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Competitions among sub-financial sectors and growth of green bond markets in ASEAN plus three countries

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Abstract

Purpose – This study aimed to explore the determining factors for green bond markets in ASEAN plus three countries. In contrast to previous publications that primarily examined the incentives for green bonds and institutional differences among economies, the analysis focused on the role of competition among sub-financial sectors in fostering the growth of green bond markets.

Design/methodology/approach – This study adopted Driscoll and Kraay fixed effect panel methods to account for country-level heterogeneity and enhance efficiency, using quarterly data from 2016 to 2022.

Findings – The findings showed that healthy competition among sub-financial sectors was crucial for the growth of green bond markets. Growth in specific sub-financial sectors such as brown corporate bond and stock markets as well as banks contributed positively to these markets. Variables related to market microstructure also had no significant impact on green bonds but macroeconomic factors did.

Practical implications – The findings suggested that governments should promote healthy competition among sub-financial sectors and implement diverse policies to ensure the sustainable growth of green bond markets.

Originality/value – This study further pioneered the importance of competition among sub-financial sectors for the development of green bond markets.

Keywords Green bond markets, Competition, Sub-financial sectors, Sustainable economy

Paper type Research paper

1. Introduction

The Paris Agreement in 2016 is calling for the transition to more sustainable and low-carbon economies. At regional and international climate summits, these economies are committed to implementing plans to reduce carbon emissions and increase the use of renewable energies. To support the initiatives, the issuance of green bonds has rapidly evolved as a primary financing instrument. However, the level of development in these markets varies among countries.

Green bond markets in the European Union, United States and China are relatively large compared to other economies and are experiencing rapid growth (Lin and Hong, 2022). However, many developing markets show significant differences in the growth stages (Torvanger *et al.*, 2021). For instance, ASEAN region which aims for green or sustainable economies shows relatively slow growth in green bond markets with diverse development levels among the countries (ADB, 2022). The European Union decided in 2023 to gradually implement the Carbon Border Adjustment Mechanism (CBAM), with a transition and reporting phase starting on October 2023 and full implementation planned for January 1, 2026. These green policies are expected to stimulate interest in green projects and bonds.

JEL Classification — F1, G21, G32

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Variations in the development of green bond markets across different economies are influenced by two factors namely the incentives associated with green bonds and institutional uniqueness in each country. Maltais and Nykvist (2021) argued three motivations for issuing and investing in green bonds namely (1) direct financial benefits such as increased or decreased returns/risk, (2) business-related incentives including image, organizational efficiency, creation of new markets and reduction of reputation risk, as well as (3) business legitimacy comprising securing a social license to operate or reducing government pressure by engaging with sustainability policies. Furthermore, Dahl and Karlsen (2019) and Torvanger *et al.* (2021) found that high green bonds obtained for various reasons hindered the issuance in Norway compared to Sweden.

Transitioning to a sustainable economy is a complex social process requiring the transformation of institutions related to sustainability (Naidoo, 2020). A previous publication by Naidoo argues that since the financial system exists within a social context and is influenced by government policies that support sustainable economic systems, financial institutions need to be transparent and actively participate in the shift towards sustainability. Torvanger *et al.* (2021) also found that the development of green bond markets was systematically related to the existing conventional bond markets based on a comparative study between Sweden and Norwegian. The article argued that when green bond markets depended on players included in banking and conventional bonds, the development would become slow. Adelegan and Radzewicz-Bak (2009) further showed that an immature financial sector constrained the growth of the domestic bond market. Lin and Hong (2022) also underscored the importance of developing financial infrastructure and supporting regulations as well as incentives for burgeoning Chinese green bond markets. However, Begum and Kamal (2018) mentioned that the dominance of bank credits in an economy impeded the development of the domestic bond market when there was a lack of sound macroeconomic systems, effective information dissemination and formal automated centralized systems. Adelegan and Radzewicz-Bak (2009) showed that the dominance of the banking sector substituted the role of the private debt market in sub-Saharan Africa. Essentially, a developed banking sector in evolving markets undermines the development of the private debt market. Therefore, the state of the financial institutions in each economy can either foster or impede the development of green bond markets.

Previous publications focus on the importance of financial institutions in the development of conventional bond markets. However, no publication has focused on the impacts of competition in the financial sector on the development of green bond markets. This study aims to find that healthy competition among sub-financial sectors is crucial for the growth of green bond markets. As a new financing instrument, green bond markets need healthy and sustainable financial space that competes to improve total efficiency. The effective functioning of brown bond markets, banks and stock markets is necessary to grow green bond markets (Flammer, 2021; Torvanger *et al.*, 2021).

Additionally, the study reaffirms the importance of macroeconomic conditions for the stable progression of green bond markets such as interest rate volatility, foreign exchange and GDP. These findings are consistent with the publications by Broadstock and Cheng (2019), Burger *et al.* (2012), Eichengreen and Luengnaruemitchai (2004), Hale *et al.* (2020) and Lee (2022).

2. Related literature and hypothesis development

2.1 Exiting financial sector and green bond markets developments

Green bond markets which support sustainable, climate and environmentally friendly projects evolved as a relatively new financing instrument in both corporate and government funding markets. The various financial and capital market institutions, specifically the dominant financial institutions of the economy, played a significant role in shaping and

developing the legal, institutional and economic environment for green bond markets (Greenwood and Javanoovic, 1990; Patrick, 1966). These institutions conducted funding activities under regulatory and economic conditions. For example, the alleviation of information friction in financial institutions as emphasized by Boyd and Prescott (1986) suggested that the level of existing financial markets directly impacted green bond markets.

(1) Brown and Green Bond Markets

Green bond markets incurred additional costs related to the verification process compared to conventional bonds as the proceeds were exclusively used for green projects (International Capital Market Association, 2022). These markets also required extra monitoring reports until the bonds reached maturity. Issuing green bonds allowed firms to showcase a credible commitment to environmental sustainability and enhance access to finance (Flammer, 2021). However, the existing conventional corporate and government bond markets of each economy significantly influenced the formulation and development of green bond markets.

The absolute size of the conventional bond market impacted the formation and development of green bond markets. Eichengreen and Luengnaruemitchai (2004) argued that when a bond market did not reach a certain minimum efficient scale, it struggled to make the corporate bond market function well. This phenomenon tended to be observed in small economies, struggling to attract foreign investors for bonds (Eichengreen *et al.*, 2022). Burger and Warnock (2007) further showed that only a small portion of United States investors participated in foreign local currency bonds due to high currency risks.

The relative development degree of existing corporate and government bond markets compared to green bond markets played a crucial role. Adelegan and Radzewicz-Bak (2009) found that a sizable government bond market tended to displace the private bond market in sub-Saharan Africa (SSA). The publication explained that competition between government and private bond markets under limited funding led to the displacement of corporate bond markets. Furthermore, Lin and Hong (2022) showed that in China, the dominance of the governments in green bond markets limited the participation of private sectors.

Market microstructures of primary and secondary conventional bond markets were often applied to green bond markets. For instance, Hong Kong allowed individual investors to participate in the primary conventional bond market while Indonesia prohibited participation. Each country applied similar regulations in the primary green bond markets (ADB, 2022). When conventional bond markets lacked transparency and had a decentralized market microstructure, it required high search costs for less sophisticated investors (Bessembinder *et al.*, 2020). However, increased transparency tended to reduce the trader's profit in over-the-counter (OTC) bond markets unless trading volumes increased (Back *et al.*, 2020). Bessembinder *et al.* (2020) further found that trading costs in the secondary market impacted transaction completions in the secondary market and subsequent debt issuance costs in the primary market.

Furthermore, Banga (2019) mentioned that market microstructure posed significant obstacles to the development of green bond markets, especially in terms of illiquidity and insufficient technological infrastructure. In evolving countries, the illiquidity of corporate bond markets and low investor diversity hindered long-term borrowing in local currency (Mizan *et al.*, 2021). Asian Development Bank (ADB) (2022) also reported that one reason investors hesitated to invest in green bond markets was the difficulty in marking the bonds. Green bond markets possessed unique risks such as potential mandatory buybacks and changes in coupon rates when green labels were violated (ADB, 2022). Bessembinder *et al.* (2006), Edwards *et al.* (2007) and Goldstein *et al.* (2007) also reported that public transaction reporting in secondary markets reduced investor transaction costs, suggesting economies with less serious information asymmetry in market microstructure experienced faster growth in green bond markets.

H1. The developed brown markets have positive effects on the development of green bond markets.

(2) Banks and Green Bond Markets Development

Traditionally, banks dominated financial institutions in most economies. During the last decade, Asian bond markets grew significantly compared to other developing bond markets (Abraham *et al*., 2021). However, financial markets, institutions and social conventions such as family connections and state interventions kept banks dominant in Asian economies despite high information imperfections (Eichengreen and Luengnaruemitchai, 2004). Kowalewski and Pisany (2019) commented on the limited function of Asian corporate bond markets which served as an alternative financing mechanism, specifically when the banking sector did not function well. However, deep and liquid bond markets reduced balance sheet mismatches and lengthened debt tenors reducing securitization costs for syndicated bank loans (Eichengreen and Luengnaruemitchai, 2004).

The dominance of the banking sector had different effects on government and corporate green bond markets. Adelegan and Radzewicz-Bak (2009) found that a large banking sector tended to facilitate the sale of government debt in the domestic markets while it often substituted the function of corporate bond markets. Banks with comparative advantage as first movers could strategically set lending and borrowing terms to disrupt bond market functions (Eichengreen and Luengnaruemitchai, 2004). Kowalewski and Pisany (2019) further found that bank lending often replaced the function of the corporate bond market in Asia. Abraham *et al*. (2021) also observed that despite significant bond market development after the Asian financial crisis, banks still substituted the corporate bond market's function. Essentially, the more dominant the banking industry in an economy, the more possible it was to substitute the function of corporate bond markets. This phenomenon was also observed in the formation and development of green bond markets.

For banks, bond markets were not only competitors in the funding market but also sources of income through bond trading. In many Asian countries, bonds were traded in OTC markets with banks intermediating OTC trading (Adelegan and Radzewicz-Bak, 2009) allowing for diversified profit sources. Therefore, the large size of the banking industry positively contributed to the development of green bond markets.

H2. The total size of banking has positive effects on the development of the green bond markets.

(3) Stock and Green Bond Markets

Most listed companies engaged in green financing through bonds rather than equity due to practical challenges associated with equity green financing. Green bond markets signaled a credible commitment to environmental sustainability (Flammer, 2021). Simultaneously, green bond issuers improved business-related incentives and legitimacy (Maltais and Nykvist, 2021), enhancing business image, creating new markets, reducing reputation risk and mitigating government pressure by engaging with sustainability policies (Maltais and Nykvist, 2021). These benefits positively impacted the value of stocks. Tang and Zhang (2020) and Flammer (2021) also provided empirical evidence of positive stock market reactions when firms issued green bonds.

H3. The size of the stock market positively influences the development of the green bond markets.

(4) The Competition of Financial Sectors and Green Bond Markets Development

This study focused on the impact of competition among financial sectors on green bond markets development. Competition among financial sectors significantly influenced the efficiency, quality and innovation of financial products and services (Claessens, 2009). Since bank loans, bonds and stocks were the main funding options, the existence of each market mechanism as an alternative source of funding could complement and compete. When a country's financing activities heavily relied on the traditional banking system, it could lead to the underdevelopment of other sub-financial markets. A preference for traditional banking activities caused reluctance to explore other financial markets due to concerns about disrupting banking competitiveness, potentially negatively impacting the country's economy.

Generally, banks efficiently funded relatively small and young firms while bond and stock markets had a comparative advantage in financing larger and more established firms (Eichengreen and Luengnaruemitchai, 2004). Elitcha (2021) further found that effective bank competition reduced lending costs as the size of the stock market increased. Elitcha (2021) also confirmed that the beneficial effects of bank competition were more profound in SSA countries with relatively underdeveloped stock markets. Similarly, the degree of competition among various capital markets influenced the funding costs of other competing markets. When one specific capital market had monopolistic power, it could hinder the development of other alternative capital markets. This phenomenon could be intensified by financial engineering such as securitization which blurred the boundaries between direct and indirect financing. Therefore, low competition among capital markets weakened the development of green bond markets as observed in the following hypothesis.

H4. Low competition among the various funding markets weakened the development of green bond markets.

2.2 Macroeconomic conditions and green bond markets

International investors had historically excluded local currency bonds from evolving markets from the portfolios until two decades ago. Mismatches in local currency which deeply depended on the macroeconomic stability of an economy were the main reason international investors avoided local currency bonds (Eichengreen *et al.*, 2022). Burger *et al.* (2012) further emphasized the importance of strengthened macroeconomic stability and improved creditors' rights as growth factors for local currency corporate bond markets.

Empirically, Eichengreen and Luengnaruemitchai (2004) showed that macroeconomic factors such as economic size, trade and capital account openness positively influenced the development of government securities markets. Hale *et al.* (2020) also found that inflation history and global financial conditions were major limitations on the development of local currency bond markets. Bassetto and Galli (2019) further underscored the risk of inflation, while Lee (2022) showed the importance of the local currency volatility closely related to other macroeconomic conditions for developing local currency bond markets. Additionally, Broadstock and Cheng (2019) discovered evidence that macroeconomic conditions impacted the development and stabilization of green bond markets through the interaction with conventional and green bond markets.

2.3 Market microstructure and green bond markets

Explaining each country's secondary market conditions was challenging due to the unique characteristics of investor types, issuers, government regulations and policies. Investor conditions, tax incentives and differing regulations also influenced the growth of green bonds which had no specific structure and were considered part of the conventional bond market structure. Based on a previous publication by Adelegan and Radzewicz-Bak (2009), there were several factors affecting bond market development in Sub-Saharan Africa such as

the structure of the economy, investment profile, law and order, size of the banking sector, level of economic development and macroeconomic factors including interest and exchange rates, capital controls, as well as fiscal balances.

Based on ADB report 2022 towards ASEAN countries, more developed capital markets were better prepared to invest in and issue green bonds. Malaysia, the Philippines, Singapore, Thailand and Vietnam showed greater interest in issuing green bonds, while Brunei Darussalam, Cambodia and Indonesia were still in the early stages of green bond market development. Several barriers to green bond development in ASEAN countries included a lack of clear benefits compared to conventional bonds, an insufficient supply of green bonds, reluctance among issuers to explore new products, an insufficient pipeline of eligible projects, lack of knowledge or awareness about green bonds and the absence of policy guidance from regulators. These factors collectively influenced the growth and development of green bond markets, emphasizing the importance of a supportive financial sector and macroeconomic conditions.

3. Data and methodology

3.1 Data

This study focused on ASEAN plus three countries from 2016 to 2022, as the group joined a Study Group to develop a sound and sustainable regional bond market following the financial crisis of 1997–1998. Asian Development Bank (ADB) initiated this program to develop the local currency bond market, promote regional financial cooperation, enhance stability and reduce the region's vulnerability to faster capital flow reversals (Asian Development Bank, 2017). The region showed significant development in corporate bond markets over the past decades (Abraham *et al.*, 2021). Given the availability of green bond data, the study selected seven ASEAN countries including Hong Kong, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam as well as three others namely Korea Rep., China and Japan making a total of ten countries observed. Data on green bond markets were sourced from Bloomberg while other financial markets, macroeconomic data and control variables were obtained from the databases of S&P Capital IQ, ADB and MF.

3.2 Empirical model

The following model was used to test the hypotheses.

$$GB_{it} = \gamma_0 + \gamma_1 BB_{it} + \gamma_2 BK_{it} + \gamma_3 SM_{it} + \gamma_4 HHIC_{it} + \gamma_5 SPD_{it} + \gamma_6 L\_COR_{it} + \gamma_7 VOL_{it} + \gamma_8 TERM_{it} + \gamma_9 GDP_{it} + \gamma_{10} CUR_{it} + \gamma_{11} INF_{it} + \sum_{\gamma=12}^{19} \gamma_i YrD_{it} + \varepsilon_{it} \quad (1)$$

Where GB (green bond) represented the outstanding green bond over GDP,

BB (Brown Bond) denoted the ratio of outstanding brown bonds over GDP,

BK (Bank Size) suggested the ratio of total bank assets over GDP,

SM (Stock Market Capitalization) represented the ratio of stock market capitalization over GDP and

HHIC (Competition of the Capital Market) was measured similarly to the Herfindahl–Hirschman Index (HHI) using the size of the market capitalization of each country's stock market, total outstanding bonds, total assets of banks and total assets of insurance firms.

$$HHIC = \left[\frac{Bank\ Size}{Marcap\ Financial\ Institutions}\right]^2 + \left[\frac{Total\ Marcap\ Stock\ Market}{Marcap\ Financial\ Institutions}\right]^2 \left[\frac{Total\ Corporate\ Brown}{Marcap\ Financial\ Institutions}\right]^2 + \left[\frac{Total\ Government\ Brown\ Bond}{Marcap\ Financial\ Institutions}\right]^2$$

SPD, L_COR, L_GOV, VOL and TERM were included as factors related to bond market microstructures. The liquidity of the bond market was derived from survey outcomes of ADB. Initially, SPD (Spread of Secondary Bond Markets), L_COR and L_GOV with a mean of six qualitative indicators of each bond market estimated by ADB based on annual surveys were used. Furthermore, VOL was measured by the volatility of 10-year local currency bonds, and TERM was evaluated as the yield spread from 10 years minus 2 years of maturity local currency bonds.

CUR, GDP and INF were used to capture the effects of the macroeconomic conditions on the development of green bond markets. GDP was measured by the log (GDP) in dollar terms, CUR as the changes in 3 months of currency appreciation or depreciation, and INF representing the change in the consumer price index.

4. Empirical evidence

4.1 Descriptive statistics

Table 1 reported the outstanding green bonds from 2016 to 2022 for ASEAN plus three countries. China dominated green bond issuance through the government and corporate sectors as emphasized by Lin and Hong (2022). Furthermore, corporate sectors slightly outpaced government initiatives in green bond issuance. China, Korea Rep. and Thailand also showed similar preferences for currency in issuing green bonds in contrast to the other countries. Despite rapid growth in green bond markets as detailed in the last column of Table 1, the size remained below 1%. Japan's green bond markets which was the second largest among ASEAN plus three was only 0.15% of the brown bond market size.

Table 1. Descriptive statistics of outstanding green bonds (in million $)

	Government issued			Corporate issued			Total
Country/ Type	Local currency	Foreign currency	All currency	Local currency	Foreign currency	All currency	% of brown bonds
China	7447.52	1125.56	8573.08	91548.09	28799.32	120347.40	0.97%
Hong Kong	273.59	2039.25	2312.83	1647.50	3548.54	5196.04	2.47%
Indonesia	49.07	1964.29	2013.35	93.30	800.36	893.66	0.97%
Japan	2281.60	802.98	3084.58	6778.57	6306.79	13085.36	0.15%
Korea Rep	612.68	3273.36	3886.04	5736.72	5720.86	11457.58	0.70%
Malaysia	–	–	–	896.91	32.59	929.49	0.25%
Philippines	–	–	–	248.54	1031.03	1279.57	0.84%
Singapore	357.24	–	357.24	687.47	1510.32	2197.79	0.64%
Thailand	74.48	–	74.48	1598.56	–	1598.56	0.41%
Vietnam	–	–	–	–	50.00	50.00	0.05%
Mean	1109.62	920.54	2030.16	10923.57	4779.98	15703.55	0.74%

Source(s): Authors' own creation

Table 2 showed that Singapore had the most bank-dominant oligopolistic market structure among the capital markets. The bank-to-GDP ratio in Hong Kong was also significantly similar to Singapore but the ratio of stock market capitalization to GDP was substantially large and banks were not as dominant in Singapore. Additionally, Indonesia had the most competitive capital markets. The low standard deviations of Herfindahl-Hirschman Index (HHIC) among capital markets from all the countries showed that this competitive structure was stable and not easily changed. However, the large standard deviation of HHIC of the capital market showed significant variation in competition levels among the countries.

4.2 Effects of Financial Industry Structure on Green Bond Markets Developments

(1) Baseline Regression Findings

All columns in Table 3 showed that low competition among various capital markets significantly reduced the outstanding green bonds or hindered the development of green bond markets (H4). Furthermore, columns (1), (3) and (4) showed that the propositions of brown bond markets, bank size and stock market capitalization to GDP positively and significantly increased the outstanding green bonds (H1, H2 and H3). These findings appeared contradictory since the growth of certain sub-financial industries compared to others automatically reduced the Herfindahl-Hirschman Index (HHI), reflecting the competition level.

Before exploring these findings, examining the impact of individual sub-financial sectors on green bond markets was essential. Furthermore, the growth of brown bond markets positively and significantly impacted green bond markets (H1). The propositionally large brown bond markets showed that these economies had more than minimum efficient scale bond markets or well-defined and structured bond market microstructures reducing various market frictions (Back *et al.*, 2020; Bessembinder *et al.*, 2020). Additionally, the relative growth of the brown bond markets suggested an increase in sophisticated investors (Bessembinder *et al.*, 2020).

The positive effects of stock market capitalization on green bond markets were consistent with the findings of Tang and Zhang (2020) and Flammer (2021). Similarly, the positive association between the size of the banking industry and green bond markets correlated with the arguments of Adelegan and Radzewicz-Bak (2009).

These findings of H1, H2, H3 and H4 collectively implied that the development of specific sub-financial sectors drove the growth of green bond markets when it did not disrupt healthy and effective competition among different sub-financial markets and institutions. However, the dominance of one or two sub-financial sectors could blunt the relative comparative advantages of others by using monopolistic power in funding markets. The growth of brown bond markets, stock markets and the banking industry positively impacted the development of green bond markets while disrupting healthy and effective competition among sub-financial industries seriously attenuated the development of green bond markets.

Column (4) in Table 3 showed that the effects of specific market microstructures such as bid-ask spread, liquidity of existing government and corporate bond markets were not significant. These findings were inconsistent with the publications by ADB (2022), Banga (2019), Bessembinder *et al.* (2006, 2020), Edwards *et al.*, (2007), Goldstein *et al.* (2007) and Mizan *et al.* (2021). However, the study did not confirm that secondary markets microstructures were irrelevant. These findings might have been influenced by the limitations of the available data. While other variables were measured quarterly, bid-ask spread and liquidity indicators of corporate and government bond markets were measured only once a year. The variables could not reflect the dynamics of secondary market microstructures. The R^2 value of only the market microstructure variables further reached 19.31%.

Table 2. Descriptive statistics of other variables

Country	Statistics	HHIC	Cor Brown bond	Gov Brown bond	Market cap	Bank	Volatility	Term St. (bps)	GDP	Inflation	Currency return (%)	LCOR	LGOV	Bid-ask (bps)
China	Mean	0.119	0.309	0.558	0.645	2.335	0.022	52.14	16.452	1.989	(0.013)	2.893	3.007	1.39
	Std	0.006	0.043	0.081	0.062	0.116	0.017	19.03	0.172	0.960	0.504	0.223	0.165	1.02
	p25	0.116	0.269	0.497	0.607	2.254	0.014	42.00	16.338	1.500	(0.231)	2.800	2.900	0.60
	p50	0.119	0.296	0.542	0.648	2.326	0.017	48.00	16.441	1.890	(0.034)	2.850	3.050	1.00
	p75	0.121	0.354	0.633	0.678	2.438	0.024	59.50	16.619	2.475	0.253	2.938	3.138	1.90
Hong Kong	Mean	0.284	0.378	0.045	12.449	9.635	0.049	45.32	12.761	1.836	(0.620)	3.263	3.259	6.27
	Std	0.014	0.059	0.015	1.781	1.009	0.031	47.04	0.052	1.340	3.281	0.477	0.461	3.51
	p25	0.277	0.310	0.035	11.192	8.890	0.033	22.00	12.730	1.290	(0.055)	3.125	3.250	3.00
	p50	0.285	0.382	0.041	12.437	9.378	0.046	49.00	12.781	2.015	0.000	3.338	3.338	4.00
	p75	0.291	0.419	0.048	13.258	10.414	0.061	75.00	12.801	2.595	0.028	3.750	3.625	9.00
Indonesia	Mean	0.013	0.026	0.210	0.453	0.582	0.063	118.29	13.867	3.054	0.118	2.845	3.070	3.89
	Std	0.005	0.002	0.050	0.039	0.029	0.078	76.70	0.100	1.169	1.033	0.178	0.137	1.02
	p25	0.008	0.025	0.171	0.444	0.564	0.034	48.50	13.792	2.245	(0.202)	2.750	2.975	2.80
	p50	0.015	0.027	0.183	0.456	0.571	0.048	96.50	13.866	3.045	(0.042)	2.825	3.063	3.90
	p75	0.017	0.028	0.275	0.473	0.604	0.065	198.00	13.930	3.610	0.339	2.850	3.188	5.20
Japan	Mean	0.005	0.154	2.018	1.231	4.106	0.014	18.43	15.401	3.023	0.142			
	Std	0.000	0.013	0.125	0.172	0.579	0.011	7.11	0.078	1.223	1.103			
	p25	0.005	0.143	1.922	1.122	3.623	0.008	14.00	15.390	2.280	(0.430)			
	p50	0.005	0.148	1.962	1.203	4.122	0.010	17.00	15.410	2.840	0.114			
	p75	0.005	0.167	2.154	1.310	4.412	0.015	23.00	15.455	3.960	0.349			
Korea Rep	Mean	0.342	0.781	0.462	0.994	2.538	0.038	42.43	14.262	1.895	(0.002)	3.055	3.377	0.49
	Std	0.009	0.063	0.066	0.149	0.420	0.023	29.27	0.050	1.620	0.827	0.275	0.268	0.07
	p25	0.335	0.721	0.409	0.885	2.132	0.024	13.00	14.238	0.785	(0.371)	3.050	3.163	0.40
	p50	0.343	0.763	0.425	0.927	2.514	0.029	47.50	14.273	1.380	(0.068)	3.175	3.538	0.50
	p75	0.347	0.850	0.528	1.102	2.922	0.040	60.00	14.296	2.315	0.412	3.213	3.550	0.50
Malaysia	Mean	0.191	0.503	0.582	1.222	3.633	0.025	77.07	12.681	1.760	(0.030)	2.946	3.021	3.44
	Std	0.008	0.046	0.074	0.177	0.200	0.016	29.27	0.061	1.809	0.725	0.351	0.487	1.51
	p25	0.187	0.467	0.522	1.176	3.474	0.014	60.00	12.650	0.545	(0.467)	2.825	3.138	2.10
	p50	0.193	0.501	0.546	1.224	3.582	0.020	73.50	12.701	1.620	(0.049)	3.088	3.163	2.70
	p75	0.196	0.546	0.662	1.341	3.833	0.031	88.00	12.723	3.405	0.432	3.175	3.300	5.30

(*continued*)

Table 2.

Country	Statistics	HHIC	Cor Brown bond	Gov Brown bond	Market cap	Bank	Volatility	Term St. (bps)	GDP	Inflation	Currency return (%)	LCOR	LGOV	Bid-ask (bps)
Philippines	Mean	0.033	0.072	0.319	0.930	0.727	0.048	122.32	12.765	3.489	0.082	2.607	2.773	4.60
	Std	0.008	0.010	0.069	0.235	0.047	0.048	74.91	0.090	1.862	0.566	0.281	0.247	1.39
	p25	0.027	0.062	0.265	0.728	0.691	0.027	74.00	12.679	2.245	(0.224)	2.413	2.588	3.20
	p50	0.034	0.073	0.277	0.905	0.720	0.038	110.00	12.808	3.075	0.072	2.525	2.688	4.60
	p75	0.040	0.080	0.404	1.110	0.765	0.056	180.00	12.841	4.230	0.428	2.850	2.925	5.60
Singapore	Mean	0.623	0.317	0.314	1.950	15.175	0.039	60.00	12.819	1.429	(0.115)	3.268	3.523	2.61
	Std	0.015	0.018	0.067	0.295	1.035	0.030	35.74	0.112	2.350	0.547	0.181	0.109	0.41
	p25	0.614	0.306	0.251	1.788	14.292	0.025	31.50	12.761	0.090	(0.321)	3.038	3.500	2.10
	p50	0.621	0.318	0.287	1.978	14.833	0.032	56.50	12.807	0.525	(0.153)	3.338	3.563	2.80
	p75	0.626	0.329	0.376	2.158	15.917	0.047	88.00	12.860	1.845	0.160	3.438	3.625	3.00
Thailand	Mean	0.066	0.222	0.386	1.055	1.726	0.034	87.43	13.084	1.377	(0.010)	2.880	3.243	2.90
	Std	0.004	0.022	0.069	0.120	0.215	0.025	33.79	0.094	2.260	0.754	0.265	0.162	1.07
	p25	0.063	0.200	0.333	1.000	1.583	0.024	61.50	13.030	0.135	(0.430)	2.600	3.063	2.30
	p50	0.066	0.222	0.339	1.039	1.600	0.029	90.50	13.113	0.825	(0.079)	2.938	3.288	2.50
	p75	0.069	0.240	0.465	1.141	1.842	0.039	111.00	13.138	1.360	0.612	3.000	3.375	3.20
Vietnam	Mean	0.027	0.032	0.194	0.996	1.463	0.043	142.21	12.485	3.023	0.032	2.373	2.748	11.16
	Std	0.033	0.024	0.015	0.262	0.153	0.035	54.25	0.249	1.223	0.071	0.290	0.204	13.43
	p25	0.004	0.014	0.178	0.837	1.382	0.021	111.50	12.282	2.280	(0.027)	2.063	2.625	4.50
	p50	0.007	0.019	0.195	1.001	1.462	0.030	143.50	12.431	2.840	0.033	2.325	2.738	5.50
	p75	0.041	0.045	0.207	1.145	1.535	0.050	185.50	12.758	3.960	0.090	2.588	2.775	8.30
Total	Mean	0.170	0.279	0.509	2.192	4.192	0.037	76.56	13.658	2.287	(0.042)	2.903	3.113	4.08
	Std	0.189	0.227	0.533	3.494	4.457	0.038	59.34	1.281	1.778	1.250	0.396	0.370	5.51
	p25	0.019	0.075	0.211	0.765	1.462	0.018	33.50	12.734	1.035	(0.280)	2.600	2.838	2.10
	p50	0.103	0.256	0.371	1.087	2.376	0.029	63.00	12.964	2.185	0.000	2.938	3.163	3.00
	p75	0.285	0.382	0.525	1.354	4.122	0.046	107.00	14.273	3.255	0.273	3.188	3.375	5.00

Source(s): Authors' own creation

	(1)	(2)	(3)	(4)
HHIC	−0.0952***		−0.1739***	−0.1713***
	(0.0110)		(0.0419)	(0.0449)
Corporate Brown/GDP	0.0006***		0.0004***	0.0005***
	(0.0001)		(0.0001)	(0.0001)
Government Brown/GDP	0.0001		0.0000	−0.0001
	(0.0001)		(0.0001)	(0.0001)
Stock Market/GDP	0.0020**		0.0019***	0.0014**
	(0.0006)		(0.0005)	(0.0005)
Bank/GDP	0.0045**		0.0046***	0.005**
	(0.0018)		(0.0014)	(0.0015)
Bid-Ask Spread		−1.3009*		−0.361
		(0.6625)		(0.4655)
Yield Volatility		0.0076	0.0133*	0.0121*
		(0.012)	(0.0061)	(0.0056)
Corp Bond Mkt Liquidity		0.0055		0.0021
		(0.0035)		(0.0019)
Gov Bond Mkt Liquidity		0.0042**		−0.0008
		(0.0017)		(0.002)
Term Structure		−0.0011	−0.0018	−0.0013
		(0.0017)	(0.001)	(0.0008)
GDP			0.0699**	0.0555**
			(0.0282)	(0.0212)
GDP Square			−0.0022**	−0.0016**
			(0.0009)	(0.0007)
Inflation			0.0006***	0.0009***
			(0.0001)	(0.0002)
Δ Exchange Rate			−0.0427	−0.0538*
			(0.0273)	(0.0282)
_cons	−0.0202**	−0.0213**	−0.5471**	−0.4643**
	(0.0068)	(0.0084)	(0.2063)	(0.1631)
Observations	280	252	280	252
Pseudo R^2	0.6003	0.1931	0.7078	0.7177

Note(s): Standard errors were in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
The study selected a fixed effects model based on the Hausman test outcomes and applied the Driscoll and Kraay covariance estimator for all panel regression for efficient standard errors (Driscoll and Kraay, 1998)
Source(s): Authors' own creation

Table 3.
Brown and green bond markets developments

Macroeconomic variables significantly influenced green bond markets as expected. The negative effects of the return of exchange rate on green bond markets were consistent with the findings of Lee (2022). The positive impacts of inflation were also consistent with the publication by Hale *et al.* (2020). Burger *et al.* (2012) further asserted that strengthened macroeconomic stability and lowered volatility of the exchange rate significantly increased the outstanding green bonds. Furthermore, the size of the economy showed non-linear effects on green bond markets development. The size of the individual firms held various information that could not be easily identified and non-linearly influenced the capital structure (Graham and Leary, 2011). Similarly, the size of the economy which was measured by GDP also incorporated complex and intertwined information. These factors contributed to the nonlinear impact of the economy's size on the development of green bond markets.

(2) Effects of Financial Market Structure on Different Currency (Issuer) Green Bond Markets

Table 4 showed the effects of financial market structures, bond market microstructure and macroeconomic conditions on the different currencies (issuers) of green bond markets.

	(1) Local currency	(2) Foreign currency	(3) Corporate	(4) Government
HHIC	−0.0478***	−0.1261***	−0.0722***	−0.1017**
	(0.0127)	(0.0354)	(0.0139)	(0.0347)
Corporate Brown/GDP	0.0001*	0.0004***	0.0003***	0.0002**
	(0.00005)	(0.0001)	(0.00003)	(0.0001)
Government Brown/GDP	0.0001***	−0.00007	0.0001***	−0.0001
	(0.000009)	(0.00005)	(0.00002)	(0.0001)
Stock Market/GDP	0.0004*	0.0015***	0.0005**	0.0014**
	(0.0002)	(0.0004)	(0.0002)	(0.0005)
Bank/GDP	0.001	0.0036***	0.0024***	0.0022*
	(0.0006)	(0.0009)	(0.0005)	(0.001)
Yield Volatility	0.0045*	0.0088*	0.0046	0.0087**
	(0.002)	(0.004)	(0.003)	(0.0034)
Term Structure	−0.0012**	−0.0006	−0.0011***	−0.0007
	(0.0004)	(0.0006)	(0.0003)	(0.0007)
GDP	0.0173	0.0526**	0.0316**	0.0383*
	(0.0109)	(0.0195)	(0.0136)	(0.0179)
GDP Square	−0.0005	−0.0017**	−0.001*	−0.0012*
	(0.0004)	(0.0006)	(0.0005)	(0.0006)
Inflation	0.0004***	0.0002**	0.0004***	0.0002**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Δ Exchange Rate	−0.0177**	−0.025	0.0034	−0.0461*
	(0.0073)	(0.022)	(0.0071)	(0.022)
_cons	−0.1458*	−0.4013**	−0.2587**	−0.2884*
	(0.0791)	(0.1436)	(0.0969)	(0.1352)
Observations	280	280	280	280
Pseudo R^2	0.6663	0.6406	0.7958	0.4870

Note(s): Standard errors were in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
The study selected a fixed effects model based on the Hausman test outcome and applied the Driscoll and Kraay covariance estimator for all panel regression for efficient standard errors (Driscoll and Kraay, 1998)
Source(s): Authors' own creation

Table 4.
Effects of financial market structure on the different currency (Issuer) of green bond markets

Columns (1) to (4) in Table 4 further showed significant negative effects on green bond markets based on local and foreign currency, as well as green bonds issued by corporations and government which was consistent with Table 3. The negative effects of improper competition among different sub-financial sectors were three times greater when green bonds were issued in foreign currency compared to local currency (Adelegan and Radzewicz-Bak, 2009; Eichengreen and Luengnaruemitchai, 2004). Although the negative effects of an unhealthy competitive structure in financial markets were larger when the government issued green bonds compared to corporate issuances, the difference was less significant than the impact observed with varying currencies.

The rapid proportional growth of the corporate brown and government bond, stock markets, as well as banking sectors consistently had positive and significant effects on various measures of green bond markets as shown in Table 3 except cases of foreign currency and government-issued green bonds which became insignificant (Bassetto and Galli, 2019; Broadstock and Cheng, 2019; Hale *et al.*, 2020). Variables related to market microstructure were not significant as shown in Table 3. All macroeconomic variables also significantly influenced green bond markets across different currencies and issuers. These findings showed consistency with the main focus of the study as detailed in Table 4.

The main purpose of Table 4 was to confirm previous regression outcomes from Table 3. Low competition still showed a significant negative effect on the development of green

bonds. However, Table 4 showed that the negative impact of low competition on the development of the markets could be minimized by issuing green bonds in local currency and the issuer played a crucial role. The findings correlated with the study of Hale *et al.* (2020) suggesting the outcomes showed that the negative correlation effect between low market competition could be minimized by issuing bonds in local currency. This presented a challenge for developing countries due to the concept of Original sin by Hale *et al.* (2020) which referred to the difficulties arising from a country's inability to borrow internationally in the domestic currency.

Furthermore, the negative effect could be minimized through the issuance of green bonds by corporations instead of governments. These findings were consistent with the conditions in most developing bond markets, where government bond markets dominated more than corporate. Therefore, the negative influence of concentration was more pronounced on the growth of green government bonds.

Outstanding corporate bonds in a particular country regardless of the issuer and currency used still had a significant positive impact on the growth of green bonds. When a country's secondary market was well developed, growth in green bonds tended to be more straightforward due to clear regulations, guidelines, benefits and investor awareness.

The size of the banking industry in a particular country had a significant positive effect on the growth of green bonds when issued using foreign currency. In principle, the banking industry in the countries certainly pursued high returns or profits. Bond issuers in evolving markets decided to bear exchange rate risk volatility and borrow in foreign currency because international investors required premium returns due to exchange rate volatility risk in local currency debt. This condition made bonds issued in local currency less attractive to international investors. The higher relative cost of borrowing in local currency shifted the composition further away making borrowing in foreign monies the preferred choice for bond issuers to attract international investors (Lee, 2022). Therefore, the outcomes in Table 4 provided valuable insights into the currency used for bonds and the identity of the issuers, considering the difficulty of changing market concentration conditions in particular countries.

4.3 Robustness tests

(1) Effects of Financial Industry Structure on the Sustainable Bond Market Development

Sustainable bonds were issued for environmental, social and governance (ESG) benefits. For less than two decades, ESG bonds have attracted the concerns of investors and authorities as sustainability-related financing promoted the global value (Kumar, 2022). However, the developments of ESG bonds followed a similar pathway as a novice including green bonds in financial markets. Outstanding ESG bonds were further selected as an alternative to green bonds. Based on Table 5, Hong Kong had the largest relative size of green and sustainable bond markets among ASEAN plus three countries compared to brown bond markets.

Table 5 showed that the size of the sustainable bond markets was relatively small similar to green bond markets in Table 2. Hong Kong and Korea Rep. had sustainable bond markets exceeding 2% of GDP. China and Japan preferred to issue the bonds in local currency which was consistent with green bonds in Table 2. However, other countries did not show a specific tendency. The majority of corporate and government issuers in the same country selected different currencies for issuing sustainable bonds.

Table 6 showed that a decrease in competition among sub-financial sectors hindered the issuance of sustainable bonds. The outcome reconfirmed the finding in Table 3. The relatively rapid growth of sub-financial sectors such as corporate bonds, stock markets and banking compared to other sub-sectors strongly supported the development of sustainable

Country	Local currency (in million $) Corporate	Government	Total	Foreign currency (in million $) Corporate	Government	Total	Percent over GDP
China	93572.92	7467.19	101040.10	32009.84	1371.17	33381.01	0.90%
Hong Kong	1749.99	273.59	2023.57	4688.99	2039.25	6728.24	2.45%
Indonesia	93.30	66.99	160.29	1303.93	2080.37	3384.30	0.31%
Japan	14792.27	7146.76	21939.02	7605.30	3838.34	11443.64	0.73%
Korea Rep	11957.46	7316.84	19274.30	12307.71	7308.08	19615.79	2.50%
Malaysia	1561.62	71.15	1632.77	419.73	200.00	619.73	0.68%
Philippines	978.01	–	978.01	1359.61	224.48	1584.09	0.69%
Singapore	981.98	357.24	1339.21	1978.14	–	1978.14	0.80%
Thailand	1796.20	954.92	2751.12	60.71	–	60.71	0.58%
Vietnam	–	–	–	141.07	–	141.07	0.04%
Mean	12748.37	2365.47	15113.84	6187.50	1706.17	7893.67	0.97%

Source(s): Authors' own creation

Table 5.
Descriptive statistics of sustainable bonds

	(1) Sustainable corporate bonds	(2)	(3) Sustainable government bonds	(4)	(5) Total sustainable bonds	(6)
HHIC	−0.0853***	−0.0815**	−0.0994**	−0.0909**	−0.2383***	−0.2241***
	(0.0250)	(0.0293)	(0.0369)	(0.0385)	(0.0634)	(0.0665)
Corporate Brown/GDP	0.0005***	0.0005***	0.0007***	0.0008***	0.0016***	0.0017***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Government Brown/ GDP	0.00006*	0.0001	0.00005	0.00003	0.0003***	0.0004**
	(0.00003)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Stock Market/GDP	0.0006**	0.0006*	0.0011**	0.0011**	0.0018**	0.002**
	(0.0002)	(0.0003)	(0.0004)	(0.0005)	(0.0007)	(0.0008)
Bank/GDP	0.0025***	0.0026**	0.001	0.0012	0.0033*	0.0033*
	(0.0007)	(0.0008)	(0.0009)	(0.001)	(0.0015)	(0.0018)
Yield Volatility	0.0055	0.0044	0.0088	0.0084	0.0201	0.0173
	(0.0042)	(0.0036)	(0.006)	(0.0052)	(0.0143)	(0.012)
Term Structure	−0.0003	−0.0005	−0.0007	−0.0006	−0.0021	−0.0023
	(0.0005)	(0.0005)	(0.0008)	(0.0008)	(0.0016)	(0.0017)
GDP	0.064***	0.0675***	0.065**	0.0677**	0.18***	0.1908***
	(0.0147)	(0.0128)	(0.0212)	(0.0231)	(0.0461)	(0.0475)
GDP Square	−0.0022***	−0.0023***	−0.0025***	−0.0026**	−0.0066***	−0.007***
	(0.0005)	(0.0004)	(0.0007)	(0.0008)	(0.0016)	(0.0017)
Inflation	0.0005***	0.0005***	0.0008***	0.0009***	0.0019***	0.0019***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Δ Exchange Rate	−0.0226**	−0.0182	−0.0416	−0.041	−0.0653	−0.0496
	(0.0097)	(0.0128)	(0.0231)	(0.0269)	(0.0388)	(0.0462)
Bid-Ask Spread		−0.1595		−0.4706		−0.8038
		(0.3147)		(0.5236)		(1.0082)
Corp Bond Mkt Liquidity		0.0008		−0.0001		0.0017
		(0.0014)		(0.0017)		(0.0037)
Gov Bond Mkt Liquidity		−0.0006		−0.0009		−0.003
		(0.0016)		(0.0021)		(0.0042)
_cons	−0.4711***	−0.4925***	−0.4322**	−0.4467**	−1.2495***	−1.3118***
	(0.1093)	(0.0944)	(0.1499)	(0.1623)	(0.3262)	(0.3284)
Observations	280	252	280	252	280	252
Pseudo R^2	0.7164	0.7165	0.6271	0.6279	0.7438	0.7377

Note(s): Standard errors are in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
The study selected a fixed effects model based on the Hausman test outcome and applied the Driscoll and Kraay covariance estimator for all panel regression for efficient standard errors (Driscoll and Kraay, 1998)
Source(s): Authors' own creation

Table 6.
Effects of financial market structures on sustainable bond markets

bond markets. Furthermore, the market microstructures of corporate and government markets did not significantly influence sustainable bond markets. Macroeconomic factors also exerted a strong influence on the market size of sustainable bonds. These outcomes closely correlated with the findings regarding green bond markets.

(2) Effects of Financial Industry Structure on Green Bond Markets Development using Log Transformation

The baseline model had potential correlation problems among the dependent and some independent variables since both were divided by the same denominator which was GDP. To mitigate this potential correlation problem, the dependent variable was transformed using the natural logarithm ln (1+Green Bond Outstanding over GDP) showing the following outcomes.

Table 7 showed outcomes consistent with the baseline findings shown in Table 3, despite a decrease in the significant level of HHIC which was competition among sub-financial industries. However, the effects of many variables, particularly those related to market microstructure diminished significantly.

	(1)	(2)	(3)	(4)
HHIC	−0.0088		−0.0169***	−0.0166**
	(0.0055)		(0.0049)	(0.0058)
Corporate Brown/GDP	0.000004		0.000003	0.00004
	(0.00003)		(0.000004)	(0.00004)
Government Brown/GDP	0.000000		−0.00001	−0.00003
	(0.000000)		(0.00001)	(0.00002)
Stock Market/GDP	0.0001		0.0004*	0.0003
	(0.0002)		(0.0002)	(0.0002)
Bank/GDP	0.0007*		0.0007*	0.0008*
	(0.0004)		(0.0004)	(0.0004)
Bid-Ask Spread		−0.0918		−0.0802
		(0.1061)		(0.1017)
Yield Volatility		−0.0012	−0.0017	−0.0023*
		(0.0012)	(0.0011)	(0.001)
Corp Bond Mkt Liquidity		0.0008		0.0005
		(0.0006)		(0.0003)
Gov Bond Mkt Liquidity		0.0002		−0.0003
		(0.0003)		(0.0002)
Term Structure		0.0002	0.00003	0.0001
		(0.0001)	(0.0001)	(0.0001)
GDP			0.0056	0.0034
			(0.0035)	(0.0039)
GDP Square			−0.0001	−0.00004
			(0.0001)	(0.0002)
Inflation			0.0001**	0.0001**
			(0.00003)	(0.0001)
Δ Exchange Rate			0.0242**	0.0253**
			(0.0097)	(0.0089)
_cons	−0.0022	−0.0022*	−0.0501*	−0.0389
	(0.0013)	(0.0011)	(0.0222)	(0.0229)
Observations	280	252	280	252
Pseudo R^2	0.1804	0.0599	0.2554	0.2770

Note(s): Standard errors were in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source(s): Authors' own creation

Table 7.
Effects of financial market structures on green bond markets using log transformation

(3) Effects of Financial Industry Structure on Green Bond Market Developments using System GMM

System GMM was applied to the baseline model to address potential endogeneity issues arising from omitted variables. This method helped to control for the proliferation of instruments in small cross-sectional units with a longer period which caused biased outcomes (Roodman, 2009). With a dataset consisting of a small group ($N = 10$) and a relatively longer period ($T = 27$), the outcomes presented in Table 8 should be interpreted cautiously.

The variable representing the first lag of green bond issuance exhibited weaker effects on the issuance of green bonds in the subsequent year. However, HHIC (competition among sub-financial industries) continued to show significant effects on green bond issuance which was consistent with the main findings in Table 3.

	(1)	(2)	(3)	(4)
Lag Green Bond	0.9873***	0.97399***	0.9261*	0.9511***
	(0.1044)	(0.1328)	(0.5025)	(0.0538)
HHIC	−0.1896		−0.1967*	−0.0754**
	(0.1307)		(0.00002)	(0.0297)
Corporate Brown/GDP	−0.0003		0.00005	0.000004
	(0.0002)		(0.00006)	(0.0001)
Government Brown/GDP	−0.0001		−0.0005	−0.00002
	(0.0001)		(0.0011)	(0.00003)
Stock Market/GDP	−0.00001		0.0014	0.0009**
	(0.00068)		(0.0009)	(0.0004)
Bank/GDP	0.0042*		0.0006	0.0008**
	(0.0033)		(0.0005)	(0.0004)
Bid-Ask Spread		−0.0887		
		(0.2420)		
Yield Volatility		0.0010		
		(0.0013)		
Corp Bond Mkt Liquidity		−0.0018		
		(0.0103)		
Gov Bond Mkt Liquidity		−0.0031		
		(0.0169)		
Term Structure		0.000009	0.0003	0.0003
		(0.0008)	(0.0004)	(0.0003)
GDP				0.0164
				(0.0112)
GDP Square			−0.00034**	−0.0004
			(0.00015)	(0.0004)
Inflation			0.0001	0.00004
			(0.0001)	(0.0001)
Δ Exchange Rate			0.0304*	0.0274***
			(0.0156)	(0.009)
_cons	0.0095**	0.0001	−0.1219	−0.1338
	(0.0039)	(0.0006)	(0.0976)	(0.0833)
Arellano-Bond test (2nd lag)	0.4374	0.2766	0.7729	0.3468
Sargan-Hansen test	0.3791	0.2047	1.000	0.9995
Observations	270	243	270	270

Note(s): Standard errors were in parentheses
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source(s): Authors' own creation

Table 8. Effects of financial market structures on green bond markets using system GMM

5. Conclusion

In conclusion, all countries supported the issuance of green instruments in various methods as corporations and investors recognized the importance of low-carbon economies. Although green bond markets grew rapidly, the degree and the size of the growth varied by country. Therefore, this study investigated the factors determining green bond markets in ASEAN plus three countries. The main findings showed that healthy competition among sub-financial sectors was crucial for the expansion of green bond markets. Simultaneously, the growth of specific sub-financial sectors such as brown corporate bond markets, stock markets and banks also supported the development of green bond markets.

Factors related to secondary market microstructures such as bid-ask spreads and qualitative liquidity measures from brown corporate and government bond markets did not significantly influence the growth of green bond markets. However, these findings should be interpreted cautiously due to data limitations.

Macroeconomic factors further significantly determined the growth of green bond markets. Interest rate volatility and inflation also positively influenced the growth of these markets while a higher interest term structure and exchange rate returns hindered growth. Furthermore, GDP exhibited non-linear effects on the development of green bond markets.

The findings suggested that governments should promote healthy competition among sub-financial sectors. Raising public awareness about green bond markets and implementing policies to support sustainable growth would enable the bonds to thrive and compete with other financial markets.

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