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Sustainable Development Goals and Sovereign Bond Spreads

Investor Implications

Eline ten Bosch
Mathijs van Dijk
Dirk Schoenmaker

DESIGN PAPER 223

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Affiliations
Eline ten Bosch – Rotterdam School of Management, Erasmus University Rotterdam
Mathijs van Dijk – Rotterdam School of Management, Erasmus University Rotterdam
Dirk Schoenmaker – Rotterdam School of Management, Erasmus University Rotterdam

Abstract

We study the relation between a country's performance on the Sustainable Development Goals (SDGs) promulgated by the United Nations and its sovereign bond spread. Using a novel country-level SDG measure for a global sample of countries, we find a significantly negative relation between SDG performance and credit default swap (CDS) spreads, while controlling for traditional macroeconomic factors. This effect is stronger for longer maturities, in line with the notion that the SDGs represent long-term objectives. The results are most consistent with perceived default risk driving this relation, rather than investor preferences. Our initial evidence suggests that investing in the SDGs provides governments with financial benefits besides ecological and social welfare.

Samenvatting

De Sustainable Development Goals (SDG's), oftewel duurzame ontwikkelingsdoelen, van de Verenigde Naties zijn in 2015 geïntroduceerd om wereldwijd duurzame ontwikkeling te stimuleren. De druk op overheden om deze doelen te halen neemt toe naarmate de deadline van 2030 nadert. Tegelijkertijd zien we dat beleggers meer en meer informatie willen over de duurzaamheidsrisico's van staatsobligaties (Hübel en Scholz, 2020). Het niet halen van de SDG's kan bovendien negatieve economische gevolgen hebben. Bijvoorbeeld, biodiversiteitsverlies (SDG 15) kan verlies van natuurlijke bestuiving en een verhoogd risico op misoogsten betekenen. En dat kan weer leiden tot economische verliezen op lange termijn voor landen en investeerders (Agarwala, Burke, Klusak, Kraemer en Volz, 2022). De combinatie van, enerzijds, de economische impact van duurzaamheid en, anderzijds, de toenemende aandacht van beleggers voor de duurzaamheidsrisico's van staatsobligaties, roept de vraag op in hoeverre duurzame ontwikkeling verwerkt is in de marktprijzen voor staatsobligaties.

In dit artikel gaan we in op deze vraag door te analyseren of er een verband bestaat tussen de SDG's en de kredietopslag op staatsobligaties wereldwijd. We gebruiken de SDG-index die is ontwikkeld door Sachs et al. (2020); deze is ontworpen om te beoordelen hoe goed landen presteren op de verschillende SDG's. De SDG-index is beschikbaar voor een breed scala van landen met lage tot hoge inkomens. Hierdoor kunnen we 59 landen uit zowel ontwikkelde als opkomende markten in onze analyses opnemen. De dataset is relatief klein met maar drie jaar (2017 tot 2019) aan data. Als afhankelijke variabele gebruiken we de 5-jaars sovereign credit default swap (CDS)-spread van Refinitiv Datastream als proxy voor de kredietcomponent van staatsobligaties. We gebruiken een panelregressie om te profiteren van de tijd- en landendimensie in onze dataset.

In onze regressie vinden we een significant negatief verband tussen de SDG-index van een land en de CDS-spread. De resultaten geven aan dat een stijging van één standaarddeviatie in de SDG-index geassocieerd is met een statistisch significante daling – van ongeveer 17 basispunten – in de 5-jaars CDS-spread. De economische betekenis van dit resultaat is aanzienlijk, aangezien zelfs een paar basispunten niet te verwaarlozen financiële voordelen kunnen opleveren voor overheden met grote uitgiften van staatsobligaties. Deze bevindingen suggereren dus een potentieel belangrijke relatie tussen duurzaamheid en CDS-spreads en geven aan dat betere SDG-prestaties overheden financieel ten goede kunnen komen. Betere SDG-prestaties verlagen ook het faillissementsrisico voor institutionele beleggers, zoals pensioenfondsen en verzekeraars.

1. Introduction

In 2015, the United Nations launched seventeen Sustainable Development Goals (SDGs) to guide global sustainable development. The pressure on governments to reach these goals, which are meant to be achieved by the year 2030, is intensifying as the deadline comes closer, and as investors increasingly demand information about the sustainability risks embedded in sovereign bonds (Hübel and Scholz, 2020). For example, investors filed a civil action against the Australian government in 2020, arguing that the public authorities failed to disclose the material risks of climate change for its sovereign bonds (Smyth, 2020). Similarly, growing concerns about the deforestation of rain forests led over a dozen financial institutions to unite and demand that the Brazilian government protect this ecosystem (Harris, 2020). In addition, Van Zanten, Sharma, and Christensen (2021) created the sovereign SDG Engagement Framework as a first step towards meaningful engagement with governments on sustainability issues.

Failure to achieve the SDGs can furthermore have negative economic consequences. Biodiversity loss (SDG 15) can result in the drop of natural pollination and in increased risk of crop failure. That in turn can result in long-term economic losses for countries and investors (Agarwala, Burke, Klusak, Kraemer, and Volz, 2022). Water scarcity (SDG 6) leads to social unrest, migration, and conflicts. In addition, approximately 80 percent of wastewater is not properly cleaned prior to dumping in rivers and lakes (SDG 14) (United Nations, 2017). This leads to water pollution and impacts underwater life and fishery. Also, growing social inequalities undermine the social fabric of countries (Robinson and Acemoglu, 2012). The economic impact of sustainability, plus the growing attention of investors to the sustainability risks of their sovereign bond investments, are reason to ask to what extent sustainable development is reflected in the price of sovereign bonds.

In this paper, we address this question by assessing whether there is a relation between the SDGs and sovereign bond spreads around the world. We use the SDGs as a proxy for a country's sustainability level since we believe that this has several key advantages over Environment, Social and Governance (ESG) ratings. The first advantage is that the SDGs can be viewed as a measure of a country's transition towards sustainable development and are therefore output-based, rather than ESG ratings, which are more input-driven. Second, the SDGs directly measure a government's pledge to achieve social inclusion and environmental protection by 2030, and thus directly feed into the policies set by governments. The third advantage of the SDGs is that all goals are interlinked and that governments have agreed to comply with all

seventeen goals. For example, a country cannot solve hunger (SDG 2) without responsible food production (SDG 12).

We use the novel SDG Index developed by Sachs et al. (2020), as this was designed to assess how well countries perform on the various SDGs. The SDG Index is available for a wide range of low- to high-income countries, such that we can include 59 countries, ranging from developed to emerging markets, in our analyses. We can use only the relatively short sample period of 2017 to 2019, since the SDG Index was initiated in 2017. As a proxy for the credit component of sovereign bond spreads, we use the 5-year sovereign credit default swap (CDS) spread of Refinitiv Datastream as our dependent variable. We use a panel regression to benefit from the time and cross-sectional dimension of our sample.

In our baseline regressions, we find a significantly negative relation between a country's SDG Index and its CDS spread. The results indicate that a one standard deviation increase in the SDG Index is associated with a statistically significant decrease of approximately 17 basis points in the 5-year CDS spread. The economic magnitude of this point estimate is non-negligible, since even a couple of basis points can yield financial benefits for governments with large sovereign bond issues. These findings thus suggest a potentially important relation between sustainability and CDS spreads, and they indicate that better SDG performance may benefit governments financially.

The limited time dimension of our sample ($t=3$) implies that our identification of the relation between the SDGs and sovereign bond spreads stems primarily from the cross-section; this motivates us to be extra careful in our efforts, to ensure that any relation we find is not due to other unobservable variables. We provide more details on these efforts below but remain cautious in our conclusions. We thus interpret our paper as providing initial but not definitive evidence on the question whether the SDGs are associated with pricing effects in sovereign bond markets.

A concern we have is that the SDGs may indirectly measure the wealth of countries and potential political risk, plus that wealthy countries may be able to invest more in the SDGs. Therefore, in the baseline regressions we control for both wealth (GDP per capita) and political risk (the Political Risk Ratings from ICRG, the International Country Risk Guide). We also repeat our analysis, where we substitute our SDG Index with an orthogonalized SDG variable, from which all variation that correlates with GDP per capita and political risk is removed. Even in this quite conservative test, our baseline result, of a statistically significant negative relation between SDG performance and CDS spreads, survives. In this set-up, we find that a one standard deviation increase in SDGs is associated with an 11 basis points decrease in CDS spread.

Next, we examine whether there are time horizon effects in the relation between the SDG Index and CDS spreads. We find that the statistical and economic significance of our results increases with maturity, rising from a potential effect on the CDS spread of 13–15 basis points at the short end of the CDS curve to over 19 basis points for the 10-year and 30-year maturities (associated with a one standard deviation increase to the SDG Index). These results seem to indicate that the market prices sustainability more on a longer time horizon.

We try to shed light on how the SDGs may impact the CDS spread and to understand what drives our main result. We link sustainability to the potential default risk of countries (default risk channel) and examine two possible explanations. The first explanation relates to the transition cost of reaching the SDGs and to the sustainability-related costs of not reaching them. Governments can transition in an orderly or disorderly way (Battiston and Monasterolo, 2019). The risk of unforeseen future SDG-related government expenses will increase when governments transition in disorderly ways and are unprepared. Since a government's expenses are closely linked to its fiscal balance, investors may demand compensation for this higher perceived country default risk (Capelle-Blancard et al., 2019). A negative projected fiscal balance typically increases the CDS spread. We argue that a country's SDG Index may mitigate this future fiscal balance risk. Countries with a high SDG Index will have lower future SDG-related expenses and sustainability risks, reducing the negative impact on the future fiscal balance. We find a significant result for this fiscal balance channel. Our result indicates that a higher SDG Index potentially mitigates the perceived risk of a forecasted negative fiscal balance and may lead to a smaller increase in CDS spread than in countries with a lower SDG Index.

For our second explanation of the default risk channel, we argue that some countries are more prone to physical climate change risks than others. We measure this exposure by applying the exposure index of the Notre Dame Global Adaptation Initiative (ND-GAIN) (Chen, et al., 2015). However, we find little evidence that the SDGs have a mitigating risk effect for countries with high climate exposure. The second transmission channel that we test is the preference channel. We use the bid-to-cover ratio from the re-opening auction of sovereign bonds as a proxy for investor preferences. However, we find no clear evidence as to whether investor preferences could account for our baseline results.

Our results are relevant for both investors and governments. Pension funds and insurers invest a large part of their asset mix in sovereign bonds and may be interested in our findings. First, from a risk perspective, countries that do well on the SDGs can be perceived to have lower default risk. This lower perceived risk will

translate into lower returns, as we know to be the case with lower-risk assets. Second, impact investing is common in different asset classes but is not associated with sovereign bond strategies. However, our results allow doing precisely that. As we find a significant negative relation between the SDGs and a country's credit spread, investing in countries that invest in sustainability can have financial benefits for investors. They can benefit by investing in SDG-improving countries early on. This strategy has gained strength in recent years due to the increased engagement with governments. Governments have an incentive to invest in SDG improvements and to engage with investors on their SDG performance. As our initial evidence suggests, they are rewarded with lower borrowing costs.

2. Sustainability and sovereign bonds

In recent years major research has been conducted on the impact of sustainability risks on macroeconomic variables and sovereign borrowing costs (e.g., Crifo et al., 2017; Capelle-Blancard et al., 2019; Hübel, 2020; Klusak et al., 2021; and Agarwala, Burke, Klusak, Kraemer, and Volz, 2022). The results indicate that sustainability risks can negatively impact sovereign credit ratings, borrowing costs, and a country's macroeconomic variables. While prior research has focused on ESG ratings or sovereign credit ratings, this paper focuses on a novel sustainability measure to make a new contribution.

The primary variable of interest is the SDG Index. The SDGs consist of 17 goals that guide countries to sustainable development by 2030.[1] The goals all have different underlying targets. For example, Goal 1 (no poverty) consists of five targets, the first being *"By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day"*. Sachs et al. (2020) developed a methodology to calculate an SDG Index as an equally weighted index of the 17 goals. They use these underlying targets to estimate how well a country performs on each SDG. In the methodology report by Lafortune, Fuller, Moreno, Schmidt-Traub, and Kroll (2018), the authors provide detailed information about the metrics and underlying data that they have used to construct the SDG Index. Approximately 65 percent of the underlying data comes from official institutions such as the World Health Organization, the World Bank, the OECD, and UNICEF. Examples of the underlying data are *"Freshwater withdrawal as % of total renewable water resources"*, *"Access to electricity (% of population)"*, *"Births attended by skilled health personnel (%)"*, *"Gender wage gap (Total, % male median wage)"*, and *"Share of renewable energy in total final energy consumption (%)"*.[2] Not all of the underlying data for the SDG goals are updated regularly; therefore, the authors also use non-official (nso) data (e.g. from research institutions or universities) to bridge the gaps (Lafortune et al., 2018). The use of these nso data benefits the work of international statistical committees, who aim to generate standardized methods for nso data to help monitor the SDGs (Lafortune et al., 2018). The SDG Index should be interpreted as a percentage. Lafortune et al. (2018) explain that a country score of 85 percent means that such country is on average 15 percent away from achieving the SDGs. In addition to the SDG

1 The report by Ten Bosch, van Dijk, & Schoenmaker (2022) contains the list of the 17 SDGs, which cover economic, social, and environmental dimensions.

2 The complete list of indicator targets is contained in the report by Lafortune et al. (2018), Annex 4.

Table 1: List of countries and SDG Performance

Country	SDG Index			Income	Country	SDG Index			Income
	2017	2018	2019	Group		2017	2018	2019	Group
Australia	75.87	72.89	73.89	HIC	South Korea	75.48	77.41	78.33	HIC
Austria	81.42	79.95	81.07	HIC	Latvia	75.23	74.75	77.13	HIC
Belgium	79.96	79.00	78.89	HIC	Lithuania	73.63	72.90	75.10	HIC
Brazil	69.51	69.69	70.62	UMIC	Malaysia	69.68	70.01	69.56	UMIC
Bulgaria	72.51	73.13	74.52	UMIC	Malta	77.02	74.20	76.11	HIC
Chile	71.57	72.79	75.61	HIC	Mexico	69.13	65.21	68.51	UMIC
China	67.12	70.05	73.21	UMIC	Morocco	66.66	66.27	69.07	LMIC
Colombia	64.80	66.61	69.57	UMIC	Netherlands	79.94	79.47	80.38	HIC
Costa Rica	69.81	73.15	74.98	UMIC	New Zealand	77.62	77.86	79.50	HIC
Croatia	76.88	76.52	77.79	HIC	Norway	83.94	81.17	80.66	HIC
Cyprus	70.60	70.36	70.14	HIC	Panama	63.94	64.89	66.31	UMIC
Czech Republic	81.90	78.72	80.74	HIC	Peru	65.97	68.45	71.19	UMIC
Denmark	84.16	84.61	85.22	HIC	Philippines	64.33	65.03	64.94	LMIC
Dominican Republic	67.22	66.42	69.76	UMIC	Poland	75.78	73.67	75.93	HIC
El Salvador	62.92	64.09	66.73	LMIC	Portugal	75.57	74.03	76.43	HIC
Estonia	78.56	78.32	80.22	HIC	Romania	74.13	71.22	72.73	UMIC
Finland	84.02	83.00	82.82	HIC	Russia	68.93	68.90	70.94	UMIC
France	80.32	81.22	81.49	HIC	Serbia	73.58	72.14	72.49	UMIC
Germany	81.68	82.28	81.07	HIC	Singapore	68.97	71.31	69.62	HIC
Greece	72.89	70.64	71.41	HIC	Slovakia	76.93	75.60	76.21	HIC
Guatemala	58.32	58.24	59.65	LMIC	Slovenia	80.54	79.98	79.41	HIC
Hungary	78.00	74.96	76.89	HIC	South Africa	61.25	60.83	61.48	UMIC
Iceland	79.29	79.75	79.20	HIC	Spain	76.75	75.42	77.84	HIC
Indonesia	62.88	62.84	64.19	LMIC	Sweden	85.61	84.98	84.99	HIC
Ireland	77.92	77.47	78.22	HIC	Thailand	69.54	69.24	73.00	UMIC
Israel	70.14	71.85	71.53	HIC	Turkey	68.48	65.96	68.49	UMIC
Italy	75.50	74.21	75.79	HIC	United Kingdom	78.28	78.67	79.38	HIC
Jamaica	66.57	65.90	68.80	UMIC	United States	72.40	73.05	74.52	HIC
Japan	80.18	78.52	78.92	HIC	Uruguay	71.05	70.42	72.55	HIC
Kazakhstan	71.09	68.13	68.71	UMIC					

Table 1 presents the list of 59 countries used in our research, with their SDG Index of 2017–2019. The SDG Index is derived from Sachs et al. (2020). The SDG Index scores vary between 0 and 100 and are to be read as percentages. An index level of 85 means that country is on average 15 percent away from reaching all of the goals. The Income Group (High, Upper Middle and Lower Middle) is derived from the World Bank classification.

Index, Sachs et al. (2020) publish the scores of the individual SDGs; these also range from 0 to 100 and are interpreted similarly as the SDG Index.

Table 1 displays the countries that we use in our research and their SDG performance over the three years. In total, we use 59 countries, ranging from high to upper-middle and lower-middle income. Using the SDGs as a proxy for a country's sustainability level has several benefits. Table 1 shows that the Scandinavian countries exhibit the highest SDG scores (between 80 and 85), while Guatemala and South Africa have the lowest SDG scores (around 60).

We wish to note that the SDGs have a bias towards social development in the composition of the SDG Index, as 11 SDGs are related to social development and 6 to

ecological development (Schoenmaker and Schramade, 2018). The SDG Index is calculated as an arithmetic average of the 17 indicators. As high-income countries score better on the social SDGs and worse on the ecological SDGs than low-income countries (O'Neill, Fanning, Lamb, and Steinberger, 2018), this composition bias can explain part of the better SDG performance of high-income countries. Even though we will primarily work with the SDG Index, we use the individual SDGs to create sub-indices for additional analyses. For example, we create an equally weighted SDG Materiality index of education (SDG 4), healthcare (SDG 3), and infrastructure, consisting of roads (SDG 9), electricity (SDG 7), and water and sanitation (SDG 6), and analyze how this index relates to the sovereign CDS spread.

Our approach has several significant advantages relative to ESG ratings. First, the strength of the SDGs is that all goals are interlinked and that governments have agreed to comply with all 17 goals. Second, the SDGs can be seen as a measure of a country's transition towards sustainable development, plus they are more output-oriented, whereas ESG rating are more input-oriented. Finally, the SDGs directly measure a government's pledge to achieve social inclusion and environmental protection. All UN member states have pledged to reach the SDGs by 2030. Unprepared governments will face the risk of higher unforeseen SDG-related government expenses and costs related to sustainability risks (e.g., see the World Bank report by Johnson et al. (2021) on the economic impact of biodiversity loss). An increase in government expenditures will negatively impact a government's budget and its likelihood to repay its debts. Investors may demand to be compensated for this higher perceived country risk, thus impacting the borrowing costs faced by governments. Therefore, we hypothesize (H1) that the *SDG Index of a country negatively impacts the CDS spread*.

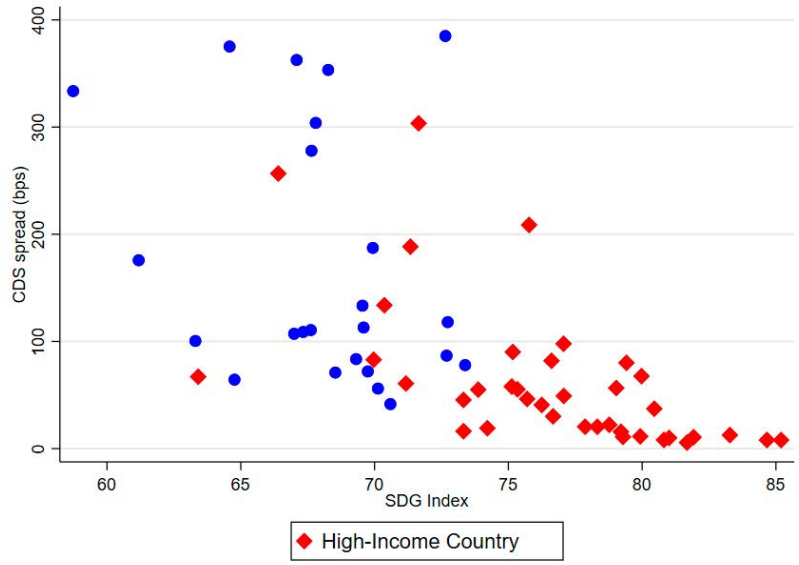
We note that many sustainability goals are long-term. For example, the SDGs are due by 2030, and the EU wants to be climate-neutral by 2050. Investors may view sustainable development as a long-term factor and price longer-maturity bonds differently than shorter-term bonds (Hübel, 2020). Therefore, the SDGs may relate differently to short and longer maturity bonds. We thus hypothesize (H2) that the *SDG Index of a country negatively impacts the CDS spread more for long-term maturities*. Recent theories describe how sustainability may impact sovereign bond spreads. The first channel links to a country's default risk. The first explanation relates to the transition costs of improving the environmental and social welfare of a country. Governments can transition in an orderly or disorderly way (Battiston and Monasterolo, 2019); as explained earlier, this can lead to future SDG-related expenses that influence a government's fiscal balance. Gruber and Kamin (2012) find a robust and significant effect of fiscal performance on long-term sovereign bond interest

rates. If a country's fiscal balance worsens, its long-term bond interest rates will rise. If the SDG Index of the country is also low, it may enhance this impact. We analyze whether the SDGs can mitigate this future fiscal balance risk and hypothesize as follows (H3): *The relation between the SDG Index and CDS spreads is stronger for countries with negative fiscal balance projections.*

3. Sovereign CDS spread and control variables

The sovereign CDS spread is the dependent variable in our research. The sovereign bond spread consists of a liquidity, a supply/demand, and a credit component. As a proxy for the credit component, we use the 5-year sovereign CDS spread. Using the sovereign CDS spread as our proxy for the credit risk has various advantages over the yield spread observed in the market. First, it enables us to use a single source with extensive country coverage instead of using different providers. Second, it bypasses the problem of dealing with the time changes of bond maturities at different points in time (Aizenman, Hutchison, and Jinjarak, 2013). We use the 5-year sovereign CDS as it is considered liquid (Pan and Singleton, 2008) and most actively traded (Palladini and Portes, 2011); it is therefore most used in academic research. Refinitiv Datastream provides the daily mid-rate for different maturity swaps and is expressed in basis points. Many macroeconomic variables used as control variables are reported quarterly. To avoid a forward-looking bias, we take the end of September (end Q3) value

Figure 1: SDG Index and Sovereign CDS spread



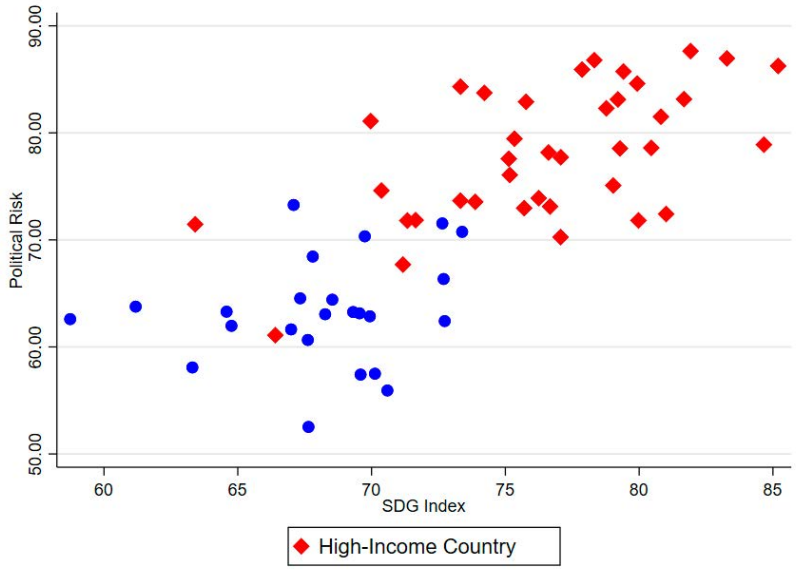
This figure displays the scatter plot of the SDGs and the CDS spread. The SDG Index data are obtained from Sachs et al. (2020) and reflect the average of the 2017-2019 period. The SDG Index scores range from 0 to 100 and are to be read as percentages. An index level of 85 means that the country involved is, on average, 15 percent away from reaching all goals. The 5-year sovereign CDS spread is obtained from Refinitiv Datastream and averaged per country. The dataset includes 59 countries from 2017-2019. The diamond-shaped observations are countries classified as high-income by the World Bank.

for the sovereign CDS spreads, as all independent variables, such as the SDG Index and macroeconomic variables, are known by then.

On average, wealthier countries have a higher SDG Index. This is clearly visible in Figure 1, which shows the correlation between the SDGs and the sovereign CDS spreads. In the graph, we notice that, on average, countries classified as being high-income have a high SDG Index and a low CDS spread. We therefore use GDP per capita as a control variable in our baseline model. This measures a country's standard of living and is a proper control variable for wealth.

Acemoglu, Johnson, and Robinson (2005) found that political institutions impact economic institutions and economic performance both directly and indirectly. This finding means that it is essential that we include a variable that captures the strength of these political institutions, to control for its potential effect on CDS spreads. The Political Risk Ratings (PRS) (used by, among others, Duyvesteyn, Martens, and Verwijmeren, 2016) from the International Country Risk Guide (ICRG) are the best fit for our research. The ratings are composed of twelve underlying factors, such as

Figure 2: SDG Index and Political Risk



This figure displays the scatter plot of the SDGs and the Political Risk variable. The SDG Index data are obtained from Sachs et al. (2020) and reflect the average of the 2017–2019 period. The SDG Index scores range from 0 to 100 and are to be read as percentages. An index level of 85 means that the country involved is, on average, 15 percent away from reaching all goals. The Political Risk Ratings (PRS) are obtained from the International Country Risk Guide (ICRG) and averaged per country. The higher the index, the more economically and politically stable the country is. The dataset includes 59 countries from 2017–2019. The diamond-shaped observations are countries classified as high-income by the World Bank.

corruption, government stability, and democratic accountability. The ratings are available for 140 countries from 1984 – 2019 and range from 0 to 100. The higher the index, the more economically and politically stable the country is. Figure 2 shows the correlation between the SDG Index and the political risk variable. On average, countries with a stable political environment have a high SDG Index. This visualization enhances our aim to fully control for political risk in our model, to ensure that we measure sustainability with the SDG Index instead of indirectly measuring political stability.

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CDS Spread (5-year)	177	97.4	101.9	5.2	422
SDG Index	177	73.6	6	58.2	85.6
Fiscal Determinants					
Debt (\% GDP)	177	62.4	39.6	8.3	236.6
Fiscal Balance (\% GDP)	177	-1.2	2.6	-9	12.4
Wealth and Political Risk					
GDP (per capita x 1,000)	177	25.3	20.1	3	81.5
Political Risk	177	72.9	9.2	51.8	89.1
Economic Fundamentals					
GDP growth (YoY)	177	3.1	1.9	-1.7	11.7
Inflation (YoY)	177	2.5	2.2	-0.2	18
Debt Liquidity and Global risk					
Reserves (/import)	177	5.5	4.8	0.1	21
Export (/import)	177	1	0.1	0.6	1.5
CBOE VIX	44	14	2.8	10.3	16.4
Transmission channels					
Fiscal Balance projection	156	-0.9	2	-6.6	7.7
Climate Exposure	177	41.5	6.1	27.3	53.8
Bid-to-cover ratio	44	2.2	0.7	1.4	4.4
Additional Analysis					
SDG Materiality index	177	80.3	8.9	57.2	96.1
SDG Environmental	166	65.5	9.3	31	85.6
SDG 13: Climate Action	177	82.8	11.3	23.3	95.2

This table presents the summary statistics (number of observations, mean, standard deviation, minimum and maximum values) of the variables used. The sovereign CDS spread (in basis points) is obtained from Refinitiv Datastream. The SDG Index is derived from Sachs et al. (2020). The SDG Index scores vary between 0 and 100 and are to be read as percentages. The SDG Materiality index is an equally weighted index of SDGs 3, 4, 6, 7 and 9. The variable SDG Environmental is the equally weighted average of SDGs 13, 14 and 15. The political risk variable is the Political Risk Ratings (PRS) from the International Country Risk Guide (ICRG). The rating ranges from 0 to 100. The higher the index, the more economically and politically stable the country is. The fiscal balance projections (% GDP) are the 5-year projections by the IMF. The exposure variable is from ND-GAIN, and ranges from 0 to 100, with 100 being fully exposed to climate change risk. The bid-to-cover ratios are from multiple debt agencies and ministry of finance websites.* All other variables come from the IMF database. The complete dataset consists of 59 countries over the 2017-2019 period.

* Ten Bosch et al. (2022) contains the complete list of bid-to-cover sources in Appendix B.

Previous literature about the determinants of sovereign bond spreads led to a set of macroeconomic factors that we can use as control variables. In addition to GDP per capita and the political risk variable, we include such factors as year-on-year inflation, GDP growth, and fiscal balance (% GDP). Table 2 displays the summary statistics of all variables that we used, while Table 3 shows the correlation between the variables.

Table 3: Correlation Matrix

	SDG Index	Debt (% GDP)	Fiscal Balance (% GDP)	GDP (per capita x 1,000)	Political Risk	GDP growth (YoY)	Inflation (YoY)	Reserves (/import)
SDG Index	1							
Debt (% GDP)	0.16	1						
Fiscal Balance (% GDP)	0.36	-0.11	1					
GDP (per capita x 1,000)	0.68	0.21	0.42	1				
Political Risk	0.74	0.28	0.42	0.81	1			
GDP growth (YoY)	-0.14	-0.28	0.07	-0.14	-0.1	1		
Inflation (YoY)	-0.33	-0.32	-0.19	-0.33	-0.45	-0.08	1	
Reserves (/import)	-0.3	-0.03	-0.22	-0.3	-0.44	-0.07	0.18	1
Export (/import)	0.35	-0.09	0.15	0.24	0.19	0.03	-0.02	0.17
CBOE VIX	-0.01	0.02	-0.01	0.01	-0.02	-0.04	0.13	-0.02
Fiscal Balance projection	0.45	-0.06	0.71	0.49	0.53	-0.02	-0.32	-0.32
Climate Exposure	-0.38	0.11	-0.16	-0.04	-0.2	-0.1	0.08	0.35
Bid-to-cover ratio	0.22	-0.47	0.37	0.17	0.32	0.26	0.26	-0.04
SDG Materiality index	0.87	0.28	0.34	0.84	0.78	-0.23	-0.32	-0.24
SDG Environmental	0.33	-0.05	-0.12	-0.21	-0.01	0.02	-0.12	-0.16
SDG 13: Climate Action	-0.07	-0.11	-0.14	-0.41	-0.28	0.11	0.1	0.13

	Export (/import)	CBOE VIX	Fiscal Balance projection	Climate Exposure	Bid-to-cover ratio	SDG Materiality index	SDG Environmental	SDG 13: Climate Action
Export (/import)	1							
CBOE VIX	-0.15	1						
Fiscal Balance projection	0.23	0.01	1					
Climate Exposure	-0.2	-0.01	-0.18	1				
Bid-to-cover ratio	0.08	-0.15	0.34	-0.19	1			
SDG Materiality index	0.43	-0.04	0.43	-0.2	0.11	1		
SDG Environmental	-0.04	-0.01	-0.02	-0.35	-0.01	-0.05	1	
SDG 13: Climate Action	-0.18	0	-0.22	-0.14	0.01	-0.34	0.56	1

This table shows the correlations between the independent variables in our research. The SDG Index is derived from Sachs et al. (2020). The SDG Index scores vary between 0 and 100 and are to be read as percentages. An index level of 85 means that the country involved is on average 15 percent away from reaching all goals. The SDG Materiality index is an equally weighted index of SDGs 3, 4, 6, 7 and 9. The variable SDG Environmental is the equally weighted average of SDGs 13, 14 and 15. The political risk variable is the Political Risk Ratings (PRS) from the International Country Risk Guide (ICRG). The rating ranges from 0 to 100. The higher the index, the more economically and politically stable the country is. The fiscal balance projection (as a percentage of GDP) represents the 5-year projections from IMF (2017), IMF (2018) and IMF (2019). The exposure variable is from ND-GAIN, the data range from 0 to 100, with 100 being fully exposed to climate change risk. The bid-to-cover ratios are from multiple debt agencies and ministry of finance websites. All other variables come from the IMF database. The complete dataset consists of 59 countries over the 2017-2019 period.

4. Methodology and results

Method

Panel data allow focusing on within-country estimation and between-country estimation. The within-estimator, better known as the fixed effects approach, minimizes the risk of omitted variable bias. The fixed effects approach is therefore often the preferred model. Unfortunately, our very short time period severely limits our ability to use fixed effects. As our data include a wide range of countries, it is worth exploiting the cross-sectional variation as well. The between-estimator focuses on the differences between individual countries. The disadvantage of this estimator is that, while the parameters are identified, the time dimension is neglected. Even though we do not have ample years in our data set we do have the data available and wish to use it.

We therefore want to use an estimator that exploits both the time-series variation and the cross-sectional variation. Two estimators that combine the within and between variations are the OLS estimator and the random effects estimator. The random effects estimator is not commonly used in finance literature (Petersen, 2009). It is, however, more efficient for combining the information of the time-series and cross-sectional dimensions than the OLS estimator (Verbeek, 2008).

Note that the data set that we work with, small as it is, has its limitations. We therefore report the results of the OLS estimator with country-clustered standard errors, the between estimator, the fixed effects estimator with country-clustered standard errors, and the random effects estimator with country-clustered standard errors in Ten Bosch et al. (2022). In this paper we focus on our preferred model, namely the random effects estimator with country-clustered standard errors.

SDG performance and sovereign CDS spreads

To estimate the relation between the SDG Index and the CDS spread, we estimate the following panel model:

$$y_{i,t} = \beta_0 + \beta_1 SDG_{i,t} + \beta_2 PoliticalRisk_{i,t} + \beta_3 \frac{GDP}{capita}_{i,t} + x'_{i,t}\gamma + \varepsilon_{i,t} \quad (1)$$

where is the 5-year CDS spread of country i (= 1,..,59) in year t (= 2017, 2018, 2019) and is the standardized SDG Index for country i in year t calculated by Sachs et al (2020).[3] To test Hypothesis H2 we replace the 5-year CDS spread with the other CDS maturities:

3 We wish to emphasize that we use a reporting lag for each of our independent variables. The CDS spread is published at the end of September in year t, while all other variables of year t are already published before September.

6 months, 1–4 years, 7 years, 10 years, 20 years, and 30 years. is the vector of the six other explanatory variables and two year-dummies. We include year-dummies to control for potential global macroeconomic trends that our traditional control variables do not capture.

As a first analysis of the relation between the SDG Index and the CDS spread, we examine whether the relation is statistically significantly negative while adding other variables that explain variation in sovereign bond spreads (Hypothesis H1). Table 4 shows the results of this relation by estimating Eq (1). The results in Table 4 indicate that the CDS spread, and the SDG Index are negatively related. We find a statistically significant, at a 10% confidence level, negative coefficient on the SDG Index. The results suggest that a one standard deviation increase in the SDG Index is associated with a decrease of approximately 17 basis points in the 5-year CDS spread. Furthermore, Table 4 also shows a significantly negative effect between a country's wealth and its CDS spread. An increase of one standard deviation of a country's GDP per capita is associated with a decrease in the CDS spread of roughly 26 basis points.

In addition, we observe the expected positive relation between debt to GDP and the CDS spread and the negative relation between GDP growth and the CDS spread. The SDG Index, wealth, and political risk of a country are highly correlated, as observed in Table 4. To ensure that our baseline results of the SDG Index are not driven by wealth or political risk, we orthogonalized the SDG Index. This means that we remove the variation in the SDG Index that is indirectly caused by wealth and political risk. We call this our orthogonalized SDG Index.[4] Column (2) of Table 4 shows the panel regression results, using the orthogonalized SDG Index instead of the standard SDG Index. It is important to note that orthogonalizing the SDG Index does not change the regression model results. We can observe this by looking at the coefficients of the control variables, such as *Inflation* and *GDP growth*, in columns (1) and (2). The economic and statistical significance of the variables not used in the orthogonalization remain the same. We include the regression with the orthogonalized SDG Index as it can provide information on whether the initial baseline result of the SDG Index in column (1) is driven by wealth or political risk. If these two variables drive the results in column (1), the orthogonalized SDG coefficient should be close to zero. However, the results in column (2) indicate that the SDG Index and the CDS spread remain significantly negatively related with an orthogonalized SDG coefficient of −11 basis points, thus mitigating the concern that wealth and political risk drive

4 For more information on how we orthogonalize the SDG Index and Political risk variable we refer to Section 2.2.3 of Ten Bosch et al. (2022).

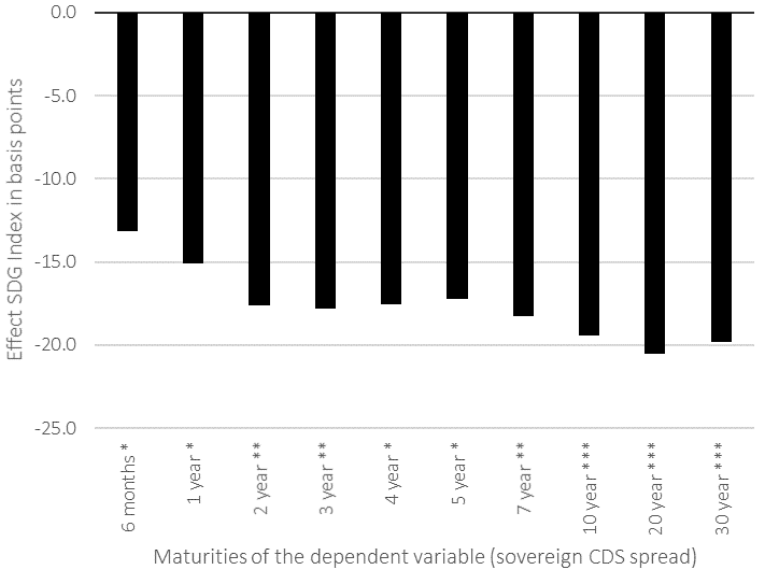
Table 4: Regression results: Relation between SDG Index and the CDS spread

VARIABLES	Random Effects	Random Effects (Orth.)
SDG Index	-17.21*	
	(9.057)	
SDG Index^{O}		-11.34*
		(5.97)
Political Risk	-20.39	
	(15.43)	
Political Risk^{O}		-17.54**
		(8.128)
GDP (per capita)	-25.93**	-54.11***
	(12.62)	(11.69)
Gov. Debt (%GDP)	17.74**	17.74**
	(8.186)	(8.186)
Fiscal Balance (%GDP)	-1.116	-1.116
	(3.574)	(3.574)
GDP (%YoY)	-5.325*	-5.325*
	(3.2)	(3.2)
Inflation (%YoY)	10.77	10.77
	(6.703)	(6.703)
Export (/import)	0.729	0.729
	(5.818)	(5.818)
Reserve (/import)	-12.89	-12.89
	(9.152)	(9.152)
year = 2018	1.55	1.55
	(5.611)	(5.611)
year = 2019	-4.658	-4.658
	(6.523)	(6.523)
Observations	177	177
R^2	0.377	0.377
Clustered Std. Err.	YES	YES
Number of countries	59	59

This table displays the relation between the SDG Index and CDS spread over the 2017-2019 period. The dependent variable is the 5-year CDS spread from Refinitiv Datastream. As independent variables we include the SDG Index from Sachs et al. (2020) and the traditional macroeconomic variables. Column 1 shows the results of Eq. (1) with the normal SDG Index. Column 2 shows the relation between the orthogonalized SDG Index and the CDS spread. The orthogonalized SDG Index is constructed such that all indirect variation that is caused by political risk and wealth is stripped from the variable. We have standardized our independent variables to improve economic comparability. In total, 59 countries are included in the model. We used country- clustered standard errors, and ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

our baseline results. We observe that, as the economic significance of the SDG Index decreases from 17 to 11 basis points, the GDP per capita variable, in absolute terms, increases in economic significance. Overall, the results of Table 1 show that the SDG Index relates negatively to the CDS spread.

Figure 3: Regression results: Relation between SDG Index and different maturity CDS spreads



This figure shows the relation between the SDG Index and different maturity CDS spreads over the 2017–2019 period. The dependent variable is the CDS spread from Refinitiv Datastream of different maturities. Each column reports the results for a different maturity CDS spread; 6 months, 1 year, 2 years, 3 years, 4 years, 5 years, 7 years, 10 years, 20 years and 30 years. We include the SDG Index from Sachs et al. (2020) and the traditional macroeconomic variables as independent variables. We standardized our independent variables to improve economic comparability. A total of 59 countries are included in the model. The standard errors in the parentheses are clustered by country. ***, **, * indicate statistical significance of the SDG Index at 1%, 5%, and 10% levels, respectively.

As a second analysis of the relation between the SDG Index and the CDS spread, we study how the SDGs relate to the different maturity CDS spreads (Hypothesis H2). The results are presented in Figure 3. Each column in the graph reports the regression results of the random effects estimator for a different maturity CDS spread: 6 months, 1 year, 2 years, 3 years, 4 years, 5 years, 7 years, 10 years, 20 years, and 30 years.

We include the same traditional control variables and year dummies as in Table 4 (Eq. (1)). Figure 3 shows a considerable increase in economic and statistical significance for longer maturity CDS spreads. A standard deviation increase in the SDG Index is associated with a sizable decrease of the 6-months and 1-year CDS spreads of approximately 13 and 15 basis points, respectively. On the contrary, a standard deviation increase in the SDG Index is associated with a considerable decrease of roughly 18 and 20 basis points for the 7-year and 20-year CDS spreads, respectively.

These results seem to indicate that the market prices sustainability more on a longer time horizon and provide evidence for Hypothesis H2. Also, the results appear to be more in line with our default risk channel than our preference channel. To

illustrate, if an investor prefers to hold the sovereign bonds of more sustainable countries, the maturity of the bonds does not have to play a role. On the other hand, the risks of unforeseen future SDG-related expenses and sustainability risk costs are more time- horizon sensitive.

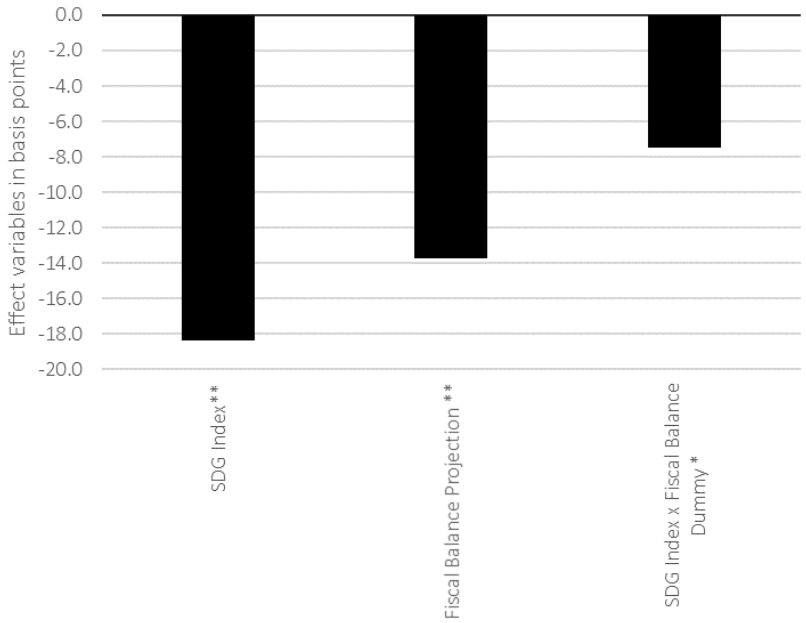
Transmission channel

The initial evidence presented above indicates a possible relation between the SDGs and sovereign credit spreads. While these results contribute to our understanding of the research on sovereign bond determinants, they do not explain *how* the SDGs relate to the CDS spread.

We examine whether the relation between the SDG Index and CDS spread is stronger for countries with a negative projected fiscal balance by estimating Eq. (1) and adding two new variables. We include the 5-year overall balance (% GDP) projections from the April fiscal monitors of 2017, 2018 and 2019 from the IMF. The forecasts are available for 52 countries in our dataset. The primary variable of interest is the interaction term between the SDG Index and the fiscal balance dummy that equals 1 if the country has a negative projected fiscal balance. We argue that achieving the SDGs increases transition costs and the risk of unforeseen future-related SDG expenses. Simultaneously we argue that not doing well on the SDGs will increase the risk of adverse economic impact, e.g., biodiversity loss and water pollution, which also increases government expenditures. If a country already has a negative projected fiscal balance, which typically increases the CDS spread, a low SDG Index might increase the CDS spread even further (Hypothesis H3). The dependent variable is the 5-year CDS spread. The results are shown in Figure 4.

From Figure 4 we observe a significant negative coefficient for the fiscal balance projection coefficient in our model specification. This result suggests that a negative projected fiscal balance is associated with an increase in CDS spread, as we expected. More importantly, we find a significant negative coefficient for the interaction term. This result suggests that a higher SDG Index can partially mitigate the impact of the negative projected fiscal balance on the CDS spread. All else equal, a one standard deviation increase of the SDG Index is associated with a sizable decrease in CDS spread, of approximately 7.5 basis points, for countries with a *negative* fiscal balance projection. The significant interaction term indicates that this decrease of 7.5 basis points may partly offset the increase in CDS spread associated with the negative fiscal balance projection. These results suggest that the SDGs may influence perceived default risk.

Figure 4: Regression results: Fiscal Balance Projections



This figure presents the relation between the SDG Index and CDS spread for countries with and without a projected negative fiscal balance over the 2017–2019 period. The dependent variable is the 5-year CDS spread from Refinitiv Datastream. As independent variables we include the SDG index from Sachs et al. (2020), the fiscal balance projections, the SDG and fiscal balance interaction term, and the traditional macroeconomic variables. We have standardized our independent variables to improve economic comparability. The fiscal balance dummy equals 1 if the country has a negative projected fiscal balance. A total of 52 are countries included in the model. The standard errors in the parentheses are clustered by country. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

We furthermore argue that some countries are more prone to physical climate change risk than others. We analyze whether the SDG Index of a country may mitigate some of this climate exposure risk. We measure climate risk by means of the exposure index of the ND-GAIN (Chen et al., 2015). In Ten Bosch et al. (2022) we observe a positive relation between the climate exposure variable and CDS spreads. This result may indicate that countries with higher climate risk exposure are deemed riskier than less exposed countries. However, we find little evidence that the SDGs have a mitigating risk effect for countries with high climate risk exposure.

In addition, we analyze the relation between the SDG index and the demand for sovereign bonds. We argue that investors might prefer to buy sovereign bonds issued by more sustainable countries. As a proxy for investor preferences, we use the bid-to-cover ratio from the re-opening auction of sovereign bonds. From our results we observe a positive coefficient on the SDG Index, which suggests that a higher SDG Index is associated with an increase in the demand for the sovereign bond. However, the SDG Index coefficient is only statistically significant within the time dimension of

our dataset, and it is not statistically significant for the remaining estimators. Overall, the results presented in Ten Bosch et al. (2022) do not show strong evidence for the preference hypothesis. Further research, based on a larger sample, may shed more light on the potential relation between investor preference and sustainability.

Additional analysis

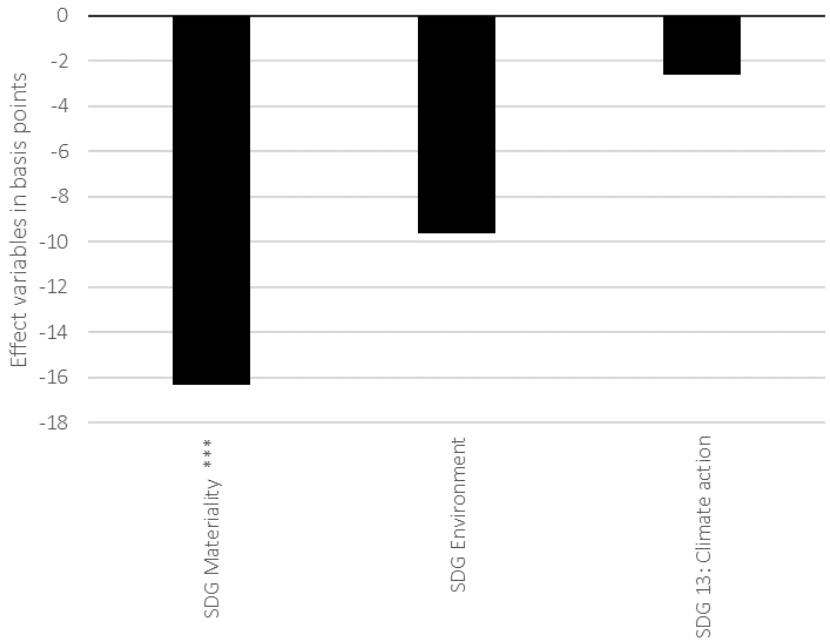
Our results thus far suggest a negative relation between the SDG Index and the CDS spreads. In addition, we argue that our evidence is more consistent with the default risk channel than with the investor preference channel. Yet, we used the SDG Index as the equally weighted index of all 17 goals. However, to expand our knowledge on the different dimensions of the SDGs, both economic, social and environmental, we extend our analysis by looking at a combination of key SDGs.

The IMF identifies five sectors/goals that are key to reaching the SDGs. It asserts that education (SDG 4), healthcare (SDG 3) and infrastructure, consisting of roads (SDG 9), electricity (SDG 7) and water and sanitation (SDG 6), are sectors that play a key role in improving social welfare (Garcia-Escribano and Prady, 2018). The IMF argues that these five sectors indirectly help reach other SDGs, meaning that they have a high spillover effect. In addition, these are also the sectors that governments devote approximately one-third of their budgets to (Garcia-Escribano and Prady, 2018). We therefore create an equally weighted SDG Materiality index of these five goals and analyze how this index relates to the CDS spread.

As the SDG Materiality index focuses on the prime social goals, we create another index that focuses on the environmental aspect of the SDGs. The main environmental goals are climate action (SDG 13), life below water (SDG 14), and life on land (SDG 15). We create an equally weighted index of these three goals called SDG Environmental. In addition to the SDG Environmental index, we also conduct a separate analysis for climate action (SDG 13). Climate change has become more visible in recent years in the media and in academic circles, and the SDGs allow us to analyze it separately.
To analyze the relation between the SDG sub-indices and the CDS spread, we examine whether the relation is statistically significantly negative while adding control variables that explain variation in sovereign bond spreads. Figure 5 shows the results of this relation by estimating Eq. (1) and substituting the SDG Index with our SDG sub-indices. Column (1) reports the results using the random effects estimator with the orthogonalized SDG Materiality.[5] Columns (2) and (3) show the SDG Environmental

5 The regression analysis using the SDG Materiality warned against multicollinearity, so we use the orthogonalized SDG Materiality. For more information on how we orthogonalize the SDG Materiality and Political risk variable, see Section 3.4 of Ten Bosch et al. (2022).

Figure 5: Regression results: Relation between SDG sub-indices and the CDS spread



This figure presents the relation between the SDG sub-indices and the CDS spread over the 2017-2019 period. The dependent variable is the 5-year CDS spread from Refinitiv Datastream. As independent variables we include the standard control variables, and we replace the SDG Index from Sachs et al. (2020) with the SDG Materiality index (column 1), the SDG Environmental index (column 2) or SDG 13 (column 3). We standardize the independent variables. All columns present the results from the random effects estimator since the estimator combines the information from both time and cross-sectional dimension most efficiently. The SDG Materiality index is an equally weighted index of SDGs 3, 4, 6, 7 and 9. Column (1) presents results using the orthogonalized SDG Materiality index and the political risk variable. The variable SDG Environmental is the equally weighted average of SDG 13, 14 and 15. Finally, column (3) shows the result of using SDG 13, which measures the preparedness of governments for climate change. A total of 59 countries are included in the model. The standard errors in the parentheses are clustered by country. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively.

and Climate Action goal regression results, respectively, also using the random effect estimator. Neither the SDG Environment goal nor the Climate Action goal is orthogonalized as the correlation between the indices and the other control variables did not warn against multicollinearity. We include the same traditional control variables and year dummies as in Table 4.

Figure 5 shows that the orthogonalized SDG Materiality index coefficient is considerable, with 16.3 basis points. The results in column (1) are similar to our main baseline results (SDG Index: −17.2 bps) in column (1) of Table 4. However, this SDG Materiality index coefficient is higher than the coefficient of the orthogonalized SDG Index in column (2) in Table 4. This finding seems to indicate that these material SDGs play a vital role in the transition towards sustainability. Overall, the results of column

(1) suggest that performing well on these key social goals may benefit governments financially.

Column (2) of Figure 5 presents the results of the SDG Environment. We observe a negative relation between the SDG Environment and the CDS spread of approximately 10 basis points. Column (3) of Figure 5 portrays our Climate Action analysis results. The economic significance drops to –2.6 basis points compared to the SDG Environmental index. The SDG Environmental and the Climate Action variable are not statistically significant in their regressions. Given the increase in investor attention towards sustainability, these results may be surprising. The results indicate that the environmental goals are not yet priced into sovereign CDS spreads.

5. Discussion and conclusion

Our study adds to the growing body of sustainable finance research. Its main purpose is to better understand the connection between sustainability and sovereign bond spreads. To that end we study the relation between the performance of a country on the SDGs and its sovereign CDS spread. SDGs measure the various outcomes on sustainable development. They are therefore a better measure of sustainability than the more input oriented ESG ratings that are currently used by the industry.

Our findings can be summarized as follows. First, we find a significant negative relation between the SDG Index and the CDS spread, i.e. the higher the index, the lower the spread. This finding is significant at the 10% level. Our results suggest that a standard deviation increase in the SDG Index is associated with a negative impact on the 5-year CDS spread of 17.2 basis points. Second, we find that this relation is economically and statistically stronger for CDSs with a longer maturity. To illustrate, an increase in SDG Index is associated with a negative effect on the CDS spread of 13 to 15 basis points at the short end of the yield curve, compared to over 19 basis points for the 10, 20 and 30-year maturities.

Next, we test two transmission channels to deepen our understanding of how the relation may materialize. We see evidence consistent with our hypothesis that the SDGs may decrease perceived country risks related to future fiscal balances. The idea is that investing in SDGs today leads to lower fiscal expenses in the future to achieve the SDGs. Our results suggest that an increase in SDG Index may partly offset, by approximately 7.5 basis points, the increase in CDS spread associated with a negative fiscal balance projection. Overall, our results indicate that investing in the SDGs may provide governments with financial benefits, in addition to improvements in ecological and social welfare.

Our results are relevant for both investors and governments. Pension funds and insurers invest a large percentage of their asset mix in sovereign bonds, to hedge their long-term pension and insurance commitments. The findings are relevant for these large sovereign bond investors. From a risk perspective, countries that do well on the SDGs can be perceived to have lower default risk. This lower perceived risk translates into lower returns, as is familiar with lower-risk assets. Next, the novelty of our paper is that it shows that impact (measured in terms of SDG performance) across sovereign bonds differs and matters. Impact investing is common in different asset classes but is not normally associated with sovereign bond strategies. However, our results allow precisely doing that. As we find a significant negative relation between the SDGs and a country's credit spread, investing in countries that invest in sustainability can lead

to financial and impact benefits for investors (as well as governments) in the form of higher bond prices and better SDG performance. Investors can benefit by investing in SDG-improving countries early on. This strategy benefits from the increased engagement by governments in recent years.

As to government engagement by investors, we realize that this is just starting, as seen in countries such as Australia and Brazil. We expect that to rise. Where possible, investors can use our information to press for increased engagement by governments. As a result, aside from the ecological and social impact of successful engagement, they may benefit financially.

Governments have every reason to invest in SDG improvements and to engage with investors on their SDG performance, as they may be rewarded with lower borrowing costs as well as greater sustainable development. Our initial evidence, in the form of a reduction of borrowing costs by 17 basis points, makes clear that investing in the SDGs may pay off financially.

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