The Effect of ESG Bond Issuance on Idiosyncratic Volatility and Firm Profitability

Elisete Beji

Dissertation written under the supervision of professor Zoë Venter.

Dissertation submitted in partial fulfilment of requirements for the MSc in Finance, at the Universidade Católica Portuguesa, 23.11.2024

Abstract

Author: Elisete Raquel Gago Beji

Title: The Effect of ESG Bond Issuance on Idiosyncratic Volatility and Firm Profitability

Keywords: ESG, Corporate Finance, Bonds, Volatility, U.S., Asia

This thesis combines Propensity Score Matching with a series of regressions covering the period between 2011 and 2023 to study the influence of ESG bond issuance on business profitability and idiosyncratic volatility in established and emerging markets, with a focus on the U.S. and Asia. The study tests three main hypotheses: first, we will investigate whether corporations that issue ESG bonds are more profitable. Further, I will look at the effect of idiosyncratic volatility on the two regions. Finally, this study will look at whether the post-pandemic period increased the positive benefits of ESG bond issuance on financial performance and risk reduction. The analysis revealed that, while issuing ESG Bonds may have a minor impact on idiosyncratic risk in the U.S., it has little to no influence on company profitability in both regions. Nonetheless, by using TVP-VAR, we can see that these impacts are robust in the short term but lose significance as the years pass. At the same time, we find that different markets react differently to ESG-related legislation due to the varying stages of ESG reporting importance.

Resumo

Autor: Elisete Raquel Gago Beji

Título: O Efeito da Emissão de Títulos ESG na Volatilidade Idiossincrática e na Rentabilidade das Empresas

Keywords: ESG, Corporate Finance, Bonds, Volatility, U.S., Asia

Esta tese combina o Propensity Score Matching com uma série de regressões, abrangendo o período de 2011 a 2023, para estudar a influência da emissão de obrigações ESG na rentabilidade empresarial e na volatilidade idiossincrática em mercados desenvolvidos e emergentes, com foco nos Estados Unidos e na Ásia. O estudo testa três hipóteses: primeiro, estudarei se as empresas que emitem obrigações ESG são mais rentáveis. Além disso, irei analisar o efeito da volatilidade nas duas regiões. Por fim, esta tese irá examinar se o período pós-pandemia aumentou os benefícios positivos da emissão de obrigações ESG no desempenho financeiro e na redução de risco específico. Os meus estudos revelaram que, enquanto a emissão de obrigações ESG pode ter um impacto menor no risco idiossincrático nos Estados Unidos, tem pouca ou nenhuma influência na rentabilidade empresarial em ambas as regiões. No entanto, ao utilizar o modelo TVP-VAR, constatámos que esses impactos são robustos em curto prazo, mas perdem significância ao longo dos anos. Simultaneamente, descobrimos que diferentes mercados reagem de forma distinta à legislação relacionada com ESG, devido às diferentes fases de importância atribuída à divulgação de informações ESG.

1 Introduction

The financial system is constantly changing as fresh information becomes incorporated into price formation. Sustainability factors are becoming more important to investors, which has a big effect on asset value. Due to the growing demand for high ESG-rated securities, Bennani et al. (2018) and Drei et al. (2019) showed that ESG-ranked portfolios in the equities market exhibit a positive premium on best-in-class stocks compared to worst-in-class stocks. Questioning whether ESG could be viewed as a risk factor, their research also showed that ESG-tilted portfolios in developed markets have beaten conventional capitalization-weighted indexes. Expanding on these observations, Slimane et al. (2019) draw attention to the increased emphasis on sustainability by investors, since companies are now acknowledged as being the major causes of social, environmental, and financial problems. As a result, companies are being held more responsible for these effects. Therefore, the aim of this thesis is to expand on these earlier studies, while empirically studying the effect of issuing ESG bonds on firm profitability and its specific risk, especially in years that corporations increasingly use ESG bonds to finance sustainable projects as companies, investors, and legislators become more conscious of Environmental, Social, and Governance considerations. Moreover, despite the increased number of studies on ESG scores and firm profitability, the academic literature still lacks sufficient research on the direct impact of ESG bonds on business profitability and idiosyncratic volatility. Although ESG bonds are marketed as tools that can improve a company's reputation and support long-term sustainability objectives, little is known about how they affect risk management and business profitability across different regions. By examining whether businesses that issue ESG bonds exhibit better financial performance and less idiosyncratic volatility across developed and emerging regions, this thesis aims to close this gap with an emphasis on Asia and USA, I find that while ESG bonds may improve a company's sustainability profile, although not having a significant impact on firm specific risk of US firms, it is found to have an impact on that of Asia by increasing firms' volatility in the short term. The differences in the two regions underscore the importance of market-specific factors in ESG bond issuance, with the U.S. benefiting the most from these bonds due to a more developed ESG bond market. This study contributes to the growing literature on ESG finance and provides valuable information for regulators, investors, and enterprises seeking the long-term benefits of sustainable investment strategies.

2 Literature Review

2.1 ESG Bonds and Corporate Finance

According to Nasdaq (2024), due to advancing pressure, companies are increasingly funding ESG projects with fixed-income securities. These ESG bonds allow issuers to fund initiatives that have a positive impact. It also gives investors the chance to earn profits while practising responsible investment. Firms and investors gain from the expanding ESG bond market since it improves issuer reputations and yields higher financial returns. This thesis is going to evaluate the effect of ESG bond issuance on company performance in the U.S. and Asia markets by focusing on the time frame both before and following the adoption of ESG financing strategies. Additional research by Apergis et al.(2022) shows that bond maturity and subordination have a favourable effect on yields, but ESG variables typically have a negative impact. Using a condensed time frame that concentrates on times with sufficient ESG score data, this thesis will expand on their work by looking at the financial performance metrics of businesses and evaluating the effects of each ESG pillar independently. Furthermore, Singh (2020, 2021) has noted that, when choosing investment-grade bonds from companies with higher ESG ratings, during difficult times, investors are more likely to put their money into corporate bonds issued by ESG leaders rather than high-yield bonds or equity since these assets provide more stability and creditworthiness. Nevertheless, emerging markets have also seen a rise in interest in sustainable finance, especially considering the COVID-19 pandemic and the resulting tigher funding requirements. With the exception of China, up to 18% of foreign financing in emerging markets today consists of sustainable finance instruments, such as ESG bonds, which provide more reliable sources of funding for nations that are particularly sensitive to climate hazards (Gautman, 2023). However, advanced countries and emerging markets exhibit very different links between ESG rankings and debt costs. Ferriani (2023) demonstrates that although in developed economies, a better ESG score is linked to a lower cost of debt, this is not always the case in emerging markets. By analysing the effects of ESG bond issuance in both emerging and developed nations, this thesis seeks to further this area of research. Using U.S. stocks, specifically those in the S&P 500, as a proxy for advanced economies and Asian stocks, including Japan, as a proxy for developing markets, this study will analyse whether the issuance of ESG bonds has a significantly different effect on businesses in these two market environments.

2.2 ESG and Firm Profitability

Aydo˘gmu¸s et al. (2022) use stakeholder theory to explore the correlation between ESG performance and financial returns. Historically, literature in this field has focused on the impact of corporate governance in determining stock prices. However, with a growing global attention to climate change and the circular economy, the environmental component of ESG has become a focus of research concerning the stock price performance. Velte (2017) used information from German firms to show that ESG performance has a beneficial impact on company value (measured by Tobin's Q) and profitability (measured by return on assets, ROA). This finding contrasts with the findings of Kim and Li (2021), who discovered opposite consequences. Furthermore, Yoon et al. (2018) discovered that ESG ratings have a favourable impact on market value, however the magnitude of this effect varies according to firm characteristics. Between 2006 and 2011, Yoon et al. discovered that strong ESG efforts helped to increase firm value. Building on this corpus of data, this thesis will broaden the scope by investigating the years between 2011 and 2023. The study's focus will remain on U.S. firms. In a second study, Quintiliani (2022) looks at the relationship between ESG scores and firm value by levered free cash flow, return on equity, current ratio, and quick ratio.

2.3 ESG Bonds and Idiosyncratic Volatility

Understanding the relationship between ESG performance and stock volatility is critical for investors, portfolio managers, and legislators looking to combine financial returns with ethical and sustainable goals. One aspect of this relationship is idiosyncratic volatility iVOL, which refers to the fraction of a stock's total volatility that cannot be explained by market-wide or systematic variables. Instead, iVOL measures firm-specific risks and uncertainties, such as earnings reports, governance issues, and changes in competitive posture (Ang, 2006). Elevated iVOL is frequently related with increased unpredictability in firm performance, which may disincentivize specific investors, particularly institutional investors who prefer low-volatility stocks. An increasing body of empirical research has studied the relationship between ESG performance and idiosyncratic volatility, with multiple results. Albuquerque et al. (2019) studies how corporate social responsibility (CSR) initiatives impact organisations' systematic and idiosyncratic risk. The researchers contend that companies with good ESG performance have low iVOL due to stronger stakeholder relationships and increased openness in their performance. They argue that this reduction in firm-specific risk is more accentuated during times of financial turmoil, as ESG practices reduce uncertainty and promote steadiness. However, the question that remains is whether this firm-specific risk will continue to be the same if the company decides to increase its ESG-related debt. Therefore, empirical research on ESG bonds and idiosyncratic volatility is gaining popularity as a means to provide additional insights into the potential effects of ESG Bond issuance. Even though there are few studies on this topic, Hoepner et al. (2019) discovers that by issuing ESG bonds, firms can benefit from lower risk. In contrast, Halbritter and Dorfleitner (2015) use two unique methodological approaches to analyse the relationship between company social performance and financial performance, with a focus on ESG ratings. Their findings show that environmental and social investments might increase firm-specific risk. They attribute this to the unpredictable payback timelines of such expenditures, as well as potential regulatory issues. At the same time, according to Tang and Zhang (2020), green bond issuers face additional information disclosures, upfront expenditures for certification and personnel, and reputation risk. This thesis tries to close the gap by evaluating corporate behaviour in a more contemporary setting, considering evolving environmental legislation and the long-term repercussions of the global epidemic. This technique will contribute to the current discussion about the relationship between ESG performance and idiosyncratic volatility in the modern financial landscape.

3 Methodology & Data

3.1 Methodology

This section describes the methodology used to investigate the impact of ESG bond issuance on corporate profitability and risk, as measured by Return on Assets (ROA) and idiosyncratic volatility, respectively. All data handling was done and results were produced using Excel, STATA and R.

3.1.1 Idiosyncratic Volatility

To study the effect of ESG bond issuance on firm-specific risk, I evaluated the idiosyncratic volatility (iVOL) using both the Fama-French 3-Factor Model (Fama and French, 1993) and the Carhart 4-Factor Model (iVOLC) (Carhart, 1997). These models take systematic elements into account when calculating stock returns, with iVOL indicating each firm's unique residual volatility. According to the Fama-French 3-Factor Model, three factors explain the predictability of asset returns in equity pricing:

$$r_{it} - RF_{it} = \alpha_i + \beta_{\text{mkt}}\,(r_{\text{mkt}} - RF_t) + \beta_{\text{smb}}\,\text{SMB}_t + \beta_{\text{hml}}\,\text{HML}_t + \epsilon_{it} \tag{1}$$

Where r_{it} is the daily return, and RF_{it} is the risk-free rate. The term $r_{\text{mkt}} - RF_t$ represents the market risk premium. The size factor, known as Small Minus Big (SMB), is expressed as SMB_t, while the value factor, High Minus Low (HML) is represented as HML_t. The parameter α_i is the individual intercept, which is the fixed effect for company i. The factor loadings are given by β_{mkt}, β_{smb}, and β_{hml}. Finally, ϵ_{it} represents the error term. Moreover, the Carhart 4-Factor Model includes a momentum factor, which is especially useful for analysing risk anomalies caused by market behaviour and investor emotion. And is usually demonstrated as follows:

$$r_{it} - RF_{it} = \alpha_i + \beta_{\text{mkt}}\,(r_{\text{mkt}} - RF_t) + \beta_{\text{SMB}}\,\text{SMB}_t + \beta_{\text{HML}}\,\text{HML}_t + \beta_{\text{WML}}\,\text{WML}_t + \epsilon_{it} \tag{2}$$

Here WML_t represents the momentum factor (Winners Minus Losers). For each firm, the daily stock prices were used to calculate the firm's daily returns:

$$r_t = \frac{p_t - p_{t-1}}{p_{t-1}} \tag{3}$$

Where r_t represents the daily returns. p_t is the price of the stock at time t, and p_{t-1} denotes the price of the stock at time $t-1$. After that, I calculated the daily excess returns simply by subtracting the daily risk-free (RF) of the specific market:

$$ER_t = r_t - RF_t \tag{4}$$

In this case, ER_t denotes the excess returns. r_t represents the daily returns, and RF_t is the risk-free rate at time t. To calculate the residuals, the above calculated excess returns were regressed on the respective model factors. The model's residuals were then isolated to account for firm-specific changes that were not explained by the systematic components. Finally, the annual iVOL for each company was determined as the squared root of the variance of these residuals, which is consistent with earlier research on firm risk and idiosyncratic volatility (Ang et al., 2006):

$$iVOL = \sqrt{\frac{1}{N-1}\sum_{t=1}^{N}\epsilon_{it}^{2}} \tag{5}$$

Where $iVOL$ represents the idiosyncratic volatility. ϵ_{it} is the error term for firm i at time t, and N is the number of observations.

3.1.2 Relationship with VIX

VIX captures investor predictions of near-term stock market volatility based on S&P 500 options. Including the VIX in my research helps to identify broader market conditions that may influence idiosyncratic volatility, resulting in a more accurate picture of firm-specific volatility in the context of ESG bond issuance. Figure 1. displays significant rises in the VIX at several

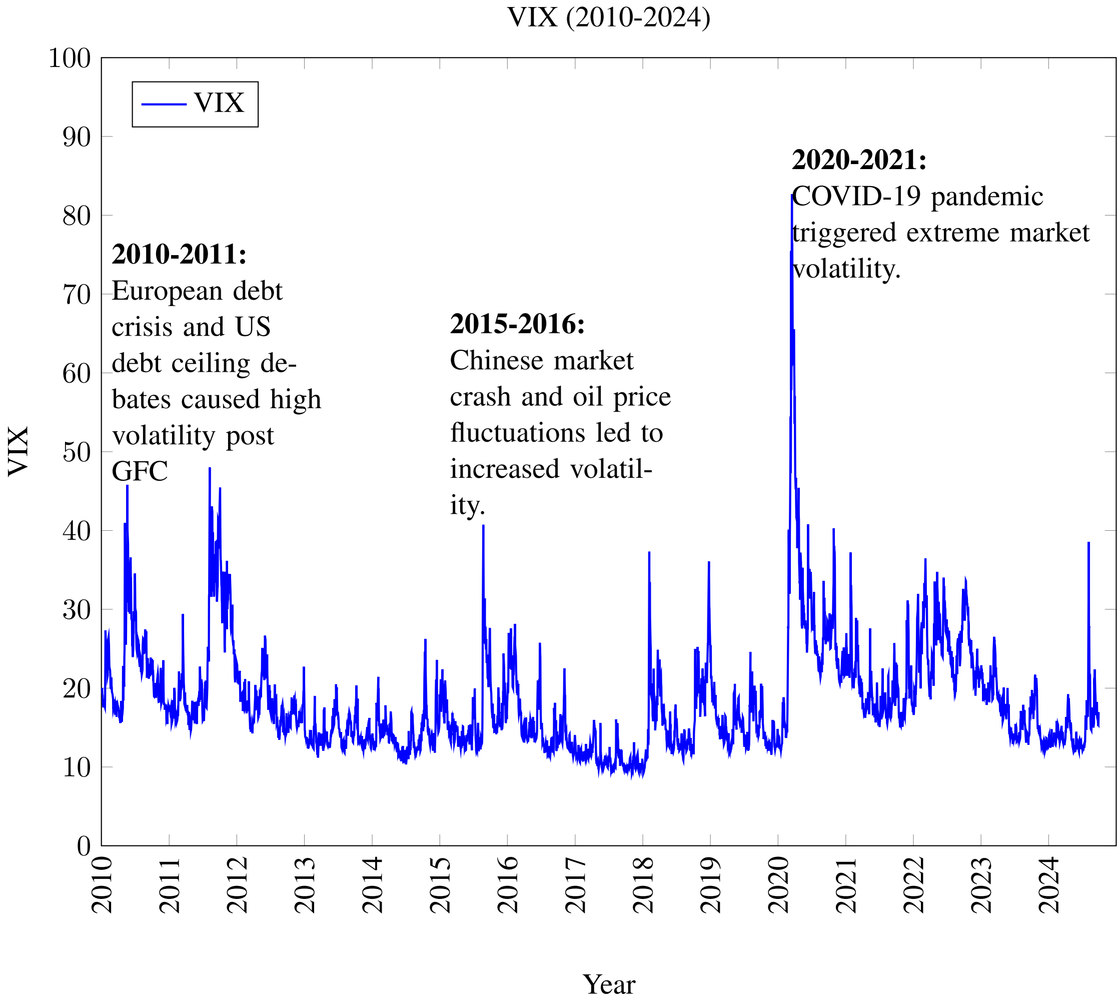

Figure 1: Historical VIX levels from 2010 to 2024

points in time, mainly around 2010, 2011, 2015-2016, and especially in 2020, when the index exceeded 80, hitting an unparalleled high. This sharp increase in 2020 coincides with the onset of the COVID-19 pandemic, which caused unprecedented levels of financial turmoil. Following the dramatic increase in 2020, the VIX has a somewhat elevated baseline. This post-crisis phase appears to be characterized by continuing, albeit moderate, volatility, indicating ongoing market concern and changes in the aftermath of the pandemic. Moreover, Kirci Altinkeski et al. (2024) studied the effects of VIX spillovers on volatility and trading volumes in both developed and emerging markets, demonstrating that VIX spikes are associated with heightened investor caution in Asia-Pacific and in other emerging markets. In this case, when U.S. market uncertainty rises, as measured by the VIX, investors frequently withdraw from riskier assets in emerging markets, which leads to a synchronized market response in Asia. We can observe this

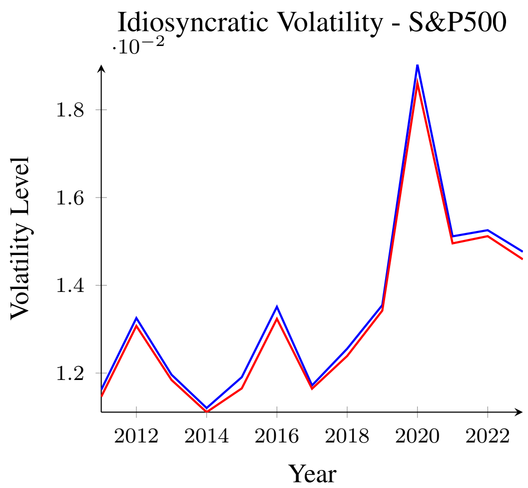

Figure 2: Plot of iVOL and iVOLC for S&P500 Over Time

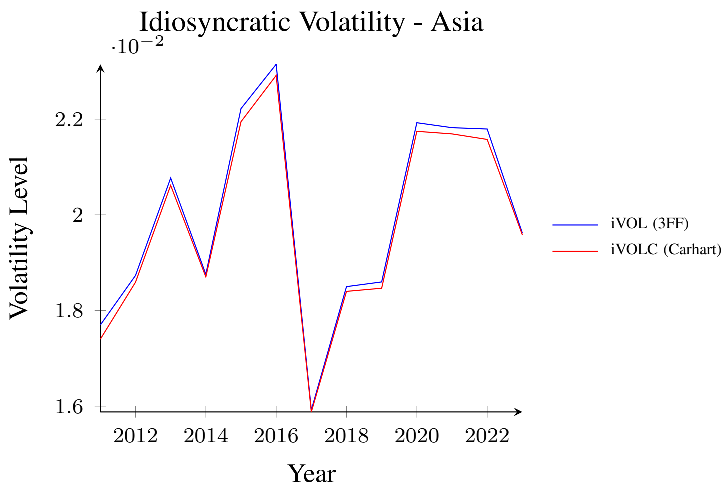

Figure 3: Plot of iVOL and iVOLC for Asian Markets Over Time

behaviour in Figure 3, where we see that Asian markets experienced increased volatility in the early 2010s as a result of rising market uncertainty. Asia has responded positively during the global financial crisis. However, specific countries, like China, witnessed higher iVOL due to shifts in regulatory frameworks, such as China's aggressive fiscal policy. The economic boost and increased public expenditure on infrastructures throughout this period not only stimulated consumption, but also brought volatility due to changes in investor confidence related to regulatory changes (Cevik & Correa-Caro, 2015). From 2015 to 2016, there was a significant increase in VIX volatility caused mainly by uncertainty in the anticipated U.S. Federal Reserve rate hikes, adding to the devaluation of the Yen, followed by oil price decline in 2016. This was worsened by the US-China trade war in 2018-2019, which caused increasing volatility in Asia as economies with close ties to China encountered supply chain disruptions and tariff implications. In 2020, the COVID-19 pandemic caused a significant increase in idiosyncratic volatility across Asia, similar to the U.S. in Figure 2.

3.2 Regression Analyses

To study the influence of ESG Bonds on company-specific risk, daily idiosyncratic volatility was estimated for each firm in the S&P 500 and three key Asian indices from 2011 to 2023. I then used several Ordinary Least Squares (OLS) regression models to analyse the relationship between idiosyncratic volatility and various financial and ESG-related factors, as shown below. The firm controls used in this model represent key financial metrics that are commonly employed to evaluate a company's financial performance and stability.

$$\text{iVOL}_{it} = \beta_0 + \beta_i \cdot (\text{Firm Controls}_{it}) + \Delta_i \cdot (\text{ESG Bonds}_{it}) + \epsilon_{it} \tag{6}$$

$$\text{IVOLC}_{it} = \beta_0 + \beta_i \cdot (\text{Firm Controls}_{it}) + \Delta_i \cdot (\text{ESG Bonds}_{it}) + \epsilon_{it} \tag{7}$$

In this thesis, ROA is used to measure corporate profitability. To study the relationship between ROA and ESG Bond issuance, I used OLS regressions as well, with an ESG Bond dummy variable as the independent variable. Each regression model contains a progressively larger range of control variables, similar to those used in the iVOL and iVOLC models. The equations below describe the multiple OLS models used in this analysis:

$$\text{ROA}_{it} = \beta_0 + \beta_i \cdot (\text{Firm Controls}_{it}) + \Delta_i \cdot (\text{ESG Bonds}_{it}) + \epsilon_{it} \tag{8}$$

The firm-level control variables used in each of the models were ROE, since it captures characteristics of business performance that may independently influence both iVOL and ROA, in addition to the effects of ESG bond issuance. Moreover, I used leverage, to account for the impact of a company's financial structure. Furthermore, firms with higher Capital Expenditure may have a different risk or profitability profile than those with lower investment levels. By adjusting for investment intensity, this thesis can differentiate both the unique effect of ESG bonds and the impact of a company's investment strategy. Finally, the ESG Combined Score identifies the influence of ESG bond issuance while accounting for each firm's overall ESG performance. These controls serve to account for many factors that may influence the company's performance, and they are included in the model to isolate the effect of ESG bonds on idiosyncratic volatility.

3.3 Propensity Score Matching

Due to an imbalanced sample of firms that have issued ESG bonds and those that have not, we used propensity score matching (PSM) to mitigate selection bias. PSM is a popular causal inference technique that was created to produce balanced treatment and control groups while maintaining comparability based on observable covariates (Rosenbaum and Rubin, 1983). PSM is used in this study to establish a statistically similar sample of companies based on specific financial and environmental variables. Furthermore, ESG bond issuance may be more common among companies with certain features. Without controlling for these features, any differences in ROA or iVOL between ESG bond issuers and non-issuers may be due to inherent discrepancies rather than the effect of the actual bond issuance. PSM mitigates these confounding influences by matching firms with similar visible qualities. To improve comparability, I chose the variables based on the significance results of the t-test performed, as shown in Figure 7 and Figure 8. I find that ROE, ROA, CAPEX, ESG individual pillars, ESG Combined Score and iVOL are critical in accounting for structural variations. Moreover, nearest-neighbour matching without replacement was used to match each ESG bond issuer with similar non-issuers. Balance diagnostics, such as standardised mean differences, were employed to evaluate matching quality, ensuring that treated and control groups are comparable (Austin, 2011). This test was conducted using STATA's psmatch2 package.

3.4 Tests for Model Selection and Data Validity

Selecting the right econometric model is critical for producing unbiased and efficient results. This study employs diagnostic tests to identify whether a fixed or random effects model is best suited to the panel data format, as well as checks for serial correlation and cross-sectional dependence.

3.4.1 Hausman Test

The Hausman test is a standard method for distinguishing between fixed effects (FE) and random effects (RE) models. This test determines whether individual effects are associated with the regressors, which is a necessary assumption for utilising RE models.

H0: No correlation between individual effects and regressors

H1: Correlation exists between individual effects and regressors

When the p-value exceeds the significance level, the null hypothesis is not rejected, indicating that the RE model should be used. Otherwise, you can reject the null hypothesis and instead adopt the FE model. The Hausman Test results (Figure 11) show that for ROA, the p-value (0.91) indicates that the RE model is appropriate, as there is no evidence of correlation between individual effects and regressors. In contrast, for iVOL and iVOLC, we find evidence of correlation (p-values of 0.065 and 0.071, respectively), favouring the FE model for these two variables in the U.S. Looking at the same table, we observe that for Asia, the pattern reverses: the RE model is recommended for iVOL and iVOLC, while the FE model would be more appropriate for ROA.

3.4.2 Wooldridge Test for Serial Correlation

Serial correlation can result in biased standard errors and inaccurate inferences in panel data models. The Wooldridge test for serial correlation is used here since it is appropriate for unbalanced panel data. Moreover, the Wooldridge Test is a reliable method for identify autocorrelation in firm-level data over time, guaranteeing the rationality of the chosen model specification.

H0: No first-order serial correlation in the residuals

H1: Presence of first-order serial correlation in the residuals

If the p-value is greater than the significance level, you cannot reject the null hypothesis, implying that there is no serial correlation. If stated otherwise, you can reject the null hypothesis and find serial correlation in the residuals. Moreover, in the Wooldridge Test (Figure 12), the p-value for the US (0.1924) indicates that we cannot reject the null hypothesis of no first-order autocorrelation, implying that there is no serial correlation in the residuals. Similarly, for Asia, the p-value of 0.1539 indicates that there is no serial correlation in the residuals.

3.4.3 Breusch-Pagan Lagrange Multiplier Test for Random Effects

The Breusch-Pagan LM test evaluates the applicability of random effects over a simple pooling OLS model. The LM test is useful for determining the presence of cross-sectional variation, implying that a random effects model is preferred to OLS (Breusch and Pagan, 1980).

4 Data Description

The dataset for this dissertation includes financial and environmental factors necessary for analysing the effect of ESG bond issuance on business profitability and idiosyncratic volatility. All the data used was retrieved using Refinitiv WorkSpace. The sample period is from 2011 to 2023, including more than a decade of improving and strengthned ESG practices, regulatory reforms, and changing market situations. This period was characterised by an increase in ESG bond issuance, regulatory promotion of sustainable practices, and increased investor interest in corporate sustainability, making it ideal for examining the financial and risk implications of ESG bond issuance. Furthermore, to capture firm performance and capital structure, we use yearly data from companies listed on the NIKKEI225 (Japan), SSE180 (China), HSI82 (Hong Kong), and S&P500 (U.S.). These indices cover a wide range of major firms from significant Asian and U.S. economies. These regions were chosen based on major disparities in ESG regulatory regimes, market structures, and ESG integration levels in financial markets. The following financial variables are included: Leverage (D/E), Return on Equity (ROE), Capital Expenditure (Log_CAPEX) and Return on Assets (ROA). Furthermore, the key environmental factors used were: Combined ESG Score, Scope 1, Scope 2 and, Scope 3 emissions, CO2 equivalent emissions, ESG Performance Indicators, and data on the ESG bonds for all the firms. Finally, for the iVOL analysis, the daily stock prices were retrieved from 2011 to 2023 from DataStream (refer to Table 9 in the Appendix).

4.1 ESG Performance Indicators

ESG is a set of non-financial criteria used to assess how well a firm manages its responsibilities for environmental sustainability, social impact, and ethical governance. The Environmental (Escore) component assesses how a company responds to environmental issues such as climate change, resource conservation, pollution control, and waste management. Companies with strong environmental practices prioritise lowering their carbon footprint, increasing energy efficiency, and implementing sustainable resource management strategies. The Social (Sscore) component looks at how a company handles its connections with employees, customers, suppliers, and the public. This encompasses labour standards, human rights, diversity, and inclusion, and safeguarding the welfare of all stakeholders. Fair treatment, employee safety, and ethical supply chains all contribute to strong social performance. Finally, Governance (Gscore) refers to the internal procedures, regulations, and standards that assure ethical decision-making, openness, and accountability among leaders. Which means that good governance consists of competent corporate oversight, alignment with shareholder interests, and a commitment to ethical practices.

Variable	**N**	**Mean**	**SD**	**Min**	**Max**
ROE	274	-0.009	2.679	-41.2	2.178
DE	274	1.773	4.170	0.028	58.15
ROA	274	0.063	0.313	-5	0.353
Log_CAPEX	274	2.198	0.083	1.822	2.38
Escore	274	74.488	13.256	31.862	98.075
Sscore	274	70.399	17.410	11.898	97.538
Gscore	274	64.052	19.954	6.714	99.408
ESG Combined Score	274	63.054	15.004	29.885	92.542
ESG Bonds	274	0.263	0.441	0	1
iVOL	274	0.015	0.006	0.005	0.049
iVOLC	274	0.014	0.006	0.005	0.047

Table 1: S&P500 Summary Statistics Matched Sample with Propensity Score Matching

Variable	N	Mean	SD	Min	Max
ROE	580	0.124	0.192	-0.694	1.165
DE	580	0.949	1.175	0	9.288
ROA	580	0.105	0.196	-0.165	0.999
Log_CAPEX	580	18.852	2.689	5.176	24.253
Environmental Score	580	55.066	25.943	0.586	97.144
Social Score	580	44.776	22.418	0.782	94.848
Governance Score	580	49.687	25.536	1.841	96.848
ESG Combined Score	580	47.63	21.169	2.362	88.879
ESG Bonds	580	0.271	0.445	0	1
iVOL	580	0.019	0.010	0.007	0.212
iVOLC	580	0.018	0.005	0.007	0.063

Table 2: Asia500 (HIS82, SSE180, NIKKEI225) Summary Statistics Matched Sample with Propensity Score Matching

5 Results

5.1 Idiosyncratic Volatility and ESG Bonds

VARIABLES	iVOL	iVOL	iVOL	iVOL	iVOLC	iVOLC	iVOLC	iVOLC
ROE	0.000290***	0.000290***	0.000266***	0.000267***	0.000279***	0.000279***	0.000256***	0.000256***
	(2.77e-05)	(2.74e-05)	(3.76e-05)	(3.79e-05)	(2.68e-05)	(2.65e-05)	(3.62e-05)	(3.65e-05)
D/E		6.59e-05***	0.000114***	0.000111**		6.18e-05***	0.000109***	0.000104**
		(1.96e-05)	(4.29e-05)	(4.96e-05)		(1.93e-05)	(4.11e-05)	(4.74e-05)
log_CAPEX			-0.0416	-0.0411			-0.0402	-0.0395
			(0.0305)	(0.0318)			(0.0288)	(0.0300)
ESG Score				7.45e-06				1.08e-05
				(3.52e-05)				(3.48e-05)
ESG Bonds	-0.000560	-0.000606	-0.000339	-0.000369	-0.000528	-0.000571	-0.000313	-0.000357
	(0.000821)	(0.000829)	(0.000939)	(0.000917)	(0.000824)	(0.000831)	(0.000937)	(0.000909)
Constant	0.0147***	0.0146***	0.106	0.104	0.0145***	0.0144***	0.103	0.100
	(0.000216)	(0.000216)	(0.0669)	(0.0709)	(0.000216)	(0.000217)	(0.0632)	(0.0670)
N	274	274	274	274	274	274	274	274
R-squared	0.045	0.049	0.119	0.119	0.045	0.049	0.118	0.119
Number of Companies	165	165	165	165	165	165	165	165

Table 3: Regression Results for iVOL and iVOLC (U.S.)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 3 summarises the findings of ESG bonds' influence on iVOL and iVOLC for the U.S. The results show negative coefficients for ESG bonds, ranging from -0.000560 to -0.000369 for iVOL and -0.000528 to -0.000357 for iVOLC. Regardless of these negative interactions, that indicate that companies that issue ESG bonds may be experiencing lower levels of volatility, even though the effects are not statistically significant. This negative link could be associated with the impression that ESG-oriented fimrs are more stable and resilient because they prioritise sustainability, corporate governance, and ethical practices. ESG bond issuance could demonstrate a company's commitment to long-term value increasing, perhaps reducing investor uncertainty and leading to more stable stock performance. Furthermore, ESG bonds may appeal to a specific segment of investors that value environmental and social considerations, thus leading to a more stable shareholder base and lower volatility.

VARIABLES	iVOL	iVOL	iVOL	iVOL	iVOLC	iVOLC	iVOLC	iVOLC
ROE	-0.000693	-0.000621	-0.000613	-0.000627	-0.000340	-0.000300	-0.000298	-0.000284
	(0.00355)	(0.00352)	(0.00353)	(0.00354)	(0.00170)	(0.00168)	(0.00166)	(0.00167)
D/E		0.000175	0.000174	0.000154		8.28e-05	8.35e-05	8.20e-05
		(0.000221)	(0.000220)	(0.000224)		(0.000181)	(0.000181)	(0.000180)
log_CAPEX			-1.80e-05	-2.05e-05			5.17e-06	5.46e-06
			(0.000123)	(0.000123)			(9.88e-05)	(9.92e-05)
ESG Score				1.06e-05				-1.60e-07
				(9.57e-06)				(1.02e-05)
ESG Bonds	0.000711	0.000732	0.000731	0.000688	0.000841**	0.000845**	0.000845**	0.000841**
	(0.000536)	(0.000536)	(0.000538)	(0.000546)	(0.000428)	(0.000426)	(0.000426)	(0.000426)
Constant	0.0201***	0.0199***	0.0203***	0.0199***	0.0184***	0.0183***	0.0183***	0.0183***
	(0.000921)	(0.000908)	(0.00283)	(0.00286)	(0.000359)	(0.000357)	(0.00192)	(0.00199)
Observations	580	580	580	580	580	580	580	580
R-squared	0.0007	0.0010	0.0010	0.0016	0.0000	0.0020	0.0020	0.0024
Number of Companies	233	233	233	233	233	233	233	233

Table 4: Regression Results for iVOL and iVOLC (Asia)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

For iVOL in the Asian market (Table 4), the regression findings show that the coefficients for ESG Bonds are positive but not statistically significant, indicating that ESG bonds issuance is related to a possible increase in firms volatility, even though there is insufficient evidence to support a link between ESG bond issuance and volatility in the Asian market setting. Moreover, the iVOLC regressions for Asia produce a different result in comparison to the other models. ESG Bonds have a small but positive and statistically significant coefficient, implying that ESG bond issuance may result in a rise in volatility for firms in Asian markets. This contradicts the notion that ESG Bonds will lower firm-specific risk by indicating stability or good governance practices. Furthermore, the regression results for both the U.S. and Asia demonstrate that ESG Bonds have a mixed and inconclusive effect on iVOL and iVOLC, in their respective markets. Despite some variances in coefficient magnitudes and statistical significance, ESG Bonds' impact on volatility appears to vary by area. In the U.S., the findings indicate a negative relationship between ESG Bonds and volatility, however it is not statistically significant. In contrast, the Asian market has a positive and statistically significant relationship for iVOLC but no meaningful link for the iVOL model.

5.2 Firm Profitability and ESG Bonds

VARIABLES	ROA	ROA	ROA	ROA
ROE	0.00275***	0.00275***	0.00266***	0.00266***
	(8.72e-05)	(8.72e-05)	(0.000122)	(0.000120)
D/E		9.88e-05	-7.07e-05	-0.000208
		(0.000289)	(0.000324)	(0.000327)
log_CAPEX			0.146	0.170
			(0.145)	(0.139)
ESG Score				0.000345
				(0.000211)
ESG Bonds	0.00623	0.00616	0.00520	0.00379
	(0.00689)	(0.00689)	(0.00694)	(0.00688)
Constant	0.0504	0.0502	-0.270	-0.343
	(0.0314)	(0.0315)	(0.317)	(0.303)
N	274	274	274	274
R-squared	0.0826	0.0828	0.1043	0.1151
Number of Companies	165	165	165	165

Table 5: Regression Results for ROA (U.S.)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 5 and Table 6 show the regression results for the relation between ROA and ESG bond issuance in the U.S. and Asian Market, respectively. The coefficient for ESG Bonds is provided across four models and shows a positive relationship with ROA. However, the relationship is not statistically significant showing coefficients from 0.00623 to 0.00379, indicating that, while ESG bond issuance may correlate with ROA, it does not have a major or direct impact on the financial performance of companies in this U.S. sample. Furthermore, the small coefficients indicate that, while ESG bond issuance may indicate a firm's dedication to long-term goals, it does not have a significant impact on short-term profitability. These findings emphasise the nuanced and complicated relationship between ESG practices and financial performance. While ESG Bonds are linked to higher ROA coefficients, their impact may be indirect, appearing through other channels like as increased risk management, stakeholder involvement, or long-term strategic positioning.

VARIABLES	**ROA**	**ROA**	**ROA**	**ROA**
ROE	0.192***	0.192***	0.192***	0.191***
	(0.0651)	(0.0652)	(0.0649)	(0.0649)
D/E		0.000324	0.000275	-0.000946
		(0.00280)	(0.00282)	(0.00285)
log_CAPEX			-0.00182	-0.00193
			(0.00272)	(0.00263)
ESG Score				0.000522
				(0.000357)
ESG Bonds	0.0140	0.0141	0.0140	0.0116
	(0.0133)	(0.0134)	(0.0133)	(0.0131)
Constant	0.0777***	0.0773***	0.112**	0.0909
	(0.00836)	(0.00905)	(0.0514)	(0.0591)
N	580	580	580	580
R-squared	0.061	0.061	0.062	0.070
Number of Companies	233	233	233	233

Table 6: Regression Results for ROA (Asia)

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Contrary to iVOL and iVOLC, in both the U.S. and Asia, the results suggest that ESG bond issuance has a positive relationship with ROA, however this relationship is not statistically significant. This conclusion implies that, while ESG bonds may be related with improved financial performance, the statistical evidence for this relationship is weak.

6 Robustness

To test the robustness of the relationship between ESG bond issuance and business performance and/or volatility, I ran a regression analysis using the individual ESG components' scores: EScore, Sscore, and Gscore, rather than the combined ESG score utilised in the first models. This extra analysis seeks to determine whether specific ESG aspects have a greater impact on iVOL and ROA, as well as to confirm the reliability and consistency of the preliminary findings.

6.1 iVOL & iVOLC and ESG Components

In the first phase of the robustness test, I looked at how each ESG component affected idiosyncratic volatility. I estimated the following regression model:

$$\text{iVOL}_{it} = \beta_0 + \alpha_i(\text{Escore}_{it}) + \gamma_i(\text{Sscore}_{it}) + \mu_i(\text{Gscore}_{it}) + \beta_i(\text{Firm Controls}_{it}) + \Delta_i(\text{ESG Bonds}_{it}) + \epsilon_{it} \tag{6}$$

$$\text{iVOLC}_{it} = \beta_0 + \alpha_i(\text{Escore}_{it}) + \gamma_i(\text{Sscore}_{it}) + \mu_i(\text{Gscore}_{it}) + \beta_i(\text{Firm Controls}_{it}) + \Delta_i(\text{ESG Bonds}_{it}) + \epsilon_{it} \tag{7}$$

The regressions for iVOL and iVOLC in the US and Asian markets were run separately to see if the effects of individual ESG components were consistent across regions.

VARIABLES	IVOL		IVOLC	
	U.S.	Asia	U.S.	Asia
Escore	-0.000114**	-1.10e-05	-0.000111**	-2.35e-06
	(5.10e-05)	(1.16e-05)	(5.11e-05)	(6.95e-06)
Sscore	4.39e-05	7.36e-06	4.10e-05	-1.42e-05
	(3.26e-05)	(1.19e-05)	(3.10e-05)	(1.14e-05)
Gscore	1.24e-06	1.31e-05	-5.88e-08	-2.67e-06
	(2.84e-05)	(1.05e-05)	(2.78e-05)	(7.42e-06)
ROE	-0.000270***	-0.000639	-0.000260***	-0.000305
	(3.53e-05)	(0.00352)	(3.40e-05)	(0.00168)
D/E	9.76e-05**	0.000152	9.10e-05**	6.47e-05
	(4.78e-05)	(0.000216)	(4.55e-05)	(0.000181)
log_CAPEX	-0.0401	-6.21e-06	-0.0385	8.42e-06
	(0.0326)	(0.000124)	(0.0309)	(9.98e-05)
ESG Score	3.63e-05	9.84e-06	3.90e-05	6.09e-06
	(3.97e-05)	(1.08e-05)	(3.92e-05)	(1.25e-05)
ESG Bonds	-0.000886	0.000706	-0.000848	0.000873**
	(0.000917)	(0.000561)	(0.000906)	(0.000431)
Constant	0.106	0.0192***	0.102	0.0188***
	(0.0719)	(0.00287)	(0.0681)	(0.00211)
N	274	580	274	580
R-squared	0.173	0.0228	0.173	0.0235
Number of Companies	165	233	165	233

Table 7: Regression Results for iVOL and iVOLC (U.S. and Asia)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

The robustness test in Table 7 assesses the effect of specific ESG components on iVOL and iVOLC in the U.S. and Asian Market. The findings demonstrate that the Environmental Score has a significant negative effect on both iVOL (-0.000114**) and iVOLC (-0.000111**) for U.S. firms, implying that higher environmental performance correlates with reduced idiosyncratic volatility. While Social and Governance Scores show insignificant effects on iVOL and iVOLC. Furthermore, the impact of ESG Bonds was insignificant in both models, indicating that the direct influence of ESG Bonds on volatility or performance is limited. These findings provide support for the original findings by indicating that environmental performance, rather than social or governance components, is more strongly related to idiosyncratic volatility.For the Asian market, the Escore has a negative but not statistically significant connection with both iVOL and iVOLC. Similarly, the Sscore has a positive but insignificant effect on iVOL and a negative but insignificant impact on iVOLC. The Gscore similarly yields conflicting results. However, ESG Bonds continue to have a positive and statistically insignificant effect on iVOL (0.000706), but a significant positive impact on iVOLC (0.000873), indicating that they may have a more notable influence on volatility as measured by iVOLC, corroborating the previous results.

6.2 ROA and ESG Components

Next, an analysis looking at the relationship between ESG components and business profitability was conducted. The regression model is as follows:

$$\text{ROA}_{it} = \beta_0 + \alpha_i(\text{Escore}_{it}) + \gamma_i(\text{Sscore}_{it}) + \mu_i(\text{Gscore}_{it}) + \beta_i(\text{Firm Controls}_{it}) + \Delta_i(\text{ESG Bonds}_{it}) + \epsilon_{it} \tag{8}$$

VARIABLES	U.S.	Asia
Escore	0.000120	-0.000136
	(0.000430)	(0.000218)
Sscore	-0.000121	0.000344
	(0.000174)	(0.000330)
Gscore	-0.000415	-0.000283
	(0.000398)	(0.000194)
ROE	0.00277***	0.313***
	(0.000142)	(0.0381)
D/E	-0.000193	-0.00739**
	(0.000353)	(0.00307)
Log_CAPEX	0.163	-0.00228
	(0.128)	(0.00286)
ESG Score	0.000385	0.000286
	(0.000296)	(0.000413)
ESG Bonds	0.00586	0.00507
	(0.00698)	(0.0138)
Constant	-0.305	0.115*
	(0.276)	(0.0600)
N	274	580
R-squared	0.1606	0.0662
Number of Companies	165	233

Table 8: Regression Results for ROA in U.S. and Asia

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

The findings are mixed across the two markets, with considerable variances in the influence of various ESG components on profitability. In the US market, ESG ratings show limited and statistically negligible effects on ROA, implying that ESG performance does not significantly drive profitability in this setting. Moreover, ESG bonds had no significant impact on ROA in either market, demonstrating that, while particular ESG components may be important, ESG bond issuance appears to have little influence on profitability in either the U.S. or Asia. However, the R-squared values for both markets are quite low, particularly in Asia (0.0662), implying that factors other than ESG and control variables may play a larger influence in influencing corporate profitability.

7 Discussion

The results show that ESG bond issuance has a higher risk-reducing effect on U.S. enterprises than on their Asian counterparts, implying that U.S.-based ESG issuers may face reduced firm-specific volatility. This is consistent with what was discussed prior about the risk-mitigation hypothesis arguing that ESG practices help firms manage non-financial risks, leading to reduced firm-specific volatility. However, we fail to find significance in any of the models for US firms. This can be because idiosyncratic volatility depends on many other factors such as leverage, company size, economic cycles, market sentiment, etc. However, for Asia I find different behaviour for the iVOL given the ESG bonds Issuance. The high correlation between ESG bonds and volatility is an important finding. This shows that companies issuing ESG bonds may experience increased stock price volatility, maybe due to the emergence of ESG investing or differing market expectations compared to the U.S. market, given that Asian markets may lack the uniformity and enforcement of ESG norms found in the U.S., investors in these locations may perceive ESG bonds as being riskier investments due to reduced transparency and institutional support. Furthermore, the results also give contradictory evidence on the impact of ESG bond issuance in firm profitability and idiosyncratic Volatility. Highlighting how different legal frameworks, market expectations, and ESG integration levels influence financial outcomes. Moreover, the relationship between ESG bond issuance and profitability differs significantly between U.S. and Asia. For U.S. based firms, the data show a positive association. This supports arguments presented beforehand that firms often enjoy reputational advantages and increased investor trust when they commit to sustainable practices. Even though the relationship between ROA and ESG bonds in US has not been significant, we can see that the years where ESG Bond issuers had the highest profitability, were the years that they had issued more ESG bonds, as seen in Table 12, specially in 2021. In 2021, it is also probable that the increase in profitability was due to an economy rebound, as COVID-19 restrictions were eased, government stimulus increased, capital became cheaper and many other factors. Moreover, in Asia, firms appear to be less influenced by ESG bond issuance, possibly due to less mature ESG markets and a trailing regulatory framework in several Asian economies. Notwithstanding, Asian markets have a diverse range of ESG regulatory norms and enforce-

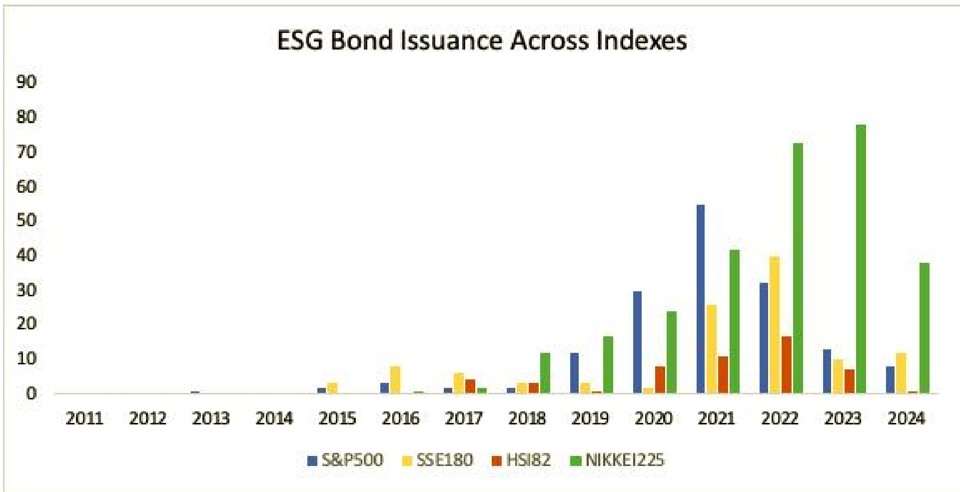

Figure 4: ESG Bonds Across Indexes

ment levels, resulting in inconsistent integration of ESG elements into corporate finance. This mismatch may make it more difficult for Asian firms to realise quick financial benefits from ESG bonds. In Asia, similarly to the U.S. the average ROA in 2021 was also one of the largest since 2011 (Table 13). As seen in Figure 4, 2021 was a crucial year for bonds issuers in Asia and U.S. According to Hasan (2023), the observed growth in ESG bond issuances in 2021 can be attributed in part to the unique diversification and safe haven features that ESG and green bonds (GBs) displayed during moments of economic crisis. These assets had minimal volatility spillovers into traditional markets, especially during crises like the COVID-19 pandemic and the Russia-Ukraine conflict. Specifically, the S&P GB Index was found to have experienced the lowest number of directional spillovers from ESG assets and had limited volatility transmission to other assets, even in the face of economic shocks. This behaviour demonstrates the potential of ESG and green bonds as stabilising components in diverse portfolios, particularly during periods of increased uncertainty and market volatility. Moreover, the increased issuance of ESG bonds in 2021 likely reflects a strategic move by corporations and financial institutions to capitalize on these safe-haven characteristics. The post-pandemic economic landscape has emphasized the need for sustainable, resilient investment options that can provide both financial and environmental returns without exacerbating portfolio risk. The lower connectivity and volatility spillovers between GBs and ESG assets during crisis periods have likely enhanced investor confidence in these assets as effective hedging instruments, thus making ESG bonds an attractive option for risk-averse and sustainability-focused investors alike. Therefore, the rise in ESG bond issuance in 2021 can be attributed to these assets' demonstrated diversification and risk-mitigation benefits during times of economic stress, as well as supportive policy shifts and an increasing investor preference for sustainable investment avenues that align with long-term environmental and financial goals.

7.1 Impact Assessment of ESG Bonds Using Propensity Score Matching and Entropy Matching: Pre- and Post-COVID

In this thesis, three different statistical methods were used: regression analysis based on PSM, entropy matching, and the impulse response functions (IRF) results of the Vector Autoregressive (VAR) model to study the dynamics of ESG bond issuance and its impact on market behaviour, particularly during the COVID-19 pandemic. The approaches provide distinct insights, but they differ in approach and capacity to capture complicated interactions between variables. This section provides a robustness check that employs the methodologies mentioned above to validate the findings considering ESG bonds issuance as a stabilising component in different portfolios.

7.1.1 U.S. - S&P500

In the U.S., the regression results, Table 14 to Table 16 and Table 20 to Table 22, reveal that ESG bonds had no meaningful impact on ROA during the pre-COVID and post-COVID periods. The coefficients for ESG bonds are statistically insignificant, showing that they have no direct effect on corporate profitability. In terms of iVOL, ESG bonds had no meaningful influence prior to COVID-19. However, in the post-COVID period, their impact is initially beneficial before turning negative over time. This shows that ESG bonds can help reduce firm-specific volatility in the long term. Similarly, for iVOLC, ESG bonds have a statistically insignificant effect in the pre-COVID period, but show a positive effect at first, which gradually turns negative, confirming the hypothesis that ESG bonds help to reduce long-term volatility. Moreover, the IRF results back up these findings, showing that ESG bonds have no immediate influence on ROA, with an initial value of zero, followed by a slight negative impact in subsequent periods, which is consistent with the regression results. For iVOL, the IRF results show a minor early rise in volatility, followed by a considerable negative effect, implying that ESG bonds reduce firm-specific risk over time. This pattern is consistent with the regression analysis, which revealed a similar trajectory of increasing iVOL followed by stabilisation. When it comes to iVOLC, it reveals a slight positive initial impact that eventually becomes negative, validating the regression findings that ESG bonds lower volatility over time, as can be seen in Figure 5.

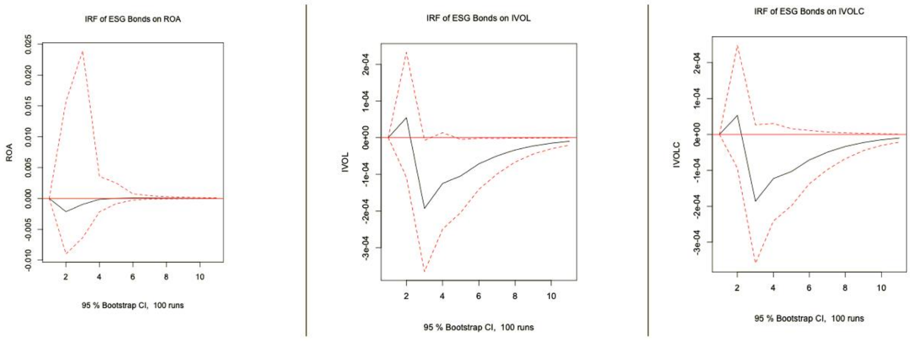

Figure 5: ESG Bonds Issuance effect overtime - U.S.

All the models imply that ESG bonds reduce volatility, especially in the post-COVID period. While regression models reveal a long-term reduction in volatility, IRF models suggest that this reduction occurs gradually over time. ESG bonds may initially have a minor or positive impact, but their stabilising effect grows stronger with time. In both models, ESG bonds have little to no effect on ROA, supporting the notion that they influence volatility and risk mitigation rather than giving an instant boost to profitability. These findings are consistent with previous research, which suggests that ESG bonds are more effective at managing volatility, particularly during times of economic uncertainty, rather than immediately increasing corporate profitability.

7.1.2 Asia - HSI82, SSE180, NIKKEI225

The study of ESG bonds' impact on profitability and idiosyncratic volatility, Table 17 to Table 19 and Table 23 to Table 25, prior to and following the COVID-19 pandemic reveals significant changes and shifts in their function in Asian markets. Regarding profitability, the findings show that ESG bonds had no statistically significant influence in either period. Prior to the pandemic, ESG bonds had a positive but statistically insignificant coefficient of 0.185, indicating no measurable short-term influence on profitability. This finding most likely reflects the long-term nature of the possible benefits of ESG bonds, such as operational efficiency or reputational gains, which may not be immediately translated into financial results. Following the pandemic, the correlation fell to 0.0136 and remained statistically insignificant. This ongoing lack of significance indicates that ESG bonds did not generate immediate profitability advantages when markets adjusted to the post-COVID environment. These findings show that the financial benefits of ESG bonds may be indirect or take time to manifest. This may be due to improved stakeholder relationships or lower exposure to ESG concerns. Furtheremore, the findings reveal a contrasting pattern between the pre- and post-COVID periods. Prior to the pandemic, ESG bonds showed a positive and statistically significant coefficient, indicating an increase in firm-specific risk. This finding may reflect the early adoption of ESG frameworks in Asian markets, where issuers faced increased scrutiny or uncertainty due to low standardisation and investor unfamiliarity with ESG concepts. Following the pandemic, the coefficient became negative but remained statistically insignificant. This reversal shows that ESG bonds began to stabilise firm-specific volatility after the pandemic, as markets adjusted to the increased importance of ESG investing. Although the negative coefficient suggests a potential risk-mitigation effect, the lack of statistical significance highlights that the issuance of ESG bonds does not have a huge impact on either the firm profitability or firm-specific risk of the Asian firms. Moreover, when momentum effects are accounted for, the results nearly match those of iVOL. Prior to the pandemic, ESG Bonds again had a positive and statistically significant, supporting the result that ESG bonds enhanced idiosyncratic volatility in the pre-COVID period. This risk amplification is likely due to speculative behaviour and increased investor anxiety in Asia's young ESG bond market. In the post-COVID period, ESG bonds had a negative and insignificant coefficient similar to the trend seen with iVOL. This trend shows that as the market matured and ESG guidelines gained traction, idiosyncratic volatility may have stabilised. However, the absence of statistical significance shows that this risk mitigation effect is not present in this market, contrary to the U.S. firms.

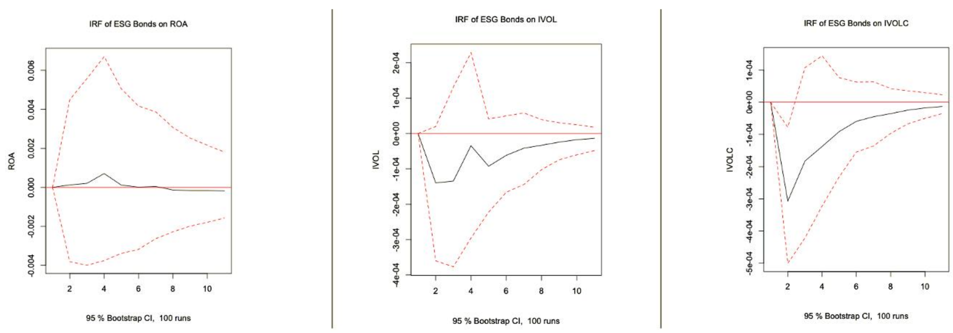

Figure 6: ESG Bonds Issuance effect overtime - Asia

Notwithstanding, the examination of IRF shown in Figure 6 gives insight into the short- and long-term impacts of ESG bonds on profitability and idiosyncratic volatility in Asian markets.

For profitability, ESG bonds have a short-term positive effect, with a coefficient of 1.25e-04 in the second period. This shows that ESG bonds could provide an early boost to profitability, possibly due to improved investor perception or reputational benefits connected with ESG adoption, but not directly linked to the issuance of ESG Bonds. However, this influence decreases over time, reaching a long-term coefficient of -1.83e-04 in the eleventh period, which is the eleventh year after the shock. The absence of consistent profitability increases is most likely due to the time it takes for the financial benefits of ESG adoption, such as cost savings or operational efficiencies, to fully materialise in this market. Finally, for idiosyncratic risk the results show a similar declining trend as the coefficient drops further to -1.32e-05 by the eleventh period, which represents the eleventh year after the shock, from -3.07e-04 in the second. Finally, the findings on profitability raise new issues about the timing and type of ESG advantages. For U.S. firms, the relationship between ESG bond issuance and profitability, while not statistically significant, is consistent with broader trends in sustainable investing. The ability of companies to use ESG bond issuance for long-term gains, even in the lack of immediate profitability, demonstrates the strategic importance of sustainable practices. In contrast, the lack of such trends in Asia shows that ESG activities are still in the experimental stage, with enterprises and markets struggling to convert them into verifiable financial benefits.

8 Conclusion & Limitations

Summarising, the findings highlight the importance of market maturity and institutional frameworks in determining the impact of ESG bonds on company performance. U.S. markets, with stronger ESG frameworks and greater investor familiarity, are better positioned to profit from ESG practices than their Asian counterparts. For example, the lower idiosyncratic volatility found among US corporations demonstrates their capacity to effectively exploit ESG issuance. Meanwhile, the variability and lack of statistical significance in Asia indicate that structural inefficiencies, such as poor enforcement of ESG regulations and fragmented investor bases, impede the realisation of ESG advantages. Addressing these problems in Asian markets could increase the possibility for ESG bond issuance. Another important element influencing the observed results is the difference in investor views and expectations between the two locations. In the U.S., ESG investing has become mainstream, with a heavy emphasis on merging financial and environmental returns. This cultural alignment boosts investor trust, allowing companies to reap reputational and financial benefits. In Asia, however, ESG investment is still in its early stages, and it is frequently seen with scepticism or as a compliance exercise rather than a strategic financial decision. This impression most likely contributes to the increased volatility and lack of profitability benefits reported for Asian enterprises. Efforts to promote transparency, standardise ESG reporting, and educate Asian investors may help to minimise these problems. To conclude, this thesis contributes to the growing field of sustainable finance by analyzing the impacts of ESG bond issuance across regions and timeframes. It provides useful insights into the influence of ESG criteria and financial indicators on firm performance before and after the COVID-19 pandemic. The findings highlight that ESG bonds can reduce risk and support long-term growth, though their immediate financial benefits are limited. The study underscores the need for policymakers and investors to enhance regulatory consistency and market transparency to maximize ESG bonds' financial and environmental returns. In the U.S., ESG bonds are associated with increased profitability, notably in 2021 during the economic recovery, fiscal stimulus, and lower-cost financing, albeit this relationship is statistically insignificant. In contrast, ESG bonds in Asia have had no meaningful short-term impact on profitability, most likely due to weaker ESG guidelines and market immaturity. The risk-mitigation argument is supported by the fact that ESG bonds have a greater impact on risk reduction in US corporations than on Asian firms. Other factors, including as leverage, business size, and macroeconomic conditions, appear to affect idiosyncratic volatility. In Asia, the high correlation between ESG bonds and volatility shows that they are viewed as riskier assets due to varying laws and enforcement. However, during the writing of this thesis, I have encountered some limitations that may inform future research. It is strongly reliant on the availability and accuracy of ESG and financial data, which may be inconsistent in particular regions and industries, adding possible bias. The models uncover substantial relationships but not causality, potentially omitting extraneous variables, particularly given the pandemic's unpredictable economic conditions. Finally, measurements such as ROE, ROA, and iVOL may fail to represent the entire financial and operational impact of ESG strategies during economic downturns. Despite these constraints, this thesis makes a contribution by showing regional differences in ESG bond impacts, the impact of the COVID-19 pandemic on ESG-related financial performance, and ESG bonds' risk-reduction potential. It also emphasises the role of legal frameworks and market maturity in determining the effectiveness of ESG activities, laying the groundwork for future research.

References

1. Albuquerque, R. et al. (2019). Corporate Social Responsibility and firm risk: Theory and empirical evidence. *Management Science*, 65(10), pp. 4451–4469.

2. Ang, A. et al. (2004). The cross-section of volatility and expected returns. *The Journal of Finance*, 61(1), pp. 285–299. doi:10.3386/w10852.

3. Apergis, N. et al (2022). ESG scores and cost of debt. *Energy Economics*, 112, p. 106186.

4. Austin, P.C. (2011). An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivariate Behavioral Research*, 46(3), pp. 399–424.

5. Aydoğmuş, M. et al. (2022). Impact of ESG performance on firm value and profitability. *Borsa Istanbul Review*, 22.

6. Breusch, T.S. and Pagan, A.R. (1980). The Lagrange multiplier test and its applications to model specification in Econometrics. *The Review of Economic Studies*, 47(1), p. 239.

7. Carhart, M.M. (1997). On Persistence in Mutual Fund Performance. *The Journal of Finance*, 52(1), pp. 57–82.

8. Cevik, S. and Correa-Caro, C. (2015). Growing (un)equal: Fiscal policy and income inequality in China and BRIC. *IMF Working Paper*.

9. Fama, E.F. and French, K.R. (1993). Common risk factors in the returns on stocks and Bonds. *Journal of Financial Economics*, 33(1), pp. 3–56.

10. Ferriani, F. (2023). Issuing bonds during the covid-19 pandemic: Was there an ESG premium? *International Review of Financial Analysis*, 88, p. 102653.

11. Gautam, D. et al. (2022). Sustainable finance in emerging markets is enjoying rapid growth, but may bring risks. *IMF*.

12. Hasan, Md.B. et al. (2023). Using green and ESG assets to achieve Post-covid-19 Environmental Sustainability. *Fulbright Review of Economics and Policy*, 3(1), pp. 25–48. doi:10.1108/frep-04-2022-0026.

13. Kim, S. and Li, Z. (Frank) (2021). Understanding the impact of ESG practices in Corporate Finance. *Sustainability*, 13(7), p. 3746.

14. Kirci Altinkeski, B. et al. (2024). Quantile connectedness between VIX and Global Stock Markets. *Borsa Istanbul Review*, 24, pp. 71–79.

15. Pisani, F. and Russo, G. (2021). Sustainable finance and Covid-19: The reaction of ESG funds to the 2020 crisis. *MDPI*, 13(23).

16. Porter, M.E. and Kramer, M.R. (2011). Creating Shared Value. *Harvard Business Review*.

17. Quintiliani, A. (2022). ESG and firm value. *Accounting and Finance Research*, 11(4), p. 37.

18. Rosenbaum, P.R. and Rubin, D.B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1), p. 41.

19. Scatigna, M. et al. (2021). Public support for ESG Markets: An Asian perspective. *The Bank for International Settlements*.

20. Singh, A. (2021). Covid-19 and ESG preferences: Corporate bonds versus equities. *International Review of Finance*, 22(2), pp. 298–307.

21. Slimane, Ben et al. (2019). ESG Investing in Corporate Bonds: Mind the Gap. *SSRN*.

22. Tang, D.Y. and Zhang, Y. (2018). Do shareholders benefit from Green Bonds? *Journal of Corporate Finance*, 61.

23. Taddeo, S., et al. (2024a). Rethinking the effect of ESG practices on profitability through cross-dimensional substitutability. *Journal of Environmental Management*, 352, p. 120115.

24. Tran MP-B, Vo DH (2023). Asia-Pacific stock market return and volatility in the uncertain world: Evidence from the nonlinear autoregressive distributed lag approach. *PLoS ONE*, 18(5), e0285279.

25. What are ESG bonds? (2024). Nasdaq.

Appendix

1 Raw Data and Calculations

1.1 Treatment and Control Variables for Propensity Score Matching

Before doing the Propensity Score Matching (PSM) analysis, the dataset was separated into treatment and control groups. The treatment variable consists of enterprises that have issued ESG bonds, whereas the control variable consists of firms that have not. Specifically:

- **Treatment group**: Firms with `ESGBonds` = 1. These are the firms that have issued ESG bonds.
- **Control group**: Firms with `ESGBonds` = 0. These are the firms that have not issued ESG bonds.

The dataset used for the analysis was based on two separate indexes:

- For U.S. companies, the dataset was taken from the **S&P 500 Index**.
- For Asian companies, the dataset was taken from the **HSI82**, **SSE180**, and **NIKKEI225** indices.

We matched the treatment and control variables using the propensity score matching method, where firms with `ESGBonds` = 1 (treatment) were matched with firms with `ESGBonds` = 0 (control) based on relevant covariates, such as firm characteristics.

Variable	Type	Source	Description	Reference
D/E	Control	Refinitiv WorkSpace	represents the ratio of Debt / by the value of Total Shareholders' Equity - including Minority Interest & Hybrid Debt * 100	Ferriani, F. (2023). Issuing bonds during the covid-19 pandemic: Was there an ESG premium?
ROE	Control	Refinitiv WorkSpace	(Net Income before Preferred Dividends - Preferred Dividend Requirement) / Average of Last Year's and Current Year's Common Equity * 100	Quintiliani, A. (2022). ESG and firm value.
Log_CAPEX	Control	Refinitiv WorkSpace	Encompass all capitalized expenditures for factories, equipment, software development costs and intangible assets that have a useful life of more than one year	Albuquerque, R. et al. (2019). Corporate Social Responsibility and firm risk: Theory and empirical evidence.
ROA	Dependent	Refinitiv WorkSpace	(Net Income before Preferred Dividends + ((Interest Expense on Debt - Interest Capitalized) * (1-Tax Rate))) / Average of Last Year's and Current Year's Total Assets * 100	Aydoğmuş, M. et al. (2022). Impact of ESG performance on firm value and profitability.
ESG Combined Score	Independent	Refinitiv WorkSpace	Refinitiv ESG Combined Score is an overall company score based on the reported information in ESG Score with an ESG Controversies overlay	Apergis, N. et al (2022). ESG scores and cost of debt.
ESG Bonds	Treatment/Independent	Refinitiv WorkSpace	Corporate bonds issued with the intention to fund environmentally sustainable projects or initiatives	Singh, A. (2021). Covid-19 and ESG preferences: Corporate bonds versus equities.
Price History	Supporting Variable to calculate iVOL and iVOLC	DataStream	Daily Price Performance	Hasan, Md.B. et al. (2023). Using green and ESG assets to achieve Post-covid-19 Environmental Sustainability
VIX	Supporting Variable	CBOE	The VIX Index is based on real-time options prices for the S&P 500® Index (SPX)	Kirci Altinkeski, B. et al. (2024). Quantile connectedness between VIX and Global Stock Markets.
iVOL & iVOLC	Dependent	Calculated in STATA	Firm-specific risk	Ang, A. et al. (2004). The cross-section of volatility and expected returns.
Environmental Pillar Score	Independent	Refinitiv WorkSpace	The environmental pillar measures a company's impact on living and non-living natural systems, including the air, land and water, as well as complete ecosystems	Aydoğmuş, M. et al. (2022). Impact of ESG performance on firm value and profitability.
Social Pillar Score	Independent	Refinitiv WorkSpace	The social pillar measures a company's capacity to generate trust and loyalty with its workforce, customers and society, through its use of best management practices	Aydoğmuş, M. et al. (2022). Impact of ESG performance on firm value and profitability.
Governance Pillar Score	Independent	Refinitiv WorkSpace	The corporate governance pillar measures a company's systems and processes, which ensure that its board members and executives act in the best interests of its long term shareholders	Aydoğmuş, M. et al. (2022). Impact of ESG performance on firm value and profitability.
Fama-French & Carhart Factors	Supporting Variable	Kenneth French - Data Library	Standard financial risk factors used in asset pricing models, including market risk, size, value, and momentum factors	Ang, A. et al. (2004). The cross-section of volatility and expected returns.
Note: All data spans from 2011 to 2023.				

Table 9: Summary of Data Description

Variable	N	Mean	Std. Dev.	Min	Max
ROE	6539	0.154	3.39	-255.298	22.82
DE	5827	18.882	301.741	0.001	9961
ROA	5957	0.084	0.228	-5.02	9
Log_CAPEX	5682	2.154	0.297	1.667	23.627
Escore	5648	54.785	24.617	0.093	98.546
Sscore	6021	59.996	20.454	0.263	98.258
Gscore	6021	59.498	20.719	0.699	99.408
ESG Combined Score	6028	52.654	17.438	1.901	92.542
ESG Bonds	6539	0.016	0.127	0	1
iVOL	6217	0.014	0.006	0	0.082
iVOLC	6217	0.013	0.006	0	0.082

Table 10: S&P500 Summary Statistics - Full Sample

Variable	N	Mean	Std. Dev.	Min	Max
ROE	4870	0.12	0.311	-16.885	1.165
DE	4987	0.808	1.088	0	21.886
ROA	4840	0.106	0.189	-0.843	1
Log_CAPEX	5002	17.75	3.297	2.565	25.097
Escore	3492	49.935	27.075	0.127	99.969
Sscore	3745	38.434	23.748	0.258	96.129
Gscore	3746	49.192	25.889	0.526	98.246
ESG Combined Score	3746	42.594	21.833	0.424	89.348
ESG Bonds	5174	0.042	0.2	0	1
iVOL	5527	0.02	0.007	0	0.212
iVOLC	5525	0.02	0.007	0.001	0.212

Table 11: Asia500 (HSI82, SSE180, NIKKEI225) Summary Statistics – Full Sample

2 t-tests

2.1 t-tests for U.S. variables

Test U.S.	Obs1	Obs0	Mean1	Mean0	Diff	Std Err	t value	p value
ROE - ESGBonds	6432	107	0.153	0.197	-0.044	0.331	-0.15	0.896
DE - ESGBonds	5723	104	19.194	1.768	17.426	29.858	0.6	0.559
ROA - ESGBonds	5851	106	0.085	0.060	0.025	0.022	1.1	0.267
CAPEX - ESGBonds	5603	79	2.154	2.212	-0.058	0.034	-1.7	0.085
Scope1 - ESGBonds	3954	104	1.621	1.623	-0.003	0.026	-0.1	0.927
Scope2 - ESGBonds	3869	104	1.661	1.721	-0.059	0.016	-3.65	0.001
Scope3 - ESGBonds	2838	94	1.737	1.810	-0.073	0.024	-3	0.003
CO2Eq - ESGBonds	4211	104	1.736	1.773	-0.036	0.018	-2.05	0.038
IVOL - ESGBonds	6112	105	0.013	0.015	-0.002	0.001	-2.3	0.021
IVOLC - ESGBonds	6112	105	0.013	0.015	-0.002	0.001	-2.35	0.018

Figure 7: t-tests for US variables

2.2 t-tests for Asia variables

Test	Obs1	Obs2	Mean1	Mean2	Diff	Std Err	t value	p value
ROE - ESGBonds	4655	215	0.120	0.115	0.006	0.022	0.25	0.79
DE - ESGBonds	4773	214	0.790	1.209	-0.418	0.076	-5.5	0
ROA - ESGBonds	4627	213	0.106	0.096	0.011	0.013	0.8	0.417
CAPEX - ESGBonds	4787	215	17.740	17.972	-0.232	0.23	-1.0	0.312
Scope1 - ESGBonds	2411	171	8.014	8.258	-0.245	0.245	-1.0	0.317
Scope2 - ESGBonds	2425	173	8.672	8.523	0.149	0.249	0.6	0.55
Scope3 - ESGBonds	1716	129	9.364	10.238	-0.873	0.286	-3.05	0.003
CO2Eq - ESGBonds	3097	180	9.203	9.245	-0.043	0.232	-0.2	0.855
IVOL - ESGBonds	4506	205	0.020	0.019	0.001	0.001	1.05	0.291
IVOLC - ESGBonds	4507	204	0.019	0.018	0.002	0.001	2.65	0.007

Figure 8: t-tests for Asia Variables

3 Balance check between treatment and control groups

3.1 U.S.

Variable	Matched	Treated	Control	% Bias	Bias	t	p-value	V(T)/V(C)
ROE	0.162	0.225	-7.000	-0.450	0.652	0.15	0.896	0.15
DE	1.790	19.438	-8.800	-0.530	0.597	0.00	0.317	0.00
ROA	0.074	0.088	-8.600	-0.530	0.595	0.07	0.418	0.07
CAPEX	2.209	2.171	15.000	0.940	0.346	0.10	0.320	0.10
Environmental Score	74.027	56.192	91.900	6.380	0.000	0.35	0.617	0.35
Social Score	71.716	60.930	59.200	4.550	0.000	0.660	0.418	0.660
Governance Score	64.328	60.055	20.700	1.750	0.080	1.030	0.080	1.030
ESG Combined Score	61.534	55.557	37.400	3.110	0.002	0.950	0.820	0.950
IVOL	0.015	0.014	18.500	1.760	0.078	1.61	0.092	1.61
IVOLC	0.015	0.014	18.800	1.790	0.073	1.590	0.125	1.590

Figure 9: Check balance between treated and control groups (U.S.)

3.2 Asia

Variable	Matched	Treated	Control	% Bias	Bias	t	p-value	V(T)/V(C)
ROE	0.111	0.119	-4.700	-0.530	0.594	0.68	0.796	0.59
DE	1.079	0.722	31.300	3.940	0.000	1.160	0.165	1.060
ROA	0.098	0.113	-7.600	-0.960	0.338	1.170	0.081	1.150
CAPEX	18.724	17.965	24.400	3.130	0.002	1.260	0.530	1.86
Environmental Score	55.124	50.413	17.800	2.130	0.033	0.940	0.140	1.010
Social Score	44.643	40.607	17.400	2.110	0.035	0.970	0.103	1.060
Governance Score	49.306	49.977	-2.600	-0.320	0.750	1.020	0.120	1.000
ESGCombined Score	46.808	45.167	7.600	0.950	0.343	1.140	0.480	1.160
IVOL	0.019	0.019	-6.400	-0.730	0.468	0.730	0.071	0.30
IVOLC	0.018	0.019	-15.900	-1.700	0.090	0.490	0.305	0.750

Figure 10: Check balance between treated and control groups (Asia)

4 Hausman Test

Variable	U.S. Chi-square test value	U.S. *p-value*	Asia Chi-square test value	Asia *p-value*
ROA	1.526	0.91	30.983	0
IVOL	10.404	0.065	7.084	0.214
IVOLC	10.163	0.071	9.049	0.107

Figure 11: Hausman Test

5 Wooldridge Test

Variable	U.S. F-value	U.S. Prob >F	Asia F-value	Asia Prob >F
Autocorrelation Test	1.760	0.1924	2.074	0.1539

Figure 12: Wooldridge Test

6 Summary Statistics of the profitability of firms that have issued bonds

Year	N	Mean	SD	Min	Max
2011	9	0.114	0.034	0.074	0.159
2012	8	0.081	0.066	0.007	0.225
2013	12	0.068	0.053	0.004	0.184
2014	4	0.106	0.120	0.030	0.285
2015	9	0.059	0.049	-0.008	0.154
2016	15	-0.251	1.315	-5.000	0.210
2017	13	0.081	0.054	0.009	0.210
2018	15	0.059	0.046	-0.010	0.136
2019	24	0.069	0.048	0.008	0.161
2020	37	0.078	0.069	-0.016	0.298
2021	55	0.091	0.066	0.009	0.353
2022	42	0.078	0.056	-0.008	0.246
2023	31	0.091	0.080	0.004	0.286

Table 12: Summary Statistics of Profitability of U.S. ESG bond issuers

Year	N	Mean	SD	Min	Max
2011	17	0.013	0.025	-0.039	0.079
2012	24	0.079	0.146	-0.047	0.688
2013	33	0.113	0.210	-0.016	0.820
2014	34	0.067	0.089	-0.038	0.419
2015	41	0.093	0.173	-0.057	0.774
2016	25	0.072	0.120	-0.023	0.614
2017	38	0.111	0.190	-0.046	0.950
2018	41	0.133	0.221	-0.049	0.813
2019	38	0.144	0.260	-0.023	0.924
2020	62	0.088	0.209	-0.165	0.973
2021	71	0.127	0.227	-0.150	0.989
2022	83	0.117	0.190	-0.011	0.964
2023	73	0.109	0.204	-0.007	0.999

Table 13: Summary Statistics of Profitability of Asian ESG bond issuers

7 Propensity Score Matching for Robustness Checks

VARIABLES	Pre-Covid	Post-Covid
ROE	-0.0698	-9.87e-05
	(0.111)	(0.00302)
D/E	-0.0172	-0.00238
	(0.0181)	(0.00477)
Log_CAPEX	0.203	-0.156*
	(0.377)	(0.0835)
ESG Combined Score	0.00685	-8.08e-05
	(0.00712)	(0.000370)
ESG Bonds	0.185	0.0136
	(0.174)	(0.00865)
Constant	-0.881	0.423**
	(1.137)	(0.196)
N	48	167
R-squared	0.0205	0.0201
Number of Companies	40	136

Table 14: Robustness Checks Pre-Covid vs Post-Covid for ROA - U.S. (PSM)

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

VARIABLES	Pre-Covid	Post-Covid
ROE	0.0612***	-0.000350***
	(0.0183)	(7.80e-05)
D/E	-0.000135	-0.00377
	(0.000432)	(0.00301)
Log_CAPEX	0.0127	-0.0133
	(0.0188)	(0.00966)
ESG Combined Score	0.000126***	-0.000147
	(1.46e-05)	(0.000110)
ESG Bonds	0.00145**	-0.00147
	(0.000597)	(0.00126)
Constant	-0.0310	0.0586**
	(0.0431)	(0.0225)
N	48	167
R-squared	0.629	0.236
Number of Companies	40	136

Table 15: Robustness Checks Pre-Covid vs Post-Covid for iVOL - U.S. (PSM)

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

VARIABLES	Pre-Covid	Post-Covid
ROE	0.0613***	-0.000350***
	(0.0196)	(8.00e-05)
D/E	-0.000182	-0.00369
	(0.000490)	(0.00290)
Log_CAPEX	0.0102	-0.0139
	(0.0204)	(0.00878)
ESG Combined Score	0.000130***	-0.000136
	(1.51e-05)	(0.000105)
ESG Bonds	0.00152**	-0.00131
	(0.000644)	(0.00125)
Constant	-0.0258	0.0590***
	(0.0468)	(0.0205)
N	48	167
R-squared	0.637	0.229
Number of Companies	40	136

Table 16: Robustness Checks Pre-Covid vs Post-Covid for iVOLC - U.S. (PSM)

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

VARIABLES	Pre-Covid	Post-Covid
ROE	0.966	-0.00543
	(0.666)	(0.111)
D/E	-0.00760	-0.000841
	(0.00840)	(0.00676)
Log_CAPEX	-0.0394	-0.000842
	(0.0320)	(0.00135)
ESG Combined Score	0.000760	0.000374
	(0.000720)	(0.000439)
ESG Bonds	0.0948	0.00573
	(0.0729)	(0.00624)
Constant	0.602	0.107***
	(0.483)	(0.0386)
Observations	88	359
R-squared	0.337	0.014
Number of Companies	67	214

Table 17: Robustness Checks on Asia Pre- and Post-COVID19 – Asia (PSM)

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

VARIABLES	Pre-Covid	Post-Covid
ROE	-0.00186	0.00170
	(0.00185)	(0.00234)
D/E	0.000200	4.79e-05
	(0.000282)	(0.000224)
Log_CAPEX	0.000319**	2.47e-06
	(0.000130)	(0.000117)
ESG Combined Score	1.30e-05	1.83e-05
	(2.21e-05)	(1.33e-05)
ESG Bonds	0.000366	-4.79e-05
	(0.00102)	(0.000611)
Constant	0.0106***	0.0184***
	(0.00262)	(0.00235)
Observations	88	359
R-squared	0.0105	0.0116
Number of Companies	67	214

Table 18: Robustness Checks on iVOLPre- and Post-COVID19 – Asia (PSM)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

VARIABLES	Pre-Covid	Post-Covid
ROE	-0.000499	-0.000357
	(0.00201)	(0.00170)
D/E	-0.000188	-0.000250
	(0.000179)	(0.000220)
Log_CAPEX	0.000202*	0.000144
	(0.000116)	(0.000105)
ESG Combined Score	-1.56e-05	-1.36e-05
	(2.03e-05)	(1.18e-05)
ESG Bonds	0.00119	0.000513
	(0.00104)	(0.000468)
Constant	0.0136***	0.0165***
	(0.00218)	(0.00211)
Observations	88	359
R-squared	0.1447	0.0371
Number of Companies	67	214

Table 19: Robustness Checks on iVOLC Pre- and Post-COVID19 – Asia (PSM)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

8 Entropy Matching for Robustness Checks

VARIABLES	Pre-Covid	Post-Covid
ROE	-0.0178	0.00438
	(0.0188)	(0.00401)
D/E	1.25e-05***	1.53e-05*
	(4.50e-06)	(8.41e-06)
Log_CAPEX	-0.0128***	-0.0495
	(0.00170)	(0.0600)
ESG Combined Score	0.000951**	-0.000124
	(0.000384)	(0.000355)
ESG Bonds	-0.00502	-0.0230**
	(0.0204)	(0.0107)
Constant	0.0614***	0.210*
	(0.0199)	(0.122)
N	3,232	1,636
R-squared	0.0077	0.0011
Number of Companies	436	448

Table 20: Robustness Checks on ROA Pre- and Post-COVID19 – U.S. (Entropy Matching)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

VARIABLES	Pre-Covid	Post-Covid
ROE	5.71e-05	-9.86e-05
	(9.07e-05)	(8.63e-05)
D/E	8.51e-08	-3.91e-07***
	(8.04e-08)	(7.67e-08)
Log_CAPEX	3.15e-06	-0.0305***
	(2.79e-05)	(0.00910)
ESG Combined Score	2.45e-05***	-2.90e-05**
	(8.80e-06)	(1.31e-05)
ESG Bonds	-0.000806	-0.000334
	(0.000665)	(0.000615)
Constant	0.0112***	0.0837***
	(0.000457)	(0.0197)
N	3,112	1,645
R-squared	0.007	0.036
Number of Companies	430	452

Table 21: Robustness Checks on iVOL Pre- and Post-COVID19 – U.S. (Entropy Matching)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

VARIABLES	Pre-Covid	Post-Covid
ROE	5.70e-05	-9.40e-05
	(8.86e-05)	(8.45e-05)
D/E	6.91e-08	-3.70e-07***
	(8.24e-08)	(7.83e-08)
Log_CAPEX	5.45e-06	-0.0282***
	(2.63e-05)	(0.00854)
ESG Combined Score	2.56e-05***	-2.82e-05**
	(8.64e-06)	(1.25e-05)
ESG Bonds	-0.000711	-0.000305
	(0.000650)	(0.000595)
Constant	0.0109***	0.0786***
	(0.000448)	(0.0185)
N	3,112	1,645
R-squared	0.008	0.034
Number of Companies	430	452

Table 22: Robustness Checks on iVOLC Pre- and Post-COVID19 – U.S. (Entropy Matching)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

VARIABLES	Pre-Covid	Post-Covid
ROE	0.146***	0.189***
	(0.0561)	(0.0608)
D/E	0.00106	0.00463
	(0.00303)	(0.00492)
Log_CAPEX	0.000172	0.00251
	(0.00106)	(0.00197)
ESG Combined Score	3.89e-06	0.000322
	(0.000139)	(0.000232)
ESG Bonds	0.00264	0.0171
	(0.0255)	(0.0107)
Constant	0.0915***	0.0497
	(0.0194)	(0.0391)
Observations	2,189	1,232
R-squared	0.028	0.061
Number of Companies	295	320

Table 23: Robustness Checks on ROA Pre- and Post-COVID19 – Asia (Entropy Matching)

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

VARIABLES	Pre-Covid	Post-Covid
ROE	0.000563	0.00180
	(0.00115)	(0.00118)
D/E	-8.21e-05	-2.77e-05
	(8.19e-05)	(0.000176)
Log_CAPEX	1.68e-05	-0.000155*
	(4.77e-05)	(8.92e-05)
ESG Combined Score	2.06e-06	1.59e-05*
	(5.81e-06)	(8.67e-06)
ESG Bonds	0.000137	0.000261
	(0.00132)	(0.000501)
Constant	0.0193***	0.0220***
	(0.000956)	(0.00172)
Observations	2,082	1,155
R-squared	0.0006	0.0016
Number of Companies	291	318

Table 24: Robustness Checks on iVOL Pre- and Post-COVID19 – Asia (Entropy Matching)

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

VARIABLES	Pre-Covid	Post-Covid
ROE	0.00130	0.000196
	(0.00226)	(0.000926)
D/E	-0.000407***	2.68e-05
	(0.000103)	(0.000181)
Log_CAPEX	-4.59e-06	-3.94e-05
	(4.33e-05)	(7.30e-05)
ESG Combined Score	-1.07e-05	3.17e-06
	(1.30e-05)	(7.18e-06)
ESG Bonds	-0.000405	-0.000169
	(0.000988)	(0.000472)
Constant	0.0205***	0.0205***
	(0.00108)	(0.00145)
Observations	2,076	1,160
R-squared	0.0058	0.0000
Number of Companies	287	317

Table 25: Robustness Checks on iVOLC Pre- and Post-COVID19 – Asia (Entropy Matching)

Robust standard errors in parentheses; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Again, as with earlier data, ESG Bonds had no direct impact on ROA in both timeframes. The lack of significant findings shows that enterprises issuing ESG bonds may not see an increase in profitability as a result of their issue. Furthermore, ESG bonds have no effect on IVOL under the Fama-French model, regardless of time period. The absence of relevance indicates that issuing ESG bonds has no major impact on idiosyncratic volatility. At the same time, ESG bonds were not a significant predictor of IVOLC before or after the pandemic. Under the Carhart model, the findings indicate that ESG bond issuance has no meaningful influence on idiosyncratic volatility.

9 Additional Analysis Details

The adjusted R^2 is a modified version of the coefficient of determination (R^2) that compensates for the number of predictors in the model vs the number of data. It's computed as:

$$R^2_{\text{adj}} = 1 - \left(\frac{(1 - R^2)(N - 1)}{N - k - 1} \right) \tag{9}$$

Where:

- R^2: The coefficient of determination.
- N: The total number of observations.
- k: The number of independent variables in the model.

To make sure that the models are not incorrectly specified, the adjusted R^2 was calculated for all of the fixed effects models of this thesis. Specifically:

$$\text{ROA}_{it} = \beta + \beta_i \text{Firm Controls}_{it} + \Delta_i \text{ESGBonds}_{it} + u_i + \varepsilon_{it} \tag{10}$$

$$\text{ROA}_{it} = \beta + \sigma_i \text{ESG}_{it} + \beta_i \text{Firm Controls}_{it} + \Delta_i \text{ESGBonds}_{it} + u_i + \varepsilon_{it} \tag{11}$$

$$\text{iVOL}_{it} = \beta + \sigma_i \text{ESG}_{it} + \beta_i \text{Firm Controls}_{it} + \Delta_i \text{ESGBonds}_{it} + u_i + \varepsilon_{it} \tag{12}$$

$$\text{iVOLC}_{it} = \beta + \sigma_i \text{ESG}_{it} + \beta_i \text{Firm Controls}_{it} + \Delta_i \text{ESGBonds}_{it} + u_i + \varepsilon_{it} \tag{13}$$

Where:

- ROA_{it}: Return on assets for firm i at time t (dependent variable).
- iVOL_{it}: Idiosyncratic volatility for firm i at time t (dependent variable).
- iVOLC_{it}: Idiosyncratic volatility (Carhart) for firm i at time t (dependent variable).
- ESG_{it}: Environmental, Governance and Social individual pillar score for firm i at time t.
- ESGScore_{it}: ESG combined score for firm i at time t.
- ESGBonds_{it}: ESG bonds issued by firm i at time t.
- u_i: Firm-specific fixed effects.

- ε_{it}: Error term.

The regression models are estimated using the ixed effects model with robust standard errors to account for heteroskedasticity.