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The effect of financial inclusion and economic integration on green growth in ASEAN

Anak Agung Ketut Agung Dharma Putra and Siskarossa Ika Oktora
Department of Applied Statistics, Politeknik Statistika STIS, East Jakarta, Indonesia

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Abstract

Purpose – This study was conducted to review the overview of green growth and examine the role of financial inclusion as well as economic integration and other variables on green growth in Association of Southeast Asian Nations (ASEAN) countries.

Design/methodology/approach – Principal component analysis (PCA) was used to construct financial inclusion variables and panel data regression analysis to examine the effect of financial inclusion and economic integration on green growth in 10 ASEAN countries from 2010 to 2021.

Findings – The results showed that financial inclusion had played a role in supporting green growth in ASEAN. The rapid development of green finance and green bonds promoted the implementation of better green growth. The variables of export diversification and trade openness had a significant effect on green growth. Therefore, there is a need for appropriate policies to prevent negative effects on the environment and the behavior of ASEAN countries.

Research limitations/implications – The findings of this study suggest that policymakers in ASEAN countries not only focus on gaining economic benefits from financial inclusion and economic integration activities but also pay attention to environmental impacts. Moreover, the ASEAN region is actively developing strategic steps in providing easy access to capital and finance as well as expanding international trade activities through ASEAN Free Trade Area (AFTA). Therefore, it is hoped that apart from being able to establish sustainable policies, this region will also encourage and optimize previous policies to make them more environmentally friendly.

Originality/value – This study used a green growth approach with the Index by the Global Green Growth Institute. This index considered aspects of green economic opportunities and social inclusion that have not been applied in previous studies. In addition, this study contributed to review the activities of economic integration and financial inclusion and the sustainability of green growth in ASEAN countries. Until now, there has been no research focused on ASEAN; even though ASEAN has long carried out economic integration and encouraged financial inclusion policies, this region is vulnerable to environmental degradation issues.

Keywords Environmental degradation, Green growth, Financial inclusion, Economic integration

Paper type Research paper

1. Introduction

Sustainable development is an effort implemented by various countries around the world. The principle is an evaluation of previous concepts focused on economic and infrastructure development, especially through the Gross Domestic Product (GDP). In addition, the importance of this evaluation is because the economic growth measured by all countries is not an accurate measure of sustainable development, specifically when serious environmental problems become inevitable (Long and Ji, 2019). The United Nations in 2002 introduced

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"Green Development" by inviting all countries to participate as a forerunner to the implementation of green growth globally recognizing the importance of the concept and its relationship with environmental aspects and welfare. In this case, green growth can be a strategic opportunity for each country because the concept supports economic development and provides resources and environmental services by supporting investment and innovation (OECD, 2011).

In this application, the concept of green growth often experiences different challenges and problems. Issues related to the environment and economic activities have not been able to benefit each other. Even though economic activities prefer the most optimal profit in supporting economic growth, these activities often have to sacrifice environmental aspects in practice. The interconnectedness of economic activities, such as through international trade, supported by the financial sector is one of the most pressing issues to be studied for its impact on the environment (Moghadam and Dehbashi, 2018). The existence of trade cooperation between countries can be an advantage, through the development of environmentally friendly innovations and technologies as an opportunity to achieve green growth, as well as a challenge with the potential for increased pollution and exploitation of natural resources (OECD, 2019). A similar phenomenon is also occurring in the development of the financial sector towards the environment. Inclusive financial services have the potential to make it easier for economic actors and communities to obtain capital while being a source of increased environmental degradation (Ozili, 2022).

A region closely related to the issue of trade cooperation and the financial sector on the environment is the Southeast Asian region, specifically countries in the Association of Southeast Asia Nations (ASEAN). The organization actively carries out economic cooperation and integration realized through the establishment of ASEAN Economic Community (AEC). In this community, a strategic step has been formed through ASEAN Economic Community Blueprint 2025 by promoting each member country to remain stable in providing easy access to capital and finance as the goal of economic integration (ASEAN, 2015). In addition, the AEC states the ease of trade through the existence of ASEAN Free Trade Area (AFTA). Due to the main objectives of creating a single market and international production base, a positive impact is expected on strengthening and creating strong and competitive economic activities (MITI, 2023). Even though the economy is growing rapidly, only 3 out of 10 ASEAN countries have environmental quality above the average of 180 countries (EPI, 2020). The two sectors should be connected with the environment to maximize the strategy of the country for increasing green growth.

Based on previous studies, there are several approaches to measuring green growth. Saleem *et al.* (2022) and Tawiah *et al.* (2021) measured the concept using an indicator approach in the environmental and resource productivity dimension of the OECD indicators. Other studies that use different approaches include Juniardi *et al.* (2022) with an average of Inclusive Growth Index and Environmental Quality Index (EQI) as well as Leth (2022) forming an index with an economic, environmental and social dimension approach. There is no green growth study with Green Growth Index (GGI) approach issued by the Global Green Growth Institute. GGI is an index formed from 4 dimensions including Efficient and Sustainable Resource Use, Natural Capital Protection, Green Economic Opportunities and Social Inclusion. Compared to the indices used in previous studies, GGI has indicators that review the green economy opportunities through green investment, trade, employment and innovation.

In reviewing the effect of financial inclusion and economic integration, several studies have been conducted previously. Economic integration efforts are approached with variables such as export diversification, trade openness and foreign direct investment (FDI). According to Saleem *et al.* (2022), SAARC member countries in South Asia for the period 2000–2019 investigated the effect of financial inclusion and export diversification as well as other variables such as FDI and quality institutions. The results show that financial inclusion, such as investment, is one of the

crucial elements in supporting green growth. This is in line with Juniardi *et al.* (2022), who noted the importance of financial performance in supporting a region to develop sustainable development. Meanwhile, Saleem *et al.* (2022) reported that FDI was the cause of moving pollution-intensive industries from one country to another. Green growth and export diversification do not affect green growth in SAARC because there are still minimal benefits obtained from exports. In addition, Tawiah *et al.* (2021) reviewed the determinants of green growth in several developed and developing countries. The results showed that economic development played a role in supporting green growth, while trade openness encouraged increased pollution due to production activities. Leth (2022) found that FDI supported the implementation of green growth in the Low-and-Middle Income Countries (LMICs) group through the technological development of a country. Hussain *et al.* (2021) showed that financial inclusion and trade openness had a significant positive effect on increasing CO_2 emissions when viewed from other environmental factors. Similar results were also seen in Zafar *et al.* (2019), where trade openness and FDI had a significant positive effect on CO_2 emissions.

Literature reviews on green growth, specifically in the region, are rare based on the search. However, the impact of economic activities and financial inclusion on the environment should be considered as a basis for designing and implementing sustainable policies. Moreover, the ASEAN region is actively developing strategic steps in providing easy access to capital and finance as well as expanding international trade activities through AFTA. Therefore, it is hoped that apart from being able to establish sustainable policies, this region will also encourage and optimize previous policies to make them more environmentally friendly. In addition, this study contributes to the literature by using a green growth approach with GGI issued by GGGI (2022). A better green growth approach is provided by including the social dimension concerning people's welfare (Jänicke, 2012). In addition, the inclusion of the green economy opportunity dimension in the GGI provides an overview of the green economy. According to the IPAT theory, variables believed to influence the environment, such as population growth, industrialization and energy consumption, must also be considered. This ensures that the resulting model comprehensively incorporates additional factors, impacting environmental sustainability.

The rest of the paper is organized as follows. Section 2 summarizes the related literature and hypothesis, and section 3 introduces the data sources and methodologies. Subsequently, section 4 presents the results and discussion. Section 5 concludes the study, recommendations and research limitations.

2. Literature review and hypotheses development

2.1 Environment degradation and green growth

Environmental degradation can be defined as damage from resource depletion, including biotic and abiotic elements that form the environment (UNESCWA, 2020). In addition, the concept can be interpreted as any change or disturbance to the environment considered destructive or undesirable. Maurya *et al.* (2020) explained that environmental degradation is caused by two main indicators, namely human activities and natural factors. In the development of science, some theories that affect environmental sustainability have been approached with mathematical calculations. The IPAT (*Impact-Population-Affluence-Technology*) model was first developed by Ehrlich and Holdren (1972), which mathematically calculates the degradation or environmental impact (I) of *Population* (P), *Affluence (*A) and *Technology* (T). Many studies have reviewed and proven the influence of these three indicators on the environment. This has led some studies to use other variable approaches with a close relationship to IPAT such as Hussain *et al.* (2021) through variables of financial inclusion, trade openness, energy consumption and industrialization. Furthermore, Le *et al.* (2020) approached this model using the variables of urbanization, industrialization, trade openness and foreign direct investment.

The concept of green growth began during a scientific debate regarding the relationship between economic growth and environmental degradation. Meadows *et al.* (1972) questioned the limits of a country's economic growth to sacrifice environmental aspects. This concept began to develop further until the recognition of economic growth while meeting the objectives of social development and environmental protection (Brundtland, 1987). The Global Green Growth Institute became an organization that specifically studied green growth as a new revolutionary development paradigm (GGGI, 2013). The implementation is expected to find opportunities for low-carbon and climate-compatible economic growth, preventing or tackling pollution, maintaining healthy and productive ecosystems, creating green jobs, reducing poverty and increasing social inclusion.

Based on the IPAT theory, which states that environmental impact (I) is caused by Affluence (A), Population (P) and Technology (T), the green growth approach in explaining environmental impact can be done because this concept can provide a more in-depth and comprehensive picture of economic and social welfare based on the environment. Specifically, GGGI developed a quantitative measure, GGI, to assess a country's green growth achievements. GGI is an index formed from 40 indicators grouped into 4 dimensions, namely Efficient and Sustainable Resource Use, Natural Capital Protection, Green Economic Opportunities and Social Inclusion. The index is a snapshot of green growth including access to basic services and resources, equal gender opportunities and social justice and protection, all of which are key to climate change adaptation. GGI scores ranged from 0 to 100 with 5 country categorizations, namely 1–20, 20–40, 40–60, 60–80 and 80–100 in very low, low, medium, high and very high scores, respectively.

If examined more deeply, IPAT theory also explains that population is one of the determining factors of environmental sustainability. Population, in this case, population growth, can provide benefits in increasing a country's innovation, especially related to environmental issues (Grigg, 1979). In addition, the population can also contribute to the environment through increased use of environmentally unfriendly materials and deforestation for settlement (Birdsall, 1992). With these two conditions, using a two-way hypothesis, the hypothesis used is as follows:

H1. Population growth has a significant effect on green growth in ASEAN in 2010–2021.

IPAT theory also explains that the Technology (T) component also has a role in environmental sustainability. Industrialization and energy consumption are indicators of technological development. Industrialization can help create new environmentally friendly technologies and well-integrated renewable energy consumption will help reduce CO_2 emissions (Javaid *et al.*, 2022; Saidi and Omri, 2020). In addition, industrialization and energy consumption that are not environmentally friendly also have a negative impact on the environment, such as increased CO_2 emissions (Tawiah *et al.*, 2021; Ullah *et al.*, 2020). Thus, based on the above, previous research suggests a two-way effect between industrialization and energy consumption and environmental impacts. Thus, the following hypothesis is applied:

H2. Industrialization has a significant effect on green growth in ASEAN in 2010–2021.

H3. Primary energy consumption has a significant effect on green growth in ASEAN in 2010–2021.

2.2 Financial inclusion and green growth nexus

Atkinson and Messy (2013) described financial inclusion as the process of promoting affordable, adequate and timely access to regulated financial services and expanding their use to all elements of society through appropriate and innovative applications. This includes

financial awareness and education to promote economic as well as social welfare. In its development, there is no single concept related to financial inclusion measurement standards that can be universally accepted. However, Conrad *et al.* (2009) explain that three indicators cause low financial inclusion in a region, including geographical limitations related to the lack of banking services in remote areas, socio-economic limitations related to financial services that can only be accessed by certain socio-economic groups and limited opportunities related to the difficulties of some people due to lack of information or guarantees to obtain financial services. Based on this, Lenka and Bairwa (2016) through their research measured financial inclusion with three dimensions consisting of two indicators. The first dimension is *geographic penetration* measured by the number of commercial banks and ATMs per 1,000 km^2, *demographic penetration* measured by the number of bank branches and ATMs per 100,000 adult population and *banking usage penetration* measured by the volume of private sector loans and deposits to the total GDP of a country.

Concerning environmental sustainability, financial inclusion impacts the environment and human life in two ways. The concept can be used as a tool to build economic resilience in communities against climate change (IPA, 2017). Access to financial services, such as insurance, savings, or loans, helps people meet their consumption needs in the face of unpredictable environmental changes. Furthermore, the development is often associated with carbon gas emissions and ease of access to the financial system has an impact on the quality of the environment. Improved financial inclusion increases the activities of different industrial and manufacturing sectors, causing CO_2 emissions (Charfeddine and Kahia, 2019). In addition, increasing the concept can improve individual energy consumption (Gök, 2020). There are analyses such as studies on 26 countries in Asia showing the effect of financial inclusion on increasing CO_2 emissions (Hussain *et al.*, 2021). Similar results were also shown by Le *et al.* (2020) and Renzhi and Baek (2020). However, research by Salman and Ismael (2023) and Khan *et al.* (2022) shows that financial inclusion affects the environment, especially in reducing CO_2 emissions and supporting the implementation of sustainable development. In addition, there is a phenomenon that shows financial inclusion has a positive impact on green growth in the South Asia region when associated with the implementation (Saleem *et al.*, 2022).

Based on the description above, previous research shows a two-way effect between financial inclusion and environmental impact. Thus, the following hypothesis is applied:

H4. Financial inclusion has a significant effect on green growth in ASEAN in 2010–2021.

2.3 Economic integration and green growth nexus

According to Adam Smith, international trade is a relationship conducted by a country based on its absolute advantage of a country (Salvatore, 2013). Mutual benefit can be obtained by specializing in absolute advantage commodities and engaging in trade to exchange a portion of output when a country exhibits greater efficiency for another commodity. Therefore, a country needs to focus and maximize on a commodity that can provide benefits.

In the development of science, there are several criticisms of a country specializing in its export activities through the Prebisch–Singer hypothesis. This hypothesis states that specialization leads to developing countries' dependence on exports of raw materials and agricultural products as well as imports of consumer and manufactured products from developed countries (Sarin *et al.*, 2022). In the uncertainty of export prices and commodities, a country tends to implement export diversification to maintain economic stability in the long run. This is also supported by Love (1986), where export diversification is a favorable policy in maintaining instability and gaining profits in trade. Therefore, many countries have implemented a more diverse export policy strategy to maintain stable economic growth conditions in the long term.

Adam Smith's theory also states that it is important to implement free trade as a form of economic integration (Salvatore, 2013). Free trade can be a way for a country to expand its trade market network. Furthermore, the concept helps in establishing economic cooperation to enable integration between countries. Economic integration can be a strength of a group of countries because this policy regulates trade activities by reducing or eliminating discriminatory trade barriers.

ASEAN is one of the regions that participate in shaping economic integration in Southeast Asia. This can be shown through the formation of AEC as one of the main topics of discussion regarding AFTA. Furthermore, AFTA should be formed to create a unified market and international production base, facilitate foreign direct investment attraction and promote the expansion of intra-ASEAN trade and investment. These efforts are directed toward strengthening and promoting positive economic activities within the region (MITI, 2023). A country needs to establish an absolute advantage and be supported by investment. This is also consistent with many studies on the relationship between export diversification, trade openness and foreign direct investment to a country's economic growth (Amir *et al.*, 2018; Khalid, 2016; Prawira *et al.*, 2017). Therefore, the aspect of international trade through the diversity of export commodities, trade openness and paying attention to the investment component is an important unit, specifically for ASEAN countries.

Some studies have questioned the influence on environmental quality even though the three variables clearly show an economic relationship. Gozgor and Can (2016) found a positive relationship between export diversification and CO_2 emissions in the Turkish economy. From the existence of various regulations to prevent environmental pollution, companies minimize the production of goods, causing high CO_2 emissions. This can be solved by expanding the export product basket with high CO_2 emissions. Meanwhile, different results have been obtained (Liu *et al.*, 2019), where increasing export diversification increases CO_2 emissions in some developing countries. More diversified export products will increase the potential to implement environmentally unfriendly practices through production activities and exploitation of natural resources.

Based on the description above, previous research shows a two-way effect between export diversification and environmental impact. Thus, the following hypothesis is applied:

H5. Export diversification has a significant effect on green growth in ASEAN in 2010–2021.

The potential of foreign direct investment can be developed and prioritized in sustainable development sectors such as renewable energy, education, health, water and sanitation when viewed from the aspect of foreign direct investment (UNESCAP, 2019). Trade openness assists channel resources between countries and leads to technological improvements (Khalid, 2016). However, foreign direct investment and trade openness can lead to increased environmental pollution. This is explained by the pollution haven hypothesis, where international business becomes a channel for transferring pollution from one country to another due to economic activities carried out (Walter and Ugelow, 1979). This occurs because developed countries have strict and expensive environmental regulations to determine other alternatives in obtaining greater profits by avoiding additional costs due to environmental protection.

Based on this description, trade openness and FDI are economic integration efforts that have a two-way effect on environmental impacts. Thus, the following hypotheses are proposed:

H6. Trade openness has a significant effect on green growth in ASEAN in 2010–2021.

H7. Foreign direct investment has a significant effect on green growth in ASEAN in 2010–2021.

3. Research methodology

3.1 Data and variables description

This study examines the effect of financial inclusion and economic integration on green growth in ASEAN countries. The variable is an approach to the economic aspect or affluence, which in IPAT theory has an impact on environmental impacts. This study also adds other variables thought to affect the environment, namely the population aspect through growth, as well as the technology aspect through primary energy consumption and industrialization (Hussain *et al.*, 2021; Le *et al.*, 2020). The countries used as the locus are 10 countries, which are the member countries including Indonesia, Malaysia, Thailand, the Philippines, Singapore, Myanmar, Cambodia, Vietnam, Laos and Brunei Darussalam, in the period from 2010 to 2021. The selection of the study period was based on the start of green growth measurement by GGGI. See Table 1.

3.2 Methods

This study uses two methods of analysis and in obtaining financial inclusion values. Principal Component Analysis (PCA) is applied by reducing the dimensionality of a data set while maintaining the variance (Jolliffe, 2002). The approach has also been carried out (Lenka

Data	Notation	Unit	Source
Dependent variable			
Green growth index	GGI	Index	Global Green Growth Institute
Independent variable			
Financial inclusion	FI	Score	Principal Component Analysis of the constituent indicators
Export diversification	DE	Index	United Nations Conference on Trade (UNCTAD)
Foreign direct investment	FDI	% GDP	World Bank
Trade openness	TO	% GDP	World Bank and ASEAN Statistical Yearbook
Population growth	PG	%	ASEAN Statistical Yearbook
Industrialization	IND	% GDP	World Bank
Primary energy consumption	ENE	Quadriliun british thermal unit (btu)	Knoema
Financial inclusion compilation indicators			
Geographic penetration			
Indicator number of ATM machines per 1.000 km^2	ATMKM	Proportion	Financial Access Survey IMF
Indicator number of commercial bank branches per 1.000 km^2	BANKKM	Proportion	Financial Access Survey IMF
Demographic penetration			
Indicator number of ATM machines per 100,000 adults	ATMA	Proportion	Financial Access Survey IMF
Indicator number of commercial bank branches per 100,000 adults	BANKA	Proportion	Financial Access Survey IMF
Banking usage penetration			
Indicator credit to private sector ratio	DC	% GDP	World Bank and Bank of the Lao PDR
Indicator deposit ratio at commercial banks	DEPOSIT	% GDP	Financial Access Survey IMF

Table 1.
Summary of variables

and Bairwa, 2016; Nguyen and Ha, 2021) by applying 3 dimensions including geographic penetration, demographic penetration and banking usage penetration and the steps in performing PCA are as follows:

a. Data preprocessing in looking at data distribution. Transformation is carried out when the data has a skewed distribution with extreme values (Jolliffe, 2002). Due to differences in the constituent indicators, data standardization is applied. This study uses natural logarithms as in Ali *et al.* (2021), Nwidobie (2019) and Thathsarani *et al.* (2021) and the following is the linear combination equation (PCA Score) formed:

$$FI_{it} = e_{11} \ln ATMKM_{it} + e_{12} \ln BANKKM_{it} + e_{13} \ln ATMA_{it} + e_{14} \ln BANKA_{it} + e_{15} \ln DC_{it} + e_{16} DEPOSIT_{it} \quad (1)$$

where $i = 1, 2, 3, \ldots, 10$, $t = 1, 2, 3, \ldots, 12$, e is weight (eigenvector) and ln is natural logarithm

b. Data feasibility is conducted using the *Measures of Sampling Adequacy* (MSA), *Kaiser–Meyer–Olkin* (KMO) and Bartlett tests. Data is stated to be suitable for analysis when it has KMO > 0.5. When it is found that <0.5, the indicator with the smallest MSA value is removed until KMO >0.5 is achieved (Field, 2009). Meanwhile, the Bartlett test is used to determine the correlation between variables. This test uses the null hypothesis, where there is no correlation between variables.

c. The number of main components is selected based on the proportion of cumulative variance and eigenvalues worth more than one. The results of the PCA Score are used to represent the financial inclusion variable.

The second analysis method used is panel data regression. In reviewing the effect of independent variables on the dependent variable, the general model applied is as follows:

$$GGI_{it} = \beta_0 + \beta_1 FI_{it} + \beta_2 ED_{it} + \beta_3 FDI_{it} + + \beta_4 TO_{it} + \beta_5 PG_{it} + \beta_6 IND_{it} + \beta_7 ENE_{it} + v_{it} \quad (2)$$

where $i = 1, 2, 3, \ldots, 10$, $t = 1, 2, 3, \ldots, 12$, β_0 is the intercept, β adalah parameter coefficient and v is the *error term*.

This study examines the best model among the Common Effect Model (CEM), Fixed Effect Model (FEM) and Random Effect Model (REM) such as the conventional flow in panel data analysis. In determining the best model, the Chow, Hausman and Breusch Pagan Lagrange Multiplier tests will be applied in comparing CEM and FEM, REM and FEM, as well as REM and CEM (Baltagi, 2005; Greene, 2012). In FEM, it is necessary to check the residual variance-covariance structure of the model. The first test is the Lagrange Multiplier test used to determine the heteroskedastic nature of the residual variance-covariance structure (Greene, 2003). The estimation method used is Ordinary Least Square (OLS) when the residual variance-covariance structure results are homoscedastic. Meanwhile, when the result of the residual variance-covariance structure is heteroscedastic, it is necessary to test λLM. Test λLM is used to determine the presence of cross-sectional correlation of residuals between individual units. The estimation method used is FGLS when a cross-sectional correlation is obtained (Feasible Generalized Least Square). However, the estimation used is Weighted Least Square (WLS) when there is no cross-sectional correlation. Meanwhile, for the other model, REM, the GLS (Generalized Least Square) estimation method will be used.

After the model is selected, multicollinearity is checked and classical assumption testing is carried out through normality, autocorrelation and heteroscedasticity tests. Classical assumption testing shows that the regression model formed is Best, Linear, Unbiased Estimator (BLUE). The checks and tests carried out are based on the estimation method used. The classical assumption tests are normality, homoscedasticity, autocorrelation and multicollinearity assumptions when OLS is the estimation method. Meanwhile, FGLS and Generalized Least Square (GLS) methods in REM only require classical assumption testing with normality tests and non-multicollinearity. This is because both methods have overcome the occurrence of heteroscedasticity and autocorrelation symptoms (Greene, 2012).

4. Result and discussion

4.1 Result

4.1.1 Constructing financial inclusion. In reviewing financial inclusion in the ASEAN region in 2010–2021, an analysis was conducted using PCA by Lenka and Bairwa (2016). The first step was to perform natural logarithm transformation and data standardization on all financial inclusion indicators. Of the six indicators, it is known that the KMO value is < 0.5 so it is necessary to eliminate one variable (Appendix 1). Thus, financial inclusion consists of 5 indicators by eliminating the indicator of the number of commercial bank branches per 100,000 population because it has the smallest MSA value. Based on the KMO test results on 5 indicators, the KMO value was 0.6296, where the data used was suitable for factor analysis (Appendix 2). Based on the Bartlett test, the test statistic value was 749.62 which was more than $\chi^2_{(0.05;\,10)} = 18.31$ or a p-value (0.000). Since the value obtained was less than 5%, H_0 was rejected and at a significance level of 5%, there was a correlation between indicators. The determination of the main components formed was based on eigenvalues that were more than one and supported by the cumulative proportion of variance of 76.10% (Appendix 3). This financial inclusion was explained by the formation of the main components with the following equation:

$$FI_{it} = 0.489 \ln ATMKM_{it} + 0.403 \ln BANKKM_{it} + 0.4275 \ln ATMA_{it} + 0.445 \ln DC_{it} + 0.4663 \ln DEPOSIT_{it} \quad (3)$$

4.1.2 Main regression result. Table 2 shows the tests for obtaining the best panel model with three tests that must be passed. The first test, namely the Chow test, to choose between CEM or FEM shows that the p-value < 0.05 so FEM is selected. From the selected FEM, the next test is carried out, namely Hausman to choose between REM and FEM. Based on this test, p-value $> 0.0\,5$ was obtained so that REM became the selected model. From the selected REM, the final test, namely BP-LM, is carried out to choose between CEM and REM. Based on this test, it was found that p-value < 0.05 so that the best model was REM which uses the GLS estimation method. The subsequent tests carried out are checking multicollinearity and testing the normality of errors with the selection of the REM model.

Test	Statistics	Prob	Conclusion
Chow	115.560	0.0000*	FEM
Hausman	2.670	0.9138	REM
BP-LM	409.117	0.0000*	REM

Note(s): * Significant at 5% level
Source(s): Authors' computation

Table 2. Summary of chow test, hausman test, LM test, and BP-LM test results

The results of checking multicollinearity show that VIF values are less than 10 for all independent variables (Appendix 4). Therefore, there is no multicollinearity in the independent variables. The Jarque-Bera test yielded a *p*-value of 0.12539, which exceeds the 5% significance level when testing the normality of errors (Appendix 5).

Table 3 shows the estimation results of the panel data regression model. Based on the processing results, the Adj *R*-Squared value is 0.4426. This means that the diversity of GGI can be explained by the independent variables by 44.26%. Based on the simultaneous test, the *p*-value was smaller than the 5% significance level. Therefore, it can be concluded that at least one independent variable has a significant effect on green growth.

4.2 Discussion

4.2.1 Descriptive analysis. Figure 1 is a line chart of the green growth index in ten ASEAN member countries in 2010–2021. Based on the chart, it can be seen that in general, the green growth index of some ASEAN countries such as Brunei Darussalam, Malaysia and Myanmar tends to be constant and other countries experience a positive trend.

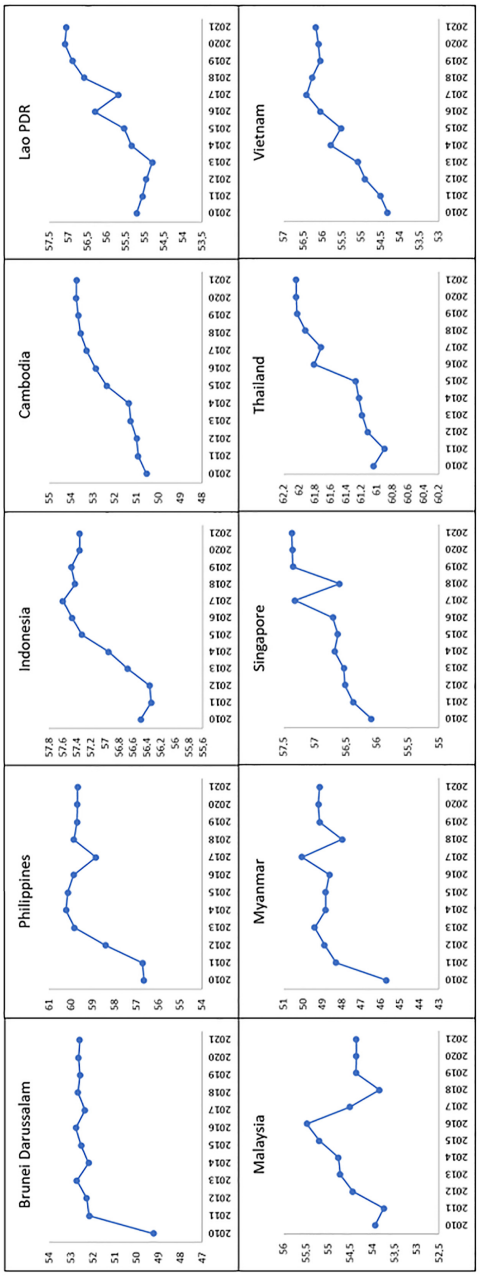
Furthermore, the development of financial inclusion and green growth in the ASEAN region is illustrated in Appendix 6. Meanwhile, economic integration is represented in 3 components, namely export diversification (Appendix 7), foreign direct investment (Appendix 8) and trade openness (Appendix 9). In addition, there are three control variables, namely population growth (Appendix 10), industrialization (Appendix 11) and primary energy consumption (Appendix 12). In general, from 2010–2021, financial inclusion shows a positive trend in all ASEAN countries. Meanwhile, different trend patterns occur in the other three variables. As in the case of export diversification, where this variable can be interpreted if the index value is close to zero, it shows that a country's exports are increasingly diversified. Based on the figure, it can be seen that many countries show a negative trend, while countries such as Indonesia and Myanmar show a positive trend.

4.2.2 Analysis of regression result. The financial inclusion variable has a significant effect on green growth with a coefficient of 0.6535. This means that there is a direct relationship between financial inclusion and GGI by 0.6535, assuming other independent variables are constant. These results are in line with the research of Salman and Ismael (2023) and Khan *et al.* (2022), where financial inclusion affects the environment, especially in reducing CO_2 emissions and supporting the implementation of sustainable development. In addition, this is also in line with Wang *et al.* (2022), where the development of financial inclusion can improve the green economy. The financial inclusion of a region can support the transfer of credit to energy-efficient and low-pollution industries. This is also in line with the development of

Variable	Coefficient	Std. Error	*t*-statistic	Prob
C	58.5251	2.1233	27.5623	0.0000
Financial inclusion	0.6535	0.0986	6.6277	0.0000*
Export diversification	−6.1907	2.3279	−2.6592	0.0090*
Foreign direct investment	0.0070	0.0366	0.1924	0.8478
Trade openness	−0.0085	0.0043	−1.9828	0.0498*
Population growth	−0.0235	0.0553	−0.4244	0.6720
Primary energy consumption	0.4452	0.1691	2.6329	0.0097*
Industrialization	0.0144	0.0248	0.5818	0.5619
Adjusted R^2		0.4426		
Prob (F-stat)		0.0000* (14.501)		

Note(s): * Significant at 5% level
Source(s): Authors' computation

Table 3.
Summary output of panel data regression model estimation results



Source(s): Global Green Growth Institute

Figure 1.
Green growth index in ASEAN countries in 2010–2021

green finance, where financing and investment are directed towards economic growth accompanied by reducing the impact of air pollution, minimizing waste and increasing efficiency in the use of natural resources (OECD, 2016). In addition, 44 green bonds or debentures have been issued in the region as of March 2020, signaling the role of a sustainable financial sector (CBI, 2020). This potential needs to be further developed in the ASEAN region. Moreover, there is research by Saydaliev and Chin (2023) that shows that an increase in green finance significantly increases the amount of pollution removed from the environment.

Export diversification has a coefficient of −6.1906, meaning that when the index increases by one unit, GGI is reduced by 6.1906, assuming other variables are constant. In other words, the more specialized a country's exports are, the more it will lead to a decrease in green growth in that country. This is in line with research by Gozgor and Can (2016), which shows that increasingly diversified exports can be beneficial to the environment. In this case, a country can prevent the production of CO_2 emissions for companies that are prone to producing high pollution by expanding the export product basket so that the possibility of pollution through CO_2 emissions can be imported or diverted. The export specialization of a country is inversely proportional to green growth due to its high dependence on certain export commodities that impact environmental sustainability. This is supported by the statement that most countries, such as Indonesia and Malaysia, tend to favor the export of extractive sectors taking their resources directly from nature (Greenpeace, 2021). The reliance on exports can compel nations to persist in production, even though it necessitates the use of environmentally unsustainable methods. The ongoing production, extraction and transportation of these resources constitute the primary contributors to elevated greenhouse gas emissions and environmental deterioration within the country (EID, 2017).

Trade openness has a significant effect on green growth with a coefficient of −0.0085. Therefore, a 1% increase in this variable reduces GGI by 0.0085 assuming other independent variables are constant. Export activities will increase the demand for natural resources to produce residues and waste, impacting environmental degradation (Hossain and Rao, 2014). These results are also consistent with the pollution haven hypothesis, where the existence of international economic agreements worsens the environmental quality of the host country due to the transfer of pollution (Tawiah *et al.*, 2021).

Primary energy consumption has a significant effect on green growth with a coefficient of 0.4452. Therefore, when energy consumption increases by one quadrillion btu, GGI increases by 0.4452, assuming other independent variables are constant. Even though energy consumption is closely related to environmental degradation, Saidi and Omri (2020) concluded that the variables derived from nuclear and renewable energy used by the industrial sector can reduce economic losses due to declining environmental quality. In addition, ASEAN is also increasingly socializing the use of renewable energy. In 2018, ASEAN has developed 13.9% of renewable energy from total primary energy and this figure will continue to be pursued to reach 23% (ESDM, 2021).

Foreign direct investment does not have a significant influence on GGI in the ASEAN region. In 2015, the countries agreed and committed to increase the share of solar, wind and hydropower from 9% in 2014 to 23% in 2025, which is one form of foreign direct investment (IRENA and ACE, 2016). However, ASEAN has become one of the slowest renewable energy development regions in terms of investment (Daubach, 2019). In 2018, the investment obtained in the renewable energy sector amounted to 7 billion US dollars or only 25% of the total targeted investment (IRENA and ACE, 2016).

Industrialization does not have a significant influence on GGI in the region. The absence of a significant effect between industrialization and green growth cannot be interpreted as the absence of consequences accepted from industrialization. This is due to the low government

support in some countries for the industrial sector in the use of renewable energy (Vakulchuk *et al.*, 2022). The increasing use of fossil fuels in the region is dominated by industrial activities (IEA, 2022). These activities focus more on increasing profits for companies without regard to environmental aspects. Therefore, industrialization support is a platform for creating new environmentally-based technologies to support green growth.

5. Conclusion and recommendations

This research was conducted to analyze the role of financial inclusion and economic integration in green growth in ASEAN using the GGI issued by GGGI. The results show that financial inclusion has contributed to supporting green economic growth in a country. This shows that developing financial inclusion can improve the green economy. This is happening only in ASEAN to the development of financial services such as green bonds. In economic integration efforts represented by three variables, only export diversification and trade openness have a significant effect on the implementation of green growth. If an ASEAN country's exports become more specialized, this will increasingly have an impact on reducing green economic growth in that country. In practice, dependence on an export commodity will encourage higher exploitation of natural resources, thereby potentially damaging the environment. Meanwhile, only primary energy consumption affected the variable when viewed from the variables in the IPAT theory, unlike population growth and industrialization. The use of IPAT ensures that the resulting model comprehensively includes additional factors that impact environmental sustainability.

The suggestions from this study were: (1) Each country implemented strategies in expanding financial services. ASEAN can strengthen regional cooperation in the development of effective green finance, such as involving the exchange of knowledge and resources between countries. In addition, the affordability of financial services should be followed by policies such as limiting investment and capital loans to environmentally unfriendly sectors and providing opportunities for more sectors to obtain business capital. (2) The government needs to improve the development of infrastructure that can support green technology. With the availability of these facilities, it is expected to encourage increased investment in the green sector to develop better. (3) There was a need to monitor international trade activities and energy consumption. An export diversification policy is recommended to reduce the environmental impact caused by dependence on one export commodity while maintaining the economic benefits obtained. In addition, it is necessary to carry out import-export activities for environmentally friendly products were carried out and followed by increased use of renewable energy.

This research is limited by the unavailability of complete data in several countries, such as the use of energy consumption variables. This variable cannot be separated between renewable and non-renewable energy consumption because complete data is not yet available in all countries so this research is only approached with primary energy consumption. Thus, future research can separate energy consumption into renewable and non-renewable energy for more in-depth analysis. In addition, future research could examine the determinants of green economic growth at a more specific level, such as provinces. This was intended to make green growth policies more specific based on the characteristics of each province.

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Online appendix

The supplementary material for this article can be found online.

Corresponding author

Siskarossa Ika Oktora can be contacted at: siskarossa@stis.ac.id