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Determinants of green bond premium in the ASEAN market amidst the COVID-19 pandemic

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Abstract

Green bonds as a means of financing instrument for sustainable projects have caught the eyes of investors in recent years. With the growth of the global green bond market exceeding 50% in 2019 (CBI, 2019), green bonds serve as a promising financial instrument for organizations and a promising financial asset for investors. Previous studies have conflicting results in identifying the premium investors pay for investing in green bonds where both a positive and negative premium was observed. This study aims to examine the premium of green bonds issued in Southeast Asia before and during the COVID-19 pandemic from March 2016 to April 2021 by using a two-step regression model. In the first step, by employing a fixed-effect model to 42 green bonds, the results of this study suggest a positive green bond premium before the COVID-19 pandemic and a negative green bond premium during the pandemic. Additionally, this study conducts cross-section regressions to investigate the determinants of green bond premium. The results imply that rating, currency, issue amount, and time to maturity significantly affect the green bond premium.

Keywords: green bonds; fixed-effect regression; premium; use of proceeds
JEL: C23, G12, G14, G20, Q56

1. INTRODUCTION

The United Nations (2015) provides a blueprint to achieve global peace and prosperity by 2030, known as the Sustainable Development Goals, consisting of 17 global goals to achieve a sustainable global future. The goals were focused on social and environmental issues. One hundred ninety-five countries signed the Paris Agreement (2015) as of 2021, which provided a framework to keep global temperatures from rising within 2^{o} C each year by financing climate-resilient infrastructures and low-carbon development. Tolliver et al. (2020) find that the Nationally Determined Contribution of country-specific pledges are a significant driver in the growth of the Green Bond market after the Paris Agreement was signed. Moreover, according to the Climate Bonds Initiative (2019), the green bond market grew 51% from the previous year, with 46% of new issuers coming to the green bond market. The report further adds that the issuance of green bonds in the ASEAN region doubles in 2019 from the year prior.

The International Capital Market Association (2021) defines a green bond as a financial instrument that proceeds are exclusively used to finance or re-finance projects classified as "green." The classification of a green project must align with the four core components of the Green Bond Principles (ICMA, 2021). First of all, the use of proceeds clearly defines the type of projects a green bond is eligible to finance. In principle, proceeds recognize several categories that align with environmental objectives such as climate change mitigation/adaptation, conservation of natural resources, pollution prevention & control, and sustainable development. Secondly, project evaluation and selection state that a green bond issue should clearly convey several key information to investors, i.e., the project's environmental objectives, how the type of project aligns with the Green Bond Principles, and the social and environmental risks of the project. Thirdly, the issuer must transparently track the balance of the proceeds and its allocation towards the project to the investors. Finally, reporting: Green bond issuers are required to provide an annual report that lists the projects financed by green bond proceeds with a clear description of the projects along with the alignment of the project to the Green Bond Principles and the number of proceeds allocated to the project.

According to Flammer (2021), investors react positively when a firm issues a green bond, especially for first-time green bond issuers. Investors consider the issuance of a green bond signals a company's commitment towards their corporate social responsibility. Furthermore, Tang & Zhang (2020) show that green bond issuance is beneficial towards a firm's shareholders by positively affecting stock prices and stock liquidity and increasing institutional ownership of domestic firms. Previous literature on green bonds has also discussed the relationship between the green bond market and other financial markets (Reboredo et al.,2020; Broadstock & Cheng, 2019; Kanamura,2020; Jin, 2020; Pham, 2020) and Nguyen et al.,2021). Some studies have also been conducted to examine the green bond premium and provide mixed results due to the different samples of the studies. Some studies (Ehlers & Packer, 2017; Baker et. al., 2018; Hachenberg & Schiereck, 2018; Zerbib, 2019; and Fatica et. al., 2021 find negative green premia whilst Karpf & Mandel (2018) and Bachelet et. al. (2019) show positive green premia.

Studies investigating the green bond market amidst the COVID-19 pandemic have extended previous literature regarding the relationship between the green bond market and other financial markets (Dutta et al., 2021; Naeem et al., 2021; and Arif et al., 2021). However, to the best of the author's knowledge, no study has been undertaken to investigate the impact of the COVID-19 pandemic on the green bond premium in Southeast Asia. The Climate Bonds Initiative (2019) reported that the ASEAN green finance issuance doubled during 2019, and the green buildings and green energy sectors are the most significant growth prospects in the ASEAN market. The report further added that the strong issuance in the ASEAN market reflects a positive sentiment from global investors; with new regulations and policies by member states that support the green economic growth, it is essential to understand the green bond market in the region.

The conflicting results of previous literature raise a question regarding the reasons for the differences in results of a green premium. This study contributes by filling the gaps of the existing literature in three ways: First, with respect to the previous studies, to the best knowledge of the author, this is the first study that discusses the green bond premium specifically in Southeast Asia, as previous studies examining green bond premium focused on worldwide and developed markets, in particular, this study aims to shed light on the green bond market in the emerging market. Secondly, this study considers a novel variable on the determinants of green bond premium that previous studies have not discussed. In this research, the use of proceeds of the green bond is a core component that constitutes a bond classified as a "green bond" according to the Green Bond Principles (2021). Last but not least, this study considers the impact of the COVID-19 pandemic on the green bond premium and its determinants.

This study is essential for socially responsible investors and impact investors to shed light on a green bond premium in the emerging market, which can be an alternative to diversify their portfolios. Moreover, this study also to green bond issuers, be it corporate, sovereign, or supranational, which can be used to evaluate the cost and benefits of issuing debt in the form of green bonds or other forms of financing. Lastly, for regulators and policymakers, the presence of a green bond premium may help in facilitating the issuance of green bonds as a means to finance sustainable investments through fiscal incentives.

This paper is organized into five sections. The following section will discuss the literature regarding the topic of interest. Moreover, data and the methodologies used in this study will be discussed in section three. Section four will highlight the result of the estimation methods and the discussions regarding the findings. The final section will present the conclusion of this study and further recommendations for future studies.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Green bond market before and after the COVID-19 pandemic

Reboredo et al. (2020) investigate the correlation between green bonds and other asset classes in the E.U. and U.S. markets. The study finds that green bonds are weakly correlated with high-yield corporate bonds, Energy, and stock markets over different periods. This study also implies that green bonds have a hedging potential for investors. Nguyen et al. (2021) examine the relationship between green bonds and other asset markets such as stocks, commodities, conventional bonds, and Clean Energy from 2008 to 2019. The study results show that green bonds have positive co-movements with other asset markets during the Global Financial Crisis. However, the study shows that after 2013, the connectedness drops too low or negative correlation with the commodity and stock markets in the short run, implying that green bonds are beneficial as diversification alternatives for active investors. Le et al. (2021) analyze the time-frequency co-movement between green bonds and other asset classes such as bitcoin, fintech index, equity indices, U.S. dollar, crude oil, gold, and VIX. The study finds that green bonds, U.S. dollar, gold, oil, and VIX are net receivers of volatility shocks, and bitcoin, equity indices, and fintech index are the contributors of the shocks. Furthermore, the study observes higher volatility transmission in the short term, indicating that green bonds along with traditional hedges such as gold and oil are good hedging towards shock in the long term.

In the meantime, Dutta et al. (2021) focus on the green bond market during the COVID-19 pandemic by scrutinizing the interactions between green bonds and different financial markets such as the S&P 500, crude oil, and gold. The study finds that Green bonds are negatively correlated with the S&P 500. However, the green bond market positively correlates with the gold market and has a near-zero correlation with the crude oil market. Naeem et al. (2021) investigate the pricing differences between green and conventional bonds before and during the COVID-19 pandemic. The study proves that conventional bonds are more efficiently priced than green bonds during economic stability and upward market trends. However, green bonds are less vulnerable to the market shock caused by the COVID-19 pandemic than conventional bonds. This is because non-pecuniary motives more drive investors in the green bond market. Arif et al. (2021) examine the time-frequency connectedness between Green and conventional bond markets. The study highlights an enhanced connectedness between the green and conventional bond markets after the COVID-19 pandemic.

The Green Bond Premium

Cheong & Choi (2020) define green bond premium as the yield differences an investor will receive for investing in a green bond rather than a comparable conventional bond. Therefore, a positive premium indicates that the investor pays a premium (i.e., receives a lower yield) by investing in a green bond instead of a comparable conventional bond and vice versa. Ehlers & Packer (2017) find a positive premium of 18 bps from 21 bonds in the E.U. and the U.S. issued from 2014 to 2017. Baker et al. (2018) find a positive premium of 7 bps in 2083 corporate and municipal green bonds issued in the U.S. from 2010 to 2016. Hachenberg & Schiereck (2018) find a positive premium of 1 bp in 63 green bonds issued globally from 2015 to 2016.

On the contrary, Karpf & Mandel (2018) show a negative premium of 7.8 bps on 1880 US municipal green bonds issued between 2010 to 2016. Zerbib (2019) obtains a negative premium of 1.8 bps in 110 bonds issued worldwide using a pair-matching sample. Other studies find mixed results, Bachelet et al. (2019) find that institutional green bonds have a negative green premium, and private green bonds have a positive green premium using 89 pair samples of green bonds issued from 2013 to 2017. Kapraun & Scheins (2019) find a positive green premium of 20 to 30 bps in the primary market and a negative green premium in the secondary market of 2 bps from 1500 bonds issued worldwide in the primary market and 4609 bonds issued worldwide in the secondary market. Hyun et al. (2019) find no evidence of a green bond premium from 60 pairs of green bonds issued between 2010 to 2017. Fatica et al. (2021) show that green bonds issued by financial institutions yield a higher premium than those issued by firms in other sectors. Moreover, green bonds issued by firms in the non-financial sector yield 80 bps lower than comparable conventional bonds, while those issued by financial institutions do not have a premium. Kapraun & Scheins (2021) use more than 1500 green bonds data and find that green premium varies by factors such as issuer type, currency, and green certification (specific to green corporate bonds).

Many studies that focus on green bond premium have accentuated the following determinants of a green bond premium. Bachelet et al. (2019), Hyun et al. (2019), and Kapraun & Scheins (2021) find that issue amount has a significantly negative relationship with green bond premium, and maturity has a significantly positive relationship with green bond premium. Zerbib (2019) and Kapraun & Scheins (2021) find that rating negatively correlates with the green bond premium.

Hypothesis Development

In investigating the presence of a green bond premium in the ASEAN market, this study follows Zerbib (2019) by employing a matching method that pairs a green bond with a similar conventional bond regarding its rating, issuer, maturity date, and issue amount. Some studies on this topic have been done in other regions. Ehlers & Packer (2017) show a positive green bond premium of 18bps from 21 green bonds in the European and U.S. primary market. Karpf & Mandel (2018) discover a negative green bond premium of 7.8 bps from 1880 US municipal bonds in the secondary market. Baker et al. (2018) suggest a positive green bond premium from 2083 corporate and municipal green bonds in the U.S. secondary market. Hachenberg & Schiereck (2018) find a positive green premium of 1bp in 63 bonds issued in the secondary market worldwide. Zerbib (2019) indicates a small but significant and negative green bond premium of 1.8 bps from 110 bonds issued globally. On the contrary, some studies provide no evidence of a significant green bond premium (Larcker & Watts, 2020) and Flammer et al., 2021). Based on the findings of the abovementioned literature, the first hypothesis of this study is:

H_1: There is a positive green bond premium in the ASEAN market.

Some studies highlight that green bond market volatility is negatively related to other markets such as the global equity markets and argue that the green bond market is an effective hedge during times of crisis (Arif et al., 2021; Dutta et al., 2021 and Naeem et al., 2021). Based on the findings of the literature discussed above, the second hypothesis of this study are as follows:

H_2: There is a negative green bond premium in the ASEAN market during the COVID-19 pandemic

The ICMA (2019) specifies that a green bond issue should clearly label its intended use of proceeds depending on the project funded by the green bond. The green bond should clearly describe the environmental benefits of such a project. According to CBI (2019), 34% of green bonds issued in the ASEAN region are used to fund green building projects and 33% to fund green energy projects. The report further added that the allocation of the green bonds' proceeds is different for each country. e.g., green bonds issued in Singapore are mainly used to fund green building projects, and green bonds issued in the Philippines, Thailand, and Indonesia are mostly used to fund green energy projects. Therefore, based on the findings of the previous literature, the third hypothesis of this study is:

H_3: There is a difference in green bond premium among use of proceeds.

3. METHOD, DATA, AND ANALYSIS

Sample and Data

This study uses samples of 42 pairs of green and conventional bonds issued in Southeast Asia from March 2016 to April 2021 that was obtained from Datastream. The starting date of the COVID-19 pandemic was set at March 11, 2020, as announced by the World Health Organization (2020). There are three research periods in this study; the first period includes all periods from March 2016 to April 2021, the second period or the pre-pandemic period is set from March 2016 to March 10, 2020, and the third period or during the pandemic period is set from March 11, 2020, to April 2021.

Previous studies such as Karpf & Mandel (2017) compare green bonds by their taxability. However, Flammer (2021) argues that ignoring the major role taxation plays in the municipal bond market biases the estimates for a green bond premium. Baker et al. (2018) utilize a single stage pooled-fixed effects regression where Larcker & Watts (2020) argues the fixed effects controls are inadequate. Larcker & Watts (2020) and Flammer (2021) use a matching technique by considering the issue amount, maturity, coupon, and days between the issuance of each pair. By far, Zerbib's (2019) methods employ a stricter matching method that considers the seniority, country of issue, and issuer. Hence, this study will be based on Zerbib's (2019) methodologies, including green bonds issued by corporate, sovereign, and supranational issuers in Southeast Asia. Moreover, Sukuk is excluded from this study to prevent inherent yield differences affecting the green bond premium (Ariff et al., 2017).

Following Zerbib (2019), the pairing of green bonds and conventional bonds is performed based on the issuer, country of issue, seniority, maturity, and issue date. This means that the issuer, country of issue, and seniority of both types of bonds must be the same. In addition, the maturities and the issue dates are no longer than two years apart. This study employs an unbalanced panel of 19320 lines for 42 bonds issued in Southeast Asia; the earliest date was in March 2016, and the latest is in April 2021.

Regression Models and Variables

Following Zerbib (2019), this study uses a two-step regression model., The first step of the regression model employs a fixed-effect model with a daily yield spread between the green bond and its conventional pair as the dependent variable. The daily yield spread is calculated as follows equation 1:

$$\Delta y_{i,t} = y_{i,t}^{GB} - y_{i,t}^{CB} \quad (1)$$

Where $\Delta y_{i,t}$ represents the daily yield spread, $y_{i,t}^{GB}$ is the daily ask yield of green bond i at time t, and $y_{i,t}^{CB}$ is the daily ask yield of the conventional bond.

Meanwhile, the independent variable of the first regression model is the bonds' liquidity, proxied by the difference between the daily bid-ask spread of the green bond and that of the conventional bond (Febi et al. 2019). The daily bid-ask spread difference between the two bond types is calculated as follows equation 2:

$$\Delta Liquidity_{i,t} = Liquidity_{i,t}^{GB} - Liquidity_{i,t}^{CB} \quad (2)$$

Where $\Delta Liquidity_{i,t}$ is the difference between the daily bid-ask spread of the green bond and that of the conventional bond, $Liquidity_{i,t}^{GB}$ is the daily bid-ask spread of the green bond, and $Liquidity_{i,t}^{CB}$ is the daily bid-ask spread of the conventional bond. Thus, the first step regression is estimated by the following model:

$$\Delta y_{i,t} = p_i + \beta_1 \Delta Liquidity_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where $\Delta y_{i,t}$ is the daily yield spread of paired bond i at time t, p_i is the unobserved effect of the green bond premium, β_1 is the coefficient of the daily difference in liquidity between the green and conventional bond, and $\varepsilon_{i,t}$ is the error term. In order to determine the best regression model used in estimating (3), this study applies the Chow test, Breusch-Pagan LM test, and Hausman test. The results of the tests indicate that Fixed-effect Model is the preferred model (Appendix A).

Table 1. Description of the variables used in the fixed-effect model specified in equation (3)

Variable	Type	Unit	Description
Yield Spread	Quantitativ e		The difference between the daily yield of the green bond and the conventional bond
Liquidity	Quantitativ e		The difference between the daily bid-ask spread of the green bond and the conventional bond

Further, to identify the determinants of green bond premium in the second step regression, this study uses a cross-section regression model. The second step regression model is estimated as follows equation 4:

$$\hat{p}_i = \alpha_0 + \sum_{j=i}^{N_{rating}-1} \alpha_{1,rating_j} 1_{rating_j} + \sum_{j=i}^{N_{use\ of\ proceeds}-1} \alpha_{2,use\ of\ proceeds_j} 1_{use\ of\ proceeds_j} + \sum_{j=i}^{N_{currency}-1} \alpha_{3,currency_j} 1_{currency_j} + \alpha_4 Maturity + \alpha_5 \log(Issue\ Amount) + \eta_i \quad (4)$$

Table 2. Description of the variables used in the cross-section regression specified in equation (4)

Variable	Type	Unit	Description
Rating	Qualitative		The credit rating is assigned to a bond issue. If there is more than one rating, the higher rating is chosen (Zerbib, 2019). The ratings can be AAA, AA, A, BAA and non-rated. The base case for this variable is AAA
Currency	Qualitative		The currency of which the bond issue is denominated in. Samples consist of MYR, IDR, SGD, PHP, THB, AUD, EUR. The base case is MYR. The meaning of each acronym is available in Appendix B.
Use of Proceeds	Qualitative		The use of proceeds as defined by the Green Bond Principles (CBI, 2021). Categories in the sample include Energy, Transport, Waste, Water and Buildings. The base case for this variable is Energy.
Maturity	Quantitative	Years	The time left of the bond until its maturity on April 1 2021.
Issue Amount	Quantitative	USD	The issue size of the bond in USD.

A Shapiro-Wilk normality test is done prior to the cross-section regression to see whether the data have met the normality assumption. Post-estimation tests such as the variance inflation factor (VIF) and the Breusch-Pagan test are done to identify the presence of multicollinearity and heteroskedasticity in the data.

4. RESULTS

Descriptive Statistics

Table 3. Descriptive statistics of the bond samples used in this study

	Min	1st Quartile	Median	Mean	3rd Quartile	Max
No of days per bond	10	141	406	460	730	1276
Ask yield of green bond (GB)	-0.11	1.83	2.42	3.15	4.76	8.72
Ask yield of conventional bond (CB)	-0.13	1.67	2.31	2.81	4.23	7.67
Yield Difference	-0.68	-0.02	0.00	-0.01	0.00	0.34
GB Maturity as of 1 April 2021	0.15	2.24	4.05	4.92	6.22	18.36
CB Maturity as of 1 April 2021	-4.31	1.26	3.81	4.19	5.14	16.59
log(GB Issue Amount)	6.79	7.26	7.96	7.84	8.25	8.95
log(CB Issue Amount)	6.93	7.61	8.14	8.01	8.39	9.10

Table 3 provides the distribution of basic variables regarding the 42 bond pairs used in this study. The number of days per bond represents how long the time series data is available per pair of bonds which starts at its issuance date. The average number of days per bond used in this study is 460 days which means, on average, there are more than a year's worth of data per bond. The average asks yield for the green bond is 3.15 and 2.81 for the conventional bond. According to Larcker & Watts (2020) and Flammer (2021), the yield difference between the green and conventional bonds is near zero, and its median is zero. Hence, the data used in this study provide evidence to the two aforementioned studies. Table 2 also displays that the maturity differences between green bonds conventional bonds are below two years, as suggested by Zerbib (2019). In addition, the log value of the issue amount indicates that the green bond and conventional bond have been matched as close as possible.

Table 4. Descriptive statistics of the liquidity proxy as represented by ΔLiquidity

	Min	1st Quartile	Median	Mean	3rd Quartile	Max	Std Dev
ΔLiquidity	-197.00%	-2.40%	0.00%	0.07%	0.50%	225.80%	10.17%

Table 4 shows that the liquidity proxy of the green bonds is concentrated near zero as indicated by its median and mean values which are 0.00% and 0.07%, respectively. This indicates that the controls for bonds' liquidity of the bonds based on the matching method have met the suggested requirements (Febi et al., 2019 and Zerbib, 2019).

Green Bond Premium

Table 5 shows the results of the first step regression by using Fixed Effect Model. As Table 5 shows, the coefficients of daily bid-ask spread difference between green and conventional bonds are all positive and significant at the 1% confidence level for all periods. These results imply that the sample of this study significantly impacts enough to estimate a green bond premium. The estimates of the green bond premium p_i as stated in equation (3) also known as the intercept of the regression. The estimation results for each bond are available in Appendix C.

Table 5. Results of the fixed effect regression in equation (3)

	Dependent variable: $\Delta y_{i,t}$		
	Fixed effect regression with White robust standard errors		
	Pre-Pandemic	**All Period**	**Pandemic Period**
ΔLiquidity	0.4162 ***	0.5007 ***	0.637 ***
Std. Error	(0.915)	(0.209)	(0.159)
Observations	9550	19320	9770
R^2	0.014	0.0215	0.0506
Adjusted R^2	0.0139	0.0214	0.0505
F Statistic	135.05	423.84	518.92
	(df=1; 9520)	(df = 1; 19277)	(df=1; 9727)

Note: ∗p<0.1; ∗∗p<0.05; ∗∗∗p<0.01.

Table 6. Estimation results of the green bond premium

pi (%)	Min	1st Quartile	Median	Mean	3rd Quartile	Max	N
All period	-2.459	-0.277	-0.148	0.009	-0.010	2.988	42
Pre-Pandemic	-0.846	-0.201	-0.149	0.143	0.002	3.241	30
Pandemic	-2.464	-0.369	-0.188	-0.025	0.044	2.808	42

Table 6 provides the distribution of the unobserved fixed-effects of panel data regression, the estimated green bond premia. The results show, on average, a significantly positive green bond premium of 0.9 bps. A significantly positive green bond premium means that green bonds issued in Southeast Asia from March 2016 to April 2021 give a lower yield than a comparable conventional bond. The results confirm the studies of Ehlers & Packer (2017) Hachenberg & Schiereck (2018) and Baket et al.,(2018).

When the research periods are categorized before, and during the COVID-19 pandemic period, there is a significantly positive green bond premium before the pandemic period of 14.3 bps and a significantly negative green bond premium of 2.5 bps during the pandemic period. Studies regarding the dynamics of the emerging markets show that emerging economies are commonly perceived as riskier than developed economies (Tebaldi et al., 2018). This study points out that the key factors affecting higher bond spreads in emerging economies are macroeconomic factors such as GDP growth, exchange rate, political stability are all seen as a measure of risk when comparing bond spreads to developed economies. Margaretic & Pouget (2018) add that the environmental performance of emerging economies does not drive their cost of borrowing down. This can explain how the results are quite different than previous studies on green bonds that focused on markets located in developed economies.

During the coronavirus pandemic, there is a significantly negative green bond premium of 2.5 bps. The negative green bond premium during the COVID-19 pandemic is consistent with the findings of Dutta et al. (2021), Naeem et al. (2021), and Arif et al. (2021) that argue green bonds are considered safe havens during times of downward economic stability caused by the pandemic. Furthermore, the study of Zaremba et al. (2021) found an increase of term spread in both the emerging and international markets during the COVID-19 pandemic. Zaremba et al. (2021) argue that the risk premium is multidimensional, meaning that the term premium is increasing during the pandemic due to higher levels of risk and uncertainty in the bond market. Janus (2021) finds that the financial shocks caused by the pandemic result in a hike in sovereign bond yields in 23 emerging market economies. Janus (2021) explains that emerging markets have a higher perceived economic and political risk than developed economies, resulting in a higher spike in bond yields during times of uncertainty. The study also shows that green bond premia drop in emerging countries during economic uncertainty, confirming that green bonds offer higher yields during the pandemic to compensate for the higher risk.

The Results regarding the Determinants of a Green Bond Premia

Table 7 provides the classification of the green bond premia. The base case for the cross-sectional regression is MYR for currency, AAA for rating, and Energy for proceeds. Zerbib (2019) employed the cross-section regression will only include variables with more than three samples to prevent overfitting. The results show that the average 0.9 bps green bond premium throughout the sample period is significantly different from zero within a 1% significant level based on the Wilcoxon sign ranked test.

In terms of currency, green bonds with negative mean premia are denominated in IDR, VND, USD, EUR, GBP, SEK, and AUD. Meanwhile, green bonds with positive mean premia are denominated in THB. Regarding the bond rating, the positive green bond premia are observed in A.A. and A-rated green bonds, while negative premia are found in BAA-rated green bonds.

These results show that the environmental aspect plays an essential role in reducing the cost of debt for lower-rated bonds, implying that higher rating bonds yield a more positive premium. Moreover, green bonds that are used to fund green energy-related projects provide a higher premium than their conventional peers. In addition, green bonds that are used to fund water and waste-related projects yield negative premia.

Table 7. Classification of the green bond premia

		Mean (p_i)	**Median (p_i)**	**$p_i \neq 0$**	**n**
Total		0.009	-0.148	***	42
Currency	CHF	-2.459	-2.459	***	1
	IDR	-0.336	-0.336	***	2
	MYR[a]	0.714	0.001		9
	PHP	2.384	2.384	***	1
	THB[b]	0.035	-0.092	**	7
	VND	-0.209	-0.209	***	2
	SGD[b]	-0.261	-0.358	**	7
	CNY	0.050	0.050	***	1
	USD[b]	-0.253	-0.262	**	7
	EUR	-0.269	-0.269	***	1
	GBP	-0.208	-0.208	***	1

		Mean (p_i)	Median (p_i)	$p_i \neq 0$	n
	SEK	-0.490	-0.490	***	2
	AUD	-0.133	-0.133	***	1
Rating	AAA[a]	-0.300	-0.268		13
	AA[b]	0.048	-0.103	**	9
	A[b]	0.658	0.050	**	9
	BAA[b]	-0.751	-0.129	***	3
	NR[b]	0.022	-0.284		8
Use of Proceeds (UoP)	Energy[a]	0.042	-0.180	***	24
	Buildings[b]	-0.229	-0.239		14
	Transport[b]	-0.334	-0.206		18
	Water[b]	-0.240	-0.262	**	9
	Waste[b]	-0.154	-0.109	**	5

[a]Base Case
[b]More than three samples

Note: *p<0.1; **p<0.05; ***p<0.01.

Table 8 highlights the result of the cross-sectional regression of the green bond premium *pi* based on the bonds' characteristics. The cross-section regression is conducted using White robust standard errors because the post-estimation test indicates the presence of heteroskedasticity. No multicollinearity was found in the post-estimation test.

Table 8 shows that A-rated green bonds yield a significantly higher premium than AAA-rated green bonds in all three periods. However, during the COVID-19 pandemic period, the differences in premia between A-rated and AAA-rated green bonds are lower. Rating plays an important role in determining the green bond premium, particularly its default risk, highlighted by previous literature (Ashbaugh-Skaife et al., 2006 and Stellner et al., 2015). The two studies point out that lower credit ratings have greater default risk but yield higher premia. Nevertheless, many studies show that the green bond market is a safe-havens during crises and can be alternatives for hedging (Arif et al., 2021; Naeem et al., 2021; and Dutta et al., 2021). The result does not find a significant relationship between AA-rated and non-rated bonds with green bond premia.

Table 8 displays that green bonds issued in SGD have significantly lower premia than those issued in MYR, providing evidence to support Tebaldi et al. (2018), which states that currency evaluation is one of the investment decisions made before determining the premium to offset the risk of the investment. During the pre-pandemic period, green bonds denominated in THB were found to have a negative premium compared to green bonds denominated in MYR. Meanwhile, there are no significant differences in premia between MYR and USD.

Table 8 shows a significant negative relationship between green bond premium and issue size regarding the issue amount. The results align with Hyun et al. (2019), arguing that a larger issue size is more attractive to investors as it indicates better liquidity. In terms of the bonds' maturity, the results show that the bonds' maturities are positively related to the green bond premia. These results are in accordance with the term structure of interest rates, where a longer maturity provides a higher premium to compensate for the higher risk exposure. Concerning the use of proceeds, the results indicate no premium differences among the use of proceeds of the bonds.

Table 8. Results of the cross-sectional regression

	Dependent variable: p_i					
	Cross-sectional regressions with White robust standard errors					
	All Period		Pre-Pandemic		Pandemic Period	
Constant	4.714	***	4.264	***	4.374	***
	1.992		1.545		2.066	
Rating AA	-0.932		-1.103		-0.919	
	0.673		0.829		0.703	
Rating A	0.645	**	1.163	***	0.755	**
	0.359		0.421		0.379	
Rating BAA	-0.621		-0.931		-0.589	
	0.974		0.778		1.006	
Non-rated	-0.271		-0.879		0.324	
	0.931		1.063		0.953	
Currency THB	-0.493		-1.312	***	-0.351	
	0.329		0.456		0.358	
Currency SGD	-0.952	*	0.003		-1.032	
	0.878		0.697		0.871	
Currency USD	0.531		0.244		0.452	
	0.411		0.277		0.42	
UoP Buildings	0.126		0.011		0.967	
	0.432		-0.836		0.593	
UoP Transport	-0.752		-0.836		-0.722	
	0.523		0.780		0.694	
UoP Water	-0.676		-0.344		-0.616	
	0.429		0.282		0.515	
UoP Waste	0.508		-0.283		0.371	
	Dependent variable: p_i					
	Cross-sectional regressions with White robust standard errors					
	All Period		Pre-Pandemic		Pandemic Period	
	0.414		0.412		0.335	
Maturity	0.069	*	0.047		0.531	
	0.037		0.053		0.04	
log(IssueAmount)	-0.57	**	-0.459	***	-0.525	***
	0.265		0.215		0.244	
Observations	42		30		42	
R2	0.627		0.775		0.583	
F-stat	5.65 (df = 13, 28)	***	5.58 (df = 13, 21)	***	4.55 (df = 13, 28)	***

Note: ∗p<0.1; ∗∗p<0.05; ∗∗∗p<0.01.

5. DISCUSSION

This study finds an average of 0.9 bps positive green bond premium, implying that green bond investors in the ASEAN market receive a lower yield of 0.9 bps than investors of similar risk conventional bonds. This positive premium confirms the first hypothesis of this study and provides evidence to support previous literature. Some studies argue that positive premium can be attributed to macroeconomic and liquidity factors (Comelli, 2012 and Clark & Kassimatis, 2015). Both studies demonstrate that macroeconomic factors such as inflation rate, exchange rate, net foreign assets are significant determinations of bond spreads. Moreover, Hund (2008) adds that increased political risk is associated with higher spreads in the emerging bond markets. Furthermore, liquidity is also a significant factor that affects yield spreads in the emerging bond market, where higher liquidity causes a positive increase in yield spreads. Gadanecz et al. (2018) further add that one reason to explain the higher yield spread in emerging markets is the exchange rate volatility. The emerging market currencies are vulnerable to investors' perception of a greater exchange rate risk compared to developed countries.

This study also shows a negative green bond premium of 2.5 bps in Southeast Asia during the coronavirus pandemic period compared to the pre-pandemic period, where there is a positive green bond premium of 14.3 bps. This negative premium during the Covid-19 pandemic supports the second hypothesis of this study and is in line with some studies (Arif et al., 2021; Dutta et al., 2021 and Naeem et al., 2021). The studies highlight that the green bond market provides an effective hedge and diversification alternative in times of crisis. The emerging green bond market offers a negative green bond premium during a crisis; hence, it can be an attractive hedge. The result also aligns with Yi et al. (2021), which find that the cumulative abnormal return of green bonds issued in China increased during the pandemic. The study explains that the economic uncertainty resulting from the pandemic increases the information asymmetry between debtholders and issuers. Information asymmetry regarding the issuer's governance and debt-paying capacity is significantly increased during the COVID-19 pandemic. This explains the increase in the yield of green bonds issued in Southeast Asia. The information asymmetry between debtholders and bond issuers is more significant, resulting in a negative green bond premium during the pandemic.

Regarding the determinants of green bond premia, this study shows rating, currency, issue amount, and maturity. However, this study finds no significant differences in green bond premia based on the use of proceeds of the green bond, thus rejecting the third hypothesis of this study.

In terms of rating, this study finds that the green bond premia of A-rated bonds are significantly positive compared to AAA-rated bonds; the positive green premia indicate that A-rated green bonds offer less yield than AAA-rated green bonds. Dorfleitner et al. (2021) find that green bond investors prefer bonds with the highest credit ratings.

In terms of currency, this study finds that SGD and THB denominated green bonds have significantly lower premia compared to MYR denominated green bonds. According to Tebaldi et al. (2018), the main reason for the difference in sovereign bond spreads of developing and emerging markets is because of macroeconomic factors such as exchange rate, inflation rate, and GDP, where exchange rates of developing markets are viewed as riskier than the exchange rates of developed countries.

With regard to issue amount, this study finds a significantly negative relationship between issue amount and green bond premium. The result is in line with the works of Bachelet et al. (2019), Hyun et al. (2019), and Kapraun & Scheins (2021) that argue a larger issue size is attractive to investors because of better liquidity conditions, where a larger issue size means that more of the bond are in circulation.

Concerning maturity, the result obtained in this study aligns with the findings of Bachelet et al. (2019), Hyun et al. (2019), and Kapraun & Scheins (2021), which that explains the higher premium from a longer maturity is due to the term premium where investors are exposed to a higher risk with a longer maturity.

6. CONCLUSION, LIMITATIONS, AND SUGGESTIONS

Conclusion

This study aims to provide evidence of green bond premia in Southeast Asia from 2016 to 2021 and identify the determinants of the premium by using a two-step regression model. The fixed-effect estimation in the first-step regression shows a significant green bond premium in the ASEAN market. Throughout the whole sample period, this study finds a significantly positive green bond premium of 0.9 bps. This result confirms the first hypothesis of this study, where a positive green bond premium is observed in the ASEAN market. This positive premium is due to the risk associated with emerging economies, where macroeconomic factors play a major role in determining risk premium, as Tebaldi et al. (2018) explained.

Secondly, this study finds a significantly positive green bond premium of 14.3 bps before the coronavirus pandemic and a negative green bond premium of 2.5 bps during the pandemic. The result of the first step regression confirms hypothesis 2. It was found that there is a difference in green bond premium between the pre-pandemic and during the pandemic period. The differences between the green bond premium before and during the pandemic are due to the negative correlation between the emerging green bond market and global financial markets. Moreover, the high information asymmetry between bondholders and issuers also causes bond yields to rise during the coronavirus crisis, which in turn causes green bond premium to go down.

Nevertheless, this study fails to find the relationship between proceeds and green bond premia in the ASEAN region. In the meantime, bond characteristics such as rating, currency, time to maturity, and issue amount can explain the yield differential.

Limitation and suggestions

This study comes with a limitation that offers an opportunity for future research. The main limitation is the small size due to the number of green bonds that are not frequently traded. Therefore, future studies can observe the green bond premium from different emerging markets. Further studies regarding the green bonds' use of proceeds can also be conducted in the global green bond market, where more data are available. In addition, once the emerging green bond market grows larger, a comparison of the green bond market dynamics between emerging and developed markets can be studied.

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APPENDIX

Appendix A Econometric tests results of the step 1 regression

	Test	P-Value	Result
Regression Model	Breusch-Pagan LM	0.0000	Random Effect
	Chow	0.0000	Fixed Effect
	Hausman	0.0001	Fixed Effect
Autocorrelation	Woolridge	0.0000	Autocorrelation
Heteroskedasticity	Wald	0.0000	Heteroskedasticity
	Breusch-Pagan	0.0000	Heteroskedasticity

Appendix B Currency acronyms

Acronym	Currency
AUD	Australian Dollar
CHF	Swiss Franc
CNY	Chinese Yuan
EUR	Euro
GBP	Great British Pound
IDR	Indonesian Rupiah
MYR	Malaysian Ringgit
PHP	Philippine Peso
SEK	Swedish Krona
SGD	Singaporean Dollar
THB	Thai Baht
USD	United States Dollar
VND	Vietnamese Dong

Appendix C Green bond premium of each bond sample

no	Bond Name	pi all period	pi pre pandemic	pi pandemic
1	CH0495570944	-2.46	-0.32	-2.46
2	IDA0000926A8	-0.51	-0.22	-0.75
3	IDA0000926B6	-0.16	3.11	-0.04
4	MYBDW1900071	2.86	3.24	2.68
5	MYBDX1900087	2.99	-0.06	2.81
6	MYBUH1800052	-0.10	0.02	-0.14
7	MYBUI1800068	0.00	-0.19	0.01
8	MYBUJ1800074	-0.21	-0.14	-0.19
9	MYBUK1800080	-0.14	-0.18	-0.10
10	MYBUL1800096	-0.20	0.97	-0.19
11	MYBUM1800102	0.71	0.61	0.22
12	MYBUN1800118	0.52		0.40
13	PHY0206KAA89	2.38		2.30
14	SGXF33778741	-0.48	-0.27	-0.69
15	SGXF50149396	0.34		0.25

no	Bond Name	pi all period	pi pre pandemic	pi pandemic
16	SGXF53470518	-0.37		-0.45
17	SGXF85628422	-0.21		-0.29
18	SGXZ57860017	-0.36		-0.44
19	SGXZ61262531	-0.58		-0.66
20	SGXZ70078092	-0.16		-0.24
21	TH0221031501	-0.09	-0.11	-0.07
22	TH0221033B03	-0.13		1.01
23	TH0221034505	-0.13	-0.08	-0.20
24	TH0221036500	0.13	0.05	0.13
25	TH6488035804	-0.04		-0.12
26	TH648803A809	-0.11		-0.19
27	TH857203D505	0.62	0.61	0.57
28	US045167CY77	-0.26	-0.20	-0.35
29	US045167DR18	-0.27	-0.21	-0.31
30	US045167EB56	-0.50	-0.30	-0.77
31	US045167EC30	-0.20	-0.18	-0.19
32	US045167EJ82	-0.12	-0.15	-0.09
33	VNBVGD164973	0.49	0.35	0.77
34	VNHCMB165062	-0.91	-0.85	-0.99
35	XS1609444556	-0.13	-0.19	0.03
36	XS1609444630	-0.28	-0.07	-0.37
37	XS1757681140	-0.45	-0.31	-0.56
38	XS1982691237	0.05	-0.13	0.05
39	XS2021306589	-0.53		-0.60
40	XS2050923825	-0.13	-0.15	-0.17
41	XS2066569489	-0.21	-0.17	-0.28
42	XS2068071641	-0.27	-0.20	-0.35