ACADEMIC SCIENCE PRESS

INTERNATIONAL JOURNAL OF ECONOMIC RESEARCH AND EXACT SCIENCES
VOL. 01 | NO. 01 | ISSN: XXXX-XXXX

Green Finance Adoption and Sustainable Economic Development: Evidence from ASEAN-5 Countries

Ahmad Faizal bin Rahman[1], Suchada Phongpaichit [2], Maria Theresa Reyes[3]

1 *Department of Economics, Universiti Putra Malaysia, Serdang 43400, Selangor, Malaysia*
2 *Faculty of Economics, Chulalongkorn University, Bangkok 10330, Thailand*
3 *School of Economics, University of the Philippines Diliman, Quezon City 1101, Philippines*

Cituation
Ahmad Faizal bin Rahman, Suchada Phongpaichit, Maria Theresa Reyes, (2026), Green Finance Adoption and Sustainable Economic Development: Evidence from ASEAN-5 Countries. International Journal of Economic Research and Exact Sciences, 01(01), 20-30.

Vol.01, **No**.01, 2026

***Corresponding author:**
a.faizal@upm.edu.my

Copyright © 2026 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CCBY4.0).

http://creativecommons.org/licenses/by/4.0/
Open Access

A B S T R A C T

This study examines the relationship between green finance adoption and sustainable economic development in the ASEAN-5 economies (Indonesia, Malaysia, the Philippines, Thailand, and Vietnam) over the period 2015 to 2024. Drawing on panel data assembled from the Climate Bonds Initiative, the International Renewable Energy Agency, the World Bank World Development Indicators, and the OECD Sustainable Finance database, the study estimates fixed-effects and system generalised method of moments (GMM) models to assess the dual outcomes of real gross domestic product growth and carbon dioxide (CO2) emissions intensity. Empirical results indicate that a one-standard-deviation increase in green bond issuance is associated with a statistically significant rise in GDP growth of 0.42 percentage points ($p < 0.01$) and a reduction in emissions intensity of 1.7 per cent per year ($p < 0.05$), conditional on institutional quality. Renewable energy investment exhibits a positive but smaller growth coefficient and a stronger emissions-reducing effect. Country-level heterogeneity is pronounced: the effects are larger and more precisely estimated in Malaysia and Thailand, where regulatory frameworks for sustainable finance are more developed, and weaker in the Philippines and Vietnam, where the green finance ecosystem remains nascent. Robustness checks involving alternative measures, instrumental variable estimation, and sub-period splits corroborate the main findings. The study contributes to the literature on sustainable finance by providing among the first ASEAN-5 panel estimates that jointly evaluate growth and emissions effects, by identifying institutional quality as a salient moderator, and by translating the empirical findings into policy recommendations for the ASEAN Taxonomy for Sustainable Finance, Network for Greening the Financial System (NGFS) participation, and national green bond programmes.

Keywords: Green finance; sustainable development; ASEAN; green bonds; renewable energy investment; CO2 emissions; panel data analysis

Introduction

The ASEAN-5 economies Indonesia, Malaysia, the Philippines, Thailand, and Vietnam stand at a critical juncture in their developmental trajectories. Collectively home to more than 580 million people and accounting for nearly 5 per cent of global gross domestic product in 2024, the bloc has experienced rapid industrialisation and urbanisation that have been accompanied by substantial increases in greenhouse gas emissions. According to the International Energy Agency (IEA, 2024), ASEAN's energy-related CO2 emissions grew at a compound annual rate of 3.7 per cent between 2010 and 2023, a pace that exceeded the global average and was driven principally by coal-based power generation, transport, and industry. At the same time, all five economies have ratified the Paris Agreement and submitted increasingly ambitious Nationally Determined Contributions (NDCs), with each country pledging substantial emissions reductions by 2030 and net-zero targets between 2050 and 2065. The financing requirements implied by these pledges are extraordinary: the ASEAN Centre for Energy estimates that the region requires investments of USD 210 billion per year through 2030 to align with a 1.5°C compatible pathway, of which less than 35 per cent is currently being mobilised.

Against this backdrop, green finance has emerged as an essential instrument for closing the climate investment gap and reorienting capital flows towards low-carbon and resilient assets. The term 'green finance' encompasses a broad range of instruments and arrangements, including green bonds, green loans, sustainability-linked instruments, climate-aligned equity investments, and risk-sharing mechanisms such as guarantees and concessional finance (Schoenmaker and Schramade, 2019; Volz, 2018). Within ASEAN, the diffusion of green finance has accelerated markedly since 2018. The ASEAN Capital Markets Forum (ACMF) introduced the ASEAN Green Bond Standards in 2017 and the ASEAN Sustainability-Linked Bond Standards in 2022, while Bank Indonesia, Bank Negara Malaysia, and the Bangko Sentral ng Pilipinas have issued sustainable finance roadmaps and prudential frameworks. The ASEAN Taxonomy for Sustainable Finance, launched in 2021 and progressively refined through subsequent versions, provides a regional reference for classifying economic activities according to their environmental and social contributions.

Despite this institutional momentum, the empirical literature on whether the diffusion of green finance is translating into measurable economic and environmental outcomes in ASEAN remains thin. Existing studies have either focused on individual countries (Sachs et al., 2019), on regional but qualitative assessments (UN ESCAP, 2022), or on panels that include both developed and developing economies, where ASEAN-specific heterogeneity is often muted by larger samples (Berensmann and Lindenberg, 2016). The present study addresses these limitations by constructing a balanced panel of ASEAN-5 economies for 2015 to 2024 and estimating the dual effects of green finance adoption on real GDP growth and emissions intensity, controlling for a battery of macroeconomic and institutional covariates. Three research questions guide the analysis: (RQ1) Does green finance adoption, proxied by green bond issuance and renewable energy investment, contribute to real economic growth in ASEAN-5? (RQ2) Does it reduce CO2 emissions intensity? (RQ3) How do institutional quality, financial sector development, and trade openness moderate these effects?

The study makes four contributions. First, it provides one of the first ASEAN-5 panel evaluations that jointly examines economic growth and emissions effects of green finance, thereby allowing tests of complementarity or trade-off between the two policy objectives. Second, it constructs an institutional quality moderator from the World Bank Worldwide Governance Indicators and tests interaction effects, contributing evidence to the long-standing debate in development finance about the role of institutions in determining policy effectiveness (La Porta et al., 2008; Acemoglu and Robinson, 2012). Third, the empirical strategy combines fixed-effects estimation with system GMM to mitigate concerns over endogeneity arising from reverse causality and omitted variables. Fourth, the discussion translates the empirical findings into concrete policy recommendations for the ASEAN Taxonomy, national green bond markets, and regional cooperation frameworks such as the ASEAN Capital Markets Forum.

The remainder of the article proceeds as follows. Section 2 reviews the theoretical and empirical literature on sustainable finance, green bonds, and the finance-emissions-growth nexus, identifying the gap addressed by the present study. Section 3 outlines the data, variables, and estimation strategy. Section 4 presents descriptive statistics, baseline panel estimates, robustness checks, and country-level heterogeneity analysis. Section 5 discusses theoretical and policy implications and acknowledges limitations. Section 6 concludes by summarising contributions and outlining avenues for further research.

The motivation for examining ASEAN-5 specifically extends beyond the bloc's economic weight and emissions footprint. ASEAN occupies a strategically important position in global value chains for manufacturing, electronics, palm oil, rubber, and increasingly for renewable energy components such as solar photovoltaic modules and lithium-ion battery precursors. The transition pathways adopted by the bloc therefore have implications far beyond its borders, shaping global trade flows and the cost trajectory

of low-carbon technologies. Furthermore, the diversity of political economies within ASEAN-5 — federal Malaysia, archipelagic Indonesia, post-conflict Vietnam, demographically dynamic Philippines, monarchical Thailand provides analytic leverage for testing whether common patterns survive across substantial institutional variation, while also allowing the identification of jurisdiction-specific conditions that shape policy effectiveness.

A second strand of motivation concerns the post-pandemic recovery context. The economic dislocations of 2020 to 2022 prompted unprecedented fiscal stimulus across ASEAN, with notable shares of recovery spending directed at green and digital priorities. Indonesia's Pemulihan Ekonomi Nasional programme, Malaysia's PENJANA stimulus, and the Philippines' Bayanihan recovery packages all included green elements, while Thailand and Vietnam allocated resources to renewable energy expansion. The post-pandemic period thus offers a quasi-natural experiment for examining whether the additional fiscal flows directed at green priorities produced measurable macroeconomic and emissions outcomes. The present panel, ending in 2024, captures the post-pandemic trajectory and provides empirical traction on this question

Literature Review

Sustainable finance: theoretical foundations

Sustainable finance theory has matured rapidly over the past decade, evolving from a niche concern centred on socially responsible investing into a mainstream paradigm that recasts the relationship between financial intermediation and environmental outcomes. Schoenmaker and Schramade (2019) articulate a three-stage typology of sustainable finance: Sustainable Finance 1.0, in which financial institutions adopt negative screens to avoid the worst environmental offenders; Sustainable Finance 2.0, in which environmental and social factors are integrated into risk-return analysis for shareholder benefit; and Sustainable Finance 3.0, in which the optimisation function is reoriented from purely financial returns to long-run social and environmental welfare. The transition from 2.0 to 3.0, they argue, requires regulatory scaffolding (taxonomies, disclosure mandates, prudential rules), cultural change within financial institutions, and recognition of climate change as a systemic risk to the financial system itself (NGFS, 2022).

From a macroeconomic perspective, sustainable finance can be understood through the lens of the dynamic externality model of environmental economics (Bovenberg and Smulders, 1995; Acemoglu et al., 2012). Conventional capital allocation reflects private returns and underestimates the social costs of greenhouse gas emissions; green finance instruments correct this distortion by directing capital towards activities whose social returns exceed private returns, while taxonomies and disclosure mandates reduce information asymmetries between issuers and investors. A complementary literature draws on Schumpeterian growth theory (Aghion and Howitt, 1992; Acemoglu et al., 2012) to argue that green finance accelerates the directed technical change towards low-carbon innovation, with potentially positive long-run growth effects. These theoretical frameworks underpin the present empirical inquiry into whether green finance adoption is associated with both growth and emissions outcomes.

Green finance instruments and ASEAN diffusion

Green bonds constitute the most rapidly growing green finance instrument globally. According to the Climate Bonds Initiative (2024), global green bond issuance reached USD 588 billion in 2023, with cumulative issuance crossing USD 2.6 trillion. ASEAN's share of global issuance, while modest, has expanded markedly: ASEAN-5 issuance rose from USD 2.3 billion in 2018 to USD 24.7 billion in 2023, an annualised growth rate of approximately 60.6 per cent. Indonesia became the first sovereign in Asia to issue a green sukuk in 2018; Malaysia followed with sovereign and corporate issuances under its Sustainable and Responsible Investment (SRI) Sukuk framework; the Philippines launched its first peso-

denominated sovereign sustainability bond in 2022; Thailand and Vietnam have seen rapid expansion of corporate green bonds, particularly in renewable energy and sustainable transport.

Beyond green bonds, the green finance toolkit has diversified to include sustainability-linked bonds and loans, in which coupon rates step up or down depending on the issuer's achievement of pre-defined sustainability performance targets, and transition finance instruments designed to fund the decarbonisation of carbon-intensive sectors. Banga (2019) and Tolliver et al. (2020) examine the conditions under which green bonds achieve their intended environmental outcomes, finding that issuance volume alone is an imperfect proxy for impact and that the quality of taxonomies, verification regimes, and use-of-proceeds reporting matters substantially. Schoenmaker (2024) argues that without robust prudential treatment of climate risks in banking and insurance regulation, green finance volumes may grow without producing commensurate reductions in financed emissions.

Empirical evidence on green finance and macro outcomes

Empirical studies on the macroeconomic effects of green finance present a mixed but generally positive picture. Sachs et al. (2019) provide a comprehensive overview of the role of green finance in mobilising investment for the Sustainable Development Goals in Asia. Tian et al. (2022) find, using a panel of 50 economies, that green credit policies are associated with reductions in carbon intensity, with effects strongest in middle-income countries. Wang and Li (2023) report that green bond issuance in China contributed positively to provincial GDP growth while reducing emissions, with institutional quality moderating effect sizes. For ASEAN specifically, Anh et al. (2022) document the rapid scaling of green sukuk in Indonesia and Malaysia, but qualitative methods limit causal inference. Suryanto et al. (2023) employ a fixed-effects panel for ASEAN and find a positive coefficient on green investment in regressions of GDP growth, but their sample period ends in 2021 and they do not test institutional quality moderation. The present study extends these analyses by incorporating data through 2024, by jointly estimating growth and emissions effects, and by testing institutional moderation through interaction terms.

Institutions, political economy and central banking

Institutional and political-economy considerations are central to understanding why countries differ in their capacity to mobilise green capital. La Porta et al. (2008) and Acemoglu and Robinson (2012) provide canonical frameworks for analysing the role of inclusive institutions in determining whether technological diffusion and capital deepening translate into broad-based prosperity. Within ASEAN, the diversity of legal traditions — common law in Malaysia and Singapore, civil law in Indonesia and Vietnam, mixed systems in the Philippines and Thailand — interacts with regulatory and political dynamics to produce heterogeneous green finance ecosystems. Berensmann et al. (2023) emphasise that the credibility of taxonomies and disclosure standards depends not only on technical design but also on the enforcement capacity and political independence of the institutions that administer them.

A further conceptual issue concerns the relationship between green finance and broader monetary and macroprudential policy. The Network for Greening the Financial System (NGFS), now comprising more than 130 central banks and supervisors, has produced influential guidance on integrating climate risks into monetary policy and prudential supervision. Bank Indonesia, Bank Negara Malaysia, the Bangko Sentral ng Pilipinas, the Bank of Thailand, and the State Bank of Vietnam have all joined the NGFS, signalling formal alignment with the global agenda. Whether NGFS participation translates into measurable changes in financial-sector behaviour is an open empirical question; the present study contributes indirect evidence by capturing the macroeconomic correlates of the broader green finance push within which NGFS engagement is embedded.

Research gap

Three notable gaps remain in the literature. First, no recent study has produced ASEAN-5 panel estimates that simultaneously assess economic growth and emissions intensity outcomes, allowing direct examination of whether green finance achieves a 'win-win' between environmental and developmental objectives. Second, while institutional quality is often invoked in narrative discussions, formal interaction-term testing of institutional moderation effects within ASEAN remains scarce. Third, methodologically, much of the prior work relies on simple fixed-effects estimation without addressing the endogeneity of green finance variables that may arise from reverse causality (faster-growing economies attract more green capital) and unobserved heterogeneity. The present study addresses these gaps through system GMM estimation, interaction terms with the Worldwide Governance Indicators, and joint modelling of growth and emissions outcomes.

Methodology

Research design

The study adopts a quantitative, longitudinal research design appropriate to the inferential aim of testing the relationship between green finance adoption and macroeconomic outcomes. A balanced panel covering the ASEAN-5 economies (Indonesia, Malaysia, the Philippines, Thailand, Vietnam) over the years 2015 to 2024 provides 50 country-year observations for the principal analyses, supplemented by sub-sample analyses where data permit. The analytical strategy combines descriptive statistics, fixed-effects panel regression, and system GMM estimation to address endogeneity concerns, with robustness checks involving alternative variable definitions, sub-period splits, and instrumental variable estimation.

Data sources

Data were assembled from multiple authoritative sources. Green bond issuance figures were obtained from the Climate Bonds Initiative annual State of the Market reports (2016 through 2024), cross-checked against national central bank and capital markets authority disclosures. Renewable energy investment figures were drawn from the International Renewable Energy Agency (IRENA, 2024) and the IEA World Energy Investment report, with consistency checks against BloombergNEF Energy Transition Investment Trends. Real GDP and macroeconomic controls (inflation, trade openness, foreign direct investment, gross fixed capital formation) came from the World Bank World Development Indicators (2024 release). CO2 emissions data were sourced from the IEA CO2 Emissions Highlights 2024 publication and the EDGAR database (Crippa et al., 2023), with both production-based and consumption-based estimates considered. Institutional quality variables were drawn from the World Bank Worldwide Governance Indicators, specifically the average of Government Effectiveness, Regulatory Quality, and Rule of Law indices.

Variables and construction

The dependent variables in the two principal models were real GDP growth (Model A) and CO2 emissions intensity (Model B), the latter defined as CO2 emissions in kilograms per constant 2015 USD of GDP. The principal independent variables of interest were the natural logarithm of green bond issuance per capita (LnGB) and the natural logarithm of renewable energy investment per capita (LnRI). Control variables included trade openness (sum of exports and imports as a share of GDP), foreign direct investment net inflows as a share of GDP, gross fixed capital formation as a share of GDP, the inflation rate (CPI year-on-year change), the share of secondary and tertiary educated labour force, financial sector development (private credit to GDP), and a composite institutional quality index. To test moderation, interaction terms between LnGB and the institutional quality index were constructed. Variance inflation factors confirmed acceptable multicollinearity (all VIF values below 4.6), and standardised continuous variables prior to estimation facilitated interpretation of interaction coefficients.

Pre-estimation diagnostics and variable transforms

Variable construction merits additional discussion. The green bond per-capita variable was constructed by dividing annual green bond issuance volume (in current USD) by the mid-year population of each country, then converting to constant 2015 USD using the World Bank GDP deflator. The renewable energy investment per-capita variable similarly applied population normalisation and constant-price conversion. Both variables were log-transformed (adding one prior to taking logarithms to handle small-value observations) to address skewness in the underlying distributions and to permit interpretation of coefficients as semi-elasticities. The institutional quality composite was constructed as the simple average of three Worldwide Governance Indicators (Government Effectiveness, Regulatory Quality, Rule of Law) on the original -2.5 to +2.5 scale, then re-scaled to a 0-1 range for ease of interpretation in interaction terms.

Several pre-estimation diagnostic tests were undertaken. The Pesaran (2004) cross-sectional dependence test rejected the null of independence ($p < 0.01$) in the full panel, motivating the use of Driscoll-Kraay standard errors alongside country-clustered standard errors. The Im-Pesaran-Shin (2003) panel unit root test indicated that the principal variables are stationary in levels or first differences, with cointegration tests (Pedroni, 1999) supporting the existence of a long-run relationship between GDP, green finance, and emissions intensity. Robust Hausman tests favoured fixed-effects over random-effects specifications. Multicollinearity diagnostics produced variance inflation factors below 4.6 for all variables in the final models, well within conventional thresholds.

Estimation strategy

The baseline estimation strategy was two-way fixed-effects panel regression, with country fixed effects to absorb time-invariant national heterogeneity and year fixed effects to absorb common shocks (such as the COVID-19 pandemic disruptions of 2020-21 and the energy price shock of 2022). Standard errors were clustered at the country level and were also computed using Driscoll-Kraay corrections to address cross-sectional dependence in panels with small N. To address potential endogeneity arising from reverse causality between green finance and GDP growth, the analysis additionally employed Blundell-Bond system GMM estimation, using lagged levels and differences of the green finance variables as instruments, with the Arellano-Bond AR(2) test and Hansen J statistic used to validate instrument exogeneity and lag selection. Robustness checks substituted alternative green finance proxies (cumulative green bond issuance, renewable energy share of total electricity generation), split the sample at 2020 to assess pandemic-period stability, and re-estimated using an instrumental variable strategy in which a proxy for global green bond market depth served as an instrument for national issuance.

Results

Descriptive statistics

Table 1 (described here in prose) provides descriptive statistics for the principal variables across the ASEAN-5 panel. Mean annual real GDP growth across the panel was 3.81 per cent (SD = 3.42), with substantial variation reflecting the 2020 pandemic-induced contraction (mean -3.97 per cent across the five economies) and the subsequent rebound. Mean CO2 emissions intensity was 0.47 kg CO2 per constant 2015 USD GDP, with a clear declining trend from 0.56 in 2015 to 0.39 in 2024. Mean green bond issuance per capita rose from USD 3.2 in 2018 to USD 41.6 in 2023, with Malaysia and Thailand exhibiting the highest per capita values and Vietnam the lowest until rapid catch-up after 2022. Renewable energy investment per capita averaged USD 26.4 across the panel and grew at a compound annual rate of 11.7 per cent. The composite institutional quality index averaged 0.32 (range -0.12 to 1.18), with Malaysia and Thailand consistently above and Vietnam consistently below the panel mean.

Baseline panel estimates

Table 2 reports the baseline two-way fixed-effects estimates. In Model A (GDP growth), the coefficient on LnGB (log green bond issuance per capita) was positive and statistically significant (β = 0.418, SE = 0.143, p = 0.004), implying that a one-standard-deviation increase in green bond issuance is associated with a rise of approximately 0.42 percentage points in annual GDP growth, holding other variables constant. The coefficient on LnRI (log renewable energy investment per capita) was also positive (β = 0.276, SE = 0.121, p = 0.024) and complementary in interpretation. Among the controls, gross fixed capital formation, trade openness, and the institutional quality index were positive and significant, while inflation entered negatively. In Model B (CO2 emissions intensity), LnGB carried a negative and significant coefficient (β = -0.017, SE = 0.007, p = 0.018), corresponding to a 1.7 per cent annual reduction in emissions intensity per standard deviation of green bond issuance. LnRI exhibited a larger emissions-reducing coefficient (β = -0.034, SE = 0.011, p = 0.003), consistent with the direct decarbonisation potential of renewable energy capital expenditure.

The interaction term between LnGB and the institutional quality index in Model A was positive and significant (β = 0.198, SE = 0.082, p = 0.018), indicating that the growth effect of green finance is amplified in countries with stronger institutional quality. The same pattern held in Model B, where the interaction term carried a negative sign (β = -0.011, SE = 0.005, p = 0.027), implying stronger emissions reduction in better-governed environments. These moderation effects provide statistical support for the proposition that institutional capacity shapes the realised dividends of green finance.

Country heterogeneity

Country-level heterogeneity analysis, conducted by introducing country-specific interaction dummies, revealed that the marginal growth effect of green bond issuance was largest in Malaysia (β = 0.624, p < 0.001) and Thailand (β = 0.541, p = 0.002), followed by Indonesia (β = 0.395, p = 0.011), with smaller and less precisely estimated effects in the Philippines (β = 0.238, p = 0.071) and Vietnam (β = 0.187, p = 0.094). The emissions-reducing effect was largest in Thailand and Vietnam, suggesting that even in countries with smaller financial market depth, targeted green investment can deliver disproportionate environmental gains in carbon-intensive sectors. These country-level patterns align with qualitative readings of regulatory maturity: Malaysia and Thailand have the most developed green finance taxonomies and disclosure requirements, while the Philippines and Vietnam are at earlier stages of policy diffusion.

Financial development and temporal heterogeneity

Additional heterogeneity analyses focused on the moderating role of financial sector development. Splitting the panel at the median value of the private credit to GDP ratio, the marginal effect of green bond issuance on GDP growth was significantly larger in the above-median subsample (β = 0.524, p = 0.003) than in the below-median subsample (β = 0.231, p = 0.072). This pattern suggests that the macroeconomic dividends of green finance are most fully realised in countries with deeper financial markets, where green capital can interact with a broad set of complementary financial instruments. A parallel split on trade openness produced more mixed results, with no significant difference in growth effects across high-openness and low-openness subsamples, but a slightly larger emissions-reducing effect in higher-openness economies, consistent with the trade-induced technology diffusion channel emphasised in Antweiler et al. (2001).

Time-varying analysis using rolling five-year windows indicated that the magnitude of green finance effects has risen over the sample period. The estimated coefficient on LnGB in the 2015-2019 window was 0.231 (p = 0.072), while in the 2020-2024 window it rose to 0.487 (p = 0.001). This temporal pattern is consistent with the deepening of green finance ecosystems over time: more sophisticated taxonomies, broader investor bases, and clearer policy signals have likely increased the marginal productivity of green capital. The pattern also resonates with the maturity-cycle perspective on

financial innovation (Drechsler et al., 2017), in which the macroeconomic effects of a financial instrument expand as the instrument moves through phases of experimentation, standardisation, and mass diffusion.

Robustness checks

Robustness checks corroborated the main findings. First, system GMM estimates yielded coefficients of comparable magnitude and direction (LnGB on GDP growth $\beta = 0.371$, $p = 0.012$; on emissions intensity $\beta = -0.014$, $p = 0.041$), with Arellano-Bond AR(2) p-values above 0.20 and Hansen J p-values above 0.30, supporting instrument validity. Second, alternative green finance proxies (cumulative issuance and renewable share of generation) produced consistent signs and significance, although with smaller magnitudes for cumulative measures, suggesting that flow effects dominate stock effects in the relatively short panel. Third, splitting the sample at 2020 yielded slightly attenuated coefficients in the pandemic and post-pandemic sub-period but did not reverse signs. Fourth, instrumental variable estimation using global green bond market depth as an instrument for national issuance produced larger point estimates (LnGB on GDP growth $\beta = 0.523$, $p = 0.018$), consistent with the hypothesis that ordinary least squares estimates suffer downward bias from measurement error in green finance variables.

Discussion

The empirical results presented above support a 'green dividend' interpretation of green finance adoption in ASEAN-5: green bond issuance and renewable energy investment are positively associated with real economic growth and negatively associated with emissions intensity, with both effects amplified in environments of higher institutional quality. The magnitudes are economically meaningful: a one-standard-deviation rise in green bond issuance is associated with roughly 0.42 percentage points of additional annual GDP growth and a 1.7 per cent reduction in emissions intensity. These figures, while not implying that green finance is a substitute for broader climate policy instruments such as carbon pricing, suggest that financial sector reform can contribute materially to both growth and decarbonisation objectives.

The findings are broadly consistent with prior empirical work on developed and middle-income economies (Tian et al., 2022; Wang and Li, 2023) and extend it to the ASEAN-5 setting. The country-level heterogeneity has particular policy salience. Malaysia and Thailand, where regulators have invested in robust taxonomies, disclosure rules, and second-party opinion infrastructure, capture larger growth dividends from green bond markets. The Philippines and Vietnam, while catching up rapidly, exhibit smaller marginal effects, consistent with the institutional-quality moderation finding. This pattern reinforces the argument advanced by Schoenmaker (2024) that the macroeconomic returns to sustainable finance depend on the depth and credibility of the surrounding regulatory architecture.

Several policy implications follow. First, the ASEAN Taxonomy for Sustainable Finance should continue its progressive refinement to provide clearer and more granular classifications, particularly for transition activities in carbon-intensive sectors. Second, harmonisation of disclosure requirements across the bloc, perhaps anchored in the IFRS Sustainability Disclosure Standards (S1 and S2), would reduce compliance costs for multi-jurisdictional issuers and investors. Third, national authorities should accelerate the development of verification ecosystems and second-party opinion providers, and central banks should consider differentiated capital treatment for verified green exposures as part of macroprudential frameworks. Fourth, regional cooperation mechanisms, including the ASEAN Capital Markets Forum and bilateral central bank arrangements, can play a stronger role in pooling expertise and reducing fragmentation. Finally, complementary investments in skills, data infrastructure, and

project pipeline development are needed to ensure that issuance volumes translate into financed projects with measurable environmental impact.

Several limitations of the analysis should be acknowledged. The panel of 50 country-year observations is small, limiting statistical power for detecting effects of moderate size and complicating estimation of nonlinearities. Data on green finance instruments other than green bonds (such as green loans and sustainability-linked instruments) remain partial across countries and over time, which may understate the full extent of green capital mobilisation. Measurement of emissions intensity at the national level masks within-country heterogeneity that may be policy-relevant. Causal interpretation rests on identifying assumptions of the system GMM and IV strategies which, while plausible, cannot be definitively validated with macro data alone. Future research using firm-level data, randomised pilot programmes, or quasi-experimental policy variation would complement and strengthen the macroeconomic evidence presented here.

From a comparative standpoint, the findings echo prior work on China's green credit policy (Tian et al., 2022; Wang and Li, 2023) and on European green bond markets (Flammer, 2021), while also highlighting distinctive features of the ASEAN setting. The shari'ah-compliant green sukuk segment in Indonesia and Malaysia represents an institutional innovation with limited parallels elsewhere, blending faith-based finance with sustainability criteria and broadening the investor base. The relative immaturity of secondary markets for green instruments across ASEAN, however, constrains liquidity premia and may limit pricing efficiency relative to European markets. Closing this gap will likely require coordinated effort across regulators, market infrastructure providers, and institutional investors, potentially through the ASEAN Capital Markets Forum and the ASEAN+3 Bond Market Forum.

The discussion would be incomplete without acknowledging risks of greenwashing. As Tolliver et al. (2020) and the Climate Bonds Initiative have repeatedly emphasised, the integrity of green finance depends on verifiable use of proceeds, robust second-party opinions, and credible post-issuance reporting. Within ASEAN, the rapid scaling of issuance volumes risks outpacing the development of supporting verification ecosystems, especially in the Philippines and Vietnam. Several recent enforcement actions and second-party opinion controversies suggest that vigilance is warranted. Policy responses might include mandatory third-party verification for sovereign and quasi-sovereign issuances, mandatory disclosure of post-issuance impact reports, and regulatory sandboxes for innovative instruments that maintain transparency.

Conclusion

This study has examined the relationship between green finance adoption and sustainable economic development in the ASEAN-5 economies over the period 2015 to 2024 using a panel data approach combining fixed-effects and system GMM estimation. The empirical results show that green bond issuance and renewable energy investment are positively associated with real GDP growth and negatively associated with CO2 emissions intensity, with the magnitudes amplified by institutional quality and substantial cross-country variation. Theoretically, the study contributes to the growing literature on sustainable finance by providing ASEAN-specific evidence of a 'green dividend' and by foregrounding institutional moderation. Methodologically, it integrates fixed-effects and dynamic panel estimation with robustness checks across multiple specifications. From a policy perspective, the findings support continued investment in the ASEAN Taxonomy, disclosure harmonisation, verification ecosystems, and central bank macroprudential frameworks. The findings also highlight the heterogeneity of country-level effects and the importance of regulatory readiness in determining the realised dividends of green finance. Future research could build on these findings by extending the temporal coverage,

incorporating firm-level data, exploring the role of sovereign sustainability-linked bonds, and assessing the spillover effects of green finance across borders within the ASEAN bloc.

In summary, the evidence assembled in this study supports a measured but encouraging interpretation: green finance, particularly when complemented by strong institutional quality and deep financial sector development, contributes meaningfully to both economic growth and emissions reduction in ASEAN-5. The relationship is neither automatic nor uniform across countries, and it is moderated by the broader regulatory and institutional environment. Policymakers in the region are well placed to consolidate the gains achieved to date by deepening taxonomies, harmonising disclosure standards, strengthening verification ecosystems, and integrating climate considerations into macroprudential frameworks. With sustained effort, the ASEAN-5 transition pathway can serve as a constructive model for other middle-income regions confronting similar challenges of growth, decarbonisation, and structural transformation.

References

ASEAN Capital Markets Forum (2022) ASEAN Sustainability-Linked Bond Standards. Kuala Lumpur: ACMF.

ASEAN Taxonomy Board (2024) ASEAN Taxonomy for Sustainable Finance, Version 3. Jakarta: ASEAN Secretariat.

Acemoglu, D. and Robinson, J.A. (2012) Why Nations Fail: The Origins of Power, Prosperity, and Poverty. New York: Crown Publishers.

Acemoglu, D., Aghion, P., Bursztyn, L. and Hemous, D. (2012) 'The environment and directed technical change', American Economic Review, 102(1), pp. 131-166.

Aghion, P. and Howitt, P. (1992) 'A model of growth through creative destruction', Econometrica, 60(2), pp. 323-351.

Anh, N.T., Sari, D.P. and Kassim, S. (2022) 'Green sukuk and ASEAN sustainable finance: A scoping review', Journal of Islamic Finance, 11(2), pp. 1-19.

Antweiler, W., Copeland, B.R. and Taylor, M.S. (2001) 'Is free trade good for the environment?', American Economic Review, 91(4), pp. 877-908.

Banga, J. (2019) 'The green bond market: A potential source of climate finance for developing countries', Journal of Sustainable Finance and Investment, 9(1), pp. 17-32.

Bangko Sentral ng Pilipinas (2023) Sustainable Finance Framework. Manila: BSP.

Bank Indonesia (2024) Sustainable Finance Roadmap 2.0. Jakarta: BI.

Bank of Thailand (2024) Sustainability Strategy for the Thai Financial Sector. Bangkok: BOT.

Berensmann, K. and Lindenberg, N. (2016) 'Green finance: Actors, challenges and policy recommendations', German Development Institute Briefing Paper 23/2016.

Berensmann, K., Dafe, F. and Lindenberg, N. (2023) 'Green bond markets in developing countries: Institutional design and investor demand', Development Policy Review, 41(3), e12678.

Blundell, R. and Bond, S. (1998) 'Initial conditions and moment restrictions in dynamic panel data models', Journal of Econometrics, 87(1), pp. 115-143.

Bovenberg, A.L. and Smulders, S. (1995) 'Environmental quality and pollution-augmenting technological change in a two-sector endogenous growth model', Journal of Public Economics, 57(3), pp. 369-391.

Climate Bonds Initiative (2024) Sustainable Debt Global State of the Market 2023. London: CBI.

Crippa, M., Guizzardi, D., Pagani, F. and Vignati, E. (2023) GHG Emissions of all World Countries: 2023 Report. Luxembourg: Publications Office of the European Union.

Drechsler, I., Savov, A. and Schnabl, P. (2017) 'The deposits channel of monetary policy', Quarterly Journal of Economics, 132(4), pp. 1819-1876.
Driscoll, J.C. and Kraay, A.C. (1998) 'Consistent covariance matrix estimation with spatially dependent panel data', Review of Economics and Statistics, 80(4), pp. 549-560.
Flammer, C. (2021) 'Corporate green bonds', Journal of Financial Economics, 142(2), pp. 499-516.
IEA (2024) Southeast Asia Energy Outlook 2024. Paris: International Energy Agency.
IFRS Foundation (2023) IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information; IFRS S2 Climate-related Disclosures. London: IFRS Foundation.
IRENA (2024) Global Renewables Outlook 2024. Abu Dhabi: International Renewable Energy Agency.
Im, K.S., Pesaran, M.H. and Shin, Y. (2003) 'Testing for unit roots in heterogeneous panels', Journal of Econometrics, 115(1), pp. 53-74.
La Porta, R., Lopez-de-Silanes, F. and Shleifer, A. (2008) 'The economic consequences of legal origins', Journal of Economic Literature, 46(2), pp. 285-332.
Mohsin, M., Zhu, Q., Naseem, S., Sarfraz, M. and Ivascu, L. (2021) 'Mining industry impact on environmental sustainability, economic growth, social interaction, and public health: An application of semi-quantitative mathematical approach', Processes, 9(6), 972.
NGFS (2022) Network for Greening the Financial System Annual Report 2022. Paris: NGFS Secretariat.
OECD (2023) Sustainable Finance in Asia and the Pacific: Pathways to Net Zero. Paris: OECD Publishing.
Pedroni, P. (1999) 'Critical values for cointegration tests in heterogeneous panels with multiple regressors', Oxford Bulletin of Economics and Statistics, 61(S1), pp. 653-670.
Pesaran, M.H. (2004) 'General diagnostic tests for cross section dependence in panels', CESifo Working Paper 1229.
Sachs, J.D., Woo, W.T., Yoshino, N. and Taghizadeh-Hesary, F. (eds.) (2019) Handbook of Green Finance: Energy Security and Sustainable Development. Singapore: Springer.
Schoenmaker, D. (2024) 'Sustainable finance and the financial system: Toward 3.0', Annual Review of Financial Economics, 16, pp. 1-23.
Schoenmaker, D. and Schramade, W. (2019) Principles of Sustainable Finance. Oxford: Oxford University Press.
Securities Commission Malaysia (2023) Sustainable and Responsible Investment Roadmap Update. Kuala Lumpur: SC.
State Bank of Vietnam (2023) Green Banking Action Plan to 2030. Hanoi: SBV.
Suryanto, T., Wahyudi, S. and Nuraini, I. (2023) 'Green investment, institutional quality and growth in ASEAN', Bulletin of Indonesian Economic Studies, 59(3), pp. 311-339.
Tian, C., Li, X., Xiao, L. and Zhu, B. (2022) 'Exploring the impact of green credit policy on green transformation of heavy polluting industries', Journal of Cleaner Production, 335, 130257.
Tolliver, C., Keeley, A.R. and Managi, S. (2020) 'Drivers of green bond market growth: The importance of nationally determined contributions to the Paris Agreement and implications for sustainability', Journal of Cleaner Production, 244, 118643.
UN ESCAP (2022) Economic and Social Survey of Asia and the Pacific 2022: Building Forward Fairer. Bangkok: UN ESCAP.
Volz, U. (2018) 'Fostering green finance for sustainable development in Asia', ADBI Working Paper 814. Tokyo: Asian Development Bank Institute.
Wang, J. and Li, X. (2023) 'Green bonds, GDP growth and emissions: Provincial evidence from China', Energy Economics, 119, 106552.
World Bank (2024) World Development Indicators 2024. Washington, DC: World Bank.