AMRO
ASEAN +3 MACROECONOMIC RESEARCH OFFICE

Analytical Note

Green Finance: Balancing Sustainability and Financial Stability [1]

February 21, 2025

Abstract

This analytical note explores the financial stability implications of green bonds issuance in the ASEAN+3 region, highlighting its role in fostering a sustainable economy while addressing potential risks. The rapid growth of green finance in the region is expected to continue, driven by initiatives such as green bonds and sustainable lending. However, challenges such as greenwashing and stranded assets could pose risks to financial stability. Our analysis reveals that green bonds offer a price premium of 15 basis points, reducing borrowing costs and easing repayment risks, thereby supporting financial stability. However, firms in the region do not always reduce their total carbon emissions after the issuance of green bonds, raising concerns about greenwashing and its potential to undermine investor confidence and asset values. These findings highlight the importance of implementing robust green taxonomies, regulatory oversight, and green central banking to mitigate these risks. By addressing these challenges, green bonds can help achieve climate goals while safeguarding financial resilience in the region.

I. Introduction

1. **The ASEAN+3 region is making good progress in green finance to address climate change and strengthen economic resilience in the transition to a green economy, in line with global efforts**. Key regional programs include the Asian Bond Markets Initiative (ABMI), which promotes local currency bonds for green projects; and the Southeast Asia Disaster Risk Insurance Facility (SEADRIF), which offers insurance to mitigate the economic impact of natural disasters. The ASEAN Green Bond Standards provide guidelines for the issuance and labelling of green bonds in the region. As the number of green bonds issued in the region has increased, its role as an important instrument in advancing sustainable finance is reinforced.

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2. The benefits of green finance for environmental and economic sustainability are well-recognized, but its financial stability implications remain largely unknown, given that it is still early days for current research on green finance and its specific financial stability impacts. Much of the existing literature has focused on risks posed by climate change and the insufficiency of green finance to meet the demand for the necessary financing needed to achieve transition into a more sustainable economy aligned with the pathway to net zero. While green finance is still in its early stage, its potential impacts on financial stability should not be overlooked.

3. This Analytical Note aims to evaluate both the benefits as well as potential financial stability risks from the issuance of green bonds, as follows:

- First, we hypothesize that one benefit from green bonds is that they offer lower borrowing costs for issuers. We examine this by analyzing the price premium for green bonds and identifying factors contributing to green-related cost savings.

- Second, we explore how greenwashing is a potential financial stability risk from green bonds and green finance in general. We establish this by empirically assessing whether firms are misrepresenting themselves as green, which could lead to asset devaluation in the future once such representation is known to investors.

- Third, we also consider banks' exposure to "stranded assets" as another financial stability risk from green bonds. Stranded Assets are assets that may lose economic value due to climate-change-related impacts (environmental, regulatory, or market changes) in the transition to a greener economy. We investigate this by quantifying the potential effects of stranded assets on banks' capital adequacy ratios, particularly from their exposure to carbon-intensive industries.

- Given these empirical findings, we propose policy recommendations to highlight the importance of regulations on green financial products based on evidence found in the ASEAN+3 region.

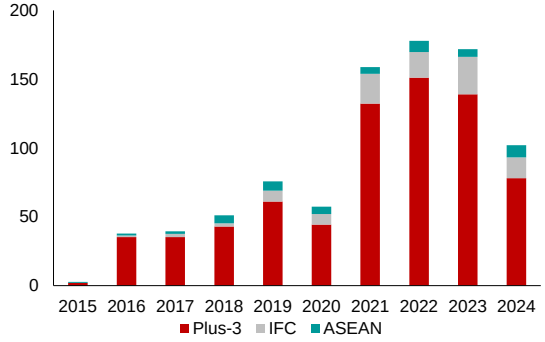
4. The remainder of this paper is organized as follows: Section II presents some stylized facts about green finance, with a particular focus on the green bond market. Section III empirically assesses the price premium of green bonds and explores its implications for financial stability, while Section IV quantifies the extent of greenwashing in the region and discusses its impact on financial stability. Section V goes on to evaluate the effect of stranded assets on the banking sector. Section VI then provides a detailed discussion of policy recommendations to further develop green finance, with a focus on tools for maintaining financial stability given its coincident risks. Finally, Section VII concludes the note.

II. Stylized Facts about Green Bonds in ASEAN+3

5. Green finance products, which have become very popular over the past decade, are debt and equity instruments issued by public or private entities that were specifically designed for channeling direct investments toward mitigating the impacts of, or adapting to, climate change (AMRO 2023). While green finance comprises a variety of products such as green loans, green bonds, transition bonds, sustainability-linked bonds, and others, green bonds remain the most prominent and well-documented, largely because of their widespread adoption and the availability of data. The analysis of potential benefits and risks from green finance will focus primarily on the case of green bonds in this note, particularly on the concepts of price premiums and greenwashing. Where the impacts of stranded assets on the banking sector are considered, the risk implication of green finance mainly covers the case of (green) loans that are exposed to stranded assets.

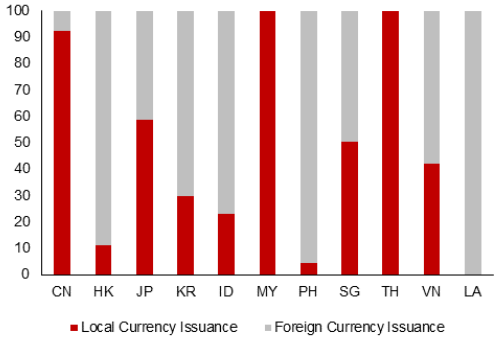
6. The issuance of green finance products has gained prominence not only globally, but also in the ASEAN+3 region, particularly in the Plus-3 economies. As of August 2024, the region accounted for 19.1 percent of global green bond issuance, with notable issuance in foreign currencies, potentially posing exchange rate risks to borrowers, particularly when servicing the debt (Figures 1 and 2). The exceptions are China, Malaysia, and Thailand, where local currency-denominated green bonds account for all or almost all issuances.

Figure 1. Selected ASEAN+3: Green Bond Issuance Amount
(Billions of US dollars)



Source: Refinitiv; AMRO staff calculations
Note: Data are as of August 15, 2024. Data covers all economies issuing green bonds. Plus-3 includes China, Japan and Korea. ASEAN includes Indonesia, Lao PDR, Malaysia, Philippines, Thailand and Vietnam. IFC includes Hong Kong and Singapore, Green bond share represents the percentage of share of ASEAN+3 green bonds in global green bond market.

Figure 2. Selected ASEAN+3: Share of Green Bonds by Currency Denominations
(Percent)



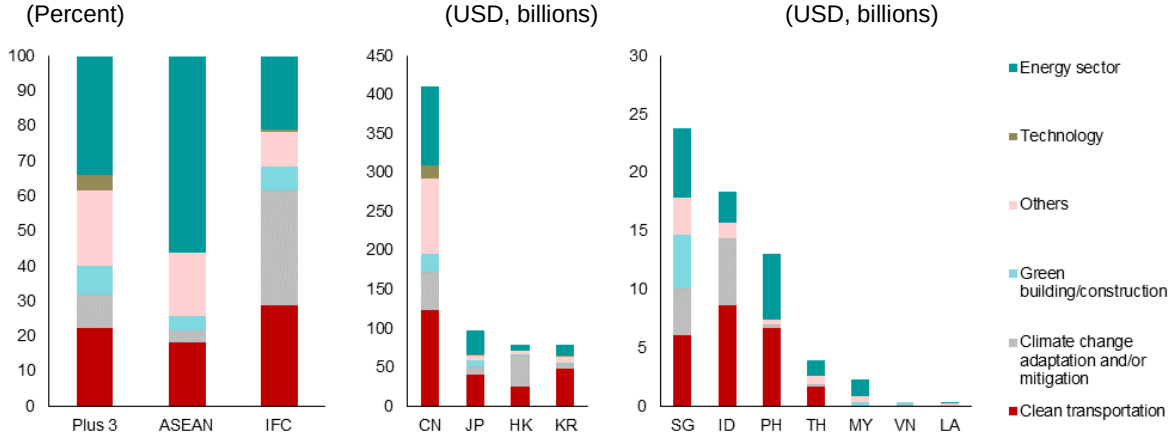
Source: Refinitiv; AMRO staff calculations
Note: CN = China; HK = Hong Kong; ID = Indonesia; JP = Japan; KH = Cambodia; KR = Korea; LA = Lao PDR; MY = Malaysia; PH = the Philippines; SG = Singapore; TH = Thailand; VN = Vietnam.

7. The usage of funds from green bonds varies across the region, with significant investments going into energy and transportation. Figure 3 shows that fund proceeds raised by Singapore and Hong Kong are more diversely distributed across usage, namely, i) energy sector, ii) technology, iii) green buildings and construction, iv) climate change adaption and mitigation, and v) clean transportation, especially in Singapore. On the other hand, China, which leads in market share with total issuance that is about four times that of Japan (the next largest), allocates a

significant share of its green funds to sectors other than the main five discussed previously. In Indonesia, a sizable portion of the funds is used in sectors related to climate change adaptation, reflecting the need to address the physical impact of climate change.

8. While these varied allocations can be viewed as a reflection of local needs and priorities, they also introduce potential risks. The diverse use of green bond funds, particularly when allocated to categories outside the traditional environmental or "green" sectors, raises concerns about whether the projects being funded are genuinely green or merely labeled as such to attract investments. For example, if green bond proceeds are used for projects that do not significantly contribute to environmental sustainability, issuers could be accused of misrepresenting their environmental impact, a phenomenon known as greenwashing. As more funds are directed into green finance, rigorous oversight and clearer criteria are essential to prevent greenwashing and to ensure that green bonds are contributing effectively to sustainability goals.

Figure 3. Selected ASEAN+3: Use of Proceeds for Green Bonds



Source: Refinitiv; AMRO staff calculations
Note: Data is as of August 15, 2024. The classification for use of proceeds is indicated by the Refinitiv. There are 73 categories at first, and these are further classified into 6 types by AMRO staff, based on category as well as a balance of number of bonds in each type. The allocation of the use of proceeds is structured as follows: Energy encompasses energy-related endeavors, while Technology supports technologies fostering eco-efficiency and sustainability. Green Building directs funds to construction meeting national or international standards. Climate Adaptation targets efforts addressing climate change adaptation, initiatives concerning natural resources, and resources towards terrestrial and aquatic biodiversity conservation. Clean Transportation supports the development of eco-friendly transportation options. CN = China; HK = Hong Kong; ID = Indonesia; JP = Japan; KH = Cambodia; KR = Korea; LA = Lao PDR; MY = Malaysia; PH = the Philippines; SG = Singapore; TH = Thailand; VN = Vietnam.

9. Going forward, the green bond market is expected to continue its expansion across countries. Based on an analysis detailed in Appendix 1, the green bond market is projected to see substantial growth in the next five years. The ASEAN+3 region—particularly the Plus-3 economies—is expected to lead this expansion, with an increase in market size ranging from 2 to 5.5 times the current figures in 2023 (Figure 4). Projected growth in ASEAN economies is more modest, at an estimated 1.5 to 4 times their current market size. The region's share of the global green bond market is projected to be between 30 percent and 60 percent by 2028, as illustrated in Figure 5.

Figure 4. ASEAN+3: Past and Predicted Future Green Bond Market Size
(USD, billions)

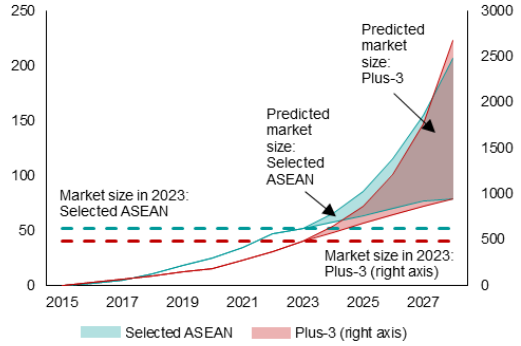
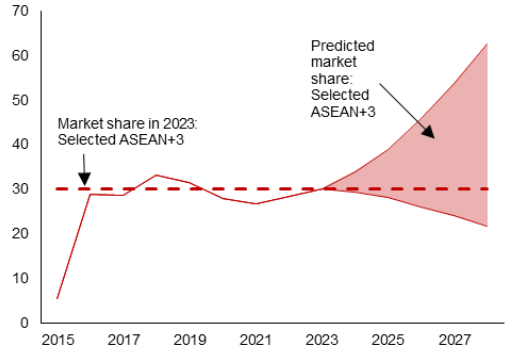


Figure 5. Selected ASEAN+3: Predicted Market Share in the Global Green Bond Market
(Percent)



Source: Refinitiv; national authorities via Haver Analytics and CEIC; IMF WEO database; European Commission Directorate-General for Joint Research Centre carbon emissions datasets; World Bank World Development Indicators (WDI) database; OECD GGI database; AMRO staff estimates
Note: The different future growth trajectories of the green bond market size shown in the figure are derived from various forecast results obtained by inputting different combinations of the X variables into the time series econometric forecasting model. Selected ASEAN economies are Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand, and Vietnam. The global market includes ASEAN+3, the European Union and the United States.

III. Examining Green Bond Price Premium beyond Claims

10. Given the projected market expansion, assessing the financial stability implications of green bonds is crucial. While green bonds purportedly offer lower borrowing costs for green projects to facilitate the transition to a greener economy, it is crucial to quantify these claims. Equally important is the monitoring of risks associated with green bonds, particularly greenwashing. Misleading claims about the environmental impact of projects could undermine investor confidence, distort capital allocation, and consequently result in significant challenges to financial stability.

11. The financial benefit associated with green bonds is referred to as the green premium (*greenium)*. When a green bond exhibits a lower yield compared with a similar conventional bond without the green label, the green bond is said to exhibit a positive *greenium*. From a borrower's perspective, a positive *greenium* translates to a lower cost of capital where the issuer pays less interest over the life of the green bond. While this claim is commonly made, is there a systematic *greenium* across the ASEAN+3 region?

12. Specifically, our empirical analysis focuses on the green premium in the primary market because it directly measures the cost of borrowing for bond issuers. In contrast, secondary market yields fluctuate due to market conditions, new information about issuers, and broader macroeconomic factors. While these secondary market dynamics affect new issuances or refinancing, they are less relevant to original borrowing costs. The ideal approach for estimating the green premium in the primary market is to compare the yield at the issuance of a green bond with the yield of a comparable non-green bond issued by the same issuer on the same issuance date. However, issuers rarely issue comparable green and conventional bonds on the same date. Therefore, we use the yields of a comparable conventional bond trading on the secondary market as a counterfactual. The assumption being that

when issuing bonds, issuers also take reference from yields on the secondary market. To best evaluate it empirically, the following equation is estimated:

$$y_{ijt} = \alpha + \beta \mathbf{Green}_{ij} + \gamma_1 \mathbf{Tenor}_{ijt} + \gamma_2 Rating_{ij} + \gamma_3 Secure_{ij} + \mathbf{Issuer}_i + \mathbf{Currency}_j + \mathbf{Date}_t + \epsilon_{ijt} \quad (1)$$

Where $Green_{ij}$ is the indicator for green bond j issued by firm i, $\mathbf{Tenor}_{ijt}$ is the remaining tenor of the bond at time t (i.e., at the issuance date of the green bond), $Rating_{ij}$ is a binary indicator if the bond rating by S&P is at least AA and above. $Secure_{ij}$ is a dummy variable if the bond is secured. Additionally, there are three fixed effects. $\mathbf{Issuer}_i$ is the issuer fixed effect, $Currency_j$ is the currency fixed effect, $\mathbf{Date}_t$ is the green bond issuance date fixed effect. Lastly, y_{ijt} is the original yield to maturity at issuance date for green bonds and secondary market yield for non-green bonds on the same date. Appendix 2 details the analyses in this section.

13. Empirical analysis of equation (1) from a pooled regression shows evidence of *greenium* of approximately 15 basis points (bps) on average in the primary market across the ASEAN+3 region (as shown in Table A2.1). Before exploring the potential factors that influence the size of the *greenium*, it is important to first quantify the *greenium* for each green bond. This is done using a synthetic method, where the baseline specification is estimated solely with conventional bonds to obtain coefficient estimates of various bond characteristics. Then, the yield at issuance is predicted based on the estimated coefficients and the characteristics of each green bond. This predicted yield serves as the counterfactual yield—what a green bond would exhibit if it were a conventional bond. The *greenium* is then calculated as the difference between the predicted yield and the actual yield of the green bond. A positive value indicates the presence of a green premium. By applying this method, the average *greenium* across the six economies in the sample is found to be 17 basis points.

14. This reduction in borrowing costs is particularly significant for financing green projects as they typically require larger capital investments with longer maturities. In the current environment of relatively high interest rates and increasing debt levels, this green premium can potentially help reduce financial stability risks by easing the burden on borrowers. By lowering borrowing costs, green finance reduces the likelihood of defaults. However, the urgency of transitioning to a greener economy requires substantially more capital (IMF, 2023). As such, this benefit of lower borrowing costs found empirically in the region will play a crucial role in supporting the need for higher financing and investments while managing the risks of the transition to a greener economy.

15. Understanding the factors driving the *greenium* estimated above are crucial in informing policy discussions on how best to maximize the benefits of

green finance while maintaining financial stability. Building on the counterfactual *greenium* estimated previously, we find three factors behind its presence (Table A2.2).

- **Certification**: Green bonds certified by the Climate Bond Initiative (CBI) are associated with an additional 17 basis points of *greenium* compared with a non-certified green bond. By enhancing the credibility of environmental claims, this certification reduces the risk of greenwashing and boosts investor confidence. Clear regulatory guidelines for green bond certification are therefore crucial in establishing a robust and credible green bond market.

- **Currency of denomination**: Green bonds issued in local currency are found to exhibit a larger *greenium* compared with those issued in foreign currency (mostly USD). This suggests that the demand for green bonds in ASEAN+3 economies is likely driven by local investors. Issuing bonds in local currency also helps mitigate exchange rate risks and supports financial stability by reducing the reliance on dollar financing, as discussed in AMRO (2024).

- **Use of funds**: A larger *greenium* is observed for green projects in the energy sector and green building, compared with projects focused on climate adaptation and clean transportation, which are intuitively thought to be more directly linked with mitigating climate change. Specifically, while the traditional energy sector has contributed to climate harm, investors are willing to pay a higher premium for these firms' transition to cleaner operations. However, some critics argue there is no evidence that firms significantly reduce their carbon emissions after having raised funds for green projects. While investors are willing to pay a higher premium for projects in certain innovative sectors, it becomes even more important to monitor potential greenwashing risks associated with these investments.

IV. Unmasking Greenwashing

16. Greenwashing can undermine financial stability in markets by increasing investors and firm losses. As investors fund green projects in the belief that the proceeds are used for sustainability purposes, misleading claims about the sustainability of investments can lead to steep withdrawal of funds, causing sharp market corrections and investor losses. Greenwashing revelations could also expose companies to reputational and litigation risks which negatively impact their financial health through deterioration in profitability. Additionally, widespread greenwashing could deter further investments in sustainable projects, thereby raising and shifting climate-related systemic risks to the financial system in the future (Emanbakhs and others, 2022).

17. Empirical analysis provides evidence of greenwashing risks. To gauge this risk, a firm's environmental performance is compared to a counterfactual group before and after the issuance of green bonds, wherein the issuance of green bonds is used as a signal of the firm’s environmental commitment (Flammer, 2021). If a firm’s environmental performance does not change, or even deteriorates after green bond

issuance, greenwashing risks are likely to be non-negligible. Conversely, post-issuance improvements suggest a genuine effort to be greener, indicating lower greenwashing risks. A difference-in-difference model is used to estimate greenwashing risks:

$$\boldsymbol{y_{ijct} = \alpha_0 + \beta_1 \text{Treated x Post}_{ijct} + \beta_2 \text{Treated}_{ijc} + \beta_3 \text{Post}_{ijct} + \theta_t + \phi_j + \xi_c + \varepsilon_{ijct}} \quad (3)$$

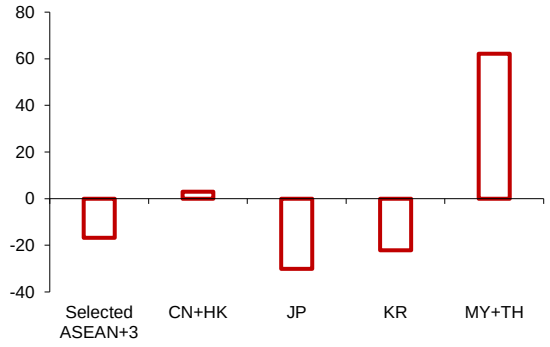
Where y is a firm's total CO_2 emissions scaled by total assets, and y_{ijct} denotes carbon emissions of firm *i*, operating in industry *j,* residing in country *c*, in year *t*. θ_t are year, ϕ_j industry, while ξ_c are country fixed effects respectively. $Treated_{ijc}$ is a dummy variable that = 1 if a firm has issued a green bond and 0 if in the control group (matched firm with similar financial characteristics as the treated firm but does not issue green bonds).[2] $Post_{ijct}$ is a dummy variable that=1 for years after the issuance of a green bond. The coefficient on the interaction term β_1 captures changes in total CO_2 emissions for treated firms *after* the issuance of green bonds relative to *before*, and relative to a group of control firms in the same period. Appendix 3 describes the methodology and results of this section in detail. Coefficients of the interaction term β_1, plotted in Figure 6, suggest that firms in selected ASEAN+3 economies (China, Hong Kong, Japan, Korea, Malaysia, and Thailand) generally do not change their greenhouse gas emissions after issuing green bonds compared with a matched counterfactual group, for years 2008-2023.[3]

18. While greenwashing risks do not appear to differ across the ASEAN+3 economies in the sample, there are differences across sectors. On an aggregate sectoral level, greenwashing risks appear to be present for various industries, with the real estate sector appearing to be more prone to greenwashing risks. Firms in the real estate sector that issue green bonds increase their CO_2 emissions by approximately 136 tons per million dollars of assets, compared to a counterfactual group (Figure 7).[4] This increase, along with the fact that investors are willing to pay a higher premium (*greenium*) for genuinely green building projects (Section III), highlights the significant risk of asset price declines should investors choose to dispose these green assets as a result of unmet environmental expectations.

19. The immediate implications of greenwashing risks in the ASEAN+3 region's financial sectors are currently minimal, as green bonds currently make up only a small portion of the total bond market. However, these risks could escalate if firms exploit investor interest by issuing more green bonds without proper verification or monitoring of fund usage and in the end erode investor confidence in green financing altogether. Ongoing vigilance is necessary as the green bonds and the green finance market in general is expanding in the ASEAN+3 region.

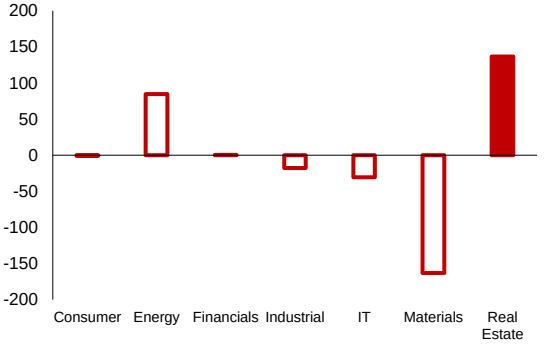
[2] For each treated firm, the nearest neighbor (using a propensity score matching method, matching on country, industry, total assets, leverage, ROA, and ESG scores) in the year prior to the issuance of the green bond is used to select the control firm.
[3] The plots in Figure 6 correspond to estimation results in Tables A3.2 and A3.3 of Appendix 3.
[4] The average carbon emissions in the sample is 152 tons per million dollars. The plots in Figure 7 correspond to estimation results in Table A3.4 of Appendix 3.

Figure 6. Selected ASEAN+3: CO_2 Emissions by Economy
(Tons per million US dollars)



Source: Thomson Reuters Eikon Database; AMRO staff calculations
Note: This bar chart plots coefficient estimates of changes in CO_2 emissions for treated firms after issuance of green bonds relative to before, and relative to a group of matched control firms. The control group is matched on country, industry, ROA, size, leverage, and ESG scores. Solid (empty) bar denotes statistical significance (insignificance) at the conventional levels. The sample consists of 93 uniquely matched publicly listed firms. The sample period is from 2008-2023.

Figure 7. Selected ASEAN+3: CO_2 Emissions by Sector
(Tons per million US dollars)



Source: Thomson Reuters Eikon Database; AMRO staff calculations
Note: This bar chart plots coefficient estimates of changes in CO_2 emissions for treated firms after issuance of green bonds relative to before, and relative to a group of matched control firms. The control group is matched on country, industry, ROA, size, leverage, and ESG scores. Solid (empty) bar denotes statistical significance (insignificance) at the conventional levels. The sample consists of 93 unique matched publicly listed firms. The sample period is from 2008-2023.

V. Impact of "Stranded Assets" in the Banking Sector

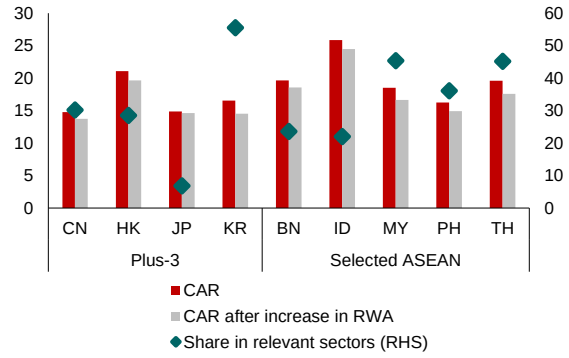
20. The accelerated transition to green lending introduces the risk of "stranded assets". As financial resources are increasingly directed to green projects, the valuation of investments and assets in traditional sectors such as fossil fuels, manufacturing, and construction may decline in the face of declining demand and regulatory changes that favor green alternatives. Advancements in green technologies may make older, less sustainable technologies obsolete, and lead to the loss of competitiveness and profitability of investments in brown sectors. Banks exposed to these depreciating assets will have "stranded assets" on their books amid the shift toward a financial system that provides incentives or a premium for green activities and entities.

21. A simulation exercise to assess the potential impact of stranded assets on ASEAN+3 banks points to possible financial stability implications of green finance. Banks' risk-weighted assets (RWAs) are recalibrated by attaching higher risk weights to assets in climate policy-relevant sectors[5] that are at risk of becoming stranded assets. Banks' exposure to these sectors varies across ASEAN+3 economies, ranging from 7 percent to 55 percent of total loans as of 2023 (Figure 8). The adjusted RWAs are then used to estimate the impact of stranded assets on banks' capital adequacy ratios (CAR) and total loss-absorbing capacity. The results indicate that while capital buffers in ASEAN+3 banks remain robust, the CAR may decline by 1.18 percentage points in Plus-3 economies and 1.53 percentage points in ASEAN

[5] Climate policy-relevant sectors are sectors most affected by climate change risks, identified by the Emissions Database for Global Atmospheric Research (EDGAR): (1) agriculture, forestry, and other land use; (2) buildings; (3) energy systems; (4) industry; and (5) transport.

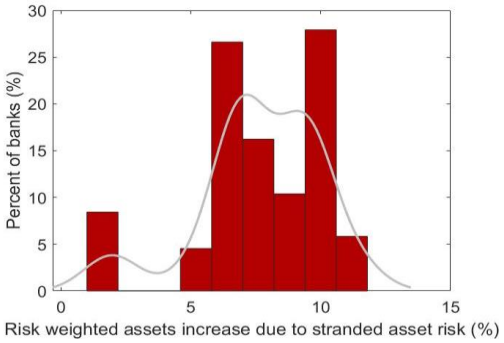
economies on average after upward revision in RWAs, given ASEAN economies' relatively higher exposure to climate policy-relevant sectors.

Figure 8. Selected ASEAN+3: Change in CAR After Increase in RWA Due to Exposure to Potential Stranded Assets
(Percent)



Source: Wind; Haver Analytics; CEIC; AMRO staff estimates
Note: Data as of 2023 for all economies. Current literature by Alessi, L. and others (2022), and Chamberlain and Evain (2021) apply increased riskiness of 10–25 percent to 'brown' exposures, here RWA is adjusted by assuming a maximum increase of 25 percent to the risk weight of estimated assets exposed to sectors relevant to climate policies. BN = Brunei; CN = China; HK = Hong Kong; ID = Indonesia; JP = Japan; KR = Korea; MY = Malaysia; PH = the Philippines; TH = Thailand.

Figure 9. Selected ASEAN+3: Distribution of Change in RWA
(Percent)



Source: Orbis BankFocus; NUS-CRI Probability of Default Database; National authorities via Haver Analytics and CEIC; AMRO staff estimates.
Note: The RWA recalibration follows a similar approach by Alessi et al. (2022), where potential stranded assets of security type and corporate loan type are adjusted with a 25-percent increase in riskiness, while stranded assets of mortgage loan type are adjusted with a 15-percent increase in riskiness.

22. To further understand the extent to which the region's banks could absorb shocks related to stranded assets, a more dynamic simulation using bank-level data was conducted. For 154 banks in the ASEAN+3 region, balance sheet data were used to recalibrate RWAs, where bank assets are adjusted to reflect the higher (climate) risks associated with each asset type.[6] In the next step, building on the methodologies in De Lisa et al. (2011) and Alessi et al. (2022), we ran one million rounds of Monte Carlo simulations in a micro-simulation model using bank balance sheet and probability of default data to derive a distribution of aggregate losses for banks in the region.[7] This aggregate loss refers to the unexpected losses that banks experience due to both broad-based economic shocks and bank-specific shocks. Additionally, it also captures the capital increase required to restore the capital level to the regulatory minimum.[8] The third step conducts a comparative analysis of the simulation results under banking crisis scenarios, both with and without taking the risk of stranded assets into account.

23. Simulation results indicate that the ASEAN+3 banking system remains resilient despite the impact of stranded assets, but vulnerabilities remain in

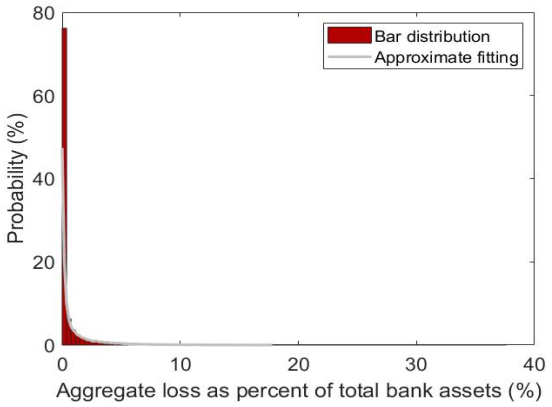
[6] Securities and corporate loans are adjusted with a 25 percent higher risk, while mortgage loan types are adjusted with a 15 percent higher risk.

[7] Bank balance sheet data is sourced from the Orbis BankFocus database, covering total assets, risk-weighted assets, regulatory capital, annual sales, and asset allocation across bonds, equities, mortgage loans, and corporate loans. The probability of default data is sourced from the NUS-CRI Probability of Default database.

[8] For standardization across the ASEAN+3 economies that are at various stages of implementation of the Basel framework, the regulatory minimum for the purpose of this exercise is set at 8 percent of risk-weighted assets.

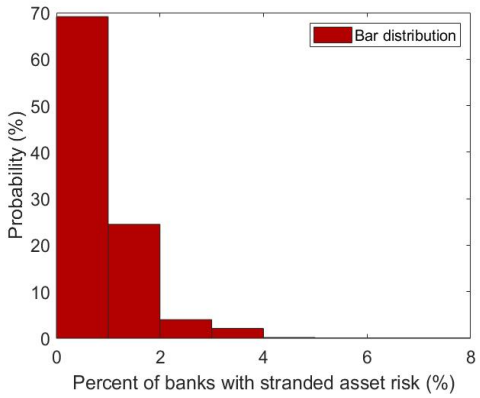
extreme scenarios. In this analysis, a bank is considered to have significant stranded asset risk if it transitions from having sufficient regulatory capital to not having enough once stranded asset risks are fully considered. The results show that most ASEAN+3 banks may see a 5 percent to 12 percent increase in their RWA after adjusting for stranded asset risks (Figure 9), but aggregate losses in a crisis scenario remain subdued at an average 0.64 percent of total banking assets (Figure 10).[9] While the share of banks with significant stranded asset risks remain low (Figure 11),[10] the long tail distribution of the results highlights the risk of potential extreme situations. In case of severe shocks to both the broader system and individual banks, significant losses could still occur. This emphasizes the potential for substantial losses in extreme scenarios, despite the system's overall resilience. Additionally, this estimated impact to the ASEAN+3 region is higher compared to EU's banking system, where the estimated RWA increase for most banks is between 1 percent and 2 percent, and aggregate losses in a crisis scenario average 0.20 percent of total banking assets (Alessi et al. 2022).

Figure 10 Distribution of Aggregate Loss as a Percentage of Total Banking Assets in the ASEAN+3 Region
(Percent)



Source: Orbis BankFocus; NUS-CRI Probability of Default Database; National authorities via Haver Analytics and CEIC; AMRO staff estimates

Figure 11 Distribution of Percent of Banks with Stranded Asset Risk in the ASEAN+3 Region
(Percent)



Source: Orbis BankFocus; NUS-CRI Probability of Default Database; National authorities via Haver Analytics and CEIC; AMRO staff estimates

VI. Policy Discussion

24. Central banks and regulatory authorities can play a crucial role in the development of a robust green finance ecosystem by promoting green finance, enhancing green taxonomies, and capturing climate-related risks in banking regulatory frameworks. This section discusses these three main areas of green central banking and related policies.

[9] Although average losses are subdued, there is a notable chance that losses could be much larger in rare cases. Specifically, there is a 3 percent chance that total losses across the ASEAN+3 banks could exceed 5 percent of their total assets, and a 1 percent chance that losses could surpass 10 percent. This underscores the potential for substantial losses in extreme scenarios, despite the system's overall resilience.

[10] The share of banks with stranded asset risk in the region ranges from 0 percent to 3 percent, with a probability of 2.4 percent of exceeding this range.

Promoting Green Finance

Green bonds face several challenges that limit their effectiveness in promoting green finance:

- **Information asymmetry**: Difficulty in obtaining reliable information about green projects makes it hard for investors to assess the true environmental impact of their investments.

- **Long gestation periods and inadequate carbon pricing**: Green investments often take a long time to generate returns, and without proper carbon pricing, these projects may appear less competitive compared to traditional investments.

- **Immature markets**: In some countries, green bond markets are not well developed, and green technologies require substantial long-term financing, which can be daunting for private investors.

These barriers make green investments less attractive to private investors, hindering the necessary levels of issuance and investment needed to advance environmental sustainability goals.

25. Central banks can play a catalytic role in directing financial flows towards a more optimal level of green investments. Green central banking is necessary when market forces alone underprovide green finance solutions. For example, central banks, through well-designed programs, can incentivize commercial banks to offer lower interest rates for environmentally beneficial investments. This encourages more green credits and helps mitigate the high upfront costs and maturity mismatches in environmental projects, supporting the advancement of environmental sustainability goals. Box 1 provides an example in China.

Box 1. Structural Monetary Policy Instruments to Promote Green Finance

The People's Bank of China (PBOC) introduced the Carbon Emission Reduction Facility (CERF) in November 2021 to mobilize green finance and help meet China's goals of hitting a carbon peak by 2030 and reaching carbon neutrality by 2060.[11] The CERF is a structural monetary policy tool targeted at closing the country's funding gap[12] for green development. The CERF involves three main stakeholders:

- **Firms in targeted sectors,** including clean energy, energy conservation and environment protection, and carbon emission reduction technologies, initiate loan applications.

[11] China pledged to achieve its carbon peak by 2030 and carbon neutrality by 2060 at the United Nations General Assembly in September 2020.
[12] Research done by China's National Development and Reform Commission suggests that an annual investment of RMB3.1-3.6 trillion will be needed to achieve a carbon peak by 2030, and new investments in the amount of over RMB139 trillion will be needed to achieve carbon neutrality by 2060.

- **Financial institutions** assess firms' projects, estimate potential carbon emission reductions, and provide loans to qualified firms at rates aligned with the Loan Prime Rate. Upon disbursing loans, financial institutions can seek funding support from the CERF.

- **The PBOC** verifies the carbon emission reduction data submitted by financial institutions and then provides 60 percent of loan principals to them at a fixed rate of 1.75 percent. This support lasts for one year and can be renewed twice. Financial institutions must provide eligible collateral and disclose loan and emission reduction information quarterly. The PBOC oversees and verifies this information with the help of third-party institutions.

The CERF has played a significant role in advancing green finance and reducing carbon emissions. As of the end of the third quarter of 2024, the outstanding amount of the CERF stood at RMB535.1 billion and supported financial institutions in the granting of carbon emission reduction loas worth over RMB1.2 trillion, facilitating a carbon emission reduction of around 200 million tons.

While the CERF has yielded positive economic and environmental outcomes, several lingering issues may limit its potential impact. Notably, the CERF operates as a temporary measure set to expire by the end of 2027. In addition, the funding support provided under the CERF has a one-year maturity, extendable twice to a total of three years, which remains significantly shorter than typical loan repayment periods. Given the ongoing concern and debate within financial institutions, it is worth exploring the possibility of transforming the CERF into a long-term instrument and extending the maturity of funding support.

Finally, in an environment where policy rates decline but the CERF's rate remains fixed at 1.75 percent, the margin for extending carbon emission reduction loans will narrow, which will diminish the appeal of the CERF and weaken financial institutions' incentive to participate. There is therefore merit in exploring adjustments to the setting of interest rates, potentially allowing it to fluctuate in tandem with policy rates.

This box was prepared by Leilei Lu.

Developing Green Taxonomies

26. Green taxonomies—classification systems that define what constitutes environmentally sustainable economic activities—are critical to the development of green finance. Central banks and regulatory agencies could address the issue of asymmetric information among investors by establishing a clear and comprehensive taxonomy. In the context of green bonds, a taxonomy is used to promote transparency, protect issuers' credibility, and channel investment towards green activities (Thür 2022), thereby reducing the risk of greenwashing and helping investors make more informed decisions (O'Mahony and Awan 2021).

27. A well-designed and effective green taxonomy can be crafted based on the five principles outlined by the Bank of International Settlements (BIS 2021).

The five principles are (1) alignment with high-level policy objectives and measurable targets;[13] (2) focus on one single objective;[14] (3) outcome-based, using simple and disclosed key performance indicators (KPIs);[15] (4) incorporation of entity-based information;[16] and (5) coverage of both high and low sustainability performance, that is to have sufficient granularity.[17] Based on these principles, a detailed evaluation of the green taxonomies developed by the EU, ASEAN and select ASEAN+3 economies is set out in Appendix 4. It should be noted that economies are still in the process of developing their green taxonomies, with some expanding their frameworks to include transitional taxonomies. These not only cover green activities but also include other actions that support the transition towards a sustainable economy. For the purposes of this note, the taxonomies evaluated are limited to green taxonomies as of March 2024.

28. The ASEAN taxonomy, designed to be interoperable with the EU taxonomy and other national taxonomies within the region, serves as a critical framework for regional green finance. The EU taxonomy is often used as the benchmark for taxonomies worldwide, and the ASEAN taxonomy aligns closely with it (ASEAN Taxonomy Board 2023). With some exceptions, both taxonomies perform similarly along each of the principles. The ASEAN taxonomy has more granularity than its EU counterpart, which means it is more inclusive and has more guidelines for transitioning activities, while the EU taxonomy is more stringent in monitoring entity-based information (Figure 12).

29. National taxonomies developed by selected ASEAN+3 economies generally perform well in "aligning with high-level policy objectives" but could do better in other criteria such as "incorporating entity-based information" (Figure 13). Addressing the following gaps could make green finance more accessible and attractive to a wider range of borrowers and investors:

- **Incorporating entity-based information:** Enhancing the availability and quality of information at the entity level helps mitigate greenwashing risks. Most member economies have not yet incorporated this into their frameworks. Bridging this information gap is a key component of an effective taxonomy framework.

[13] An effective taxonomy should aid investors in channeling capital into long-term national sustainable development plans. For example, the taxonomy objectives should be aligned with high-level policy objectives of the Paris Agreement and/or existing national standards and regulations. In addition, the objectives should be translated into measurable outcomes—for example, a reduction of GHG emissions by a set benchmark.

[14] Taxonomies usually encompass multiple objectives that may be interlinked, and this could lead to information loss. For example, a project may be positively contributing to one environmental objective, while harming another at the same time. Without a clear label, investors would face considerable uncertainty over the environmental benefits of the certified assets.

[15] The choice of KPIs should be directly linked with the high-level policy objective. For example, GHG emissions, whereby both direct and indirect emissions are taken into consideration.

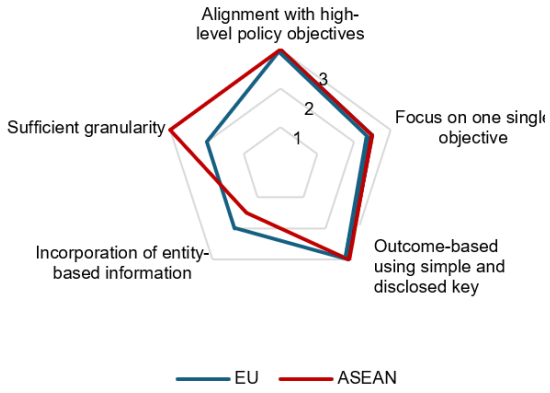
[16] Entities may label some activities as green, despite their overall carbon footprint being substantial. It is important for taxonomies to be able to affect incentives on an entity level.

[17] Taxonomy that only labels an activity as "green" vs "not green" greatly limits the range of investment strategies. By targeting only firms with strong environmental performance, this fails to capture firms that are currently transitioning towards greener practices. Therefore, taxonomies should have different categories with thresholds that can be adjusted to circumstances, to determine if an asset or project is on a pathway to be aligned with high-level objectives.

- **Green bond certification:** Certified green bonds are shown to exhibit a premium. Central banks could facilitate this by using an effective taxonomy to certify green bonds issued in their jurisdictions.

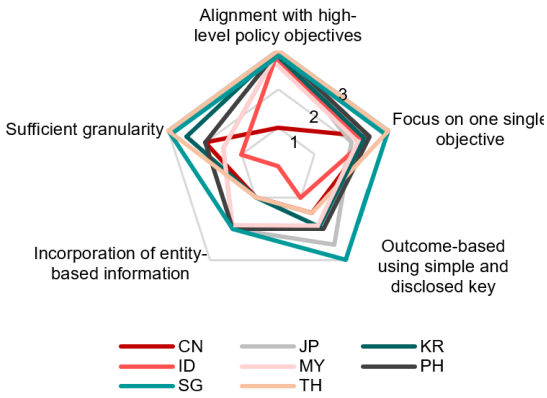
- **Data disclosure enforcement:** Central banks should enforce transparent disclosure requirements on the allocation of proceeds from green bond issuances and ensure that the impact of the funded projects is verified and monitored.

Figure 12. EU and ASEAN: Difference in Taxonomy
(Index)



Source: AMRO staff calculations
Notes: For each principle (represented by a vertex on the pentagon), a score between 0, 0.5, 1.0, 1.5, 2.0, 2.5 and 3 is assigned. A higher score denotes greater efficiency in the respective principles. More detailed explanations of how the scores are assigned can be found in Appendix 4.4.

Figure 13. Selected ASEAN+3: National Taxonomies
(Index)



Source: AMRO staff calculations
Notes: National taxonomies included in the diagram are from China (CN), Japan (JP), Korea (KR), Indonesia (ID), Malaysia (MY), the Philippines (PH), Singapore (SG), and Thailand (TH). Details of the scores for each principle within the framework can be found in Appendix 4.4.

Capturing Climate-related Risks in Banking Regulatory Frameworks

30. Rapid shifts to green lending, without managing exposure to carbon-intensive sectors, may potentially undermine banks' financial soundness. As climate-related policies continue to intensify globally, banks with high exposure to carbon-intensive sectors may face stranded asset risks as they lose value due to regulatory changes, consumer preferences, and technological advancements. These risks can lead to sudden increases in risk premiums, disrupt asset price correlations and exacerbate credit, liquidity, and counterparty risks, complicating financial risk management. Ultimately, this may lead to financial losses, weaken their capital positions and increase their vulnerability to economic shocks.

31. Regulators should be fully aware of the implications for stranded assets that can result from the increasing shift to green lending. Banks should also integrate any potential risks of stranded assets into their risk management frameworks. To that end, the Basel Committee on Banking Supervision has revised its Core Principles for Effective Banking Supervision to integrate climate-related risks (BCBS 2024). Significant progress has been made by ASEAN+3 financial regulators, such as by issuing transition planning, climate-related risk management guidelines, and pushing banks to incorporate climate-related risks in stress testing. While these broader efforts are a welcome move, there is still room for ASEAN+3 authorities to

fully incorporate the BCBS' Core Principles into their banking regulations. This can be done by explicitly integrating climate-related risk considerations in the guidance on the calculation of risk-weighted assets across all risk categories (credit, operational, market, and liquidity risk), and enforcing the supervisory expectations through other supervisory tools like penalties and capital add-ons when needed. (Durrani and Bingler 2024)

32. In addition to prudential regulations, encouraging portfolio diversification in banks can also help reduce exposure to high-risk sectors, even as financial incentives are provided for sustainable investments. Regulatory frameworks should mandate detailed disclosure of climate-related financial risks and ensure that investors are fully informed of potential risks associated with non-green investments. These actions, aligned with Basel and FSB recommendations, will help mitigate financial risks and support a smooth transition to a low-carbon economy.

VII.Conclusion

33. Green bonds have experienced robust growth in recent years, a trend that is expected to continue due to the need to mitigate both the physical and transitional risks from climate change. Although green finance is still in its early stages, the financial stability risks associated with this form of financing should not be overlooked, just as the risks from climate change itself cannot be ignored. This note provides empirical evidence of a green premium in the bond market, which can contribute to financial stability by reducing the debt burden for borrowers financing their green transitions.

34. However, greenwashing could be a concern. Firms in the region do not always reduce their carbon emissions after the issuance of green bonds. If investors in green assets exit their positions because of greenwashing, it could lead to significant financial stability risks, including sharp price corrections or a loss of investor confidence and a consequent fire sale of assets.

35. Green loans—another form of green finance—also carry potential risks. As banks accelerate green lending initiatives and as the policy push for more sustainable finance continues, there is a risk of "stranded assets" emerging. This may increase the vulnerability of banks with significant exposure to assets tied to traditional carbon-intensive or "brown" sectors, as borrowers in these industries could encounter heightened financing or liquidity challenges or even risk of insolvency under extreme conditions. Our simulation results reveal that banks could face substantial stress during a crisis, highlighting the critical need for a regulatory framework that effectively addresses the elevated risks posed by climate-related financial challenges.

36. While further efforts are required from authorities to close the financing gap and accelerate green investment, remaining vigilant about the financial stability risks associated with green finance is crucial. Addressing these risks requires a comprehensive and holistic approach that integrates market-based strategies with the right central bank policies and regulatory initiatives. First, green central banking is essential to meet the growing funding demand for green projects.

Second, enhancing green taxonomies—which define what qualifies as green finance—are a vital tool in preventing greenwashing. This will reduce the likelihood of greenwashing and thereby mitigate financial stability risks. The effectiveness of these taxonomies can be further strengthened through common certification standards from regulatory authorities, with interoperability across borders to attract international investors. Finally, banking regulations must evolve to integrate climate-related risks and prevent the buildup of systemic risks in the financial sector.

37. On the whole, transparency, robust verification, and regulatory oversight are essential for maintaining trust in green finance. These measures will help realize its full potential while safeguarding financial stability and promoting sustainable economic growth.

Appendix 1. Forecasting Green Bond Market Size[18]

This forecasting exercise employs an extended autoregressive (AR) model of order 1, a method widely adopted in the literature, including studies by Tu et al. (2020a, 2020b), Tolliver et al. (2020), ADB (2022), and Nguyen et al. (2023).

$$\text{Green Bond Market Size}_t = \beta_1 * \text{Green Bond Market Size}_{t-1} + X\beta + \varepsilon_t;\ \forall \mathcal{P}(\text{X}) \qquad \text{(A1)}$$

This time series forecasting model incorporates a variety of explanatory variables that may be expected to influence the growth of the green bond market. These variables include financial development and economic development[19], carbon emissions[20], climate risk[21], emissions reduction policies and measures[22], public sector governance[23], and environment-related technology development[24]. To capture the range of potential market sizes, the model uses different combinations of these factors in each iteration. This method provides an estimate of the future growth trajectories for the green bond market by accounting for the uncertainties associated with which drivers will influence its development and to what extent.

Forecasted GDP data in this model is sourced from the IMF. Using this data, future consumption, investment, trade, bond market size, bank lending market size, corporate loan market size, and corporate equity market size are projected using a structured model. For other factors, we use values lagged by five years to estimate the coefficients in equation (A1). Subsequently, the most recent values are used together with the projected paths of the above financial development and economic development variables to make predictions about the green bond market size in the next five years.

This exercise is repeated for 11 ASEAN+3 economies—China, Hong Kong, Indonesia, Japan, Korea, Lao PDR, Malaysia, the Philippines, Singapore, Thailand, and Vietnam—as well as the US and the Euro area. The historical green bond market size data is sourced from Refinitiv, aggregated to the economy level. The explanatory variables are obtained from various sources, including national authorities via CEIC or Haver Analytics, the IMF's World Economic Outlook (WEO) database, the European Commission's Directorate-General for Joint Research Centre's carbon emission datasets, the World Bank's World Development Indicators (WDI) database, and the OECD's Green Growth Indicators (GGI) database.

[18] This appendix is authored by Alex Liyang Tang.

[19] Financial development variables include bond market size, bank lending market size, corporate loan market size, and corporate equity market size. Economic development variables cover private consumption, private investment, public consumption, public investment, GDP, and trade volume. The future paths of these variables are sourced from a structured model aligned with the IMF's forecasted GDP growth paths for the current and next five years from 2024 to 2028 (IMF 2024). A general overview of this structured model can be found in Tang (2022) and Vitek (2018).

[20] Carbon emission indicators include total greenhouse gas emissions as tons of CO_2 equivalent per year, provided by the European Commission's Directorate-General for Joint Research Centre. These indicators only have historical data, and when used as X variables to estimate the econometric model and make predictions, their lagged data is employed. The following other indicators are also processed in the same manner.

[21] Climate risk indicators, sourced from the World Bank's World Development Indicators (WDI) database, include cooling degree days, heat index 35, and the standardized precipitation-evapotranspiration index.

[22] Emission reduction policies and measures indicators, sourced from the OECD's Green Growth Indicators (GGI) database, involve environmentally related taxes as percent of GDP and energy-related tax revenue as percent of GDP.

[23] Governance indicators, sourced from the World Bank's WDI database, cover government effectiveness and regulatory quality.

[24] Environmentally related technology development indicators, sourced from the OECD's GGI database, include development of environment-related technologies as a percent of all technologies, development of environment related technologies as inventions per capita, relative advantage in environment related technology, and development of environment-related technologies as a percent of inventions worldwide.

Appendix 2. Greenium Estimation[25]

In estimating the green premium in the primary market, the ideal calculation would involve comparing the yield at issuance of both green and comparable non-green bonds on the same issuance date. However, this is rarely observed in practice. To best approximate this, we compare the yield of green bonds at issuance with the yields of non-green bonds available in the market on the same date, controlling for main bond variables that affect yields from the market perspective. When the yield at issuance for a green bond is unavailable, it is approximated using the issuance price (P), face value (F), coupon payment (C), and maturity (N), based on the following equation,

$$\text{YTM} \approx \frac{C + \frac{(F - P)}{N}}{\frac{(F + P)}{2}}$$

All data are obtained from the Refinitiv database, covering China, Japan, South Korea, Hong Kong SAR, Indonesia, and Thailand. To ensure comparability between green and conventional bonds, it is also required that each issuer must have issued at least one green bond and one conventional bond.

The final sample includes 3,125 unique conventional bonds and 913 green bonds issued by 358 borrowers across six economies, although the data is heavily concentrated in the Plus-3 economies.

Table A2.1. ASEAN+3: Primary Market Greenium Result

	(1)	(2)	(3)	(4)
Green	-0.142*	-0.154*	-0.141*	-0.152*
	(0.079)	(0.080)	(0.079)	(0.080)
Tenor	0.014***	0.015***	0.014***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)
Rating		-0.159***		-0.141***
		(0.042)		(0.041)
Secured			-0.448*	-0.417*
			(0.250)	(0.250)
Issuer FE	Y	Y	Y	Y
Issue Date FE	Y	Y	Y	Y
Currency FE	Y	Y	Y	Y
R^2	0.77	0.77	0.77	0.77
Observations	8,383	8,383	8,383	8,383
Conv. Bonds	3,125	3,125	3,125	3,125
Green Bonds	913	913	913	913
Issuers	358	358	358	358

Standard errors in parentheses (robust)
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1 in the main text shows a summary statistic of the estimated *greenium* for each green bond using the synthetic method. Overall, this estimate also shows the existence of *greenium* with an average of 17 bps and median value of 24 bps. This aligns with the pooled regression result in Table A2.1, further reinforcing the credibility of the findings. After estimating the

[25] This appendix is authored by Chenxu Fu.

greenium for each green bond in Table 1, the following equation is estimated to assess factors that might affect the magnitude of this premium.

$$\text{Greenium}_{csj} = \alpha + \gamma_1 \text{Certified}_{\text{csj}} + \gamma_2 \text{LocCur}_{\text{csj}} + \gamma_3 \text{UoP}_{\text{csj}} + \text{country}_{\text{c}} + \text{sector}_{\text{s}} + \text{month}_{\text{t}} + \epsilon_{csj}$$

where Greenium_{csj} is estimated greenium of green bond j from Table 1 for borrower in the country c and sector s. $\text{Certified}_{\text{csj}}$ is an indicator if the green bond is CBI certified. $\text{LocCur}_{\text{csj}}$ is an indicator if the green bond is issued in domestic currency, or similarly if the green bond is issued in the domestic market. UoP_{csj} denotes the main area of the usage of proceed. Note that we are only controlling for country and industry fixed effects here, given the relatively small number of green bonds per issuer. Table A2.2 shows that a green bond exhibits a larger premium if (1) it is certified by a third party or the financial regulator, (2) it is issued in the local currency, and (3) the capital raised is used for green projects in the energy sector and green building.

Table A2.2. Underlying Factors of *Greenium*

	(1)	(2)	(3)	(4)
CBI Certified	0.182*			0.171*
	(0.094)			(0.098)
Local Currency		0.381**		0.376**
		(0.192)		(0.188)
Climate Adaptation			0.315	0.263
			(0.207)	(0.209)
Energy Sector			0.280*	0.187
			(0.150)	(0.155)
Green Building			0.463**	0.405**
			(0.192)	(0.189)
Technology			0.298	0.235
			(0.221)	(0.229)
Clean Transportation			0.274	0.234
			(0.188)	(0.192)
Country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
Month FE	Y	Y	Y	Y
R^2	0.39	0.40	0.39	0.40
Observations	878	878	878	878
Issuer	328	328	328	328
Country	6	6	6	6

Standard errors in parentheses (robust)
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix 3. Greenwashing Estimation[26]

This appendix describes the empirical approach and analyses used to assess greenwashing risks. As mentioned, firms' greenwashing risk is inferred in accordance with their behavior after they have issued green bonds. Specifically, as the issuance of green bonds functions as a signal of the firm's environmental commitment, greenwashing is present if firms' environmental performance does not improve in the post-issuance period.

One empirical challenge is that the issuance of green bonds is not random and may be driven by firm characteristics. To ameliorate these concerns of self-selection, a matching approach following Flammer (2021) is used to construct a plausible counterfactual of how firm outcomes would have evolved in the absence of green bond issuance. The control group is constructed using a propensity score matching (PSM) method with replacement wherein a most similar control firm is matched to each treated firm (treated firms are defined as firms that have issued green bonds).

The matching process is as follows. First, among the pool of firms that have not issued green bonds, only firms that operate in the same country and industry as the treated firm are considered. Second, a probit regression that predicts treatment (the issuance of a green bond) on a host of firm-level characteristics such as return on assets (ROA), size (log total assets), leverage (total liabilities divided by total assets) and ESG scores in the year prior to the issuance of the green bond (*t*-1) is conducted. Following this, a PSM method is used to select the nearest neighbor, the control firm.

The matching criteria is selected to ensure that control firms are as similar as possible in various characteristics to treated firms, other than the issuance of green bonds. Matching on country and industry means that treated and matched control firms face similar business, economic, and regulatory conditions, including their exposure to environmental concerns and pressures. Profitability, size, and leverage matching alleviates concerns that more profitable, larger, and less levered firms are more likely to access capital markets and issue green bonds. Lastly, matching on ESG scores prior to the issuance of green bonds reduces self-selection issues relating to the notion that more socially conscious firms (those with higher ESG scores) are more likely to issue green bonds. It should be noted that while the matching strategy only matches on observable characteristics, having similar ex-ante characteristics reduces the possibility of unobservables biasing the regression.

After the matching process, a difference-in-difference model is used to estimate if firms become more environmentally conscious after issuing green bonds:

$$y_{ijct} = \alpha_0 + \beta_1 \text{Treated x Post}_{ijct} + \beta_2 \text{Treated}_{ijc} + \beta_3 \text{Post}_{ijct} + \theta_t + \phi_j + \xi_c + \varepsilon_{ijct}$$

Where *y* is CO_2 emissions scaled by total assets, and y_{ijct} denotes carbon emissions of firm *i*, operating in industry *j,* residing in country *c*, in year *t*. θ_t are year, ϕ_j industry, while ξ_c are country fixed effects respectively. $Treated_{ijc}$ is a dummy variable that = 1 if a firm has issued a green bond and 0 if in the control group. $Post_{ijct}$ is a dummy variable that=1 for years after the issuance of a green bond. Control variables do not feature in the baseline specification as their inclusion could introduce bias if these variables are themselves affected by the issuance of green bonds. The difference-in-difference coefficient on the interaction term β_1 captures *changes* in CO_2 emissions for treated firms *after* the issuance of green bonds relative to *before*, and relative to a group of counterfactual control firms in the same period.

[26] This appendix is authored by Wen Yan Ivan Lim.

Data used in these analyses is from Thomson Reuters Eikon Database. The sample starts off with all firms that have issued green bonds in ASEAN+3 economies and are in the database. Our unmatched sample (all possible control firms) consists of publicly listed firms operating in the same country and industry as treated firms, which have non-missing financial data (total assets, leverage, ROA, ESG score, CO_2 emissions). This unmatched sample has 130 (1604) unique treated (control) firms from nine ASEAN+3 economies (China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, and Thailand). *t*-tests of differences in means shows that firms that issue green bonds (treated firms) are larger, more levered, and have better financial as well as ESG performance (Table A3.1).

After applying the PSM matching approach as described above, the final sample includes 93 (75) unique treated (control) firms from six ASEAN+3 economies (China, Hong Kong, Japan, Korea, Malaysia, and Thailand) from years 2008-2023. The matching process appears to be effective in removing any observable differences between treated and control firms (Table A3.1). Therefore, matched control firms are likely to form a suitable counterfactual.

Table A3.1. Financial Characteristics of Matched and Unmatched Firms

Unmatched (Difference in means *t*-1)						
	Treated		**Control**		**Difference-in-means**	
Variable	**#**	**mean**	**#**	**mean**	**(Treated-control)**	***p***
Log (total assets)	130	3.49	1604	2.53	0.96	0.00***
Leverage	130	0.64	1604	0.54	0.1	0.00***
ROA	130	0.028	1604	0.037	-0.009	0.04**
ESG score	130	58.1	1604	53.1	5	0.00***
PSM Matched Sample (Difference in means *t*-1)						
	Treated		**Control**		**Difference-in-means**	
Variable	**#**	**mean**	**#**	**mean**	**(Treated-control)**	***p***
Log (total assets)	93	3.74	93	3.4	0.34	0.15
Leverage	93	0.65	93	0.65	0	0.95
ROA	93	0.028	93	0.029	-0.001	0.87
ESG score	93	60.9	93	59.4	1.5	0.53

Source: AMRO staff estimates; Thomson Reuters Eikon Database
Note: Variables are winsorized at the 1 percent tails. Asterisks (*, **, ***) denote significance levels at 10 percent, 5 percent, and 1 percent, respectively.

Table A3.2 shows the results for the difference-in-difference analysis using different samples. The first column uses the PSM matched sample described above while the second column uses an unmatched sample; that is, the 130 (1,604) unique treated (control) firms prior to the matching process. While firms that issue green bonds are observably different from firms that have not, we run our analysis using an unmatched sample nonetheless to investigate whether the results of the analysis would differ. The third and fourth column modifies the PSM matched sample but uses a 3- and 5-year window for *Post*. A shorter window around the estimation period can help alleviate concerns of noise entering the regression.

In all columns, the coefficient on *Treated x Post* is not statistically significant. On average, treated firms in the selected ASEAN+3 economies do not change their carbon emissions after the issuance of green bonds as compared to a counterfactual group of firms. These findings indicate that greenwashing risks are not absent in our sample.

Table A3.2. Difference-In-Difference Results: Greenwashing Risk

	(1)	**(2)**	**(3)**	**(4)**
Sample =	**PSM matched**	**Unmatched**	**PSM matched**	**PSM matched**
			(3-yr window)	**(5-yr window)**
Variable	**CO_2/Assets**			
Treated x Post	-16.83	55.21	27.14	43.34

	(1)	(2)	(3)	(4)
Sample =	**PSM matched**	**Unmatched**	**PSM matched**	**PSM matched**
			(3-yr window)	**(5-yr window)**
Variable	**CO_2/Assets**			
	(-0.49)	(0.43)	(0.35)	(0.72)
Treated	18.39	167.32**	-23.45	-15.60
	(1.04)	(2.24)	(-0.49)	(-0.40)
Post	10.23	326.71***	-45.10	-43.06
	(0.32)	(4.96)	(-0.78)	(-0.95)
Intercept	141.67***	562.04***	197.58***	187.05***
	(8.86)	(9.06)	(4.79)	(5.66)
Observations	2,011	7,590	552	833
Country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.211	0.112	0.184	0.201

Source: AMRO staff estimates; Thomson Reuters Eikon Database
Note: t-statistics are reported in parenthesis. Variables are winsorized at the 1 percent tails. Asterisks (*, **, ***) denote significance levels at 10 percent, 5 percent, and 1 percent, respectively.

Additional analyses are conducted using various sub-samples. Table A3.3 investigates greenwashing for the different selected ASEAN+3 economies while Table A3.4 shows estimates for different sectors. Table A3.3 reveals that greenwashing risks do not differ in the different economies; *Treated x Post* is statistically insignificant in all the columns. However, when the analyses are conducted for different sectors in Table A3.4, it is observed that firms in the real estate sector have higher risks of greenwashing (column 7); *Treated x Post* is positive and statistically significant at the 10 percent level. In terms of economic magnitude, real estate firms increase their carbon emissions by 136 tons per million-dollar assets as compared to a counterfactual group of control firms.

Several caveats are in order. First, it should be noted that since the totality of a firm's greenwashing risks are not directly observable, our analysis only considers firm's greenwashing risks around the issuance of green bonds. Indeed, while firms can make environmental commitments in various ways, we argue that since the issuance of green bonds requires significant capital market participation and costs, it is likely to be a strong signal of a firm's commitment, and thus, a suitable experiment to study a firm's risk of greenwashing. Nonetheless, future studies might study firm greenwashing risks using different settings. Second, the use of a fairly tight empirical strategy means that we trade off sample size in the analyses. Therefore, we caution against overinterpreting some of the sub-sample tests, particularly those involving a small number of observations.

Overall, while greenwashing risks cannot be ruled out in select ASEAN+3 economies, the real effects of these risks on financial stability are expected to be fairly limited at present due to the relatively small proportion of green assets (bonds) as compared to the market for conventional bonds.

Table A3.3. Difference-In-Difference Results: Economy Greenwashing Risk

	(1)	(2)	(3)	(4)
Sample =	**CN+HK**	**JP**	**KR**	**MY+TH**
Variable	**CO_2/Assets**			
Treated x Post	2.99	-30.09	-22.15	62.12
	(0.02)	(-1.36)	(-0.46)	-0.68
Treated	-118.97	52.66***	44.96**	-68.91
	(-1.20)	(3.75)	(2.53)	(-1.17)
Post	-0.50	15.16	-39.93	-29.97

	(1)	(2)	(3)	(4)
Sample =	**CN+HK**	**JP**	**KR**	**MY+TH**
Variable	**CO_2/Assets**			
	(-0.00)	(1.17)	(-1.24)	(-0.46)
Intercept	346.89***	85.74***	114.46***	354.58***
	(3.63)	(11.5)	(7.89)	(6.72)
Observations	329	1,306	292	84
Country FE	No	No	No	No
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.221	0.226	0.529	0.713

Source: AMRO staff estimates; Thomson Reuters Eikon Database
Note: t-statistics are reported in parenthesis. Variables are winsorized at the 1 percent tails. Asterisks (*, **, ***) denote significance levels at 10 percent, 5 percent, and 1 percent, respectively.

Table A3.4. Difference-in-difference Results: Industry Greenwashing Risk

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sample =	**Consumer**	**Energy**	**Financials**	**Industrials**	**IT**	**Materials**	**Real Estate**
Variable	**CO_2/Assets**						
Treated x Post	-0.82 (-0.10)	84.86 (0.92)	0.42 (0.63)	-17.70 (-0.31)	-30.69 (-1.37)	-163.07 (-0.60)	**136.66*** (1.93)
Treated	-27.82*** (-5.87)	-19.81 (-0.34)	1.00*** (2.77)	-24.90 (-0.74)	45.37*** (3.43)	289.75*** (2.89)	-123.43** (-2.26)
Post	6.08 (0.91)	-191.82*** (-2.91)	0.20 (0.83)	34.20 (0.52)	-7.87 (-0.53)	50.19 (0.16)	-64.62 (-0.92)
Intercept	53.67*** (11.53)	446.44*** (8.63)	0.62*** (5.06)	163.27*** (5.15)	63.68*** (6.01)	392.03*** (4.04)	114.51** (2.22)
Observations	200	118	420	681	194	222	172
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	No	No	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.213	0.387	0.146	0.0415	0.385	0.168	0.0449

Source: AMRO staff estimates; Thomson Reuters Eikon Database
Note: t-statistics are reported in parenthesis. Variables are winsorized at the 1 percent tails. Asterisks (*, **, ***) denote significance levels at 10 percent, 5 percent, and 1 percent, respectively.

Appendix 4. Green Taxonomies Evaluation Details[27]

Green taxonomies are crucial for directing capital towards environmentally responsible economic activities. Several ASEAN+3 members have developed green taxonomies to enhance transparency and assist investors in making informed decisions. This appendix evaluates green taxonomies across the region, along with EU and ASEAN taxonomies, assigning scores based on the criteria shown in Table A4.1. Table A4.2a–Table A4.2c shows a more detailed rationale for how the scores are given in Table A4.1.

Table A4.1. Scoring of Taxonomies: EU Taxonomy, ASEAN Taxonomy and National Taxonomies in ASEAN+3

Principle	Criteria	Regional/ National Taxonomies									
		EU	ASEAN	CN	JP	KR	ID	MY	PH	SG	TH
Alignment with high-level policy objectives	1 if aligned with high-level policy goals during development; 0.5 if mentioned but without clarity; 0 otherwise.	1	1	1	1	1	1	1	1	1	1
	1 if there is clarity on what the targets are; 0.5 if mentioned but without clarity; 0 otherwise.	1	1	0.5	1	1	1	1	1	1	1
	1 if the objectives are forward looking, measurable, and realistic; 0.5 if mentioned but without clarity; 0 otherwise.	1	1	0.5	1	1	1	1	1	1	1
Focus on one single objective	1 if the objectives can be focused on one at a time; 0.5 if mentioned but without clarity; 0 otherwise.	1	1	1	1	1	1	1	0.5	1	1
	1 if there are criteria and thresholds to determine if an activity qualifies for an environmental objective; 0.5 if mentioned but without clarity; 0 otherwise.	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1
	1 if there is screening to ensure that while one environmental objective is supported, no harm is done to others; 0.5 if mentioned but without clarity; 0 otherwise.	1	1	1	0.5	1	1	1	1	1	1
Outcome-based using simple and disclosed key performance indicators (KPIs)	1 if the choice of KPIs used can be linked directly to the sustainability objective; 0.5 if mentioned but without clarity; 0 otherwise.	1	1	1	1	1	1	1	1	1	1
	1 if all relevant greenhouse gases emitted are covered; 0 otherwise.	1	1	0.5	0.5	0	0	0.5	1	1	0
	1 if there is coverage of indirect emissions from production inputs,	1	1	0	1	1	0	0.5	0	1	0.5

[27] This appendix is authored by Kit Yee Lim.

Principle	Criteria	Regional/ National Taxonomies									
		EU	ASEAN	CN	JP	KR	ID	MY	PH	SG	TH
	production distribution, and usage; 0.5 if mentioned but without clarity; 0 otherwise.										
Incorporation of entity-based information	1 if assessment/ measurement of KPIs is done on an entity level; 0.5 if mentioned but without clarity; 0 otherwise.	0	1	1	1	0	0	0	1	1	1
	1 if past performance of an entity is measured; 0.5 if mentioned but without clarity; 0 otherwise.	1	0.5	0	1	1	0	1	0.5	0	0
	1 if the taxonomy considers that an entity is on a transition pathway to become "green"; 0.5 if mentioned but without clarity; 0 otherwise.	1	0	0	0	0	0	1	0.5	1	0
Sufficient granularity	1 if there are clear thresholds for carbon emissions for the activity or assets to be labeled as green; 0.5 if mentioned but without clarity; 0 otherwise.	1	1	1	0.5	0.5	0.5	0	0.5	1	1
	1 if there are different thresholds for carbon emissions for different sustainability performance stages; 0.5 if mentioned but without clarity; 0 otherwise.	0	1	0	0	1	0.5	0.5	0.5	1	1
	1 if there are information disclosure requirements for green assets/ activities/ projects; 0.5 if mentioned but without clarity; 0 otherwise.	1	1	1	1	1	0	1	1	1	1

Source: AMRO staff calculations
Note: EU = Europe; CN = China; JP = Japan; KR = Korea; ID = Indonesia; MY = Malaysia; PH = the Philippines; SG = Singapore; TH = Thailand. The principles and criteria are set based on the paper "A taxonomy of sustainable finance taxonomies" by the BIS (2021).

Table A4.2a. EU and ASEAN: Rationale of Scores in Table A4.1 Taxonomy

Principle	Criteria	EU Taxonomy	ASEAN Taxonomy
Alignment with high-level policy objectives	Aligned with high-level policy goals during development	In line with the European Green Deal and Paris Agreement	Developed with the intention to be interoperable with the EU Taxonomy and other national taxonomies in the ASEAN region
	Clarity on what the target is and how it can be measured	Net-zero GHG emissions	Net-zero GHG emissions
	Forward-looking objectives that are realistic and measurable	Net-zero GHG emissions by 2050	As early as in the latter half of the 21st century
Focus on one single objective	There is a label for each environmental objective so that they can be focused on one at a time	6 environmental objectives	4 environmental objectives accompanied by 3 essential criteria

Principle	Criteria	EU Taxonomy	ASEAN Taxonomy
	Criteria and thresholds are set to determine if an activity qualifies for an environmental objective	There must be substantial contribution to an environmental objective but there are no clear thresholds for reference	Detailed explanation of environmental objectives and criteria to fulfil them but there are no clear thresholds for reference
	Management of negative impacts to the environment that may arise	Application of the Do No Significant Harm (DNSH) principle to ensure the activity does not harm other environmental objectives while contributing to one	DNSH to other environmental objectives while substantially contributing to one
Outcome-based using simple and disclosed key performance indicators (KPIs)	KPIs used can be linked directly to the sustainability objective	Carbon emissions where applicable, other measurements in place where necessary	GHG emissions where applicable, other measurements in place where necessary
	Coverage of greenhouse gases other than carbon dioxide emitted	Mainly covers carbon dioxide emissions but also has requirements for the other GHGs	Covers GHGs other than carbon dioxide like methane, nitrous oxide, hydrofluorocarbons, etc.
	Coverage of indirect emissions from production inputs, production distribution, and usage	There are thresholds for indirect GHG emissions	There are technical screening criteria for indirect carbon dioxide emissions
Incorporation of entity-based information	Entity level assessment/ measurement of KPIs	Activity level measurement of GHG emissions when conducting Climate Benefit Analysis	The entity's strategic focus and policies are used to determine which environmental objective is most relevant to the activity in consideration
	Past performance of an entity is measured	The Taxonomy Regulation requires corporates to disclose information (KPIs related to turnover, capital expenditure, and operational expenditure) about the extent of association of the activities to environmental sustainability	Past data is used in technical screening where applicable
	Considers that an entity is on a transition pathway to become "green"	Transitional and enabling activities are considered when calculating the green ratio	Only done on an activity level
Sufficient granularity	Clear thresholds for carbon emissions for the activity or assets to be labeled as green	There are criteria for an activity to have a substantial contribution to an environmental objective	There are thresholds the activity must not exceed to be considered green
	Different thresholds for carbon emissions for different sustainability performance stages	Binary, whereby an activity is only considered to be complaint or not (i.e. green or not green)	There are different thresholds where the activity can be categorized according to a traffic light system
	Information disclosure requirements for green assets/ activities/ projects	There are disclosure requirements for information regarding transition and enabling activities	Sustainability reporting disclosures at a portfolio and product level are required

Source: AMRO staff compilation
Note: The principles and criteria are set based on the paper “A taxonomy of sustainable finance taxonomies” by the BIS (2021).

Table A4.2b. Plus-3: Rationale of Scores in Table A4.1 Taxonomy

Principle	Criteria	China Green Bond Endorsed Projects Catalogue	Japan Green Bond/ Loan and Sustainability Linked Bond/ Loan Guideline	K-Taxonomy
Alignment with high-level policy objectives	Aligned with high-level policy goals during development	In line with China's 2030 Agenda for Sustainable Development	Developed in line with the Paris Agreement and the International Capital Market Association's Green Bond Principles	Development guided by the "Framework Act on Carbon Neutrality and Green Growth for Coping with Climate Crisis"
	Clarity on what the target is and how it can be measured	With Climate Crisis by the National Assembly		
	Forward-looking objectives that are realistic and measurable	Unclear	Carbon neutral and GHG emissions reduction by 50 percent	Carbon neutrality by achieving net-zero GHG emissions
Focus on one single objective	There is a label for each environmental objective so that they can be focused on one at a time	Unclear	Carbon neutral by 2050	Carbon neutral by 2050
	Criteria and thresholds are set to determine if an activity qualifies for an environmental objective	6 environmental objectives	5 environmental objectives	6 environmental objectives
	Management of negative impacts to the environment that may arise	Metrics with thresholds that are aligned with national standards but there are no clear thresholds for reference	Criteria are set to determine the eligibility of Green Projects but there are no clear thresholds for reference	Criteria are set in which the target project will be assessed against, but there are no clear thresholds for reference
Outcome-based using simple and disclosed key performance indicators (KPIs)	KPIs used can be linked directly to the sustainability objective	DNSH to other environmental objectives while substantially contributing to one	Disclosure of the negative impacts are required but unclear how the information will affect the evaluation	DNSH to other environmental objectives while substantially contributing to one
	Coverage of greenhouse gases other than carbon dioxide emitted	China Banking Regulatory Commission-issued guidelines and KPIs for implementing green credit, which includes carbon emission	GHG emissions and other pre-established KPIs	GHG emissions and other KPIs
	Coverage of indirect emissions from production inputs, production distribution, and usage	Information disclosure required for carbon dioxide, sulfur dioxide, chemical oxygen demand and nitrogen oxides. Unclear how the information will	Reduction of air pollutants including sulfur oxides, nitrogen oxides, etc. must also be reported (but this is not a requirement for all projects)	Unclear

Principle	Criteria	China Green Bond Endorsed Projects Catalogue	Japan Green Bond/ Loan and Sustainability Linked Bond/ Loan Guideline	K-Taxonomy
		affect the final decision		
Incorporation of entity-based information	Entity level assessment/ measurement of KPIs	Unclear	Reporting indirect GHG emissions is required	Indirect GHG emissions are monitored
	Past performance of an entity is measured	Institution-level information disclosure (strategy, core value, and policies as well as their level of carbon emissions, etc.)	Entity-level GHG emission must be reported	Activity-level assessment
	Considers that an entity is on a transition pathway to become "green"	Unclear	Issuers need to disclose at least 3 years of externally verified data for the KPIs if they have not previously done so	Previous emissions are used for new performance evaluation
Sufficient granularity	Clear thresholds for carbon emissions for the activity or assets to be labeled as green	No transition activity considered	Unclear	Transitional area is only done on an activity level
	Different thresholds for carbon emissions for different sustainability performance stages	Set of criteria to be met for an activity to be eligible	There are criteria but no clear thresholds to be met to be considered green	Mentioned but there is no clarity on thresholds
	Information disclosure requirements for green assets/ activities/ projects	Binary, whereby an activity is only considered to be complaint or not (i.e. green or not green)	Binary, whereby an activity is only considered to be complaint or not (i.e. green or not green)	Has activity criteria for "transitional area"

Source: AMRO staff compilation
Note: The principles and criteria are set based on the paper “A taxonomy of sustainable finance taxonomies” by the BIS (2021).

Table A4.2c. Selected ASEAN: Rationale of Scores in Table A4.1 National Taxonomies

Principle	Criteria	Indonesia Green Taxonomy	Malaysia Climate Change and Principle-based Taxonomy	Philippine Sustainable Finance Taxonomy	Singapore Taxonomy	Thailand Taxonomy
Alignment with high-level policy objectives	Aligned with high-level policy goals during development	Alignment with Indonesia's Sustainable Finance Roadmap Phase I and II	Alignment with the Paris Agreement and relevant national policies and plans	Alignment with the Paris Agreement and Philippines National Development Plans	Alignment with the Paris Agreement and Singapore Green Plan 2030	Alignment with the Paris Agreement and Thailand's National Strategy
	Clarity on what the target is and how it can be measured	GHG emissions reduction	GHG emissions intensity of GDP reduction	GHG emissions reduction	GHG emissions reduction	GHG emissions reduction
	Forward-looking objectives that are realistic and measurable	Net zero GHG emissions by 2100	45 percent GHG emissions intensity of GDP reduction by 2030	75 percent GHG emissions reduction by 2030	Net-zero GHG emissions by 2050	Net-zero GHG emissions by 2065
Focus on one single objective	There is a label for each environmental objectives so that they can be focused on one at a time	4 environmental objectives and 3 essential criteria	Clear set of guiding principles and environmental objectives	2 environmental objectives and 2 more future ones under development	5 environmental objectives	6 environmental objectives
	Criteria and thresholds are set to determine if an activity qualifies for an environmental objective	Criteria are set for determining the eligibility of the activities but there are no clear thresholds for reference	Clear set of criteria but no thresholds for reference	Clear set of criteria but no thresholds for reference	Clear set of criteria and thresholds for reference	Clear set of criteria and thresholds for reference
	Management of negative impacts to the environment that may arise	DNSH to other environmental objectives while substantially contributing to one	Guiding Principle 3 of the taxonomy states there must be no harm to the environment to be eligible	DNSH to other environmental objectives while substantially contributing to one	DNSH to other environmental objectives while substantially contributing to one	DNSH to other environmental objectives while substantially contributing to one
Outcome-based, using simple and disclosed key performance indicators (KPIs)	KPIs used can be linked directly to the sustainability objective	GHG emissions and other KPIs	GHG emissions and other KPIs	GHG emissions and other KPIs	GHG emissions and other KPIs	GHG emissions and other KPIs
	Coverage of greenhouse gases other than carbon dioxide emitted	Not mentioned	GHGs other than carbon dioxide, such as methane are mentioned, but it is unclear if there are more	GHGs other than carbon dioxide, such as methane, nitrous oxide, hydrofluorocarbons and many others are covered	GHGs other than carbon dioxide, such as nitrogen oxides, and many others	Unclear
	Coverage of indirect	Not mentioned	One of the assessment	Ineligible if there are indirect effects	Indirect emissions are	Indirect emissions are

Principle	Criteria	Indonesia Green Taxonomy	Malaysia Climate Change and Principle-based Taxonomy	Philippine Sustainable Finance Taxonomy	Singapore Taxonomy	Thailand Taxonomy
	emissions from production inputs, production distribution, and usage		requirements is that there shall not be indirect contribution to negative effects to the environment, but more elaborate criteria need to be set	that detract from the contribution to the intended environmental objectives, but seems to only be on an activity level	covered while assessing for DNSH	covered during activity assessment, but it is unclear if it is also done on an entity level
Incorporation of entity-based information	Entity level assessment/ measurement of KPIs	Not mentioned	Unclear	The entity's strategic focus and policies are used to determine which environmental objective is most relevant to the activity in consideration	Entity level targets are set	Company compliance with the criteria is taken into consideration while assessing for eligibility
	Past performance of an entity is measured	Not mentioned	Company information and track record on sustainability are assessed	Business activity indicators such as capital expenditure, operational expenditure, and turnover are to be disclosed but it is unclear if this is also done on an entity level	Unclear	Not mentioned
	Considers that an entity is on a transition pathway to become "green"	No explicit incentives for transition activities yet	Encourages financial institutions to assist customers' transition towards sustainable practices in business operations	Enabling sectors that do not harm the environmental objectives are considered, but it is unclear if this is also done on an entity level	Set of criteria and thresholds for entities not yet in the green category	Set of criteria and thresholds for activities but not entities
Sufficient granularity	Clear thresholds for carbon emissions for the activity or assets to be labeled as green	Mentioned, but there is no clarity on thresholds	No clear thresholds set	Set of criteria but no clear thresholds	Set of criteria and thresholds	Set of criteria and thresholds
	Different thresholds for carbon emissions for different sustainability performance stages	Traffic light system is in place, but no clear thresholds have been set for each category yet	Criteria caters to the developmental stage, but no clear thresholds are set	Traffic light system is in place, but there are no clear thresholds for each category yet	Traffic light system is with thresholds for each category	Traffic light system is with thresholds for each category
	Information disclosure requirements for green	Not mentioned	Task force in place in enforcing climate-	Entity portfolio is assessed with reference to	Assessments on a project portfolio basis	Assessments on assets are done

Principle	Criteria	Indonesia Green Taxonomy	Malaysia Climate Change and Principle-based Taxonomy	Philippine Sustainable Finance Taxonomy	Singapore Taxonomy	Thailand Taxonomy
	assets/ activities/ projects		related finance	environmental objectives		

Source: AMRO staff compilation

Note: The principles and criteria are set based on the paper "A taxonomy of sustainable finance taxonomies" by the BIS (2021).

References

Alessi, Lucia, Francesca Erica Di Girolamo, Andrea Pagano, and Marco Petracco. 2022. "Accounting for Climate Transition Risk in Banks' Capital Requirements." JRC Technical Report No 129221, Joint Research Centre (JRC) of European Commission, Ispra, 22 June. *https://joint-research-centre.ec.europa.eu/reports-and-technical-documentation/accounting-climate-transition-risk-banks-capital-requirements_en*

Anh Tu, Chuc, Tapan Sarker, and Ehsan Rasoulinezhad. 2020a. "Factors Influencing the Green Bond Market Expansion: Evidence from a Multi-Dimensional Analysis." Journal of Risk and Financial Management 13(6): 126. MDPI, 13 June. *https://doi.org/10.3390/jrfm13060126*

Anh Tu, Chuc, Tapan Sarker, and Ehsan Rasoulinezhad. 2020b. "Investigating Solutions for the Development of a Green Bond Market: Evidence from Analytic Hierarchy Process." Finance Research Letters 34: 101457. Elsevier, 12 February. *https://doi.org/10.1016/j.frl.2020.101457*

Asian Development Bank (ADB). 2022. "Green Bond Market Survey for Indonesia: Insights on the Perspectives of Institutional Investors and Underwriters." ADB Report, ADB, Manila, November. *http://dx.doi.org/10.22617/TCS220536-2*

Basel Committee on Banking Supervision. 2022. "Principles for the effective management and supervision of climate-related financial risks" *https://www.bis.org/press/p220615.htm*

Basel Committee on Banking Supervision. 2024. "Core Principles for effective banking supervision"

https://www.bis.org/basel_framework/standard/BCP.htm

Chamberlin, B and J Evain. 2021. "Indexing capital requirements on climate: What impacts can be expected?", Institute for Climate Economics, Climate Report, 40(3):123–141. *https://www.i4ce.org/en/publication/indexing-capital-requirements-on-climate-what-impacts-can-be-expected/*

De Lisa, Riccardo, Stefano Zedda, Francesco Vallascas, Francesca Campolongo, and Massimo Marchesi. 2011. "Modelling Deposit Insurance Scheme Losses in a Basel 2 Framework." Journal of Financial Services Research 40: 123–41. Springer, December. *https://doi.org/10.1007/s10693-010-0097-0*

Durrani, Aziz, and Julian Bingler "The Basel Committee's Revised Core Principles for Effective Banking Supervision: Addressing Climated-Related Financial Risks in ASEAN+3". https://amro-asia.org/the-basel-committees-revised-core-principles-for-effective-banking-supervision-addressing-climate-related-financial-risks-in-asean3

Ehlers, Torsten, Diwen (Nicole) Gao, and Frank Packer. 2021. "A Taxonomy of Sustainable Finance Taxonomies." BIS Papers, No. 118. Bank of International Settlements, Basel, 8 Oct. *https://www.bis.org/publ/bppdf/bispap118.htm*

Emambakhsh, T., Giuzio, M., Mingarelli, L., Salakhova, D., & Spaggiari, M. 2022. Climate-related risks to financial stability. *Financial Stability Review*, *1*. https://www.ecb.europa.eu/press/financial-stability-publications/fsr/html/ecb.fsr202205~f207f46ea0.en.html

Financial Stability Board. 2020. “The Implications of Climate Change for Financial Stability.” https://www.fsb.org/2020/11/the-implications-of-climate-change-for-financial-stability/

Flammer, Caroline. 2021. "Corporate green bonds." Journal of financial economics 142(2): 499-516. https://doi.org/10.1016/j.jfineco.2021.01.010

International Monetary Fund (IMF). 2024. “World Economic Outlook, April 2024.” International Monetary Fund, Washington, DC, 16 April. https://www.imf.org/en/Publications/WEO/Issues/2024/04/16/world-economic-outlook-april-2024

Nguyen, Anh Huu, Thinh Gia Hoang, Duy Thanh Nguyen, Loan Quynh Thi Nguyen, and Duong Thuy Doan. 2023. "The Development of Green Bond in Developing Countries: Insights from Southeast Asia Market Participants." The European Journal of Development Research 35(1): 196–218. Springer, 21 February. https://doi.org/10.1057/s41287-022-00515-3

O’Mahony, David, and Manal Awan. 2021. “ESG: Greenwashing and the EU Taxonomy Regulation - Part 1 - Greenwashing, What is it?” Matheson, 15 April. https://www.matheson.com/insights/detail/greenwashing-and-the-eu-taxonomy-regulation-part-one

People’s Bank of China (PBOC). 2024. “China Monetary Policy Report Q3 2024.” People’s Bank of China, Beijing, 6 December. *http://www.pbc.gov.cn/en/3688229/3688353/3688356/5188141/5528500/index.html*

Roberts, Michael R., and Toni M. Whited. 2013. "Endogeneity in empirical corporate finance." In Handbook of the Economics of Finance, vol. 2, pp. 493-572. Elsevier. https://doi.org/10.1016/B978-0-44-453594-8.00007-0

Schoenmaker, Dirk. 2023. “Low Carbon Allocation in the Implementation of Monetary Policy.” https://www.europarl.europa.eu/RegData/etudes/IDAN/2023/755710/IPOL_IDA(2023)755710_EN.pdf

Tang, Alex Liyang. 2022. “Introduction to the Large-Scale AMRO Global Macro-Financial (DSGE) Model.” AMRO Working Paper 22–05, ASEAN+3 Macroeconomic Research Office, Singapore, 19 July. https://www.amro-asia.org/introduction-to-the-large-scale-amro-global-macro-financial-dsge-model/

Tolliver, Clarence, Alexander Ryota Keeley, and Shunsuke Managi. 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. Elsevier, 20 January. https://doi.org/10.1016/j.jclepro.2019.118643

Thür, Deborah. 2022. “Green Taxonomies Around the World: Where Do We Stand?” Eco: Fact, Zurich, 1 Nov. https://www.ecofact.com/blog/green-taxonomies-around-the-world-where-do-we-stand/

United Nations Trade and Development. 2023. “The Role of Central Banks in Supporting Green Structural Transformation in the Lease Developed Countries.” *https://unctad.org/system/files/official-document/ldc2023_ch4_en.pdf*

Vitek, Francis. 2018. “The Global Macrofinancial Model.” IMF Working Paper 18/81, International Monetary Fund, Washington, DC, 9 April. *https://www.imf.org/en/Publications/WP/Issues/2018/04/09/The-Global-Macrofinancial-Model-45790*

Xian, Zhuo and Zhang Liping. 2015. “A Framework for Green Finance: Making Clear Waters and Green Mountains China’s Gold and Silver.” *https://www.iisd.org/system/files/publications/greening-chinas-financial-system-chapter-1.pdf*