growth in the country.

The United Arab Emirates, particularly Dubai and Abu Dhabi, also made a significant contribution. Being a global financial and investment center, the country has successfully attracted investors to the Islamic finance sector through innovative products and sophisticated Islamic financial services.

Indonesia, with the world's largest Muslim population, is a key player in the rise of Islamic finance. Increased public awareness of the principles of Islamic finance, along with government support in developing favorable regulations, has created a conducive environment for the growth of the sector.

In accordance with **Figure 1**, the average value of Islamic finance from 4 countries shows that 2015 was the lowest in generating Islamic finance, which amounted to 60545.338 million US dollars.

This phenomenon can be explained by several factors that affected the Islamic finance industry in 2015. One of them is the global economic conditions that have not fully recovered after the global financial crisis in 2008. This condition put pressure on the financial sector as a whole, including the Islamic finance sector.

In addition, internal factors in each country can also affect the performance of Islamic finance. For example, Malaysia, Saudi Arabia, United Arab Emirates and Indonesia have different economic and financial dynamics. Changes in economic policies, financial regulations, and political conditions in each country can also affect the performance of the Islamic finance sector.

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In 2016 to 2020, despite fluctuating global economic conditions, the Islamic finance industry began to show signs of recovery. Countries involved in the Islamic finance industry have made various efforts to strengthen their Islamic finance infrastructure, improve Islamic finance literacy, and expand shariah-compliant financial products.

In addition, the growing awareness and interest in Islamic finance in a number of countries has also contributed to the growth of the sector. The development of Islamic financial institutions, such as Islamic banks, Islamic insurance companies, and other financial instruments, has been a major focus in increasing the penetration of the Islamic finance market at both domestic and global levels.

Therefore, despite 2015 being a challenging year for the Islamic finance industry, the period afterward showed signs of recovery and more stable growth. The continuation of development and innovation efforts in the Islamic finance industry is expected to help face future challenges and strengthen the position of the Islamic finance sector in the global economy.

In line with **Figure 1**, the average value of GDP per capita from 4 countries shows that 2019 is the highest in producing GDP per capita, which is 19649,624 (Constant 2015 US$).

Malaysia is one of the four countries that contributed to the highest average GDP per capita in 2019. Malaysia, as a developing country with a growing economy, has strong economic sectors, especially in manufacturing, technology and tourism. Steady and diversified economic growth has helped Malaysia achieve a significant position in contributing to high GDP per capita.

Saudi Arabia, an economy dominated by the oil and gas sector, also contributed greatly to the average GDP per capita in 2019. Although Saudi Arabia is highly dependent on the energy sector, efforts have been made to diversify the economy to reduce dependence on oil and gas. Nonetheless, the contribution of the energy sector remains the main driver of Saudi Arabia's economy.

The United Arab Emirates is another country that was instrumental in achieving the highest average GDP per capita in 2019. The country is well known for its remarkable economic transformation, especially in the construction, tourism, and finance sectors. Dubai and Abu Dhabi, the two main cities in the United Arab Emirates have become important financial and tourism centers in the Gulf region, contributing significantly to the country's GDP per capita.

Indonesia as one of the most populous countries in the world, also contributed to a high average GDP per capita in 2019. Although Indonesia still faces challenges in infrastructure development and equitable economic distribution across regions, steady economic growth and success in sectors such as agriculture, manufacturing, and services have helped the country increase its contribution to GDP per capita.

Following **Figure 1**, the average value of GDP per capita from 4 countries shows that 2020 is the lowest in producing GDP per capita, which is 18571,820 (Constant 2015 US$).

Malaysia is one of the four countries that contributed to the average GDP per capita in 2020. The country has a history of fairly stable economic growth and has a diverse industrial sector, including manufacturing, agriculture and tourism. However, the impact of the COVID-19 pandemic as well as other global economic factors may have affected Malaysia's economic performance in the year.

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A country rich in natural resources, especially oil, Saudi Arabia also contributed to the average GDP per capita in 2020. Despite its abundance of natural resources, Saudi Arabia faces challenges in diversifying its economy and relies too much on the oil sector.

The United Arab Emirates is another country that is part of the 2020 average GDP per capita. The UAE is well known for its economy driven by the oil and gas sector, and has a thriving tourism and finance sector. However, similar to Saudi Arabia, the UAE also needs to continue working to reduce its dependence on the oil sector.

Indonesia the largest of the four countries in terms of population, also contributed to the average GDP per capita in 2020. Indonesia has diverse economic sectors, including agriculture, manufacturing, mining, and services. However, challenges such as economic inequality, inadequate infrastructure, and environmental issues may have affected Indonesia's economic growth.

Pursuant to **Figure 1**, the average value of globalization from 4 countries shows that 2019 is the highest in terms of globalization, which is 72.033 (Globalization Index).

Malaysia is known for its open and robust economy. The country has become a trade and investment hub in Southeast Asia, attracting the attention of many investors and multinational corporations. Malaysia's integration in global supply chains as well as its participation in international trade organizations are important factors in its contribution to the Globalization Index.

Saudi Arabia plays an important role in the context of globalization through its strong oil industry. The country is not only the world's largest oil producer but also an influential member of OPEC. Saudi Arabia's involvement in the global energy market makes it one of the major players in the globalization process.

The United Arab Emirates also play an important role in globalization, especially through their financial and trade hubs in Dubai and Abu Dhabi. The United Arab Emirates has become an important destination for international business, tourism and investment. The United Arab Emirates' progressive policies in developing infrastructure and attracting foreign capital have increased the country's involvement in the global economy.

Indonesia as one of the countries with the largest population in the world, has a significant impact in the context of globalization. Its huge economic potential, abundant natural resources, and position as a member of the G20 make Indonesia a major player in the regional and global economy. Indonesia's contributions to international trade, investment and diplomacy have solidified its position in the global arena.

Derived from **Figure 1**, the average value of globalization from 4 countries shows that 2016 is the lowest in terms of globalization, which is 70.982 (Globalization Index).

The cause of low globalization was the unstable global economic situation during that time. 2016 was a period in which countries faced significant economic challenges, including fluctuating commodity prices, financial market uncertainty, and declining economic growth globally. This led many countries to reduce their involvement in international economic relations and reduce levels of cross-border investment and trade.

Countries that are part of the average index, namely Malaysia, Saudi Arabia, United Arab Emirates, and Indonesia, may have had more protectionist policies at the time. These policies may include restrictions on trade, foreign investment, or other policies that slow down their economic integration with other countries.

Another factor that can affect the decline in the Globalization Index is political and social changes in some countries. Political policy changes or social tensions can reduce a

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country's willingness to engage in international relations or forge closer partnerships with other countries.

In addition, in 2016, there may also have been a rise in nationalist or protectionist sentiments in some countries that affected their political and economic decisions. Global political uncertainties, including the outcome of the Brexit referendum in the UK and the controversial US presidential election, may also have contributed to the decline in the Globalization Index.

As such, the decline in the Globalization Index in 2016 reflects the complexity of the economic, political and social challenges faced by countries around the world at that time. It shows that globalization does not always move forward in a linear fashion, but can be affected by a variety of complex and often unforeseen factors.

Next, we will discuss the analysis results based on a sample of 4 countries for 2015-2020. First, choose the estimation method between First-Differences GMM (FD-GMM) or System GMM (Sys-GMM) with One Step Estimator. , which is then compared with FEM or Fixed Effect Model and PLS or Pooled Least Squared to ensure that the selected estimation method meets the criteria for unbiasedness. Second, validate and ensure consistency to establish that the System GMM (Sys-GMM) estimation method results with the One Step Estimator are suitable and reliable. Third, interpret the results of the chosen estimation method, System GMM (Sys-GMM). Finally, interpret the results of the short-term and long-term analysis.

Determination of the Estimation Method between First-Differences GMM (FD-GMM) or System GMM (Sys-GMM) with One Step Estimator that Meets Unusual Criteria

Table 2 illustrates the results of comparing estimation methods, including First-Differences GMM (FD-GMM) or System GMM (Sys-GMM) with One Step Estimator, Fixed Effect Model (FEM), and Pooled Least Squared (PLS).

Table 2. Comparison of FD-GMM, SYS-GMM, FEM, and PLS

Variable	FD-GMM	SYS-GMM	FEM	PLS
LnCO2 lag	0.328	0.399	0.328	0.431
LnKI	-0.110	-0.055	-0.110	-0.050
LnGDP	0.949	0.790	0.949	0.825
LnGLB	-37.297	-31.245	-37.297	-35.322
LnGLBE	10.775	8.909	10.775	10.294
LnGLBS	10.321	9.561	10.321	10.684
LnGLBP	17.102	12.069	17.102	14.079
Constant	-10.285	-2.553	-10.285	-4.887

Source: Data processed by the author from Stata version 17 output

The estimation method between First-Differences GMM (FD-GMM) or System GMM (Sys-GMM) with One Step Estimator is said to be suitable for use, and the estimation results can be relied upon if they meet the criteria for the unbiased model. To find out whether the estimation method meets the criteria for unbiasedness, that is, by comparing the results of the LnCO2 lag with the Fixed Effect Model (FEM) and Pooled Least Squared (PLS). If the LnCO2 lag value from the estimation method between First-Differences GMM (FD-GMM) or System GMM (Sys-GMM) with One Step Estimator is between the LnCO2 lag value of the Fixed Effect Model (FEM) and Pooled Least Squared (PLS), then the method The selected estimate meets the criteria for the unbiased model.

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In accordance with **Table 2**, the results show that the LnCO2 lag value from First-Differences GMM (FD-GMM) is 0.328, while the respective LnCO2 lag values from the Fixed Effect Model (FEM) and Pooled Least Squared (PLS) are 0.328 and 0.431. So the value of FD-GMM is not between FEM and PLS but is similar to the FEM value. Hence, the FD-GMM estimation method fails to meet the criteria for an unbiased model, rendering it unsuitable for this research.

Then the LnCO2 lag value from System GMM (Sys-GMM) shows a result of 0.399, while the respective LnCO2 lag values from the Fixed Effect Model (FEM) and Pooled Least Squared (PLS) are 0.328 and 0.431. So the value of Sys-GMM is between FEM and PLS. Therefore, the Sys-GMM estimation method meets the criteria for the unbiased model. So, the best estimation method used in this research is System GMM (Sys-GMM).

Validity Check on System GMM (Sys-GMM). **Table 3** displays the System GMM (Sys-GMM) estimation method results.

Table 3. Sys-GMM Validity Check Results

Validity test	
Chi2(13)	Prob more than Chi2
8.378	0.818

Source: Data processed by the author from Stata version 17 output

The system GMM (Sys-GMM) estimation method is said to have met the validity model criteria if the value of Prob more than Chi2 is more significant than 0.050. The validity test used is the Sargan test (Wicaksono et al., 2023). In accordance **Table 3**, the Prob more than Chi2 value from Sys-GMM is 0.818, more significant than 0.050. Thus, the Sys-GMM estimation method has met the validity model criteria and is suitable for this research.

Table 4. Results of Sys-GMM Consistency Checking

Test Consistency		
Orders	Z	Prob
1	-1.288	0.197
2	-0.367	0.713

Source: Data processed by the author from Stata version 17 output

The sys-GMM estimation method is said to have met the consistency model criteria if the value of Prob in order 2 is more significant than 0.050. The consistency test used in this estimation method is the Arellano-Bond test (Wicaksono et al., 2023). As depicted in **Table 4**, the Prob order two value from Sys-GMM is 0.713, more significant than 0.050. Thus, the Sys-GMM estimation method has met the consistency model criteria and is suitable for this research.

Table 5. Results of the Sys-GMM Estimation Method

Predictor	**Coefficient**	**Standard Error**	**Z**	**P-value**
LnCO2 lag	0.399	0.046	8.640	0.000

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LnKI	-0.055	0.014	-3.830	0.000
LnGDP	0.790	0.1692	4.670	0.000
LnGLB	-31.245	5.499	-5.680	0.000
LnGLBE	8.909	1.590	5.600	0.000
LnGLBS	9.561	1.510	6.330	0.000
LnGLBP	12.069	2.932	4.120	0.000
Constant	-2.553	4.168	-0.610	0.540
Wald chi2(3) = 266.390 Prob = 0.000				

Source: Data processed by the author from Stata version 17 output

Derived from **Table 5**, the equation model of the Sys-GMM estimation method is as follows:

$$LnCO2_{i,t} = -2.553 + 0.399\ LnCO2_{i,t-1} - 0.055\ LnKI_{i,t} + 0.790\ GDP_{i,t} - 31.245\ LnGLB_{i,t} + 8.909\ LnGLBE_{i,t} + 9.561\ LnGLBS_{i,t} + 12.069\ LnGLBP_{i,t} + \varepsilon_{i,t}$$

Wald test results show that the independent variable contributes significantly simultaneously to the dependent variable (Krishnankutty et al., 2023). If the Wald chi2 probability value is smaller than the significance level of 0.010, then the independent variable will contribute significantly simultaneously to the dependent variable. Observing **Table 5**, the probability value for the Wald chi-squared test is 0.000., which means it is smaller than 0.010. So, the lag variables of carbon dioxide emissions, Islamic finance, economic growth, and globalization (economic, social, political, and overall) contribute significantly to carbon dioxide emissions.

Short-Term and Long-Term Estimates in the System GMM (Sys-GMM) Estimation Method.

Table 6. Short-Term and Long-Term Estimation Results

Variable	Short-term		Long-term	
	Coefficient	**P-value**	**Coefficient**	**P-value**
LnKI	-0.055	0.000	-0.092	0.000
LnGDP	0.790	0.000	1.315	0.000
LnGLB	-31.245	0.000	-52.033	0.000
LnGLBE	8.909	0.000	14.837	0.000
LnGLBS	9.561	0.000	15.923	0.000
LnGLBP	12.069	0.000	20.099	0.001

Source: Data processed by the author from Stata version 17 output

The System GMM (Sys-GMM) estimation method shows short-term or long-term contributions (Wicaksono et al., 2023). If the probability value is less than the significance level of 0.010, then the independent variable significantly contributes to the dependent variable. Interpreting the information from **Table 6** above yields the following interpretation:

In the short term, Islamic finance has a coefficient value of -0.055 with a probability value of 0.000, thus indicating that Islamic finance contributes negatively to carbon dioxide emissions. Thus, if Islamic finance increases by 1per cent it will reduce carbon dioxide emissions by 0.056 per cent in the short term and vice versa. Meanwhile, in the long term,

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Islamic finance has a coefficient value of -0.092 with a probability value of 0.000, thus indicating that Islamic finance contributes negatively to carbon dioxide emissions. Thus, if Islamic finance increases by 1per cent, it will reduce carbon dioxide emissions by 0.093 per cent in the long term and vice versa.

Economic growth, as proxied by gross domestic product in the short term, has a coefficient value of 0.790 with a probability value of 0.000, indicating that economic growth contributes positively to carbon dioxide emissions. Thus, if economic growth increases by 1per cent, carbon dioxide emissions will increase by 0.790 per cent in the short term and vice versa. Meanwhile, in the long term, economic growth has a coefficient value of 1.315 with a probability value of 0.000, indicating that economic growth contributes positively to carbon dioxide emissions. Thus, carbon dioxide emissions increase by 1.320 per cent due to economic growth increasing by 1per cent in the long term and vice versa.

Globalization of overall aspect in the short term has a coefficient value of -31.245 with a probability value of 0.000, thus indicating that overall aspect globalization contributes negatively to carbon dioxide emissions. Thus, if the overall aspect of globalization increases by 1 per cent, it will reduce carbon dioxide emissions by 31.250 per cent in the short term and vice versa. Meanwhile, the overall globalization aspect in the long term has a coefficient value of -52.033 with a probability value of 0.000, thus indicating that the overall globalization aspect contributes negatively to carbon dioxide emissions. Thus, if the overall aspect of globalization increases by 1per cent, it will reduce carbon dioxide emissions by 52.030 per cent in the long term and vice versa.

Globalization of economic aspects in the short term has a coefficient value of 8.909 with a probability value of 0.000, thus indicating that globalization of economic aspects contributes positively to carbon dioxide emissions. Thus, if the economic aspect of globalization increases by 1 per cent, it will also increase carbon dioxide emissions by 8.910 per cent in the short term and vice versa. Meanwhile, in the long term, globalization of economic aspects has a coefficient value of 14.837 with a probability value of 0.000, thus indicating that globalization of economic aspects contributes positively to carbon dioxide emissions. Thus, if the economic aspect of globalization increases by 1 per cent, it will also increase carbon dioxide emissions by 14.840 per cent in the long term and vice versa.

Globalization of social aspects in the short term has a coefficient value of 9.561 with a probability value of 0.000, thus indicating that globalization of social aspects contributes positively to carbon dioxide emissions. Thus, if the social aspect of globalization increases by 1 per cent, it will also increase carbon dioxide emissions by 9.560 per cent in the short term and vice versa. Meanwhile, in the long term, globalization of social aspects has a coefficient value of 15.923 with a probability value of 0.000, thus indicating that globalization of social aspects contributes positively to carbon dioxide emissions. Thus, if the social aspect of globalization increases by 1 per cent, it will also increase carbon dioxide emissions by 15.920 per cent in the long term and vice versa.

Globalization of political aspects in the short term has a coefficient value of 12.069 with a probability value of 0.000, thus indicating that globalization of political aspects contributes positively to carbon dioxide emissions. Thus, if the political aspect of globalization increases by 1 per cent, it will also increase carbon dioxide emissions by 12.070 per cent in the short term and vice versa. Meanwhile, in the long term, political aspects of globalization have a coefficient value of 20.099 with a probability value of 0.001, thus indicating that political aspects of globalization contribute positively to carbon dioxide

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emissions. Thus, if the political aspect of globalization increases by 1per cent, it will also increase carbon dioxide emissions by 20.100 per cent in the long term and vice versa.

DISCUSSION

Islamic finance, which is proxied by financing carried out by Islamic banks towards the private sector, the results of this research show that the role of Islamic bank financing towards the private sector has gone well in supporting the sustainability of environmental quality, namely by reducing carbon dioxide emissions. Hence, we hope that Islamic banks' financing to the private sector in Malaysia, Saudi Arabia, the United Arab Emirates, and Indonesia for the 2015 to 2020 period will persist and further enhance their contribution to preserving environmental quality. It involves reducing projects or other activities in the future that generate carbon dioxide emissions.

The results of this study accept the **first hypothesis** and are in line with the findings of previous studies. For example, research in 12 countries of the Organization of Islamic Cooperation in 2013 to 2018 showed that Islamic finance, proxied by the issuance of sukuk and total sharia financing, contributed significantly to reducing CO_2 emissions (Setiawati & Salsabila, 2022). Then, research in Indonesia from 2000 to 2018 revealed that Islamic finance contributed significantly to reducing CO2 emissions (Iskandar et al., 2020).

The above is due to Islamic finance in the 4 countries during the period of 2015-2020 adhering to the principles of halal and sustainable economic activities: these principles encourage investments in projects that promote environmental protection and responsible resource utilization. Then the principle of financing focused on green sectors: Islamic banks tend to provide financing to environmentally friendly sectors, such as renewable energy, waste management, and sustainable transportation. This helps reduce dependence on industries that contribute significantly to carbon dioxide emissions. Furthermore, the commitment to sustainable economic growth: these countries have shown commitment to sustainable economic growth and reduction of greenhouse gas emissions. Islamic financing focused on sectors contributing to the reduction of carbon dioxide emissions aligns with these goals. Finally, the development of green infrastructure: Islamic financing can also be used for the development of green infrastructure, such as environmentally friendly mass transportation systems, renewable energy-based power plants, and energy efficiency improvements.

Economic growth in this research shows that economic growth has not gone well in supporting the sustainability of environmental quality, namely by reducing carbon dioxide emissions. Therefore, we hope that in the future, the countries of Malaysia, Saudi Arabia, the United Arab Emirates, and Indonesia will develop a strategy for the 2015 to 2020 period. This strategy ensures that all activities contributing to the countries' economic growth incorporate environmentally friendly and energy-saving technology. This approach is expected to contribute to reducing carbon dioxide emissions, thereby assisting in addressing the issue of climate change.

The results of this study accept the **second hypothesis** in the short term and reject the second hypothesis in the long term and are in line with the findings of previous studies. For example, research in 17 Asia-Pacific countries from 1960 to 2020 showed that economic growth harmed the environment, increasing CO_2 emissions (Rahman & Alam, 2022). Then, research took place in Saudi Arabia from 1985 to 2019, resulting in economic growth that contributed to increasing CO_2 emissions (Alajlan & Alreshaidi, 2022).

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This is because economic growth in the four countries during the period of 2015-2020 experienced an increase in energy consumption: as the economy grows, energy consumption tends to rise. The higher energy demand is usually accompanied by increased use of fossil fuels, which are the main source of carbon dioxide emissions. Furthermore, infrastructure expansion often follows economic growth, such as the development of larger infrastructure like transportation networks, factories, and settlements. This development requires significant energy use and often results in carbon dioxide emissions, especially if the infrastructure is not designed with energy efficiency and environmental impact in mind. Additionally, industrialization often accompanies economic growth, leading to more intensive industrial processes. These industries typically produce high carbon dioxide emissions as a result of energy production and usage in manufacturing processes. Lastly, changes in consumption patterns: economic growth often increase people's purchasing power, leading to increased consumption of goods and services. The production of these goods often requires energy and natural resources that contribute to carbon dioxide emissions. Thus, while economic growth provides benefits in terms of increased welfare and social progress, its side effects in the form of increased carbon dioxide emissions highlight the importance of developing more sustainable and environmentally friendly growth models.

The overall aspect of globalization in the results of this research shows that globalization has gone well in supporting the sustainability of environmental quality, namely by reducing carbon dioxide emissions. Hence, we hope that the overall aspect of globalization in Malaysia, Saudi Arabia, the United Arab Emirates, and Indonesia for the 2015-2020 period will persist and further enhance its contribution to reducing carbon dioxide emissions. This can be achieved through the transfer of technology that utilizes environmentally friendly energy sources and by fostering continuous collaboration. Internationally, in overcoming climate change, to create excellent and sustainable environmental quality in the global world.

The results of this research reject the **third hypothesis** in the short term, accept the third hypothesis in the long term, and are in line with the findings of previous studies. Such as research that took place in 36 member countries of the Organization for Economic Co-operation & Development (OECD) for the period 1985 to 2018, the result of which was that globalization helped reduce carbon dioxide emissions, thereby improving environmental quality (Cao et al., 2021). The research conducted in 9 countries showed that globalization contributed to mitigating CO2 emissions, creating environmental sustainability (Weimin et al., 2022).

This is because the overall aspect of globalization in the four countries during the period of 2015-2020 has facilitated green technology transfer: globalization enables the transfer of green technology between developed and developing countries. Technologically advanced countries can share knowledge and environmentally friendly technologies with developing countries, assisting them in adopting cleaner and more sustainable practices. Additionally, foreign investment and environmental standards: globalization facilitates the flow of foreign investment into developing countries. To attract foreign investment, these countries often have to adhere to higher environmental standards. This can encourage the use of cleaner technology and more environmentally friendly business practices. Furthermore, increased environmental awareness: with globalization of information and communication, awareness of environmental issues has become more widespread. People worldwide are becoming increasingly aware of the importance of environmental protection

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and reducing carbon dioxide emissions. This can trigger pressure on governments and companies to take more proactive action in combating climate change. And international collaboration in climate change mitigation: globalization facilitates international collaboration in addressing climate change. Countries work together in international agreements such as the Paris Agreement to collectively reduce carbon dioxide emissions.

The economic, social, and political aspect of globalization in this research shows that it has not gone well in supporting the sustainability of environmental quality, namely by reducing carbon dioxide emissions. Therefore, we anticipate that the globalization of economic, social, and political aspects in Malaysia, Saudi Arabia, the United Arab Emirates, and Indonesia for the 2015 to 2020 period will facilitate the transfer of green technology, enhance production efficiency, and promote sustainable trade. Then, provide knowledge to increase global awareness in regulating more sustainable energy consumption patterns. One important thing is increasing political pressure from international organizations to encourage stricter policies and concrete steps to reduce carbon dioxide emissions to help overcome climate change.

The results of this study in line with the findings of previous studies. For example, research in South America for the 1995 to 2020 period showed that economic aspects of globalization contributed to environmental pollution through CO_2 emissions (Ali et al., 2022). Furthermore, research in 170 countries from 1990 to 2018 showed that social aspects of globalization contributed to increasing carbon dioxide emissions (Muhammad & Khan, 2021). Then, research in Singapore from 1970 to 2014 found that political aspects of globalization contributed to increasing carbon dioxide emissions (Mehmood, 2021).

CONCLUSION

This research analyzes the influence of Islamic finance, economic growth, and globalization (economic aspects, social aspects, political aspects, and overall aspects) on carbon dioxide emissions in 4 countries for the 2015 to 2020 period. The estimation method used in this analysis, which meets the model criteria of unbiasedness, validity, and consistency, is System GMM (Sys-GMM). The analysis shows that Islamic finance, economic growth, and globalization (economic aspects, social aspects, political aspects, and overall aspects) simultaneously contribute to carbon dioxide emissions with a significance level of 0.010 or a confidence level of 99 per cent. In the short term, Islamic finance and globalization contribute to reducing carbon dioxide emissions with a significance level of 0.010 or a confidence level of 99 per cent. Meanwhile, economic growth social and political globalization contribute to increasing carbon dioxide emissions with a significance level of 0.010 or a confidence level of 99 per cent. Then, in the long term, Islamic finance and globalization contribute to reducing carbon dioxide emissions with a significance level of 0.010 or a confidence level of 99 per cent. Meanwhile, economic growth social and political globalization contribute to increasing carbon dioxide emissions with a significance level of 0.010 or a confidence level of 99 per cent.

Based on the results obtained from this research, we can propose several policy implications. Firstly, Islamic banks providing financing to the private sector should actively promote environmentally friendly activities or projects, and private sector entities should implement energy-efficient activities or projects. Secondly, state policymakers should formulate strategies to ensure that all activities or projects contributing to the country's economic growth integrate renewable energy technology, efficient energy use, and

sustainable trade practices that preserve the environment. Finally, policymakers from international organizations are encouraging the implementation of stricter regulations and concrete steps to overcome carbon dioxide emissions by investing in environmentally friendly technology and increasing global awareness in managing more sustainable energy consumption patterns.

This research solely considers the contribution of Islamic finance to carbon dioxide emissions through the financing conducted by Islamic banks for the private sector. Therefore, we suggest that future researchers who will analyze the influence of Islamic finance on carbon dioxide emissions can consider Sharia finance not only from the aspect of Sharia bank financing but also from other aspects, such as the use of funds from Sharia social institutions, and the sharia capital market aspect. The limitation of this research is that the time-series data is relatively short because data for carbon dioxide emissions, economic growth, and globalization is only available globally until 2020. In contrast, data on Islamic finance available globally for several countries only started in 2015.

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