



Sustainable Economic Performance in Kalimantan: A Perspective from Islamic and Conventional Banks—The Potential for Agricultural Financing and Financial Literacy

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Abstract: The island of Kalimantan, with its wealth of natural resources and strong agricultural and forestry sectors, is key to driving green economic development in Indonesia. This study develops a Data Envelopment Analysis model to measure sustainable economic performance in Kalimantan, focusing on the agricultural and forestry sectors. The potential for agricultural financing from commercial banks (conventional and Islamic banks), as well as regional banks (BPR and BPRS), is proposed as a driving factor for Sustainable Economic Performance, incorporating the moderating effect of financial literacy. This study utilises panel data from 55 regencies/cities on the island of Kalimantan for the period 2014–2023. The findings reveal that Sustainable Economic Performance on the island of Kalimantan is not yet efficient, with the highest level of Sustainable Economic Performance recorded in East Kalimantan Province and the lowest in South Kalimantan Province. Regression analysis results indicate that the potential for agricultural financing in Conventional Commercial Banks, Sharia Commercial Banks and Rural Banks (BPR) has a negative effect on Sustainable Economic Performance. However, the moderation of conventional and Sharia financial literacy successfully exerts a positive influence on the potential for agricultural financing in each of these banking sectors regarding Sustainable Economic Performance. Conversely, for Islamic Rural Banks (BPRS),

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no evidence was found of an influence of the potential for agricultural financing on Sustainable Economic Performance in Kalimantan, either before or after moderation by Islamic financial literacy. The research findings recommend that regulators provide substantial support for agricultural financing across various banking schemes and develop more integrated financial literacy enhancement programmes.

Introduction

Enhancing economic resilience whilst taking environmental quality into account has become an international agenda promoted through the concept of the green economy (Liu *et al.*, 2022). The United Nations Environment Programme (2011) defines the green economy as a low-carbon, resource-efficient, and socially inclusive economy. From an Islamic perspective, this agenda is consistent with the objectives of Maqasid al-Shariah, namely to promote the welfare of the community (jalb al-masalih) and to prevent harm (dar' al-mafasid) (Waid & Lestari., 2020). In Indonesia, the government has responded to the green economic transition by issuing the Sustainable Finance Roadmap and OJK Regulation No. 51 of 2017 on the Implementation of Sustainable Finance and the Indonesian Green Taxonomy. One of its key focuses is to encourage financial institutions to develop various sustainable and environmentally friendly financial instruments. In this context, one of the financial instruments that can be highlighted is agricultural financing (Nasution *et al.*, 2021; Pambekti and Lestari, 2023).

Agricultural financing in Indonesia is primarily channelled into productive sectors such as agriculture, plantations, and forestry (Otoritas Jasa Keuangan, 2018). In the agricultural sector, for example, agricultural financing can help agricultural industry players secure additional capital to adopt more intensive and sustainable farming practices (Andriani *et al.*, 2021; Xu *et al.*, 2022), such as the purchase of environmentally friendly fertilisers, crop rotation, and improved erosion management (Yang *et al.*, 2022). Productive and sustainable agricultural financing represents the practical application of *Hifz al-Mal* within the modern financial system; capital is not merely sought for profit, but also to safeguard the sustainability of natural resources as a trust (*istikhlaf*) from Allah SWT entrusted to humankind as His vicegerents on earth (Zain *et al.*, 2024).

Unfortunately, the agricultural financing portfolio held by banks in Indonesia remains very low. According to the Indonesian Banking Surveillance Report for the Third Quarter of 2023, the share of bank lending to the agriculture, hunting, and forestry sectors stood at just 7.03% of total bank lending (Otoritas Jasa Keuangan, 2023). Several studies also indicate that financing in green sectors such as agriculture carries a relatively high level of risk (Morgan *et al.*, 2012; Yin *et al.*, 2019, 2020). In addition to market and business operational risks, this sector is vulnerable to additional weather-related risks (Yin *et al.*, 2020). Banks also typically lack adequate monitoring and control mechanisms, as agricultural and forestry production is usually located in remote areas, where transport and information gathering face access limitations (Yin *et al.*, 2020). On the other hand, several studies suggest that banks that play an active role in supporting green projects can enhance their reputation in the eyes of the public and their customers (Abuatwan, 2023; Park and Kim, 2020; Zhang *et al.*, 2022). By integrating agricultural financing into their portfolios, banks can expand their market share by attracting customers who are increasingly concerned about environmental issues (Mirovic *et al.*, 2023).

Within the framework of *Maqashid al-Shariah*, banks including Islamic banks, bear a moral responsibility to channel capital into sectors that support *Hifz al-Nafs* (the protection of life through food security) and *Hifz al-Biah* (the protection of the environment), so that financial intermediation truly serves as an instrument for the public good, rather than merely for profit (Zain et al., 2024). Ultimately, banks and society must work hand in hand to transition towards a green economy. It is therefore important to encourage the banking sector to maximise the potential of agricultural financing that can be offered to the public in support of sustainable economic performance.

Based on this motivation, this study examines the potential for agricultural financing across four banking schemes: conventional commercial banks, Islamic commercial banks, Rural Credit Banks (BPR), and Islamic Rural Credit Banks (BPRS). Given the diversity of economic, social and cultural characteristics in Indonesia, the study focuses on a regional analysis, with the island of Kalimantan as the unit of analysis. The island of Kalimantan was chosen due to its significant role in reducing carbon emissions by setting aside 45% of its territory for forest conservation, thereby making it one of the world's 'lungs' (Center for International Forestry Research, 2012). The conservation of Kalimantan's forests embodies *Hifz al-Biah* (environmental protection), which Yusuf al-Qaradawi and Jasser Auda have identified as the sixth *maqasid*, complementing the classical *maqasid*. Forest destruction not only has ecological impacts but also threatens *Hifz al-Nafs*, *Hifz al-Nasl*, and *Hifz al-Mal* through disasters, ecosystem degradation, and declining agricultural productivity. Therefore, financing sustainable agriculture in Kalimantan serves as a convergence point between the interrelated principles of *Hifz al-Mal* and *Hifz al-Biah* (Zain et al., 2024). Agricultural financing is expected to help Kalimantan maintain this status through capital support for green projects. Furthermore, there is a strong push to adopt sustainable agricultural practices in Kalimantan, particularly since the region was designated as one of Indonesia's food estate development hubs (Rasman et al., 2023). Economic performance in the agriculture and forestry sectors in Kalimantan remains relatively low and therefore needs to be improved. For example, the contribution of the agricultural sector to economic growth in South Kalimantan was only 1.59% in 2022 and 3.17% in 2023 (BPS Kalimantan Selatan, 2023). Consequently, agricultural financing is expected to support green economic growth in Kalimantan by promoting environmentally friendly investment and empowering the local economy.

This study also incorporates financial literacy as a moderating variable. Financial literacy is considered important for the public to access agricultural financing from banks (Pambekti and Lestari, 2023), particularly in rural areas such as the island of Kalimantan. Financial literacy indices in most provinces of Kalimantan up to 2022 still showed unsatisfactory results, falling below the national financial literacy index of 49.68% (OJK, 2022). Low levels of financial literacy can hinder individuals' understanding of banking products and services, thereby creating disparities in access that affect economic development (Agarwalla et al., 2017; Andreou and Anyfantaki, 2021; Hasan et al., 2021). From the perspective of *Maqashid al-Shariah*, low financial literacy hinders *Hifz al-'Aql* because it makes it difficult for people to make rational economic decisions. Therefore, adaptive financial literacy is an important component in achieving economic well-being (Zain et al., 2024).

Against this background, this study offers three key contributions. Firstly, this study will be the first to evaluate agricultural financing within the dual banking system: Islamic and conventional. Islamic banks use a profit-sharing model that differs from that of conventional banks, and they normatively direct their financing in accordance with the principles of *Maqasid al-Sharia*, including support for the agricultural sector as an implementation of *Hifz al-Mal* and *Hifz al-Biah* (Khan et al., 2023). This issue has led to a gap in previous studies regarding the provision of appropriate recommendations for the development of more inclusive financial

products and services within this dual banking system. Secondly, this study specifically examines sustainable economic performance at the sub-regional level, namely in the districts/cities of the five provinces on the island of Kalimantan, thereby providing a more detailed picture for the formation of agricultural financing portfolios tailored to the characteristics of each region an aspect rarely considered in previous research. Examination at the regional level will assist in the development of more targeted strategies and policies and can demonstrate the investments required to achieve sustainable development at the regional level (Yang *et al.*, 2015). Finally, this study will report on the effectiveness of agricultural financing on various types of financial literacy, serving as a valuable reference for the development of more adaptive financial literacy programs and as a concrete step toward the realization of *Hifz al-'Aql* within an inclusive financial system.

Literature Review and Hypothesis Development

Sustainable Economic Performance

Sustainable economic performance combines economic expansion, resource conservation and environmental protection simultaneously (Li and Lin, 2016). Zhao *et al.*, (2020) measured sustainable economic performance in terms of its efficiency using a comprehensive index that combines economic, social and environmental development within resource and environmental constraints. Islamic economics views sustainability objectives as being closely aligned with *Maqasid al-Shariah*, which emphasise the preservation of human welfare and ecological balance (Ansori *et al.*, 2025). Economic development is therefore expected not only to achieve productivity and growth, but also to protect social well-being and environmental sustainability (Al-Jayyousi, 2023). In sectors closely associated with natural resource utilisation, such as agriculture and forestry, the principles of *Hifz al-Mal* (protection of wealth), *Hifz al-Nafs* (protection of life), and *Hifz al-Biah* (environmental protection) position sustainable resource management as an inseparable component of economic development in Islam (Hasanah *et al.*, 2025).

Several studies have used Data Envelopment Analysis (DEA) to assess Sustainable Economic Performance by measuring efficiency in energy use and pollutant emissions (including CO₂). For example, Chen (2015) developed dynamic indicators to measure the green economic transition in China using a slack-based DEA model. Chen *et al.*, (2016) measured the development of the green industry in China, whilst Fei and Lin (2016) assessed sustainable economic performance based on energy efficiency in China's agricultural sector. However, much previous research has used cross-sectional data to evaluate energy and environmental performance, rather than panel data, which incorporates a time dimension. Consequently, a limitation of these studies is their inability to analyse dynamic changes in efficiency performance, such as green economic growth (Zhang and Choi, 2013). Therefore, this study will assess Sustainable Economic Performance using a DEA model, which will be explained in more detail in the Methodology section.

Potential for Agricultural Financing

Agricultural financing, often referred to as green lending, green financing or green loans (Al-Qudah *et al.*, 2022; Azad *et al.*, 2022; Zhou *et al.*, 2022) is investment financing and lending intended for various projects and initiatives that reduce negative environmental impacts whilst taking into account environmental risk management strategies and the long-term sustainability of such plans (Sharma *et al.*, 2022). One area of green financing is funding in the agricultural sector through capital assistance for farmers to develop organic farming, expand the scale of organic farming, and realise significant ecological and social value (Lv *et al.*, 2023).

Specifically in Indonesia, green financing is also utilised for the sustainable management of industrial forests and to support sustainable food crop farming systems (Budiasa, 2020). Governments that prioritise agricultural financing demonstrate their commitment and role in sustainability and social responsibility (Rahmawaty and Helmayunita, 2021). Agricultural financing is not merely about seeking profit, but also about engaging ethically with key stakeholders. This reflects a sustainable approach to business, which integrates social and environmental considerations into decision-making (Biancone and Radwan, 2019; Xu *et al.*, 2022).

Agricultural financing within the Islamic financial system is not limited to commercial lending activities but also incorporates specific Sharia contracts designed to support productive agricultural activities whilst preserving justice and sustainability (Al-Daihani *et al.*, 2024). Among the most relevant contracts are *Salam* and *Muzara'ah*. *Salam* refers to a forward financing contract in which payment is made in advance for agricultural products delivered at a future date, thereby helping farmers obtain working capital before harvest periods. This mechanism reduces farmers' dependence on exploitative informal financing and supports production continuity (Devi *et al.*, 2026). Meanwhile, *Muzara'ah* represents a sharecropping partnership between landowners and farmers based on profit-sharing arrangements, thereby distributing agricultural risks more equitably between parties (Majid, 2021). Both contracts reflect Islamic principles of fairness, risk-sharing, and social responsibility, which are closely aligned with sustainable agricultural development and environmentally responsible farming practices.

This study examines the potential for agricultural financing on the island of Kalimantan, both at the national and regional banking levels, given the urgency of funding projects related to environmental sustainability. National banks (namely Conventional Commercial Banks and Sharia Commercial Banks) are considered to have significant potential in financing large-scale green projects due to their substantial capital base (Zhou *et al.*, 2022). Meanwhile, for regional banks (namely Rural Banks and Sharia Rural Banks), agricultural financing is viewed as a business strategy to engage ethically with the local community and customers (Pambekti and Lestari, 2023), as well as to support economic growth and development at the regional level (Liu *et al.*, 2023; Ma *et al.*, 2023).

Moderation of Financial Literacy

Financial literacy plays a vital role in facilitating agricultural financing to enhance sustainable economic performance (Budiasa, 2020; Zhang *et al.*, 2022). Good financial literacy is essential to enable communities and businesses in the green sector to access and manage credit or bank financing wisely (Siddik *et al.*, 2023). Improving financial literacy helps them to make smarter decisions about how to manage their funds, thereby enhancing the performance of green projects (Andreou and Anyfantaki, 2021). In this regard, both national and regional banks can play a role in promoting financial literacy, thereby developing financial products and services tailored to the needs of the green sector, whilst providing guidance on effective financial management. Strong partnerships between banks and green sector stakeholders can help ensure that agricultural financing is used wisely to support a sustainable green sector (Mirza *et al.*, 2023; Zhou *et al.*, 2022).

Islamic financial literacy differs conceptually from conventional financial literacy because it incorporates not only financial knowledge and decision-making capability, but also ethical and spiritual dimensions derived from Islamic teachings (Albaity & Rahman, 2019). Islamic financial literacy includes an understanding of Sharia principles such as justice (*adl*), trustworthiness (*amanah*), moderation (*wasatiyyah*), and moral responsibility (*akhlaq*) in economic activities (Wahyuni, 2012). Consequently, individuals with higher Islamic financial

literacy are theoretically expected to avoid environmentally destructive economic behaviour because financial decisions are evaluated not solely in terms of profitability, but also according to their social and environmental consequences (Kumari & Harikrishnan, 2021). Within agricultural activities, this ethical orientation may encourage more responsible farming practices, sustainable resource management, and greater awareness of environmental stewardship as part of humankind's role as *khalifah* (vicegerent) on earth (Al-Daihani et al., 2024).

Hasan et al. (2021), Pambekti and Lestari (2023), dan Siddik et al. (2023) explain that knowledge and understanding, gained through strong financial literacy, of how to manage financial resources wisely can improve access to agricultural financing, which in turn promotes sustainable economic performance whilst maintaining a healthy environment. Improved financial literacy supports the ability of rural communities to manage their finances, thereby contributing to the fulfilment of financial goals and good environmental conditions (Agarwalla et al., 2017). Therefore, financial literacy moderation is a key factor in linking agricultural financing to support sustainable economic performance.

Research Framework

Based on the above discussion, this study proposes an integrative model to optimise the achievement of Sustainable Economic Performance on the island of Kalimantan, as shown in Figure 1.

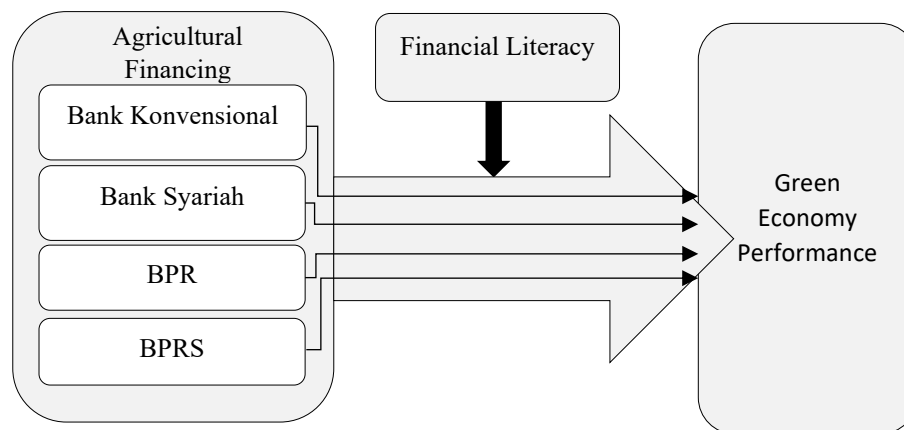


Figure 1. Research Model

Method

This study employs a quantitative approach using panel data covering 55 districts and cities in the Kalimantan region over a ten-year observation period (2014–2023). Only Mahakam Hulu District was excluded from the research dataset due to incomplete data, resulting in a total of 550 observations. The analysis was conducted in two stages: DEA and regression analysis.

DEA Technique

DEA is used to measure the Sustainable Economic Performance score. The DEA procedure selected is the slack-based model (DEA-SBM) developed by Tone (2001) as it can handle data with zero or negative values, which are common in carbon emissions data (Wu et al., 2023). The DEA-SBM model can also avoid problems when desirable and undesirable outputs change in equal proportions (Ma et al., 2023; Streimikis and Saraji, 2022; Tone, 2001).

). The DEA model in this study uses production units or Decision Making Units (DMUs) in the form of regencies/cities on the island of Kalimantan. The input factors used are: (1) labour, referring to the capital required for the provision of labour (Xu & Deng, 2022), which in this study is measured by the number of people in employment in the regency/city multiplied by the regency/city minimum wage (UMK); (2) capital, referring to productive capital typically derived from foreign investment (Lan et al., 2022; Li and Lin, 2016), which in this study is measured using the realised value of foreign direct investment (FDI); (3) energy consumption, refers to the level of primary energy consumption for a region's economy (Iqbal et al., 2019), where some studies use measures such as electricity consumption or distribution (Lin et al., 2023; Xue et al., 2022). Furthermore, the 'desirable output' factor refers to a region's economic performance (Lan et al., 2022; Li and Lin, 2016; Liu et al., 2022), which can be measured using Regional Gross Domestic Product (RGDP). Meanwhile, undesirable output refers to the environmental impact generated by a region (Liu et al., 2021, 2023) and is therefore measured using the ratio of greenhouse gas emissions per capita. The equation used for DEA-SBM is adapted from Streimikis dan Saraji (2022) as follow:

$$\rho_t = \min \frac{1 - \frac{1}{I} \sum_{i=1}^I \frac{s_i^x}{x_i^t}}{s_i^x, s_j^g, s_l^b \left(1 + \frac{1}{J+L} \left(\sum_{j=1}^J \frac{s_j^g}{x_j^t} + \sum_{l=1}^L \frac{s_l^b}{x_l^t} \right) \right)}$$

$$\begin{aligned} \sum_{k=1}^K \lambda_k X_i^k + S_i^t &= X_i^t, i = 1, 2, \dots, I; \\ \sum_{k=1}^K \lambda_k G_j^k - S_j^t &= G_j^t, i = 1, 2, \dots, I; \\ \sum_{k=1}^K \lambda_k B_l^k + S_l^t &= B_l^t, i = 1, 2, \dots, L; \\ \lambda_k &\geq 0, k = 1, 2, \dots, K; \\ s_i^x, s_j^g, s_l^b &\geq 0 \end{aligned} \dots\dots\dots(1)$$

Where $X = (x_1, \dots, x_I) \in R_+^I$ is the input vector, $G = (g_1, \dots, g_J) \in R_+^J$ is the desirable output vector, and $B = (b_1, \dots, b_L) \in R_+^L$ is the undesirable output vector. Meanwhile, λ^k is the intensity vector and $k = (k_1, \dots, K)$ is the DMU index. Furthermore, $0 \leq \rho_t \leq 1$ where $\rho_t = 1$ indicates total efficiency with $t = 1, 2, \dots, K$. The t -th observation represented by the input-output (x_i^t, g_i^t, b_i^t) is shown on the production frontier at that point $(x_i^t - s_i^{x*}, g_j^t + s_j^{g*}, b_l^t - s_l^{b*})$, where s_i^{x*} , s_j^{g*} , and s_l^{b*} are the optimal values of s_i^x, s_j^g , dan s_l^b (Li et al., 2016; Streimikis & Saraji, 2022).

Regression Technique

To examine the impact of agricultural financing on each type of banking, a regression analysis was conducted based on the following four equations:

$$GEP_{i,t} = \alpha + \beta_1 GLC_{i,t} + \beta_2 FL_{i,t} + \beta_3 GLC_{i,t} * FL_{i,t} + \beta_4 Control_{i,t} + \mu_{i,t} + \sigma_{i,t} + \varepsilon_{i,t} \dots\dots\dots(2)$$

$$GEP_{i,t} = \alpha + \beta_1 GLS_{i,t} + \beta_2 IFL_{i,t} + \beta_3 GLS_{i,t} * IFL_{i,t} + \beta_4 Control_{i,t} + \mu_{i,t} + \sigma_{i,t} + \varepsilon_{i,t} \dots\dots\dots(3)$$

$$GEP_{i,t} = \alpha + \beta_1 GLR_{i,t} + \beta_2 FL_{i,t} + \beta_3 GLR_{i,t} * FL_{i,t} + \beta_4 Control_{i,t} + \mu_{i,t} + \sigma_{i,t} + \varepsilon_{i,t} \dots\dots\dots(4)$$

$$GEP_{i,t} = \alpha + \beta_1 GLRS_{i,t} + \beta_2 IFL_{i,t} + \beta_3 GLRS_{i,t} * IFL_{i,t} + \beta_4 Control_{i,t} + \mu_{i,t} + \sigma_{i,t} + \varepsilon_{i,t} \dots\dots\dots(5)$$

$GEP_{i,t}$ is the Sustainable Economic Performance of district/city i in year t . $GLC_{i,t}$ $GLS_{i,t}$ $GLR_{i,t}$ $GLRS_{i,t}$ are, respectively, Agricultural Financing at Conventional Commercial Banks, Sharia Commercial Banks, Rural Banks (BPR) and Sharia Rural Banks (BPRS). As the focus of agricultural financing in many countries is on the agricultural sector, in this study

agricultural financing is measured using the amount of financing channelled to the agricultural and forestry sectors. The use of the term “potential for agricultural financing” in this study is intended to describe the opportunities for members of the public, as prospective banking customers, to access such agricultural financing (Pambekti and Lestari, 2023). The formula follows the approach adopted in previous studies examining financing accessibility and regional financing capacity (Pambekti & Lestari, 2023, 2024). Population was intentionally used to represent the scale of potential financial access and market reach within each district/city, rather than to measure agricultural productivity or land capacity. The study focuses on the potential opportunity for communities to access agricultural financing within the banking system, particularly in regions where agricultural activities remain strongly linked to rural population distribution. Therefore, the multiplication by population was intended to normalise financing potential according to the size of the economically active community within each region. Therefore, the formula used to measure the potential for green financing is as follows:

$$\text{Agricultural Financing Potential} = \frac{\text{Agricultural and Forestry financing}}{\text{Total financing}} \times \text{Population}..(6)$$

Furthermore, $FL_{i,t}$ represents conventional financial literacy, which is tested as a moderating variable in the sub-sample of conventional commercial banks and rural banks (BPR). Meanwhile, $IFL_{i,t}$ represents Islamic financial literacy, which is tested as a moderating variable in the sub-sample of Islamic commercial banks and Islamic rural banks (BPRS). The study also utilises several control variables, namely interest rates, poverty levels and inflation. These three control variables were selected as they represent the importance of the green economy at the macro level (Chen et al., 2021; Li et al., 2023). Furthermore, $\mu_{i,t}$ represents the specific consequences for the regency/city, $\sigma_{i,t}$ represents the specific consequences for the year of observation, and $\varepsilon_{i,t}$ is the error term. In more detail, the explanation of each variable and its measurement is summarised in Table 1.

Table 1. Variables and Measurement

Variable	Proxy	Measurement	Data Source
Dependent Variable			
Green Economy Performance	GEP	Input: <i>Labor</i> (LAB): The number of people in employment multiplied by the minimum wage for the city/district in millions of rupiah Note: For districts/cities where no district/city minimum wage data is available, the provincial minimum wage rate shall apply. <i>Capital</i> (CAP): Foreign Direct Investment in thousands of US dollars	The Central Statistics Agency and the Investment Coordinating Board
		Desirable Output: Regional Gross Domestic Product (RGDP) by expenditure, by regency/city, in billions of rupiah	The Central Statistics Agency
		Undesirable output: Greenhouse gas (GHG) emissions per capita in cities and regencies, expressed in CO2 equivalents	Ministry of Environment and Forestry

Variable	Proxy	Measurement	Data Source	
Dependent Variable				
Independent Variable				
Agricultural Financing Potential	GLC	Agricultural Financing Potential (agricultural and forestry sectors) at Conventional Commercial Banks in billions of rupiah	Financial Authority	Services
	GLS	Agricultural Financing Potential (agricultural and forestry sectors) at Sharia Commercial Banks and Sharia Business Units in billions of rupiah		
	GLR	Agricultural Financing Potential (agricultural and forestry sectors) at Rural Banks in billions of rupiah		
	GLRS	Agricultural Financing Potential (agricultural and forestry sectors) at BPRS in billions of rupiah		
Moderating Variable				
Financial Literacy	FL	Conventional financial literacy index by province	Financial Authority	Services
	IFL	Provincial Sharia financial literacy index Note: The financial literacy survey is not conducted every year; therefore, for years for which data is not available, data from the previous year's index is used		
Control Variable				
Interest rates	SBC	Natural logarithm of the average interest rate on loans to the agriculture and forestry sector in conventional banking	Financial Authority and Bank Indonesia	Services and Bank
	SBS	Natural logarithm of the average margin rate for financing in the agriculture and forestry sector in Islamic banking		
Inflation	INF	Natural logarithm of annual inflation by district/city Note: For districts/cities where inflation data is not available, provincial inflation data is used	The Central Statistics Agency and Bank Indonesia	
Poverty rate	MIS	Natural logarithm of the percentage of the poor population by district/city	The Central Statistics Agency	

Analysis and Discussion

Descriptive Statistics

The descriptive statistics in Table 2 show that all variables have positive mean values. However, the GHG variable has a minimum negative value, reflecting the efforts of each province in the Kalimantan region to achieve net-zero carbon. More detailed descriptive statistics by year and by province are presented in Appendix Tables L1 and L2.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
LAB	550	368186	246688.9	16950.3	1426625
CAP	550	55559.3	125150.6	0	1475212
ELC	550	191373.9	273829.1	2961.1	1910454
PRDB	550	16073.8	22392.1	1963.3	135406
GHG	550	12.32	36.4	-1.2	285.4
GLC	550	48998.5	36577.4	0	173483.4
GLS	550	31552.8	37558.2	0	234813.2
GLR	550	17671.4	11902.2	0	55680.52
GLRS	550	6064.4	14110.2	0	175128
FL	550	32.8	9.7	21.8	58.7
IFL	550	4.2	2.9	0	9.2
SBC	550	10.3	1.2	8.5	12.1

Variable	Obs	Mean	Std. dev.	Min	Max
SBS	550	13.4	2.1	10.4	17.4
INF	550	3.8	2.1	0.6	11.9
MIS	550	6.2	2.2	2.3	13.7

DEA Results

Table 3 shows the average DEA scores as a proxy for Green Economic Performance (GEP) in districts and cities across Kalimantan during the period 2014–2023. A score close to 1 indicates a high level of performance and efficiency, a score close to 0 indicates a low level of performance and inefficiency, and a score of 0.5 (as the midpoint) indicates moderate performance and efficiency. Overall, the DEA score for the island of Kalimantan is moderate at 0.502. At the provincial level, high and efficient Sustainable Economic Performance was achieved by East Kalimantan with a score of 0.769, followed by North Kalimantan with a score of 0.609. Meanwhile, the other three provinces—West Kalimantan, South Kalimantan and Central Kalimantan—exhibited less efficient sustainable economic performance with scores of 0.415, 0.404 and 0.474 respectively. At a smaller scale, several regencies/cities recorded high and efficient sustainable economic performance throughout the period 2014–2023, with the three highest scores being in Kutai Kartanegara (0.995), East Kutai (0.967), and Bontang (0.899). Meanwhile, Mempawah Regency recorded the lowest Sustainable Economic Performance score at 0.206.

Table 3. Economic Sustainability Performance Scores for Regencies and Cities in Kalimantan

Bengkayang	0.365	Kota Singkawang	0.511	Sambas	0.453	West Kalimantan; 0.415
Kapuas Hulu	0.476	Kubu Raya	0.789	Sanggau	0.332	
Kayong Utara	0.507	Landak	0.331	Sekadau	0.493	
Ketapang	0.267	Melawi	0.219	Sintang	0.295	
Kota Pontianak	0.560	Mempawah	0.206			
Balangan	0.576	Hulu Sungai Utara	0.407	Tanah Bumbu	0.447	Kalimantan South; 0.404
Banjar	0.402	Kota Banjar Baru	0.266	Tanah Laut	0.295	
Barito Kuala	0.217	Kota Banjarmasin	0.515	Tapin	0.294	
Hulu Sungai Selatan	0.530	Kotabaru	0.530			
Hulu Sungai Tengah	0.379	Tabalong	0.388			
Barito Selatan	0.376	Katingan	0.298	Palangka Raya	0.392	Kalimantan Central; 0.474
Barito Timur	0.575	Kotawaringin Barat	0.362	Pulang Pisau	0.478	
Barito Utara	0.561	Kotawaringin Timur	0.319	Seruyan	0.631	
Gunung Mas	0.327	Lamandau	0.639	Sukamara	0.738	
Kapuas	0.403	Murung Raya	0.533			
Balikpapan	0.838	Kutai Barat	0.671	Paser	0.849	Kalimantan East; 0.769
Berau	0.652	Kutai Kartanegara	0.995	Penajam Paser Utara	0.357	
Bontang	0.899	Kutai Timur	0.967	Samarinda	0.695	
Bulungan	0.406	Nunukan	0.674	Tarakan	0.576	Kalimantan North; 0.609
Malinau	0.562	Tana Tidung	0.830			
KALIMANTAN ISLAND						0.503

Note: The DEA model was run using a slack-based measure, an output-oriented approach and Variable Returns to Scale (VRS) using the MaxDEA Lite 12.0.8 software.

Sustainable economic performance in each province in the Kalimantan region was also examined based on annual trends, as shown in Figure 2. The years 2014 and 2015 recorded super-efficient sustainable economic performance (score 1) in several regencies/cities in the Kalimantan region, including Tana Tidung, Nunukan, East Kutai, Kutai Kartanegara, Bontang, Paser, Lamandau and Sukamara. This implies the ability of these regencies/cities to optimise the efficient use of their inputs, such as human resources, foreign investment capital and energy resources, to generate regional economic value whilst minimising the environmental impact of carbon emissions. Nevertheless, some regencies and cities still demonstrate inefficient performance, and overall, the trend in sustainable economic performance across the Kalimantan region remains highly dynamic, indicating an uneven distribution of inputs used to achieve efficient sustainable economic performance. For example, foreign capital investment (FDI) in South Kalimantan and Central Kalimantan remains very low compared to the other three provinces in Kalimantan (see Appendix Table L2).



Regression Results

Following a series of model selection tests comparing Fixed Effect (FE), Random Effect (RE) and Ordinary Least Squares (OLS) estimates using the Lagrange Multiplier test and the Hausman test, it was determined that the best model is the FE model. The results of the model selection are presented in the appendices, Tables L3–L6. All variables have also been

confirmed to be free from multicollinearity, with VIF values below 10 (see Appendix Tables L7–L10). Furthermore, to avoid issues of autocorrelation and heteroscedasticity, the fixed-effects regression analysis was conducted using the robust cluster standard error scheme, with the results shown in Tables 4 and 5.

Table 4. Regression Results for Conventional Commercial Banks and Islamic Commercial Banks

Dependent:	(1)	(2)	(3)	(4)	(5)	(6)
GEP	Conventional	Conventional	Conventional	Sharia	Sharia	Sharia
GLC	-0.0455*	-0.0149	-0.102***			
	(0.093)	(0.573)	(0.009)			
FL	-0.000955	0.00432**	0.00337*			
	(0.281)	(0.031)	(0.073)			
GLCxFL			0.000000673*			
			(0.022)			
GLS				-0.000000391	0.000000756*	-0.00000154*
				(0.215)	(0.059)	(0.098)
IFL				-0.0188	0.000802	-0.0278**
				(0.120)	(0.944)	(0.038)
GLSxIFL						0.00000144***
						(0.004)
SBC		0.733***	0.764***			
		(0.004)	(0.002)			
SBS					0.511***	0.544***
					(0.001)	(0.001)
INF		0.00726	0.00585		0.00808	0.0133
		(0.768)	(0.815)		(0.711)	(0.556)
MIS		-0.171	-0.165		-0.210	-0.189
		(0.151)	(0.170)		(0.112)	(0.144)
_cons	1.002***	-0.968	-0.210	0.535***	-0.498	-0.582*
	(0.001)	(0.143)	(0.731)	(0.000)	(0.112)	(0.063)
Year (FE)	No	Yes	Yes	No	Yes	Yes
Obs.	500	500	500	440	440	440
Adj.R2	0.0177	0.0797	0.0931	0.00524	0.114	0.130

Note: The regression was conducted using a fixed-effects model with robust cluster standard errors. *P*-values at the significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4 shows that the potential for agricultural financing at Conventional Commercial Banks (GLC) and Islamic Commercial Banks (GLS) has a significant negative impact on Green Economic Performance (GEP). This indicates that the potential for green financing channelled by these two types of commercial banks has not yet led to efficient Sustainable Economic Performance. A 1% inefficiency in GEP is predicted to result from a 10.2% increase in GLC and a 0.000154% increase in GLS. On the other hand, conventional financial literacy (FL) has a significant positive effect on improving Sustainable Economic Performance. A 0.337% increase in FL can increase GEP by 1%. Meanwhile, for Islamic financial literacy (IFL), the resulting effect is negative at 2.78%. Nevertheless, both levels of financial literacy—conventional (GLCxFL) and Islamic (GLSxIFL)—successfully moderate the potential impact of agricultural financing on Sustainable Economic Performance in a positive and significant manner. FL can strengthen the effect of GLC on GEP by 0.000067%, and IFL can strengthen the effect of GLS on GEP by 0.000144%. These results indicate that the potential of agricultural

financing in both conventional and Sharia banks can contribute effectively to generating efficient sustainable economic performance when accompanied by good financial literacy.

Table 5. Regression Results for BPR and BPRS

Dependent: GEP	(1) BPR	(2) BPR	(3) BPR	(4) BPRS	(5) BPRS	(6) BPRS
GLR	-0.125 (0.163)	-0.0506 (0.226)	-0.214* (0.052)			
FL	-0.0477* (0.098)	0.0923 (0.210)	0.0204 (0.779)			
GLRxFL			0.00000387* (0.095)			
GLRS				-0.0100* (0.062)	-0.000562 (0.918)	0.0107 (0.627)
IFL				0.00545* (0.070)	0.00854 (0.191)	0.0119 (0.214)
GLRSxIFL						-0.00000204 (0.506)
SBC		0.655** (0.012)	0.606*** (0.010)			
SBS					0.275 (0.107)	0.321* (0.097)
INF		0.00331 (0.888)	0.00694 (0.772)		-0.0299 (0.343)	-0.0280 (0.387)
MIS		-0.168 (0.124)	-0.160 (0.161)		-0.234* (0.064)	-0.336** (0.046)
_cons	1.858** (0.031)	-0.625 (0.441)	1.056 (0.349)	0.586*** (0.000)	0.181 (0.670)	0.143 (0.745)
Year (FE)	No	Yes	Yes	No	Yes	Yes
Obs.	525	525	525	323	323	251
Adj.R2	0.0286	0.0798	0.0901	0.0101	0.0440	0.0486

*Note: The regression was conducted using a fixed-effects model with robust cluster standard errors. P-values at the significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.*

Table 5 shows a significant negative effect of the potential for agricultural financing at rural banks (GLR) on sustainable economic performance. A 2.14% increase in GLR is predicted to contribute to a 1% decline in sustainable economic performance. These results indicate that the potential for Agricultural Financing at BPRs has not yet been able to generate efficient Sustainable Economic Performance. Nevertheless, the moderating role of financial literacy (GLRxFL) was found to significantly promote the positive impact of Agricultural Financing potential in BPRs on Sustainable Economic Performance. A moderation of financial literacy by 0.000387% contributes to a 1% positive impact of GLR on GEP. Unfortunately, no statistical evidence was found to indicate the influence of the potential for Agricultural Financing at BPRS (GLRS) on Sustainable Economic Performance in Kalimantan. This implies that Agricultural Financing at BPRS has not been considered by the public, as customers, in supporting their activities that could bolster the green economy. Islamic financial literacy (IFL) within the BPRS framework was also found to have no significant effect on Sustainable Economic Performance, nor did the moderating function of Islamic financial literacy on Agricultural Financing at BPRS (GLRSxIFL) have a significant effect.

Robustness Testing

To ensure the consistency of the results from the FE regression, this study also conducted a robustness check using the Seemingly Unrelated Regressions (SUR) test. The SUR model accounts for the underlying covariance structure of the error terms in tests comprising multiple

equations (Peremans and Van Aelst, 2018). This provides a more comprehensive view of the relationships between the variables in the panel model. The results of the SUR test in Table 6 are consistent with the FE estimates for all four equations tested, thus validating the FE regression results.

Table 6. Results of the Robustness Test using SUR

Dependen:	(1)	(2)	(3)	(4)
GEP	Conventional Bank	Islamic Bank	BPR	BPRS
GLC	-0.265*** (0.000)			
GLCxFL	0.00000111*** (0.000)			
GLS		-0.0729*** (0.001)		
GLSxIFL		0.000000845* (0.056)		
GLR			-0.425*** (0.000)	
GLRxFL			0.00000725*** (0.000)	
GLRS				-0.00931 (0.769)
GLRSxIFL				0.00000126 (0.724)
FL	0.409*** (0.000)		0.296*** (0.001)	
IFL		-0.167*** (0.000)		-0.183*** (0.000)
SBC	1.820*** (0.000)		1.874*** (0.000)	
SBS		-0.375 (0.127)		-0.480 (0.133)
INF	-0.0597* (0.093)	-0.0164 (0.676)	-0.0709** (0.037)	0.00486 (0.937)
MIS	-0.0698** (0.011)	-0.0204 (0.498)	-0.00500 (0.857)	0.0950** (0.028)
_cons	-2.412** (0.043)	2.398*** (0.001)	-1.235 (0.276)	1.933** (0.027)
Year (FE)	Yes	Yes	Yes	Yes
Obs.	500	400	525	251
Adj.R2				

Discussion

The results of the analysis highlight that the agricultural financing provided by conventional commercial banks and Islamic commercial banks has a negative impact on sustainable economic performance. These findings suggest that the agricultural financing efforts undertaken by both types of banks have not yet succeeded in improving efficiency in sustainable economic performance. This may indicate shortcomings in the implementation or allocation of agricultural financing, which may not be well-targeted or sufficiently effective in supporting projects that genuinely contribute to sustainability and environmental efficiency. Budiasa (2020) dan Zhang *et al.*, (2022) highlight obstacles in applying green principles within banking operations, and there may be a gap between agricultural financing policies and their practical implementation on the ground. Conversely, conventional financial literacy has a positive influence on enhancing sustainable economic performance; that is, when the public

has a good understanding of conventional financial concepts and practices, they are better able to manage and utilise agricultural financing effectively to support sustainable economic activities. A good understanding of finance enables individuals to make more informed and strategic decisions regarding the use of funds (Hasan *et al.*, 2021; Siddik *et al.*, 2023), which in turn enhances efficiency and has a positive impact on the environment (Pambekti and Lestari, 2023).

On the other hand, Islamic financial literacy has a negative impact on sustainable economic performance. This is due to a lack of in-depth understanding or misconceptions regarding Islamic financial products and services, which can hinder the optimal use of agricultural financing within an Islamic framework (Pambekti and Lestari, 2023). This challenge stems from the complexity of the Sharia principles that must be adhered to, which can limit flexibility in financial decision-making (Biancone *et al.*, 2019). The insignificant and negative relationship between Islamic financial literacy and sustainable economic performance may also indicate that Islamic financial literacy in practice remains concentrated on technical knowledge of Islamic financial products rather than a deeper understanding of Islamic ethical objectives. Public understanding may still focus primarily on contractual distinctions between Islamic and conventional banking, such as profit-sharing mechanisms, whilst insufficiently internalising broader Islamic values related to environmental stewardship, social justice, and sustainable resource management (Indana & Pambekti, 2022). Consequently, Islamic financial literacy may not yet fully translate into environmentally responsible economic behaviour within agricultural activities (Sofiana *et al.*, 2019). Strengthening the ethical dimension of Islamic financial literacy, particularly through the values of *akhlaq*, *amanah*, and *Maqasid al-Shariah*, therefore becomes essential to align agricultural financing with sustainable economic objectives.

Nevertheless, both conventional financial literacy and Sharia financial literacy successfully moderate the potential of Agricultural Financing on Sustainable Economic Performance in a positive manner. This implies that when financial literacy is high—whether in a conventional or Sharia context—the ability to utilise Agricultural Financing increases, thereby having a positive impact on Sustainable Economic Performance (Beny *et al.*, 2023). These results indicate that improving financial literacy in both sectors is crucial to ensuring that Agricultural Financing can contribute effectively to green economic efficiency (Kumari and Harikrishnan, 2021). Consequently, education and training on financial literacy must be enhanced, in both conventional and Islamic contexts, so that the public can understand and make optimal use of Agricultural Financing products.

Another interesting finding in this study is that the potential for agricultural financing through rural banks (BPR) has a negative impact on sustainable economic performance. This indicates that, although efforts are being made to secure environmentally friendly funding through BPRs, its use has not yet been able to generate efficient sustainable economic performance. This is because the management of green funds at the regional level has not yet fully accounted for the environmental impacts of the funded projects (Liu *et al.*, 2023). On the other hand, financial literacy can moderate and drive the potential of agricultural financing towards positive sustainable economic performance. These findings reinforce the importance of a sound understanding of green financial management for stakeholders (Andreou and Anyfantaki, 2021; Hasan *et al.*, 2021), including Rural Banks and funding recipients, through training, awareness-raising and literacy programmes. High financial literacy can help ensure that green funds are effectively allocated to projects that genuinely contribute to environmental protection efforts and sustainable economic development (Kumari and Harikrishnan, 2021; Siddik *et al.*, 2023). Thus, financial literacy is key to optimising the benefits of Agricultural Financing and enhancing overall Sustainable Economic Performance.

Meanwhile, there are significant obstacles to harnessing the potential of agricultural financing from BPRS to support green economic growth in Kalimantan. It is evident that the contribution of agricultural financing from BPRS has not yet been fully recognised by the public as part of a strategy to promote sustainable economic activity. These obstacles include: firstly, the limited capacity and operational scale of BPRS, which are relatively smaller compared to commercial banks (Wasiaturrahma *et al.*, 2020). Second, Sharia compliance requirements may act as a barrier for the public in accessing agricultural financing from BPRS, thereby hindering the achievement of green economic goals through this channel (Pambekti and Lestari, 2023). Furthermore, Sharia financial literacy does not appear to have a significant impact on sustainable economic performance, and the interaction between Sharia financial literacy and agricultural financing also does not yield a meaningful effect. This evidence indicates a gap between the public's level of understanding of Sharia finance concepts, such as *musharakah* and *mudharabah* (Albaity and Rahman, 2019; Ariss, 2010), and the Sharia financial products offered by BPRS. In other words, further efforts are still needed to improve public understanding of Islamic financial products that have the potential to support green economic growth (Khan *et al.*, 2023; Mirza *et al.*, 2023).

Conclusion

The DEA model estimates that overall Sustainable Economic Performance on the island of Kalimantan remains at a moderate and inefficient level. Three provinces, namely South Kalimantan, West Kalimantan, and Central Kalimantan, exhibit relatively low levels of Sustainable Economic Performance. Agricultural Financing is identified as one potential mechanism to improve sustainable economic outcomes in the region. The regression results demonstrate that Agricultural Financing can contribute positively to Sustainable Economic Performance when supported by higher levels of financial literacy, particularly in Conventional Commercial Banks, Sharia Commercial Banks, and Rural Banks (BPR).

In contrast, Agricultural Financing within Islamic Rural Banks (BPRS) was not found to have a significant impact on Sustainable Economic Performance, even after moderation by Islamic financial literacy. This finding may reflect limitations related to financing scale, institutional capacity, and the implementation of Sharia-based financing mechanisms in environmentally sensitive sectors. The results also indicate that financial literacy plays a crucial role in strengthening the effectiveness of Agricultural Financing across different banking schemes. At the same time, the negative individual effect of Islamic financial literacy suggests that knowledge of Islamic financial products may not automatically translate into sustainability-oriented economic behaviour when ethical and environmental dimensions of Islamic finance remain insufficiently internalised in financial decision-making.

The findings further highlight the importance of strengthening Islamic sustainable finance mechanisms within regional banking systems. Approaches such as Value-Based Intermediation (VBI), alongside the integration of Islamic social finance instruments including Green Waqf and Cash Waqf Linked Sukuk (CWLS), may provide alternative mechanisms to support high-risk agricultural and environmental projects in Kalimantan whilst reducing financing constraints faced by BPRS. Such approaches may also strengthen the alignment between Islamic financial intermediation, environmental sustainability, and broader social welfare objectives embedded within Maqasid al-Shariah.

Policymakers and financial regulators, particularly Bank Indonesia and the Otoritas Jasa Keuangan (OJK), should therefore strengthen sustainability-oriented financial literacy programmes and encourage the development of integrated Islamic sustainable finance mechanisms to improve the effectiveness of Agricultural Financing in environmentally

sensitive regions. Greater institutional support for Value-Based Intermediation (VBI), Green Waqf, and Cash Waqf Linked Sukuk (CWLS) may help expand financing accessibility for sustainable agricultural, forest conservation, and environmentally responsible rural development projects in Kalimantan.

Nevertheless, this study acknowledges several limitations. The inconsistency of data availability across observation periods may affect the robustness of the analysis. Future research may incorporate broader macroeconomic indicators, such as the Human Development Index, fiscal expenditure, and other dimensions of green finance and financial technology, to provide a more comprehensive understanding of sustainable economic development in environmentally sensitive regions. Future studies may also consider incorporating more sector-specific agricultural indicators, such as agricultural land area or the number of active farmers, to improve the measurement of Agricultural Financing potential within regional sustainability analysis.

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