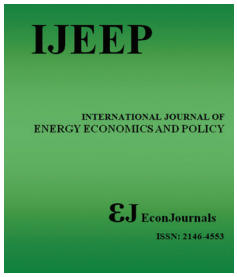

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2026, 16(2), 129-136.

How Renewable Energy Consumption Affects Economic Growth in ASEAN: The Role of Banking Sector

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Received: 10 July 2025 **Accepted:** 26 December 2025 **DOI:** https://doi.org/10.32479/ijeep.21249

ABSTRACT

This study investigates the impact of renewable energy consumption on economic growth in ASEAN countries and the moderating role of banking sector development during the period 2000-2022, using a Multi-way Fixed Effects (MWFE) regression model. The empirical results show that renewable energy consumption has a negative impact on economic growth in ASEAN. However, this relationship becomes less negative due to the moderating effect of banking sector development. The study also finds that internal conditions within ASEAN countries have contributed to the inverse effect of renewable energy consumption on economic growth. This study is the first to examine the regulatory role of bank development in the relationship between renewable energy consumption and economic growth. Based on these findings, the authors explain the underlying causes and suggest several solutions to promote renewable energy development in the region.

Keywords: Renewable Energy, Economic Growth, ASEAN, Banking Sector Development
JEL Classifications: Q43, O40, G21, C33

1. INTRODUCTION

Renewable energy, derived from naturally replenished sources such as solar energy, wind, rainfall, geothermal heat, and tidal power, has become an inevitable trend in global energy strategies since the late 20th century. This transition is largely driven by the depletion of fossil fuel reserves and their severe environmental and human health (Abidin et al., 2015; Deshmukh et al., 2023). In response, numerous governments and international institutions have introduced policies and initiatives to promote renewable energy as a sustainable alternative. However, the development and deployment of renewable energy continue to face considerable obstacles, particularly high technological costs, unstable supply chains, and limited access to financing. Among these, the banking sector plays a pivotal role in mobilizing capital for renewable energy projects, thereby facilitating the transition to a low-carbon economy (Dimnwobi et al., 2019; Anton and Nucu, 2020; Mukhtarov et al., 2022).

While renewable energy is expected to foster green growth, empirical evidence on the relationship between renewable energy consumption and economic growth remains inconclusive. Some studies report a positive and statistically significant impact, arguing that renewable energy promotes economic expansion through improved energy efficiency, reduced fossil fuel dependence, and the creation of green jobs (Chontanawat et al., 2008; Sadorsky, 2009; Dogan and Ozturk, 2017). Other studies, however, find no significant relationship, suggesting that renewable energy has yet to become a key driver of economic performance, especially in transitional economies (Bowden and Payne, 2009). Notably, several researchers have documented a negative relationship, attributing it to the high initial costs, lower energy output efficiency, or insufficient infrastructure associated with renewable energy (Ocal and Aslan, 2013; Bhattacharya et al., 2016). These divergent findings indicate the need for further research in context-specific settings.

In the ASEAN region, energy demand is projected to increase by over 20% by 2024 compared to 2021 (ASEAN Centre for Energy, 2024), while renewable energy adoption remains below the regional target of achieving a 23% share in total primary energy supply by 2025, as outlined in the APAEC framework (AEO7, 2022). Meanwhile, global commitments such as COP28 and rising geopolitical uncertainties are putting additional pressure on ASEAN member states to ensure energy security and accelerate green transition. In this context, the role of the banking sector as a key enabler of renewable energy development becomes increasingly vital. Banking sector development can facilitate the energy transition by expanding access to credit, supporting investment in clean technologies, and reducing financial barriers (Islam et al., 2013; Paramati et al., 2017). Nevertheless, few studies have explicitly examined whether banking sector development moderates the relationship between renewable energy consumption and economic growth.

Against this backdrop, the present study aims to assess the impact of renewable energy consumption on economic growth in ASEAN countries, while also exploring the moderating role of banking sector development. By addressing a gap in the existing literature and providing context-specific empirical evidence, the findings are expected to inform policymakers in designing integrated energy–finance strategies that support the region's sustainable development goals.

The remainder of this paper is structured as follows. Section 2 presents the theoretical framework and establishes the linkages among renewable energy consumption, banking sector development, and economic growth. Section 3 describes the research methodology and variable definitions. Section 4 reports and discusses the empirical results. Finally, Section 5 concludes the study and outlines key policy implications derived from the findings.

1.1. Literature Review and Hypothesis Development

The relationship between renewable energy consumption, banking development, and economic growth is rooted in classical and modern growth theories. The neoclassical model (Solow, 1956) emphasizes capital and technology as key drivers of output, while endogenous growth theory (Romer, 1990; Lucas, 1988) highlights innovation and human capital. In this view, bank credit supports investment and productivity. Financial intermediation theory (Schumpeter, 1911; Levine, 1997) further stresses the role of banks in funding innovation and allocating capital efficiently. A developed financial system enables green investment and fosters sustainable economic growth.

Numerous studies have shown that renewable energy consumption (REC) can positively influence economic growth (EG). Yildirim et al. (2012) found that in the U.S., biomass energy significantly contributed to GDP growth due to its low production cost and existing infrastructure. Al-Mulali et al. (2014) observed that both renewable and non-renewable energy sources supported EG in Latin American countries, though fossil fuels had a stronger impact due to infrastructure compatibility. Inglesi-Lotz (2016) highlighted the role of REC in enhancing energy security and reducing dependence on imports in OECD countries. Similarly, Rahman et al. (2021) and Guliyev and Tatoğlu (2023) found that REC, along with trade and FDI, positively impacted long-term EG. Studies by Xie et al. (2023) and Jia et al. (2023) further confirmed the indirect effect of REC on EG through capital accumulation and trade expansion in N11 and BRI countries.

Conversely, other studies found no significant or even negative impacts. Bhattacharya et al. (2016) noted that in some countries, the effects of REC were insignificant or adverse due to high investment costs and low efficiency. Ocal and Aslan (2013) and Fang (2011) reported negative effects in Turkey and China due to limited infrastructure and policy constraints. Destek (2016) showed mixed results across newly industrialized countries, while Gyimah et al. (2022) found only limited indirect effects of REC on EG in Ghana. Some studies argue that the impact of REC on EG may be linear or conditional on specific national circumstances (Yildirim et al., 2012; Al-Mulali et al., 2014; Rahman et al., 2021). Overall, findings remain inconclusive due to differences in methodologies, models, and country-specific contexts (Šimelytė and Dudzevičiūtė, 2007).

In addition to REC, the financial system—particularly the banking sector—is also considered a key driver of EG, with numerous studies emphasizing the role of domestic credit and financial development in supporting production, investment, and consumption. Numerous studies have explored the link between financial development and EG, with banking development often measured by the ratio of domestic credit to the private sector (DCB) as a percentage of GDP (Anton and Nucu, 2019). Research consistently finds that domestic credit plays a crucial role in stimulating economic growth by facilitating access to capital for households and businesses (Durusu-Ciftci et al., 2017; Sharma and Kautish, 2020). Empirical studies across ASEAN, Africa, and Latin America suggest that banking credit enhances productive activities and long-term growth (Beck and Levine, 2004; Malarvizhi et al., 2019; Claessens and Laeven, 2001). However, several studies reveal mixed or negative effects. For instance, Abubakar and Gani (2013) found that private credit had an adverse impact on growth in Nigeria due to misallocation and high interest rates. Mobolaji (2010) showed limited impact in Sub-Saharan Africa, likely due to prolonged financial repression. Moreover, some studies suggest a non-linear (inverted U-shaped) relationship, where financial development beyond a certain threshold may hinder growth (Arcand et al., 2012; Cecchetti and Kharroubi, 2012). When credit surpasses 90-100% of GDP, rising financial risks and inefficient resource allocation may offset the benefits of credit expansion. Similarly, Chu and Trung (2019) found that credit exceeding 103% of GDP turns its effect on growth from positive to negative.

In addition to the individual effects of REC and banking development on EG, recent studies have begun to explore their combined role in promoting sustainable economic development. Several studies have emphasized the role of banking sector development in promoting renewable energy consumption in emerging economies. Wu and Broadstock (2015) indicate that a developed financial system—particularly the banking sector—enhances access to credit and reduces capital costs for renewable

energy projects, thereby encouraging private investment. Burakov and Freidin (2017) find that in Russia, banking development has a long-term effect on renewable energy consumption by providing stable and long-term capital flows, which align with the investment characteristics of the sector. Similarly, Kutan et al. (2018) show that in Brazil, China, India, and South Africa, the banking sector plays a key role in financing renewable energy projects through medium- and long-term loans, while improving capital allocation efficiency by reducing information asymmetry and transaction costs. Hasanov and Huseynov (2013) also demonstrate that in Azerbaijan, bank credit supports the growth of the non-oil sector, thereby indirectly contributing to renewable energy consumption through a shift toward sustainable economic development.

Due to the inconsistent findings in previous studies, it remains unclear whether and how renewable energy consumption (REC) and banking sector development influence economic growth (EG). Therefore, this study aims to investigate the relationship between REC, banking development, and EG in the ASEAN region. Specifically, we examine the direct impact of REC on EG and the moderating role of banking sector development in this relationship. Accordingly, the following hypotheses are proposed:

H_1: Renewable energy consumption has an impact on economic growth.

H_2: Banking sector development moderates the relationship between renewable energy consumption and economic growth.

2. DATA AND METHODOLOGY

2.1. Model Construction

Based on the studies of Fang (2011), Destek (2016), Inglesi-Lotz (2016), and Jia et al. (2023), this research employs variables representing key production inputs within the Cobb–Douglas framework, including labor force (LBF), gross capital formation (GCF), and foreign direct investment (FDI), which is used as a proxy for technological innovation. Renewable energy consumption (REC) is measured as the percentage of renewable energy in total final energy consumption. Banking sector development is measured by domestic credit to the private sector by banks (% of GDP), based on the widely adopted method proposed by Beck and Levine (2004), which is a standard proxy for financial development in empirical research. The model is designed:

$$\ln GDPpc_{i,t} = \alpha + \beta_1 REC_{i,t} + \beta_2 DCB_{i,t} + \beta_3 CONTROL_{i,t} + \lambda_i + \varepsilon_{i,} \quad (1)$$

Where the subscript i denotes the country in the sample, and t represents the year of observation. λ_i captures country-specific fixed effects to control for unobservable characteristics that are constant over time within each country. $\varepsilon_{i,t}$ denotes the random error term.

- lnGDPpc: The natural logarithm of GDP per capita, measured by GDP per capita in current US dollars
- REC: Renewable energy consumption, measured by the percentage share of renewable energy in total final energy consumption. This is the key explanatory variable.
- DCB: Banking sector development, measured by domestic credit to the private sector by banks as a percentage of GDP.

DCB.REC: The interaction term between DCB and REC, included to examine the moderating effect of banking development on the REC–EG relationship.

CONTROL variables include: GCF: Gross capital formation, measured by total investment in fixed assets plus inventory changes, as a percentage of GDP. lnLBF: The natural logarithm of labor force, measured by the percentage of the population aged 15-64. lnFDI: The natural logarithm of foreign direct investment, measured by net FDI inflows in current US dollars, serving as a proxy for technological progress. INF: Inflation rate, measured by the annual percentage change in the consumer price index (CPI). PG: Population growth, measured by the annual percentage change in total population.

The second model is extended by introducing an interaction term to test Hypothesis H_2, which examines the moderating role of banking sector development in the relationship between renewable energy consumption and economic growth. This model is grounded in the Endogenous Growth Theory (Romer, 1986; Lucas, 1988) and Schumpeter's (1911) Theory of Financial Intermediation. The adjusted model is specified as follows:

$$\ln GDPpc_{i,t} = \alpha + \beta_1 REC_{i,t} + \beta_2 DCB_{i,t} + \beta_3 DCB.REC_{i,t} + \beta_4 CONTROL_{i,t} + \lambda_i + \varepsilon_{i,t} \quad (2)$$

2.2. Data and Sample

This study employs an annual macro-level panel dataset covering 10 ASEAN countries over the period 2000-2022, based on data availability and accessibility from reputable sources. The data were obtained from trusted international databases, including the World Development Indicators (WDI) of the World Bank, the International Energy Agency (IEA), and the Asian Development Bank (ADB). The data were cleaned to remove outliers and to address inconsistencies in the number of observations across countries in the sample. The descriptive statistics of the variables used are presented as follows:

Table 1 shows that lnGDPpc has a mean of 7.992 and a standard deviation of 1.593, indicating significant disparities in economic development among ASEAN countries—from high-income nations like Singapore to lower-income ones like Myanmar and Laos. REC averages 33.558% with high variability (SD = 27.633),

Table 1: Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
lnGDPpc	230	7.992	1.593	4.947	11.324
REC	220	33.558	27.633	0	85.77
DCB	214	60.251	41.808	3.121	133.786
GCF	230	26.112	6.44	10.148	41.067
lnFDI	224	21.941	2.654	16.644	37.184
lnLBF	230	16.213	1.803	11.926	18.737
INF	230	4.642	6.562	−2.315	57.075
PG	230	1.214	0.507	0.134	2.57

Source: Authors' calculation using Stata 15

Table 2: Correlation matrix of variables

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) lnGDPpc	1.000							
(2) REC	−0.866	1.000						
(3) DCB	0.598	−0.672	1.000					
(4) GCF	0.159	−0.194	0.131	1.000				
(5) lnFDII	0.403	−0.430	0.590	0.242	1.000			
(6) lnLBF	−0.555	0.288	0.070	0.053	0.319	1.000		
(7) INF	−0.481	0.483	−0.346	−0.214	−0.215	0.204	1.000	
(8) PG	−0.188	0.010	−0.233	−0.321	−0.425	−0.152	−0.051	1.000

Source: Authors' calculation using Stata 15

reflecting uneven adoption of renewable energy. While Vietnam and Thailand have advanced in renewables, countries like Singapore and Brunei remain reliant on fossil fuels. DCB has a mean of 60.251% of GDP and a standard deviation of 41.808, highlighting differences in banking sector development across the region. GCF is relatively stable across countries, with a mean of 26.112% and SD of 6.44. lnFDI (mean = 21.941, SD = 2.654) suggests generally balanced FDI inflows, though higher in Singapore and Vietnam. lnLBF (mean = 16.213, SD = 1.803) shows a relatively even labor force distribution. INF averages 4.642% with wide variation (SD = 6.562), pointing to differing levels of macroeconomic stability. Finally, PG has a mean of 1.214% and SD of 0.507, with higher rates in the Philippines and Vietnam, and lower rates in Singapore and Cambodia.

The correlation matrix of explanatory variables in Table 2 indicates low correlations among the independent variables. The Variance Inflation Factor (VIF) values in Table 3 are all above 1 but remain at relatively low levels, suggesting that multicollinearity is not a concern in the model. Therefore, the proposed model is considered appropriate.

Table 3: Variance inflation factor (VIF)

Variables	VIF (1)	1/VIF (1)	VIF (2)	1/VIF (2)
REC	2.9	0.345	3.815	0.262
DCB	2.488	0.402	3.482	0.287
DCB.REC			2.036	0.491
lnFDII	2.23	0.448	2.323	0.431
lnLBF	1.596	0.627	1.783	0.561
PG	1.483	0.675	1.485	0.673
INF	1.381	0.724	1.407	0.711
GCF	1.237	0.809	1.333	0.75
Mean VIF	1.902		2.208	

Source: Authors' calculation using Stata 15

Table 4: Results of the Durbin–Wu–Hausman endogeneity test

Variables	(1)	(2)
r_REC		
F	1.38	1.30
Prob	0.2420	0.2553
r_DCB		
F	0.39	1.16
Prob	0.5325	0.2821

Source: Authors' calculation using Stata 15

Bilgili and Ozturk (2015) argue that studies examining the relationship between renewable energy consumption and economic growth often face endogeneity issues when using panel data. Endogeneity violates the assumptions of the regression model, leading to biased OLS estimates and undermining the robustness of the findings. To address this, the authors conducted the Durbin–Wu–Hausman test for endogeneity, following the steps proposed by Davidson and MacKinnon (1993). The test results are presented as follows:

The results indicate that endogeneity is not present in either Model (1) or Model (2). This implies that there is no evidence to confirm whether renewable energy consumption and banking sector development have reverse causality effects on economic growth.

3. EMPRICAL RESULTS

3.1. Benchmark Results

Table 4 presents the impact of REC on EG, where columns (1), (2), and (3) report the estimation results using the multi-way fixed effects (MWFE) regression with two-way clustered standard errors to address heteroskedasticity and autocorrelation. To test the robustness of the model and enhance the reliability of the estimates, the Newey–West method (Newey and West, 1987) is applied to correct standard errors in the presence of autocorrelation and heteroskedasticity, as shown in column (4).

The results across all four models consistently confirm that the proposed model is both appropriate and robust under different estimation methods. Therefore, the study adopts the results from the main model presented in column (3) as the benchmark findings. Both REC and DCB are statistically significant at the 5% level, indicating that renewable energy consumption and banking sector development have a strong impact on economic growth.

The coefficient of REC is negative (−0.0333) and statistically significant at the 1% level, suggesting an inverse relationship. Specifically, renewable energy consumption appears to have a negative effect on GDP per capita, meaning that higher REC is associated with lower economic growth. This finding is consistent with prior studies by Ocal & Aslan (2013) and Bhattacharya et al. (2016), which found that in developing countries, renewable energy consumption may hinder economic growth due to poor resource management and insufficient infrastructure. Furthermore, although renewable energy is sustainable and crucial for the future, its high initial investment costs can reduce the efficiency of its utilization in production, potentially leading to adverse economic effects (Ocal & Aslan., 2013; Bhattacharya et al., 2016).

Banking sector development (DCB) has a positive effect on economic growth at the 1% significance level, indicating that a more developed banking system fosters economic growth in ASEAN. This finding is consistent with the studies of Camba and Camba (2020), Durusu-Ciftci et al. (2017), and Guru and Yadav (2019), which highlight the crucial role of bank credit and financial market development in promoting long-term economic growth, particularly by improving resource allocation and enhancing access to capital. Moreover, according to ADB (2020), the threshold at which the marginal impact of domestic credit to the private sector begins to decline has not yet applied to developing Asian countries. This suggests that ASEAN economies still have room to expand bank credit as a means to sustain sustainable growth over the long term.

The control variable lnLBF is statistically significant at the 1% level and negatively signed, indicating that the labor force has a dampening effect on economic growth. This finding aligns with Donovan et al. (2023), who argue that an excessively large labor force may negatively impact economic performance. This also helps explain the negative effect of PG (population growth) in the model, which is consistent with the findings of Klasen and Lawson (2007), suggesting that population growth can hinder economic growth.

GCF also has a negative and statistically significant impact on lnGDPpc at the 1% level, implying that gross capital formation reduces economic growth in ASEAN. This relationship may be attributed to inefficiencies in capital allocation and the quality of infrastructure investment. The result is in line with Onyinye et al. (2017) and Topcu et al. (2020), who note that capital accumulation does not necessarily lead to higher GDP per capita unless investment is efficient, well-managed, and supported by sound public policy. Topcu et al. (2020) further highlight that in low-income countries, capital accumulation may not boost growth in the absence of structural reforms. Similarly, Onyinye et al. (2017) emphasize that insufficient or inefficient capital formation is a key constraint on sustainable growth. The IMF (2025) also cautions that in the absence of strong fiscal strategies, high levels of public investment in ASEAN countries may lead to rising public debt. The variable lnFDI is statistically significant at the 1% level and positively signed, as expected. This confirms the findings of Joshua et al. (2020) and Zhao (2013), who demonstrate that FDI serves as a driver of economic growth in several countries. The result may be explained by the role of FDI in providing capital for investment, especially in high-tech, infrastructure, and manufacturing sectors, thereby enhancing productivity and competitiveness in ASEAN economies. Finally, INF is statistically significant at the 1% level and negatively associated with GDP, indicating that higher inflation reduces GDP per capita. This is consistent with Mandeya and Sin-Yu (2022), who find that inflation has a detrimental effect on economic growth.

Thus, the findings from Table 5 support Hypothesis H_1: Renewable energy consumption has an impact on economic growth. Specifically, a 1% increase in renewable energy consumption is associated with a 0.0333 unit decrease in economic growth, indicating a negative effect of renewable energy consumption on economic growth in ASEAN.

3.2. The Moderating Role of Banking Sector Development in the Relationship between Renewable Energy Consumption and Economic Growth

To examine the moderating role of banking sector development in this relationship, we continue to apply the Multi-Way Fixed Effects (MWFE) estimation method and test the robustness of the results using the Newey–West standard error correction approach. This study follows the framework of Anton and Nucu (2019), which argues that banking development promotes renewable energy consumption through three main channels: (i) Direct effect – financial resources provide capital for investments in energy infrastructure, thereby increasing the capacity for energy production and consumption; (ii) business effect – access to finance helps enterprises expand their operations, which leads to greater energy demand; and (iii) wealth effect – improved financial conditions raise living standards and incomes, which in turn increases energy use through higher consumption of energy-intensive goods and services.

We argue that the banking system can indirectly support renewable energy consumption through long-term financing, enabling renewable energy projects or firms investing in renewables to access cheaper capital and adopt cleaner technologies. Additionally, by facilitating technological innovation, the banking system can help reduce the high upfront costs of renewable energy, thereby mitigating its potential negative impact on economic growth. Islam et al. (2013) demonstrated that a sufficiently developed financial system can promote investments in clean energy technologies, making renewable energy consumption more economically viable. Therefore, the moderating role of banking

Table 5: Main regression results

Variables	lnGDPpc (1)	lnGDPpc (1)	lnGDPpc (1)	lnGDPpc (1)
REC	−0.0492*** (0.00192)		−0.0333*** (0.00202)	−0.0333*** (0.00248)
DCB		0.0226*** (0.00188)	0.00308*** (0.00108)	0.00308** (0.00139)
GCF			−0.0133*** (0.00483)	−0.0133** (0.00595)
lnLBF			−0.409*** (0.0288)	−0.409*** (0.0322)
lnFDI			0.123*** (0.0367)	0.123*** (0.0367)
INF			−0.0145*** (0.00441)	−0.0145*** (0.00499)
PG			−0.564*** (0.0627)	−0.564*** (0.0791)
Constant	9.616*** (0.0898)	6.628*** (0.157)	13.96*** (0.552)	13.96*** (0.624)
Observations	220	214	202	202
R-squared	0.724	0.341	0.933	

Robust standard errors in parentheses. ***P<0.01, **P<0.05, *P<0.1. Source: Authors' calculation using Stata 15

Table 6: Interaction between banking sector development and renewable energy consumption on economic growth

Variables	lnGDPpc (2)	lnGDPpc (2)
REC	−0.0315*** (0.00240)	−0.0315*** (0.00305)
DCB	0.00435*** (0.00122)	0.00435*** (0.00160)
DCB.REC	−6.65e-05** (2.95e-05)	−6.65e-05* (3.94e-05)
GCF	−0.0108** (0.00505)	−0.0108* (0.00630)
lnLBF	−0.396*** (0.0288)	−0.396*** (0.0322)
lnFDI	0.116*** (0.0367)	0.116*** (0.0370)
INF	−0.0157*** (0.00456)	−0.0157*** (0.00515)
PG	−0.570*** (0.0652)	−0.570*** (0.0820)
Constant	13.80*** (0.547)	13.80*** (0.612)
Observations	202	202
R-squared	0.934	

Robust standard errors in parentheses. ***P<0.01, **P<0.05, *P<0.1. Source: Authors' calculation using Stata 15

sector development may enhance the ability of renewable energy consumption to foster economic growth.

To test Hypothesis H_2, we extend the original model (1) by incorporating an interaction term between banking sector development and renewable energy consumption.

The results from Model (2) and the robustness checks indicate that the moderating role of banking sector development on renewable energy consumption (REC) has a negative effect on economic growth in ASEAN at the 5% significance level. The negative impact of the interaction term DCB.REC suggests that the financial system in ASEAN has not effectively supported renewable energy development, thereby limiting REC's contribution to GDP growth as banking development increases. Sadorsky (2011) emphasized that credit only promotes energy consumption when it is efficiently allocated. However, in ASEAN, financial flows into the renewable energy sector remain limited, while the expansion of production is still primarily reliant on fossil fuels, which reduces the potential positive impact of REC on economic growth (IRENA, 2022). This result is also consistent with Islam et al. (2013), who argued that the relationship between financial development and energy consumption is not always linear—especially in developing economies, where grid infrastructure has yet to keep pace with the expansion of renewable energy. Although the DCB.REC interaction term is negatively signed, its magnitude is less severe than the standalone effect of REC, suggesting that banking sector development may still offer some buffering effect against the risks associated with renewable energy.

In summary, the negative sign of DCB.REC reflects the limited effectiveness of banking support and inadequate infrastructure, which diminish the economic efficiency of REC. Nonetheless, the lessened negative effect implies that banking systems could help absorb initial investment shocks, facilitate technological innovation, and create favorable conditions for REC to contribute more positively in the long run. This finding highlights the importance of green finance policies and green credit in advancing energy transition.

Thus, Hypothesis H_2 is confirmed—in other words, banking sector development plays a moderating role in the relationship between renewable energy consumption and economic growth. Specifically, banking development helps mitigate the negative impact of renewable energy consumption on economic growth.

4. IMPLICATION AND CONCLUSION

This study investigates the impact of renewable energy consumption on economic growth, taking into account the moderating role of banking sector development in this relationship and clarifying its contribution. Using panel data from 10 ASEAN countries over the period 2000-2022, the findings confirm both a significant relationship between renewable energy consumption and economic growth, and the moderating effect of banking development.

The results show that increased renewable energy consumption is associated with lower economic growth. However, this relationship is moderated by the level of banking sector development, which helps mitigate the negative impact. This is because a developed banking system can indirectly support renewable energy consumption through long-term investment, providing renewable energy projects with better access to affordable capital and facilitating technological innovation. The findings suggest that renewable energy consumption in ASEAN is not yet optimized, partly due to the higher investment costs of renewable energy compared to conventional sources such as oil and coal, which in turn constrains economic growth. These results offer important implications for policymakers in designing effective energy transition strategies to enhance economic performance. Recognizing the role of banking sector development, regulators are encouraged to consider targeted policies and financial solutions that support renewable energy enterprises and projects in accessing timely and affordable funding.

This study also has several limitations. First, the research is constrained by data availability, as reliable sources such as the World Development Indicators (WDI) and the IMF do not provide complete statistics for all ASEAN countries and across the full time span. Consequently, the analysis is limited to the period from 2000 to 2022, which may not capture the broader global economic landscape. Second, the study focuses only on the short-term effects of renewable energy consumption on economic growth and the moderating role of banking sector development in this relationship within ASEAN, without exploring the long-term impacts. Third, the study does not delve into the sectoral impacts of renewable energy consumption—how it may affect different industries or sectors within the economy. Future studies may further explore this relationship by addressing the aforementioned limitations.

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