SCHOOL OF
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Bachelor's Programme in Economy and Society

Investing in Emerging Markets
Environmental Performance and its Effect on Risk Profile

By

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ABSTRACT

Debt has gained paramount importance for policy makers, stakeholders, and investors due to its far-reaching implications on economic stability, growth prospects, and financial resilience. Meanwhile, environmental conditions are increasing in importance when assessing credit risk. This study examines the relationship between environmental risk, environmental progress, and credit default swap (CDS) spreads in emerging economies. The findings reveal a significant positive impact of environmental risk on CDS spreads. However, there is no sufficient evidence for the effect of environmental progress on CDS spreads. The results have implications for sovereign debt investment, risk assessment, and sustainable policies. The results also highlight the amplified influence of environmental factors during economic downturns and the complex dynamics within emerging economies. While acknowledging limitations, we suggest future research explore broader implications, economic conditions, and standardized frameworks for incorporating environmental considerations in risk assessment.

Keywords: CDS spread, sovereign debt, ESG, environment, emerging economies

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List of Abbreviations

AM - Asset Management

BP - Basis points

CDS - Credit Default Swap

CFA - Chartered Financial Analyst

CO2 - Carbon dioxide

EF - Ecological Footprint

EU - European Union

ESG - Environmental Social and Governance

FD - Financial Development

HSBC AM - Hongkong and Shanghai Banking Corporation Asset Management

IMF - International Monetary Fund

GDP - Gross Domestic Product

KMO - Kaiser-Meyer-Olkin

MSCI - Morgan Stanley Capital International

OECD - The Organization for Economic Cooperation and Development

PCA - Principal Component Analysis

PRI - Principles for Responsible Investment

UNEP - United Nations Environment Programme

US - United States

USD - United States dollar

WDI - World Development Indicators

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1. Introduction

The financial crisis of 2008 shook the world economy and consequently led the EU to enter what is now known as the Great Recession, spanning from 2008 to 2009 (Szczepanski, 2019). This was followed by a sovereign debt crisis, exacerbated by the collapse of several financial institutions, increases in government debt, and rapidly rising bond yield spreads in government securities (Szczepanski, 2019). The crisis nearly broke the euro, necessitated numerous bail-outs, and left a lasting impact on sovereign debt worldwide.

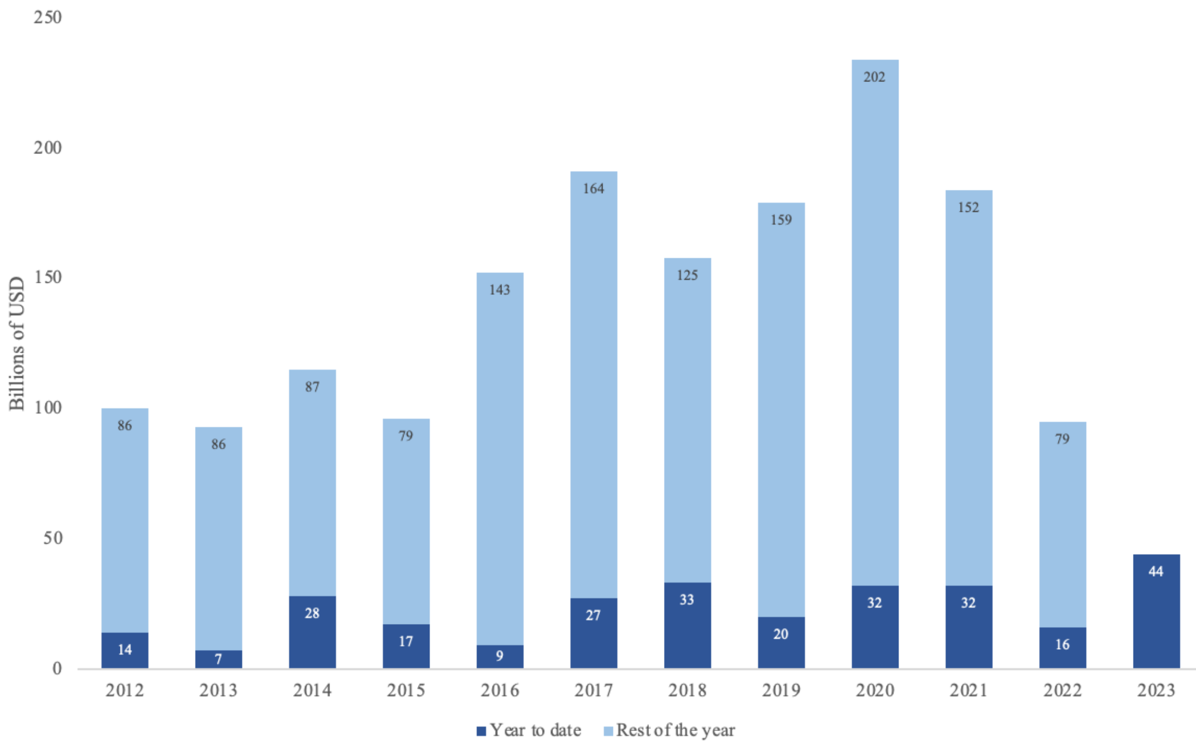
As countries began defaulting on their loans, the conventional perception of sovereign debt started shifting. Today, we can no longer accept the notion that these assets are risk-free (Cheng et al., 2022; UNEP, 2012).

In light of the prevailing economic climate and the recent Covid-19 pandemic, debt in emerging economies has drastically increased. Amidst the crisis, nations across the world were compelled to adopt extractionary fiscal policies in order to absorb the shockwaves caused by the pandemic, resulting in significant spikes in debt (Cakmakli et al., 2020). In 2023, debt issuance in emerging markets skyrocketed to unprecedented levels, reaching a sovereign supply of 44 billion USD as early as January, as illustrated in Figure 1.1.

As a result, the creditworthiness and security of sovereign bonds have come under intense scrutiny, highlighting the need for more robust risk assessments and rigorous valuation methods. This need is particularly pronounced among emerging economies, as they remain more vulnerable to external shocks compared to already developed nations (International Monetary Fund, 2022, Ch. 2)

Figure 1.1

Emerging markets sovereign bond supply in billion of USD



Note: Date until January 26

Source: Reuters (2023)

To properly assess risk and value of sovereign debt, increasing attention has been paid to extra-finanical considerations. One heavily incorporated component in investment has been Environmental, Social and Governance (ESG) conditions (UNEP, 2012; PRI, 2019). The demand for incorporating these additional indicators of risk and value has been high on demand among stakeholders and investors and been heavily adopted within firms. In comparison however, the integration of ESG factors in the valuation of government fixed-income instruments has been subpar (PRI, 2019). Due to the volatile nature of emerging economies, studies have found ESG integration to have higher importance when investing in emerging markets than in developed markets (Rahman et al., 2021), making this highly relevant for future valuation models within these markets. These findings highlight the importance of examining the possible impacts of extra-financial conditions on sovereign debt within emerging economies. As we move closer to heightened levels of indebtedness and the possibility of a global recession, being able to properly assess sovereign risk profile becomes even more pressing and demands greater attention.

With increasing concern being paid to the potential impact of climate change on politics and economics, environmental impact grows more acute to adopt into these valuation models. This study will therefore focus on the E of ESG and examine the impact of environmental risk and progress on the risk profile of emerging economies.

1.1 Aim of the study

The aim of this bachelor thesis is to comprehensively examine the impact of environmental risk and progress, utilizing indicators collected from the World Development Indicators (WDI), on credit default swap (CDS) spreads in emerging economies. The primary objective is to analyze how environmental factors, encompassing aspects such as carbon emissions, renewable energy consumption, tree cover loss, and energy intensity, influence the pricing of CDS spreads, which serve as indicators of a country's credit risk (Jeanneret, 2019). Through analysis and econometric modeling, this study aims to contribute to a better understanding of the dynamic relationship between environmental factors and financial markets. By providing empirical evidence and quantitative assessments, it seeks to contribute to the ongoing academic and policy discussions surrounding the incorporation of environmental considerations into sovereign credit risk assessment frameworks.

This will be done with the following research questions at hand:

> How does environmental risk affect sovereign CDS spread?
>
> How does environmental progress affect sovereign CDS spread?

1.2 Scope of the study

Capelle-Blancard et al. (2019) differentiates the reserach conducted on increasing extra-financial measures in valuation models to be of two different natures. The first category argues that extra-financial considerations, such as those encompassed in environmental, social, and governance (ESG) criteria, serve as an ethical motivation for investors and stakeholders. The second category emphasizes the empirical relationship between extra-financial conditions and sovereign risk, calling for thorough analysis and examination of this association. The scope of this study solely focuses on the second category and aims to investigate the potential relationship between environmental conditions and sovereign credit risk.

This study does not delve into the ethical considerations surrounding extra-financial measures. Instead, its aim is to rigorously examine the empirical link between environmental conditions and sovereign credit risk. By focusing on this empirical relationship between environmental conditions and sovereign credit risk, it seeks to provide a deeper understanding of the factors that determine risk profiles. The findings will contribute to ongoing discussions surrounding the integration of environmental factors into credit risk assessment frameworks and offer practical insights for decision-makers in assessing the financial implications of environmental risks.

1.3 Defintions

This paper encompasses terms such as risk profile and risk of default. As the scope of the study limits itself to investigating the effect of economic performance on CDS spread, our definition of these terms is also limited to performance of CDS spread. Both risk profile and risk of default is therefore used synonymous with the basic characteristics of credit default swaps and their functioning.

The argument for doing this is partly the consistent nature of CDS, which makes them suitable for panel model regression. This means CDS can consistently be compared across countries due to their standardized features such as similar maturity dates, restructuring clauses and currency denominations (Jeanneret, 2018). It is also due to the basic characteristics of CDS spreads, which corresponds to the rate that determines the periodic payments by the buyer throughout the life of the CDS contract which means it reflects the government’s probability of default (Hübel, 2020).

1.4 Thesis outline

The next section of the paper will present a background on credit default swaps and ESG, as well as a literature review of previous research made on the topic. This part aims to provide knowledge about the nature of credit default swaps, their current rating framework, and where these frameworks lack. The intention here is to synthesize the existing literature and address any gaps in previous research. An argument will be made that the current research on the topic has further to go and more areas to explore more thoroughly. Based on previous research, hypotheses will be presented.

Following this, the data used in the study will be presented. All statistical procedures that occurred prior to the hypothesis testing will be explained. Descriptive statistics on the final version of the data will be presented. The method for the regression analysis is then presented. This part includes all econometric reasoning used when deciding on model specifications for hypothesis testing.

The main results are presented, followed by some additional results to assess the robustness of the outcomes in different circumstances. Following the results section is the discussion, and later the final conclusions of the paper are presented.

2. Literature review

2.1 Background and theory

2.1.1 Credit Default Swaps (CDS) and sovereign debt

Sovereign credit default swaps (CDS) are a type of financial derivative. These financial instruments derive their value from an underlying asset, which in the case of CDS is the risk of a country defaulting on its debt. CDS function similarly to insurance policies, as the buyer of the CDS receives a payout if the underlying asset fails. This means that the price of a sovereign CDS increases with the risk of default in a country. In other words, the higher the likelihood of a country defaulting on its debt, the higher the price of its CDS. (CFA, 2023)

Credit default swap (CDS) prices are commonly expressed as credit spreads, and represent the implied number of basis points paid by the buyer of credit protection to the seller to compensate for the risk of default. This paper uses CDS spreads as it reflects the cost of providing the protection and is used as a measure of the credit risk associated with a particular issuer or instrument (CFA, 2023). Because credit default swaps (CDS) have standardized features such as similar maturity dates, restructuring clauses, and currency denominations, they can be compared consistently across different countries and are therefore suitable for a panel model regresison (Jeanneret, 2018). This standardization allows investors to assess and compare the credit risk of various countries in a uniform manner.

2.2 Literature review and hypothesis

Standards and Poor's (S&P), which are one of The Big Three credit rating agencies, present five key areas to determine a sovereign's creditworthiness: institutional assessment, economic assessment, external assessment, fiscal assessment, and monetary assessment (S&P, 2019). These pillars, in turn, incorporate parameters such as the country's income level, growth prospects, economic diversity and volatility, the status of a sovereign's currency in international markets, external liquidity, resident's assets and liabilities, the exchange rate regime and the credibility of monetary policy.

Environmental, social and governance (ESG) conditions have been increasingly adopted into the framework of investment as there is demand for more sustainable investment (PRI, 2019).

While ESG conditions have been increasingly adopted into the frameworks of debt investment, the incorporation of extrafinancial conditions such as these have been lacking within sovereign debt, when compared to corporate debt (PRI, 2019). As they work to assess the sustainability and risk of economies over the dimensions of environment, social conditions and governance, they are highly relevant for obtaining full transparency on a country's risk of default.

The vast majority of empirical literature on sovereign debt examines the impact of macroeconomic and financial market climates on sovereign bond performance, measured in terms of bond yield and CDS spreads. Recently, however, a new dimension of research has emerged, exploring the influence of extra-financial determinants, such as ESG conditions, on sovereign bond yield spread. Research specifically focused on the impact of environmental conditions on CDS spread and sovereign debt is limited. Moreover, the literature varies in its coverage of developing and developed countries, with studies primarily focused on emerging economies being underrepresented.

The following section of this paper aims to provide a chronological account of existing research pertaining to extra-financial factors in sovereign debt. Additionally, it seeks to identify and address any gaps in the research that are relevant to our present study

2.2.1 Early literature on macroeconomic and financial determinants of CDS

Early studies have examined the influence of the financial and economic climate on the behavior of sovereign CDS. Edwards (1986; 1984) investigates how macroeconomic fundamentals affected CDS spreads and found that variables such as debt-to-output ratio, reserves-to-GDP ratio, current account-to-GDP ratio, and inflation had significant positive coefficients in spread regressions. Recent studies on CDS spreads have confirmed this and indicated that public debt and debt-to-GDP ratio lead to an endogenous increase in CDS spreads (Huyugüzel Kışla et al., 2022; Stamatopoulos et al., 2017; Dieckmann & Plank, 2012). This will prove important to us when deciding on control variables.

Further, Hilscher and Nosbusch (2010) found that volatility in macroeconomic fundamentals, such as terms of trade, had significant explanatory power in sovereign spread variation in emerging markets. Dieckmann and Plank (2012) also investigated the comovement of CDS spreads and the financial market during the Eurozone crisis and found that the monetary authority had a significant impact on the sensitivity between financial markets and CDS prices. In particular, countries that had adopted the euro experienced higher sensitivity to the health of financial systems.

2.2.2 Early adaptation of ESG

Earlier literature on extra-financial determinants of sovereign debt used an early adaptation of ESG terminology and primarily focused on governance conditions. In their study, Ciochini et al. (2003) investigated governance conditions and their effects on sovereign bond spreads in emerging markets. They found that countries with higher levels of corruption were subject to increased risk premium payments when issuing bonds. Several similar studies have been conducted on the subject of governance.

Drut (2010) was the first to examine the early ESG data set forth by Vigeo and its impact on the mean-variance efficient frontier in developed countries. His findings demonstrate that portfolios with higher-than-average responsible ratings can be constructed for portfolio investing without incurring significant loss of return.

Several studies have since expanded upon the framework established by Drut (2010), resulting in a collection of ESG-based research within the field of sovereign debt.

2.2.3 The impact of ESG on sovereign debt

Several studies have investigated the impact of ESG performance on sovereign bond spreads, i.e., the difference in yield on different bonds. Crifo et al. (2017) found that OECD countries with higher ESG ratings have lower borrowing costs than OECD countries with lower ESG ratings. However, these effects were found only to impact a third of the effect as financial ratings, indicating that ESG could sufficiently work as a supplement to already established financial ratings. Similarly, Capelle-Blancard et al. (2019) investigated whether ESG has an impact on the risk of default and sovereign bond yield spread in OECD countries. They found a strong negative correlation between ESG rating and both risk of default and sovereign bond yield spread, with social and governance conditions accounting for the effect, while environmental dimensions had little to no statistical inference.

Margaretic and Pouget (2018) also investigated the impact of ESG on bond spreads but focused their research on emerging markets rather than the OECD. Similar to the results of Capelle-Blancard et al. (2019) and Crifo et al. (2017), they found capital costs in countries with higher social and governance performance to be lower than in those with low social and governance performance.

Similar research has also been conducted, with a primary focus on CDS spreads rather than bond yield spreads. Jeanneret (2018) investigated how CDS spreads interacted with the level of governance and found that CDS spreads decreased with government efficiency. His results indicate that government efficiency accounts for decreased risk of default, which becomes most prominent in times of deteriorating fiscal conditions.

Building on the research of Jeanneret (2018) and Capelle-Blancard (2019), Hübel (2022) incorporated all ESG conditions when analyzing CDS spreads and covered approximately 60 countries in his study. The results indicated that countries with weaker ESG performance experienced lower CDS spreads and flatter CDS credit curves, suggesting a risk mitigation effect that becomes increasingly significant over time. The increasing significance over time was mainly driven by environmental and social conditions, highlighting the long-term risk-reducing effect of social and environmental sustainability. Hübel (2020) also found that environmental and governance conditions still remained significant after controlling for credit ratings, indicating that social conditions seem to be adequately incorporated into credit rating, while environmental and governance conditions are not. Reznick et al. (2019) had similar findings. This calls for further research within this area.

A study of similar relevance, which incorporates both sovereign bond yield spreads and CDS spreads, is that of Pineau et al. (2022). They examined the impact of ESG on creditworthiness by investigating bond yields and CDS spreads. Their findings revealed that governance was the primary determinant in advanced economies, while the environment played a crucial role in developing agrarian economies. Furthermore, they observed that advanced developing countries were primarily influenced by non-ESG factors, which supported their rapid economic growth. Pineau et al. (2022) also found temporary impacts on the importance of ESG ratings caused by financial crises and economic recessions, with results indicating that market turbulence diminished the effect ESG has on sovereign debt.

Hill Clarvis et al. (2014) identify linkages between environmental risks and macroeconomic variables already recognized as relevant to sovereign credit risk. They adopt an approach that concentrates on resource balance, trade-related risks, degradation-related risks, and financial resilience. Their work emphasizes the significance of environmental risk on sovereign debt through these channels.

Lastly, De Boyrie and Pavlova (2020) examined the specific influence of environmental conditions on the cost of insuring sovereign debt across a study involving 50 countries. Their findings reveal that robust environmental performance correlates negatively with CDS spreads, suggesting a connection between environmental performance and reduced credit risk.

While research has been conducted on the impact of environmental conditions on sovereign debt and sovereign CDS spreads, the existing literature remains incomplete. This research paper aims to contribute to the literature, focusing specifically on CDS spreads in emerging countries. Furthermore, the paper will delve into a novel categorization of environmental conditions, distinguishing between risk variables and progress variables, an approach that has not been explored before.

Drawing upon the existing knowledge within the field, the main hypothesis of this paper posits that environmental conditions do show significant impact on CDS spread and should therefore be reflected in both environmental progress and risk.

3. Data

3.1 Sample size and population

The population of this study encompasses the list of emerging economies provided by the International Monetary Fund (IMF) in 2022. The list comprises 20 countries: Argentina, Brazil, Chile, China, Colombia, Egypt, Hungary, India, Indonesia, Iran, Malaysia, Mexico, the Philippines, Poland, Russia, Saudi Arabia, South Africa, Thailand, Turkey, and the United Arab Emirates.

However, the sample size is limited to 14 of these countries due to the lack of Credit Default Swaps (CDS) data. The included countries are Argentina, Brazil, Chile, China, Colombia, Hungary, Indonesia, Malaysia, Mexico, the Philippines, Poland, South Africa, Thailand, and Turkey. This data will undergo analysis for the period spanning from 2005 to 2020, resulting in approximately 220 observations per variable. Given the availability of environmental and macroeconomic data, all information will be gathered on an annual, end-of-year basis.

3.2 Credit Default Swap (CDS) data

Our data depends on Credit Default Swap (CDS) as an indicator of risk of default which acts as the dependent variable of the regression. A CDS is an insurance contract which covers the default risk of a country. The protection buyer of the CDS is entitled to receive compensation if the country defaults, and in exchange, the protection buyer makes periodic payments. The CDS spreads determine these payments and are therefore directly linked to the country's probability of default (Hübel, 2020; Jeanneret, 2018).

Our analysis considers sovereign, 5-year CDS spreads collected from Bloomberg. Our sample is limited to end-of-year spread observations of CDS denominated in US dollars. The data consists of observations from 15 emerging economies, during the period 2005 to 2020.

3.3 Environmental index

To get a fair representation of each environmental variable and their weight of importance in the sample, two environmental indeces are created. The following section describes the construction of these indexes, which acts as the two independent variables used in this study. This includes the selection of variables and the statistical framework used to create the environmental indices that are intended to represent environmental progress and environmental risk, and to act as independent variables in this study.

3.3.1 Compiling and testing the data

Numerous scholars studying ESG-related performance often utilize established ESG indices developed by various rating agencies as an approach for their studies (Hübel, 2022; Margaretic & Pouget, 2018; Brut, 2010). However, established ESG ratings are often anchored in policies and symbolic activities and do not directly measure raw data on progress in environmental, social, or governance performance (Gonenc & Sholtens, 2017; Chatterji et al., 2009). This means that phenomena such as greenwashing and empty political promises are not properly judged. This is an aspect of ESG ratings that often comes under scrutiny, as it limits the transparency of the ratings. To address this issue, a composite index of directly observable items will be constructed, utilizing the Principal Component Analysis (PCA) approach. While this approach has previously been adopted by scholars such as Capelle-Blancard et al. (2019) and Nicoletti et al. (2000), this paper will mainly follow the econometric approach described by Tabachnick and Fidell (2007).

The variables choosen for the two indices corresponds to VIGEO's (2013) four recommended ESG dimensions for calculating environmental perfomance, namely: air quality, water and sanitation, forests, and renewable energy. Air quality, water and sanitation as well as forests, are also advocated as key indicators of environmental performance in ESG analysis reports published by HSBC AM (2013), Natixis AM (2013) and MSCI ESG Research (2011).

The suggested environmental data is compiled from World Development Indicators (WDI) and categorized as either environmental progress or environmental risk, as has been presented in Table 3.1.

Table 3.1
Environmental dimensions

Dimensions	Measuring items	Code	Source
Environmental progress			
Forests	Forest area (% of land area)	Forest area	WDI
Renewable energy	Renewable energy consumption (% of total final energy consumption)	Renewable energy	WDI
Environmental risk			
Air quality	CO2 emission (metric tons per capita)	CO2 emission	WDI
Water and sanitation	Level of water stress (freshwater withdrawal as a proportion of available freshwater resources)	Water stress	WDI
Forests	Tree cover loss (hectares)	Tree cover loss	WDI
Renewable energy	Energy intensity level of primary energy (MJ/$2017 PPP GDP)	Energy intensity	WDI

Table 3.2
Kaiser–Meyer–Olkin (KMO) results.

Variable	KMO	Grade[a]
CO2 Emission	0.6342	Mediocre
Water stress	0.8038	Meritorious
Tree cover loss	0.6912	Mediocre
Energy Intensity	0.6372	Mediocre
Forest area	0.7457	Middling
Renewable energy	0.6518	Mediocre
Overall	0.6837	Mediocre

Note: The KMO value should optimally lie between 0.8 and 1, however, must be at least 0.6 to be deemed adequat for a PCA analysis.
a. According to the Kaiser, the results of an KMO should be graded as follows: 0.00 to 0.49 unacceptable, 0.50 to 0.59 miserable, 0.60 to 0.69 mediocre, 0.70 to 0.79 middling, 0.80 to 0.89 meritorious, 0.90 to 1.00 marvelous

To assess the adequacy of these variables within the sample, a Kaiser-Meyer-Olkin (KMO) test is conducted. This test measures the suitability of the dataset for a Principal Component Analysis (PCA). The KMO statistic gauges the proportion of variance among the variables that can be attributed to common variance, also known as systematic variance. For factor analysis to be appropriate, this statistic should fall within the range of 0.6 to 1.0 (Tabachnick and Fidell, 2007). In simpler terms, the data set must exhibit a meaningful degree of correlation to share common factors. The outcomes of the KMO test are presented in Table 3.2, demonstrating that all variables have values >0.6, confirming their adequacy for proceeding with the factor analysis.

3.3.2 Principal Component Analysis (PCA)

The first step of the PCA is presented in Table 3.3, where six principal components, also referred to as principal axes, have been generated. These principal components identify linear combinations that are ordered based on the variance they explain in the original dataset (Tabachnick and Fidell, 2007). Each principal component corresponds to an eigenvalue, which indicates the percentage of variation explained in the entire dataset (Tabachnick and Fidell, 2007).

Following Kaiser's criterion, only components with an eigenvalue > 1.0 will be retained for use in the subsequent stages of the PCA. This selection process results in two principal components remaining, as shown in Table 3.3 and Figure 3.1.

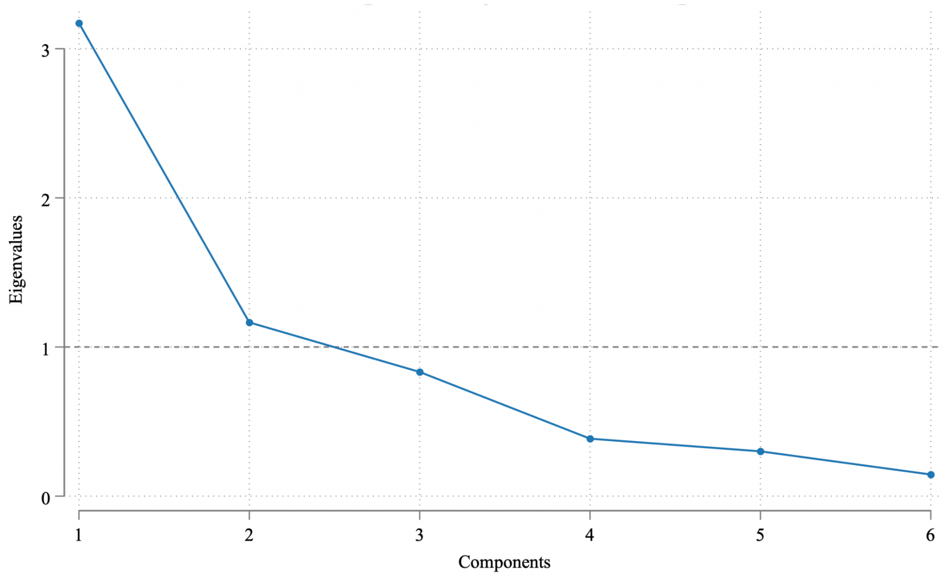
Table 3.3
Total variance explained by the eigenvalue of the retained components

Component	Eigenvalue	Differnce	Proportion	Cumulative
1	3.1717	2.0069	0.5286	0.5286
2	1.1648	0.3321	0.1941	0.7228[a]
3	0.8327	0.4474	0.1388	0.8615
4	0.3854	0.0849	0.0642	0.9258
5	0.3005	0.1555	0.0501	0.9758
6	0.1449	.	0.0242	1.000

Note: The eigenvalue (variance) for each principal component indicates the percentage of variation explained in the total dataset. According to the Kaiser's criterion, all components with an eigenvalue of > 1.0 are retained.
a. According to the Kaiser's criterion, our indicators are correlated with two main factors, which account for 72 percent of total variance.

Figure 3.1

Eigenvalues. Components eigenvalues graphed out with the reference line ($Y = 1$) representing the Kaiser's criterion to retain components into PCA analysis.



Once components with an eigenvalue below 1.0 are removed, the variance contributed by each variable to components 1 and 2 is retained. Subsequently, a varimax factor rotation is conducted, which is a crucial step within the PCA process The aim of the varimax factor rotation is to maximize the total variance of the squared loadings, resulting either large or near zero coefficients, while minimizing intermediate values (Tabachnick and Fidell, 2007). The objective is to associate each variable with at most one principal component.

Table 3.4 illustrates the results of the PCA after the varimax factor rotation has been conducted.. The results depict each variable and its contribution to the variance in principal components 1 and 2, indicated by their factor loadings. For better visualization, the results are grouped according to the variable categorization that will be employed in this study: environmental risk and progress.

When constructing their index, Capelle-Blancard et al. (2019) conceptually organize their variables into three categories: environment, social, and governance. These conceptual groupings of variables are clearly demonstrated in their rotated PCA loadings, as the groupings align with how their variables contribute to the variance in the first three principal components. Governance contributes the most variance to component 1, social contributes the most variance to component 2, and environment contributes the most variance to component 3.

Table 3.4 illustrates that this alignment holds true for all variables except tree cover loss. Forest area and renewable energy, which fall under the categorization of environmental progress, both contribute the most to the variance in component 1. Similarly, CO2 emissions, water stress, and energy intensity, which fall under the categorization of environmental risk, all contribute the most to the variance in component 2. These results demonstrate that the variance in the dataset aligns with the conceptual grouping of variables as we have defined. However, while tree cover loss is conceptually classified as an environmental risk, it contributes the most to the variance in component 1, thus behaving as an environmental progress variable.

Table 3.4
Principal Component Analysis (PCA) results[a]

Index grouping	Variable	Component 1	Component 2
Environmental risk	CO2 Emission	-0.1489	0.5081
	Water stress	-0.1385	0.4294
	Tree cover loss	0.6861[b]	0.1781
	Energy Intensity	0.1932	0.6936
Environmental progress	Forest area	0.5031	-0.0622
	Renewable energy	0.4444	-0.2021
	Total variance explained by factor %	36.48	35.79
	Eigenvalue	3.1717	1.1648

a. Based on rotated component index
b. Tree cover loss accounts for more variance in component 1 as compared to component 2.

Since the factor loadings are exclusively dependent on the variance and covariance in the data, the decision to classify tree cover loss as an environmental risk remains unaltered. This determination is driven by the conceptual grouping of variables based on their inherent characteristics. However, the weight assigned to tree cover loss within the composite index will be affected by the factor loading in component 2 (0.1781), as shown in Table 3.4. This will result in a comparatively lesser influence on our dataset compared to what would have been the case had it been determined by the factor loading of component 1 (0.6861).

3.3.3 Construction of composite environmental index

The last step is to construct the environmental index based on the results presented in Table 3.4. This is done by calculating the normalized weight of variable variance in each principal component. The completed composite index is shown in Table 3.5.

Table 3.5
Complete composite environmental index[a]

Variable	Component 1	Component 2
CO2 Emission	0	0.28
Water stress	0	0.24
Tree cover loss	0	0.1
Energy Intensity	0	0.38
Forest area	0.53	0
Renewable energy	0.47	0
Total variance explained by factor %	34	66
Eigenvalue	3.1717	1.1648

a. Based on rotated component index

The index is then calculated as follows:

Equation 3.1

$$Environmental\ risk = 0.28 \cdot CO2\ Emssision + 0.24 \cdot Water\ stress + 0.1 \cdot Tree\ cover\ loss + 0.38 \cdot Energy\ Intensity$$

Equation 3.2

$$Environmental\ progress = 0.53 \cdot Forest\ area + 0.47 \cdot Renewable\ energy$$

When the indices have been compiled, the values are normalized to a scale between 0-100.

3.4 Control variables

A country's risk of default is largely driven by macroeconomic fundamentals such as debt burden (Bernoth et al., 2012), openness and terms of trade (Eichler & Maltritz, 2013; Maltritz, 2012) and fiscal variables (Hübel, 2020). To strengthen our correlation analysis and isolate the impact of environmental risk and progress on CDS spreads, the study controls for external influences by incorporating relevant macroeconomic and financial variables.

The study follows the framework of scholars such as Hübel (2020), Jeanneret (2018), Capelle-Blancard et al. (2019) and Hilschber and Noschbuch (2010) which all study the impact of ESG on sovereign debt performance (see Table 3.6). Hübel (2020) and Jeanneret (2018) both include six common macroeconomic variables: annual GDP growth rate, economic volatility, level of exports, international reserves as a percentage of GDP, inflation rate and exchange rate. They also include three common financial variables: MSCI stock market returns, 5-year US treasury rate and the US treasury yield curve.

When studying sovereign bond yield, Edwards (1986; 1984) found macroeconomic fundamentals such as the debt to output ratio, reserves to GDP ratio, current account to GDP ratio, and inflation to be significant positive coefficients in spread regressions. More recent literature on CDS spreads similarly show that public debt, and debt as a percentage of GDP, endogenously leads to increases in CDS spreads (Huyugüzel Kışla, et al., 2022; Stamatopoulos et al., 2017; Dieckmann & Plank, 2012). Dieckmann and Plank (2012) also examined the impact of inflation and current account on CDS spreads, but found no significant effect. To avoid possible biases, we will therefore refrain from including debt as a percentage of GDP as a control variable. Rather, we will adopt the methodology of Jeanneret (2018) and include GDP per capita as an alternative approach.

As can be summarized from table 3.6, this study will adopt the same control variables as Jeanneret (2018), with the argument that his compiled data reduces omitted variable bias and presents the most robust analysis.

Table 3.6
Control variables used by prior scholarly work.

Variable	Jeanneret (2018)	Hübel (2020)	Capelle-Blancard et al. (2019)	Hilschber & Noschbuch (2010)
Debt (% of GDP)		X	X	X
GDP/capita (US$)	X*			
Annual GDP growth	X*	X	X	
Economic volatility 5-year standard deviation of GDP growth	X*	X		
Level of exports (goods and service, % of GDP)	X*	X	X	
Amount of international reserves (net of gold, % of GDP)	X*	X		X
Inflation rate	X*	X	X	
Exchange rate return	X*	X		
MSCI world stock market returns	X*	X		
5-year U.S. Treasury rate	X*	X		X
U.S. Treasury yield curve	X*	X		X

*Included in the study's set of control variables.

3.5 Descriptive statistics

Table 3.7 presents an overview of the descriptive statistics for the variables used in the study. These statistics provide a basic summary needed to further understand this study.

Table 3.7
Descriptive statistics. This table presents the descriptive statistics of the variables in the empirical analysis. The series consists of yearly observations from 2005 to 2022 and covers 14 countries. The yearly observations are taken at the end of year.

	Obs	Mean	Median	Stand. Dev.	Minimum	Maximum	Source
CDS spread 5Y (USD)	224	266.48	125.17	511.05	12.50	5392.86	Bloomberg
CDS spread 5Y (ln)	224	4.8250	4.8297	15.297	0.0000	8.5928	Bloomberg
Environmental risk	207	8.9245	3.0430	15.297	0.0000	99.850	WDI
Environmental progress	210	31.442	25.326	21.783	0.0000	82.814	WDI
GDP per capita (current USD)	224	8491.7	8565.5	3913.1	1245.3	16783	WDI
GDP growth (annual %)	224	3.4828	4.1827	2.8616	-9.9432	14.230	WDI
Exports (% of GDP)	224	37.259	28.355	23.171	10.706	112.90	WDI
Reserves (current USD)	224	$2.88 \cdot 10^{11}$	$8.10 \cdot 10^{11}$	$7.42 \cdot 10^{11}$	$1.50 \cdot 10^{10}$	$3.90 \cdot 10^{12}$	WDI
Inflation (annual %)	224	6.2857	4.6343	7.3129	-5.9922	49.196	WDI
Volatility[a]	224	2.1836	1.8452	1.6129	0.1073	9.3548	WDI
Exchange rate (annual %)	224	1049.3	13.308	2974.2	1.3015	14582	WDI
MSCI Index	224	389910	316170	174470	166150	750260	St. Louis Fed[b]
Treasury rate	224	2.1344	1.8450	1.1657	0.3600	4.7000	St. Louis Fed
Treasury yield	224	1.5625	1.8000	1.1381	-0.3100	3.7900	St. Louis Fed

a. 5 year standard deviation of GDP growth
b. Federal Reserve Bank of St. Louis

4. Methodology

This section explains the methodology of the paper, including research design for the main regression testing as well as for the additional regression testing. It also includes the econometric analysis conducted before the execution of the regression analysis.

4.1 Research Design

The research design consists of a panel data regression analysis where the time dimension consists of the years 2005-2020 and the cross-sectional dimension consists of 15 emerging economies. The model specifications are in accordance with previous studies on CDS spreads (Hübel, 2020; Jeanneret, 2018; Hilscher & Nosbusch, 2010; Doshi et al., 2017):

Equation 4.1

$$cs_{i,t} = \alpha + \beta risk_{i,t-1} + \delta controls_{i,t} + cs_{i,t-1} + \varepsilon_{i,t}$$

Equation 4.2

$$cs_{i,t} = \alpha + \beta progreess_{i,t-1} + \delta controls_{i,t} + cs_{i,t-1} + \varepsilon_{i,t}$$

The dependent variable is the logarithm of the 1-year CDS spread for country i of year t, and is denoted $cs_{i,t}$. This acts as an indication of a country's risk of default (Jeanneret, 2018). The natural logarithm of the CDS is used to minimize outliers and strengthen linear relationships.

α denotes the constant of the regression. The independent variables are denoted $progress_{i,t-1}$ and $risk_{i,t-1}$ both of which are lagged to minimize the risk of reverse causality. The reason why this is of importance, is the lagged nature of risk assessment (Capelle-Blancard et al., 2019; Jeanneret, 2018). Since CDS spread is determined by the market's expectations on a country's future risk of default, the effect of environmental progress and risk on CDS spreads will not be immediate. Therefore, lagging the variable 1 year allows for testing the effect environmental progress and risk in year $t - 1$ has on CDS spread in year t. The β connected to $progress_{i,t-1}$ and $risk_{i,t-1}$ denotes the regression coefficient for our independent variables and measures the marginal effect of environmental risk and progress on CDS spreads.

To reduce any omitted variable bias, $cs_{i,t-1}$ and $controls_{i,t}$ are included. As previously stated, the current price of CDS is a reflection of the market's expectations on the future risk of default which means the current price of CDS, $cs_{i,t}$, is highly dependent on the past price of CDS, $cs_{i,t-1}$. Due to this persistent nature of CDS spreads, the CDS spread is lagged 1 year ($cs_{i,t-1}$) and included as an additional control variable (Capelle-Blancard et al., 2019). To further strengthen the analysis, the control variables presented in Table 3.6 are included as the vector variable $controls_{i,t}$ where δ denotes their respective regression coefficients. $\varepsilon_{i,t}$ is included as a clustered standard error to avoid any heteroskedasticity.

4.1.2 Additional testing

To further test the robustness of the results, and investigate the circumstantial importance of environmental performance on CDS spread, additional regression testing is conducted. To assess the importance of GDP growth on the regression, equations 4.1 and 4.2 are extended to equations 4.3 and 4.4.

Equation 4.3

$$cs_{i,t} = \alpha + \beta risk_{i,t-1} + \beta_1 Dummy + \beta_2 Interaction + \delta controls_{i,t} + cs_{i,t-1} + \varepsilon_{i,t}$$

$$where\ Dummy\ = 1\ if\ GDP\ growth\ <\ 0,$$
$$and\ Interaction\ = Dummy\ \cdot risk_{i,t-1}$$

Equation 4.4

$$cs_{i,t} = \alpha + \beta progreess_{i,t-1} + \beta_1 Dummy + \beta_2 Interaction + \delta controls_{i,t} + cs_{i,t-1} + \varepsilon_{i,t}$$

$$where\ Dummy\ = 1\ if\ GDP\ growth\ <\ 0,$$
$$and\ Interaction\ = Dummy\ \cdot progreess_{i,t-1}$$

Equation 4.3 and 4.4 has extended with one dummy and interaction variables. The dummy variable in above equations represents a state of economic recession as it takes on the value 1 when GDP growth is negative. The interaction variable represents the joint influence of a reccesionary period with a country’s environmental performance in the regression.

This means that while the dummy variable acts to detect any statistical significant relation between GDP growth and CDS spread, the interaction variable acts to detect whether a recessionary period negatively or positively impacts the effects that environmental performance has on CDS spread. In other words, a positive β_1-coefficient with statistical significance indicates there is a positive relation between recessionary periods and CDS spread, i.e. CDS spread increases during recessionary periods as opposed to non-recessionary periods, indicating higher credit risk. A positive β_2-coefficient with statistical significance indicates that the effect of environmental performance is enhanced during recessionary periods.

4.2 Hausman test

When conducting a panel data regression analysis, the data is tested for whether a fixed or random effect model is appropriate, with the help of a Hausman test.

Table 4.1
Hausman test results.

Included variables	**p-value**[a]	**Suitable panel model**
Global : Risk	0.000	Fixed effect model
Global: Progress	0.000	Fixed effect model
Financial: Risk	0.000	Fixed effect model
Financial: Progress	0.000	Fixed effect model
Economic: Risk	0.000	Fixed effect model
Economic: Progress	0.000	Fixed effect model
Univariate: Risk	0.927	Random effect model
Univariate: Progress	0.102	Random effect model

a. A p-value > 0.05 (significance level) indicates a random effect model is most suitable for the dataset. A p-value < 0.05 (significance level) indicates a fixed effect model is most suitable for the dataset.

To control wheteher our data set is suitable for a fixed/random effect model a Hausman test is conducted. The results are displayed in Table 4.1. The Hausman test helps to identify whether there is presence of endogenity in a sample and thereby helps determine what panel model is suitable for the data set. The null hypothesis states that there is no endogenity in the sample, which would indicate the unique errors are not correlated with the regressor (Deutsch, 2012). If the null hypothesis is rejected with a p-value < 0.05, a fixed effect model is suitable for the panel data. If the null hypothesis is not rejected, a random effet model is suitable for the panel data. (Tabachnick and Fidell, 2007)

In summary, the results presented in Table 4.1 have determined the appropriate model for conducting the regression analysis.

4.3 Adressing autocorrelation and heteroskedasticity

Both autocorrelation and heteroskedasticity are two statistical issues that can impact the validity of a regression analysis and the interpretation of results in empirical studies. These concerns will therefore be addressed in the following section, where the approach to avoid any biases or altering of results will be explained.

Autocorrelation, also known as serial correlation, occurs when the residuals of a regression model are correlated with each other over time or across observations. This violates the assumption of independence of residuals and can lead to biased coefficient estimates and unreliable hypothesis tests. Autocorrelation is particularly relevant for panel data analysis such as this, where observations are often correlated due to temporal or spatial dependencies.

To mitigate any possible autocorrelation, this regression analysis includes lagged dependent variables as additional explanatory variables in the model.

Heteroskedasticity refers to the unequal variance of the residuals across different levels of the independent variables. When heteroskedasticity is present, standard errors of coefficient estimates can become biased, leading to incorrect hypothesis tests and confidence intervals.

To mitigate any possible heteroskedasticity, clustered standard errors are included in all regression testing as a corrective measure.

5. Empirical findings

In the following section empirical findings will be presented. This includes results from a Pearson correlation matrix, the main results from the panel regression analysis and results from further regression testing.

5.1 Bivariate analaysis

Table 5.1 shows the results of the bivariate analysis where a Pearson correlation test has been conducted. As visible, CDS spread has no significant bivariate correlation with either environmental risk or environmental progress. CDS spread does have significant correlation of at least 95% with all included variables except for our dependent variables, exchange rate and the MSCI index. This means, only analyzing direct correlation gives no indication of the importance of either environmental risk or environmental progress on the risk of default in emerging economies.

Table 5.1
Pearson correlation matrix.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) CDS spread (ln)	1												
(2) Environmental risk	0.10	1											
(3) Environmental progress	-0.11	0.68***	1										
(4) GDP per capita	0.16**	-0.09	-0.29***	1									
(5) GDP growth (%)	-0.20***	-0.12*	0.06	-0.23***	1								
(6) Exports	-0.30***	-0.31***	-0.13*	0.20***	0.00	1							
(7) Reserves	-0.16**	-0.06	0.02	-0.09	0.28***	-0.10**	1						
(8) Inflation	0.58**	0.06	0.24***	0.10	-0.16**	-0.31***	-0.13**	1					
(9) Economic volatility	0.32***	-0.06	-0.21***	0.18***	-0.22***	-0.08	0.01	0.26***	1				
(10) Exchange rate	-0.04	0.33***	0.40***	-0.40***	0.10	-0.21***	-0.04	-0.01	-0.26***	1			
(11) MSCI index	-0.15	0.03	-0.02	0.18***	-0.39***	-0.06	0.07	-0.01	-0.10	0.06	1		
(12) US treasury rate	-0.30***	0.01	0.01	-0.28***	0.34***	0.05	-0.10	0.02	-0.23***	-0.02	-0.36***	1	
(13) US treasury yield	0.36***	-0.02	0.00	0.09	-0.10	-0.03	0.04	-0.06	0.26***	-0.02	-0.37***	-0.40***	1

***, **, * Significance at 1, 5 and 10 percent respectively

5.2 Main results

Table 5.2

Main results. Column (1) shows the univariate regression analysis conducted only with environmental risk and environmental progress respecitvely. Column (2) includes the economic control variables GDP per capita, GDP growth, exports, reserves, inflation, economic volatility, exchange rate. Column (3) further includes the financial control variables MSCI index, US treasury rate and US treasury yield. Column (4) includes all previously mentioned control variables as well as our dependent variable CDS price (ln) in lagged form. The left list within each column represents the results from the regression conducted with environmental risk as an independent variable, and the right column represents the results from the regression conducted with environmental progress as an independent variable.

	(1) Univariate		(2) Economic controls		(3) Financial controls		(4) All variables	
Environmental risk	0.005** (1.98)		0.008* (1.79)		0.017*** (3.34)		0.015*** (3.78)	
Environmental progress		0.001 (0.10)		0.026 (0.69)		0.033 (0.84)		0.011 (0.38)
GDP per capita			0.000 (0.79)	0.000 (0.69)	-0.000 (-1.47)	-0.000 (-1.43)	-0.000 (-1.09)	-0.000 (-1.27)
GDP growth (%)			-0.012 (-0.88)	-0.014 (-0.98)	-0.010 (-1.06)	-0.013 (-1.15)	-0.010 (-1.21)	-0.010 (-1.09)
Exports			-0.002 (-0.14)	-0.005 (-0.30)	-0.003 (-0.29)	-0.008 (-0.72)	0.000 (0.04)	-0.002 (-0.29)
Reserves			0.000** (2.23)	0.000** (2.62)	0.000** (2.55)	0.000*** (3.14)	0.000** (2.26)	0.000** (2.87)
Inflation			0.0141 (1.05)	0.010 (0.82)	0.013 (1.37)	0.008 (0.84)	0.015 (1.70)	0.011 (1.35)
Economic volatility			0.001 (0.03)	0.001 (0.03)	-0.152*** (-3.85)	-0.155*** (-4.22)	-0.150*** (-5.22)	-0.148*** (-5.39)
Exchange rate			-0.000*** (-3.51)	-0.000 (-0.57)	0.000 (-0.18)	0.000 (0.58)	0.000 (1.26)	0.000 (0.64)
MSCI index					-0.000*** (-5.18)	-0.000*** (-3.59)	-0.000*** (-6.45)	-0.000*** (-4.87)
US treasury rate					-0.342*** (-6.67)	-0.341*** (-7.52)	-0.340*** (-10.51)	-0.338*** (-11.81)
US treasury yield					0.163*** (4.50)	0.142*** (4.25)	0.057 (1.73)	0.035 (1.13)
Lagged CDS price, ln							0.230*** (4.81)	0.325*** (5.55)
Constant	4.78*** (7.28)	4.791*** (7.28)	4.53*** (4.97)	3.889** (1.49)	6.484*** (9.68)	5.913** (2.18)	4.985*** (7.50)	4.865** (2.79)
Observations	219	224	219	224	219	224	218	224
Clustered St Er	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overall R^2	0.010	0.013	0.018	0.000	0.084	0.005	0.354	0.225

Regression coefficients are presented in the table with t-scores within the parentheses below the regression coefficients.

***, **, * Significance at 1, 5 and 10 percent respectively

The main results of the study are presented in Table 5.2.

5.2.1 Environmental risk

Column (1) include the result of the univariate regression, where environmental risk and progress has been plotted against CDS spread. As hypothesized, there is a positive relation between CDS spread and environmental risk ($\beta = 0.005$) with a significance of 0.05. As CDS spread is used in its natural logarithm, its minimum to maximum values range from roughly 2.5 to 8.6, as is depicted in Table 3.7. Meanwhile, the risk variable is normalized to a scale of 0-100, with a mean of roughly 9. Given the regression coefficient of 0.005, this implies that a 1 percent increase in the environmental risk index is associated with an approximate 0.5 percent increase in the CDS spread, assuming all other variables are held constant. This means a β-coefficient of 0.005 accounts for a noteworthy relationship between the two variables.

While this makes it possible to reject the null hypothesis that environmental risk does not affect CDS spread, the relation is not highly significant, with a t-stasticic of 1.98. The low R^2 -value of 0.010 also indicates the model only explains 1 percent of the relationship between the independent and the dependent variable. As there are no controlling variables included in the model, the results can be considered overall non-robust.

Column (2), (3) and (4) consequently adds control variables to the regression to isolate the effect of our independent variables on our dependent variable. As more control variables are added to the model both relationship and significance becomes stronger, with the exception of column (2) and the adding of economic controls. Column (4) presents the results from the complete regression model (Equation 1 & 2) and displays both the highest β-value (= 0.015), and the highest t-statistic (= 3.78). In terms of magnitude, this implies that a 1 percent increase in the environmental risk index is associated with an approximate 1.5 percent increase in the CDS spread, assuming all other variables are held constant. Isolating the effect of the independent variable from the univariate regression tripled the impact of the regression coefficient.

With the exception of column (2) and the adding of economic control variables to the environmental progress regression, the model improves as more control variables are added. This becomes clear by the apparent increase in overall R^2 as the regression expands. This is consistent with the prior reasoning behind the control variables and indicates increased robustness.

While overall R^2 increases in the regression, the entire panel model only offers the R^2-value of 0.354. This means that the univariate panel model explains roughly 1% of our observed data, while the entire model explains 35% of our observed data. While the entire model offers a substantial improvment from the univariate results, it is clear there is further room for improvement of the model.

5.2.2 Environmental progress

Contrary to the results of environmental risk, there is no statistical significance between environmental progress and CDS spread and therefore it is not possible to reject the null hypothesis that environmental progress has no statistical impact on CDS spread. This is the case throughout all regression testings, column (1) to (4).

Similar to the case of environmental risk, the complete model in column (4) offers the highest R^2 value of 0.225, indicating the most thorough regression model. While most thorough, it only accounts for about two thirds of the R^2-value for environmental risk (0.354) in the same regression model. This implies environmental progress calls for more, or other, control variables to explain the variability in the sample.

5.2.3 Additional comments on main result

This section will discuss the results of the regression analysis focusing on trends within the control variables. It will not discuss the results in terms of magnitude.

In the cases of environmental risk and environmental progress as independent variables respectively, the model's added control variables act relatively similar to one another. Reserves, economic volatility, MSCI index, US treasury yield and US treasury rate are all variables that act the same in terms of significance and direction of coefficients as the regression expands.

Reserves remain a significant constant throughout the regression testing with a positive β-value. And the t-statistic of the variable follows the same pattern with both environmental risk and enivoronmental progress as the regression expands. The same is true for MSCI Index and US Treasury rate.

Economic volatility is insignificant in column (2) and significant in column (3) and (4). This means its statistical significance only becomes apparent after isolating the effect of the variable by introducing financial control variables. This suggests that financial variables act as omitted variables to economic volatility.

US treasury yields show the opposite pattern. While significant in the results of column (3), the introduction of the lagged CDS spread variable recedes the statistical significance of US treasury yield. This indicates endogenity between CDS spread and US treasury yield, meaning the two are mutually interdependent and that US treasury yield therefore is biased without the inclusion of lagged CDS spread.

Interestingly, the economic variables are in majority when it comes to lacking importance with GPD growth, GDP per capita, exports and inflation consistently not showing signs of any statistical significanc. This indicates that while the null hypothesis aims to investigate the effect of environmental performance on sovereign risk profile measured in CDS spread, macroeconomic variables do not have a meaningful or substantial effect on risk profile when considering the question at hand. This contradicts former reasoning among scholars.

5.3 Adjusted results

To further test the robustness of the results, and investigate the circumstantial importance of environmental performance on CDS spread, additional regression testing has been conducted.

5.3.1 GDP growth

For GDP growth, a regression analysis has been performed differentiating the effect of environmental risk and progress as GDP growth goes from negative to positive in accordance with equation 4.3 and 4.4. The results are depicted in table 5.3.

Table 5.3

Regression results with dummy- and interaction variables included. The left list within each column represents the results from the regression conducted with environmental risk as an independent variable, and the right column represents the results from the regression conducted with environmental progress as an independent variable.

	Coefficient results	
Environmental risk	0.015^{***} (3.57)	
Environmental progress		-0.010 (0.40)
Dummy variable	-0.627^{***} (-4.14)	-0.737^{***} (-4.55)
Interaction variabel	0.015^{***} (4.09)	0.007^{***} (3.04)
Constant	5.068^{***} (7.55)	4.932^{***} (4.28)
Observations	218	223
Clustered St Er	Yes	Yes
Overall R^2	0.422	0.292

Regression coefficients are presented in the table with t-scores within the parentheses below the regression coefficients.
***, **, * Significance at 1, 5 and 10 percent respectively.
The table has been reduced and does not show the regression coefficients of the control variable.

The left column depicts the results of the regression analysis with environmental risk acting as indepedent variable. These results show a significant regression coefficient for environmental risk (β = 0.015), indicating that environmental risk, on its own, has a statistically significant impact on CDS spreads in accordanc to the result of table 5.2. With a t-statsic of 3.57, this is adequate enough evidence to reject the null hypothesis that environmental risk does not impact CDS spread.

The dummy variable in the sample represents a recessionary period, as its value (Dummy variable = 1) depends on the condition that GDP growth < 0, in accordance with equations 4.3 and 4.4. With a significance level of 0.01, the results imply that being in a recessionary period has a statistically significant effect on CDS spread, assuming all other variables are held constant. With the value of the regression coefficient (β = -0.627) being negative, this entails

CDS spread tends to decrease during recessionary periods, as compared to non-recessionary periods. This implies that during recessionary periods the prices of CDS decreases, reflecting lower credit risk. While this seems counterintuitive, it could reflect the behavioural financial behvaiour such as increased investment during recessionary periods.

The interaction variable in the sample represents our dummy variable's interactions with our independent variables in accordance with equation 4.3 and 4.4. With a significance level of 0.01, the results imply that the joint influence of environmental risk and recessionary periods has a significant effect on the CDS spread. The positive coefficient indicates that the impact of environmental risk on the CDS spread is more pronounced during recessionary periods.

Combining the results of the dummy- and interaction variable we can conclude that during recessionary periods the impact of environmental risk on CDS spread encances. This impact takes effect as price decreases which reflects lower credit risk..

The right column depicts the result of the regression analysis with environmental progress acting as independent variable. These results show no statistical significant regression coefficient for environmental progress, indicating that environmental progress, on its own, has no statistically significant impact on CDS spreads as expected from the result of table 5.2.

The regression coefficient of the dummy variable (β = -0.737) is significant at 0.01, which implies that recessionary periods have a statistically significant impact on CDS spread. As should be expected, the results mimic that of environmental risk and also present a negative coefficient.

The regression coefficient of the interaction variable (β = 0.007) is significant at 0.01. This implies that the joint influence of environmental progress and recessionary periods has a significant effect on the CDS spread. Similarly to the case of environmental risk, the positive coefficient indicates that the impact of environmental progress on the CDS spread is more pronounced during recessionary periods.

To sumarize these findings, it is clear that recessionary periods have a negative impact on the CDS spreads. It is also certain that recessionary periods enhance the effect of both environmental progress and environmental risk on CDS spread, indicating that more rigorous environmental valutaion methods could expecially benefit innvestors and stakeholders during recessionary periods.

6. Discussion

6.1 Summary of results

The analysis conducted in this study provides evidence to reject the null hypothesis that environmental risk does not have an effect on CDS spread in emerging economies. With a significance level of 0.01, the regression provides a statistical relationship between CDS spread and environmental risk at $\beta = 0.015$ and with a t-statistic of 3.78 which is the highest measured t-statisitc within the sample. It does not however provide evidence to reject the null hypothesis that environmental progress has an effect on CDS spread.

It also provides evidence that recessionary periods have a significant, positive effect on CDS spread in emerging markets. In addion to this the study found the impact of both environmental risk and progress to be enhanced during periods of negative economic growth.

6.2 Implications of results

6.2.1 Environmental risk

The implications of the results obtained from the quantitative analysis conducted in this thesis hold significant importance in advancing our understanding of sovereign debt investment, CDS spreads and the interplay between environmental conditions and risk profile in emerging economies.

The findings presented in this study regarding the positive relationship between environmental risk and CDS spread align with previous research that confirms the impact of environmental conditions on sovereign debt and CDS spreads (Reznick et al., 2019; Jeanneret, 2018; Capelle-Blancard et al., 2019; Hübel, 2022, Pineau et al., 2022; De Boyrie & Pavlova, 2020; Hill Clarvis et al., 2014; Margaretic & Pouget, 2018; Crifo et al., 2017). It also expands on earlier studies from scholars such as Drut (2010), who found no ESG investing could be done without incurring significant loss of return.

Firstly, this incentivizes stake-holders, investors and policy makers to take into account environmental risk when considering sovereign risk profile and should therefore be more thoroughly applied to the credit ratings of sovereigns. This would increase transparency in risk assessment and investment strategies, and might incentivize investors to engage with sustainable sovereign issuers to encourage more sustainable policies and practices as well as push for improved disclosure of environmental risk and mitigation efforts.

It may also entail that scoring higher on the environmental risk index increases the cost of borrowing for debt issuers, both when issuing new debt as well as refinancing existing debt. To mitigate this, debt issuers would be forced to offer higher yields to attract investors. This could act as an additional incetive for policymakers to refocus their fiscal policy on bringing down their environmental risk score as a way to bring down borrowing costs

Environmental risk and its effect on risk of default indicates possible long term effects on growth prospects, fiscal health, ability to service debt and investor interest in aspects such as research and development (R&D). Further reseach should therefore include reviewing the implications of these findings on long term economic stability.

These implications may be especially important within emerging economies, as previous research has found environmental conditions to be most curcial within developing and agrarian eocomies while governance is the primary determinant for advanced economies (Pineau et al., 2022).

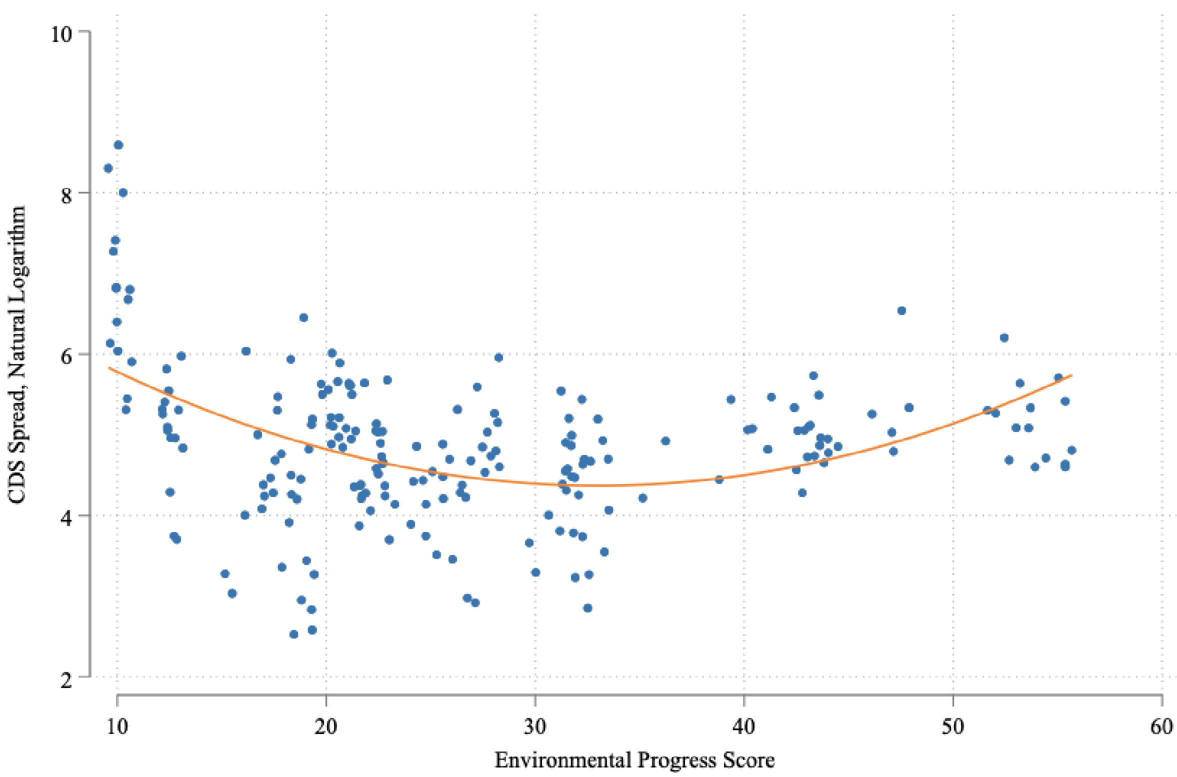
The results of this study do however differ from previous studies in regards to the impact of recessionary periods. While Pineau et al. (2022) found that market turbulence such as recessionary periods, diminishes the effect of ESG on sovereign debt, the additional regression analysis in this study presents contradictory findings. According to our results, during recessionary phases, both environmental risk and progress exhibit an amplified influence on CDS spreads. Pineau et al. (2022) conducted their study from 2002 to 2018, encompassing advanced economies and emerging markets. The difference of outcomes might therefore stem from either the inclusion of advanced economies in their sample or the incorporation of social and governance factors within their ESG framework. As this is a relatively unexplored area of research, these findings underscore the need for future research.

6.2.2 Environmental progress

No significant correlation could be found between environmental progress and CDS spread which partly contradicts the findings of prior work on the impact of environmental impact on sovereign debt (Reznick et al., 2019; Jeanneret, 2018; Capelle-Blancard et al., 2019; Hübel, 2022, Pineau et al., 2022; De Boyrie & Pavlova, 2020; Hill Clarvis et al., 2014)

Figure 6.1 illustrates CDS spreads in their natural logarithm plotted against environmental progress score. While low environmental progress scores indicate a negative relation with CDS spread, a score higher than approximately 32 correlates with a positive relation with CDS spread. This is a Kuznet-like relationshiphip which implies that at a low environmental progress scores, increases in environmental progress mitigate risk. However, after reaching an environmental progress score of 32, further increases in environmental progress causes greater credit risk.

Figure 6.1
Scatter diagram of environmental progress score over CDS spread, fitted



One explanation for this could be the fact that our sample is digesting emerging economies. In economies where financial and economic markets are not yet at their full potential, too much environmental focus could increase the risk profile of the country, as green capital investment might not be the most useful allocation of capital.

A study on economic globalization and productivity and its effect on environmental quality by Calgar (2022) has shown there is a negative correlation between newly industrialized countries' increased attempts of economic welfare and productivity and environmental quality which could help make our previous point. While GDP correlates positively with ecolocial footprint, economic globalization and human capital negatively correlates (Calgar, 2022).

In addition to this, Kihombo et al. (2021) investigates the relationship between financial development (FD) and ecological degratation and found that while technical innovation is helpful to decrease ecological footprint (EF), FD increases EF. While these findings are not directly translated to the findings in this study, it gives insight to the complex nature between financial conditions of sovereign and their environmental state.

6.2.3 Additional comments

There are some additional findings worth noting. While Edwards (1986; 1984) found macroeconomic fundamentals such as debt-to-output ratio, reserves-to-GDP ratio, current account-to-GDP ratio, and inflation had significant positive effects on CDS spread, this does not completely align with the findings of this study. While reserves show significant relation to CDS spread in the regression analysis of this study, inflation does not. The isolating effect of introducing environmental risk and progress therefore seem to have a decreasing effect on the significance inflation has on CDS spread. This calls for further research within the area.

6.3. Robustness

The concept of robustness is central to the interpretation and generalization of regression results. It refers to the stability and reliability of findings across different model specifications, control variables, and data conditions.

When conducting the univariate regreesion, the low R^2-value (R^2 = 0.010) and the relatively weak t-statistic (1.98) indicate that the model lacks the ability to explain a substantial portion of the observed variation and that the relationship might not be fully robust when accounting for other factors.

Column (2) introduces economic controls, but intriguingly, this addition weakens the t-statistic (1.79) for the environmental risk regression as well as the R^2-value (0.000) of the environmental progress regression. This may indicate potential multicollinearity or complex interactions between environmental risk and economic factors that require further exploration.

However, the robustness of the relationship is notably improved when more comprehensive control variables are added in Columns (3) and (4). In these models, the positive association between environmental risk and CDS spreads becomes more pronounced and statistically significant. The highest β-value (0.015) and t-statistic (3.78) are achieved in Column (4), demonstrating that the relationship holds even when controlling for a range of potential confounders. The highest R^2-values (0.354 and 0.225) are also found in Column (4).

While the introduction of control variables bolsters the robustness of the findings, limitations remain. The final model, while improved, still leaves a significant portion of the observed data unexplained. This suggests that other unaccounted factors might influence CDS spreads. The pursuit of further robustness could involve exploring additional variables, alternative functional forms, or interaction effects to enhance the model's explanatory power.

For the scope of this study, the conducted robustness checks and assurances are deemed sufficient, rendering the results trustworthy.

6.4 Limitations

During the process of constructing the environmental risk and environmental progress indices, a Principal Component Analysis (PCA) was utilized to determine the weights of each variable contributing to the indices. Prior to conducting the PCA, a Kaiser-Meyer-Olkin (KMO) analysis was performed to assess the correlations among the variables. Based on established theoretical considerations, only variables exhibiting a significant level of correlation (>0.6) were retained for inclusion in the PCA analysis. Consequently, the number of variables available for the composition of the environmental indices was substantially reduced.

The data for this study was sourced from various rating agencies' Environmental, Social, and Governance (ESG) reports, obtained from the comprehensive data bank compiled by WDI. In terms of environmental variables within the ESG framework, WDI encompasses a total of 131 ESG indicators, whereas 32 of those are of environmental profile. However, for the purposes of this study, only 6 out of these 32 variables were included. Notably, this limitation is particularly relevant to the environmental progress index, as it comprised solely two variables.

Concluding on a positive note, the process of constructing the environmental risk and progress indices has enabled a refined and insightful approach to assessing their impacts. By employing Principal Component Analysis (PCA) and evaluating the correlations through Kaiser-Meyer-Olkin (KMO) analysis, a robust foundation has been ensured for the indices' composition. Despite the reduction in the number of variables, this methodological precision enhances the credibility of the findings of this study.

The utilization of Environmental, Social, and Governance (ESG) reports from reputable rating agencies, as made available through WDI's comprehensive database, provides a rich data source. While the study focused on a subset of environmental variables, this selection was guided by a thoughtful consideration of their relevance and impact. Emphasizing quality over quantity, this approach has afforded the study a clearer lens to examine the intricate relationship between environmental factors and sovereign risk profile.

6.5 Future research

As previously discussed, the relation between environmental risk and CDS spread is of importace for stakeholders, investors and policy makers due to its vital implications on credit risk profile and risk of default. However, the discussion on what this entails for the bigger picture could be further explored. For example, the impact environmental risk could have on long-term economic stability, fiscal helath, ability to service debt and investor interest in aspects such as R&D are areas of study which should be further explored.

This study also opened up discussions on the impact of recessionary periods, which showed contradictory results from scholars such as Pineau et al. (2022). The field of study which investigates the impact ESG or environmental conditions has on sovereign debt rarely focuses on different ciscumstantial prerequisites. Exploring how the impact of ESG and environmetnal conditions differ during periods of various economic growth, inflationary landscape and general debt could therefore pave the way for further studies and give additional insight in the interplay between extrafinanical conditions and sovereign debt.

Furthermore, scholars, along with data providers, incorporate ESG factors and environmental conditions in valuation models in different ways, as highlighted by Kotsantonis and Serafeim (2019). The diversity in these approaches stems from the fact that various frameworks employed to integrate ESG and environmental considerations are encompassing unique fundamental variables and econometric strategies. This is a cause for concern for investors and policy makers.

For robust and uniform risk assessment and credit rating procedures, standardized frameworks for incorporating environmental conditions in investment should be established. This would decrease the need for interpretation in risk assessment, and make the work of investors and policy makers easier.

7. Conclusions

In conclusion, the analysis conducted in this study offers valuable insights into the relationship between environmental risk, environmental progress, and credit default swap (CDS) spreads in emerging economies. The results challenge the null hypothesis, revealing a significant positive impact of environmental risk on CDS spreads, denoted by a β coefficient of 0.015 and a high t-statistic of 3.78. However, the study does not find sufficient evidence to reject the null hypothesis regarding the effect of environmental progress on CDS spreads.

The implications of these findings are multifaceted and hold substantial importance in advancing our understanding of sovereign debt investment, CDS spreads, and the interplay between environmental factors and risk profiles in emerging economies. The positive relationship between environmental risk and CDS spreads aligns with prior research, suggesting the need for increased consideration of environmental risk in sovereign risk assessment. This, in turn, could promote transparency, encourage sustainable policies, and lead to improved disclosure of environmental risks and mitigation efforts.

Interestingly, the study introduces a nuanced perspective on the impact of recessionary periods. While earlier research indicated a diminishing effect of environmental, social, and governance (ESG) factors during such periods, this study's results reveal an amplified influence of both environmental risk and progress on CDS spreads during economic downturns. This discrepancy with prior findings calls for further exploration, potentially driven by differences in sample composition or ESG framework incorporation.

The absence of a significant correlation between environmental progress and CDS spreads, contrary to some previous studies, highlights the intricate nature of the relationship between financial conditions and environmental advancements. The Kuznet-like pattern observed, where environmental progress initially mitigates risk but then exacerbates credit risk beyond a certain point, underscores the complex dynamics at play within emerging economies.

It is essential to acknowledge the limitations of this study. The reliance on a reduced set of variables in constructing environmental indices and the selectiveness in choosing ESG indicators could impact the robustness of the results. Additionally, the role of environmental factors may vary depending on specific circumstances, which necessitates further exploration.

Future research avenues should delve into the broader implications of environmental risk on long-term economic stability, fiscal health, debt servicing capability, and investor interests such as research and development. Moreover, investigating the impact of ESG factors under various economic conditions and establishing standardized frameworks for incorporating environmental considerations in risk assessment and credit rating procedures could contribute to more informed decision-making by stakeholders, investors, and policy makers. Ultimately, this study highlights the intricate relationship between environmental factors and sovereign debt, urging for continued exploration and a more comprehensive understanding of this vital intersection

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