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# Sustainability as a Leading Indicator for Credit Events

## Can MSCI ESG Ratings Help Identify Latent Credit Risk in a Bond Portfolio?

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## Executive summary

This study explores whether sustainability data — specifically MSCI ESG Ratings and datapoints within — can help with early identification of corporate bonds at risk of adverse credit events such as distressed valuations, credit-rating downgrades or sizable spread widening.

Using a 10.5-year dataset covering over 21,000 bonds included in MSCI Fixed Income Indexes, we found that bonds of issuers with low MSCI ESG Ratings were significantly more likely to experience such events.[1] We observed these results across both the investment-grade and high-yield bond universes.

Employing survival-analysis techniques, we illustrated that high-ESG-rated bonds not only experienced fewer credit events but remained unaffected longer — suggesting sustainability data may be useful in modeling both the probability and timing of credit events.[2]

As issuers from different sectors grapple with different sustainability risks, analyzing performance on individual environmental (E), social (S) and governance (G) key issues may at times be more accurate in identifying bonds at risk, underlining the value of focusing on the most material risks issuers face.

Taken together, these findings suggest that integrating sustainability data into credit-risk frameworks may be valuable in portfolio construction and risk monitoring, helping investors identify and avoid latent credit risk before it adversely affects performance. The tools and approaches presented here offer practical pathways to utilize sustainability data in credit-event risk management.

**Key takeaways:**

- Bonds of issuers with low ESG Ratings were 45% more likely to experience credit events during the study period. **ESG Ratings** provided forward-looking, not just reactive, signals of credit events.
- We estimated that bonds of issuers with high ESG Ratings had a 37% lower hazard of experiencing a credit event and 69% longer survival time without an incident than those of low-ESG-rated issuers.
- Sector-level analysis revealed that **environmental** and **social** risks showed sector-specific relevance. For example, environmental issues were more informative in utilities and materials, while social risks and opportunities mattered more for financials and health care.
- There was a strong relationship between **governance** and event risk. Performance on key issues that looked at ownership dynamics, board composition and pay practices, was among the strongest predictors of future credit events in most sectors.
- Sustainability risk was relevant in anticipating adverse credit events. These findings could be used in portfolio construction, risk monitoring and exit strategies for both passive and active investors.

[1] We divided the analyzed bond universe into terciles based on the issuer's MSCI ESG Rating. Bonds of issuers with high (top) or low (bottom) ESG Ratings refer to those in the highest and the lowest tercile, respectively.

[2] Survival analysis estimates the likelihood of avoiding a negative outcome (e.g., credit default) over time. It models both the timing and probability of such events, enabling comparison of resilience associated with different characteristics, such as the sustainability profile.

# Introduction

For creditors, the ability to anticipate adverse credit events — particularly defaults — is fundamental to pricing and managing risk and improving long-term risk-adjusted returns on their committed capital.

Holding a debt security nearing default may result in sudden price declines and potential forced selling or write-offs due to regulatory or mandate-driven constraints, especially for regulated institutions with conservative investment mandates — particularly banks, insurers, pension funds and their managers (Aslan and Kumar, 2018). The ability to identify securities at heightened risk of incurring a credit event is therefore essential in credit portfolio construction, risk monitoring, and performance optimization.

A substantial body of research, including meta studies, such as Friede, Busch and Bassen (2015) or Atz et al. (2022), identified sustainability-related risks as relevant for financial performance. As proposed in Giese et al. (2019), there may be concrete transmission mechanisms of how sustainability risk (measured by MSCI ESG Ratings) may be linked to fundamental and market performance of listed companies. Mendiratta, Varsani and Giese (2021) and Wang, Malich and Husi (2025) later brought this concept to the corporate-bond market by setting it within the Merton model (Merton, 1973) and studied whether bonds of issuers with lower sustainability risk displayed greater distance to default and whether that was reflected in their market risk and return.

This study attempts to add another piece of evidence to the existing body of research tying sustainability to financial outcomes, specifically focusing on credit-event risk associated with corporate bonds. Like the Wang et al. (2025) study in equities, we attempt to identify which sustainability risks and opportunities may be the most relevant in anticipating adverse credit events for issuers in different sectors of the economy.

# Data and analysis setup

## Analysis universe

Our analysis covered a 10.5-year period of monthly data between January 2015 and June 2025. The analyzed universe contained over 21,000 bonds that were constituents of the MSCI Corporate Bond Indexes during the study period. For the purposes of the analysis, we excluded bonds of issuers that did not have an MSCI ESG Rating at any point during the study period (see Appendix 1 for more details). The bonds that remained in the study sample were equal weighted in the analysis.

## ‘Credit events’ definition

We defined three types of credit events to track in our bond universe — a distress signal, credit-rating downgrade and sizable idiosyncratic spread widening.

### Distress signal

To design the first credit-event flag, we took the rule-of-thumb measures of bond distress. These were either the bond having a credit rating in the extremely speculative or defaulted territory or trading at a credit spread of over 1,000 basis points (bps).[3]

### Credit-rating downgrade

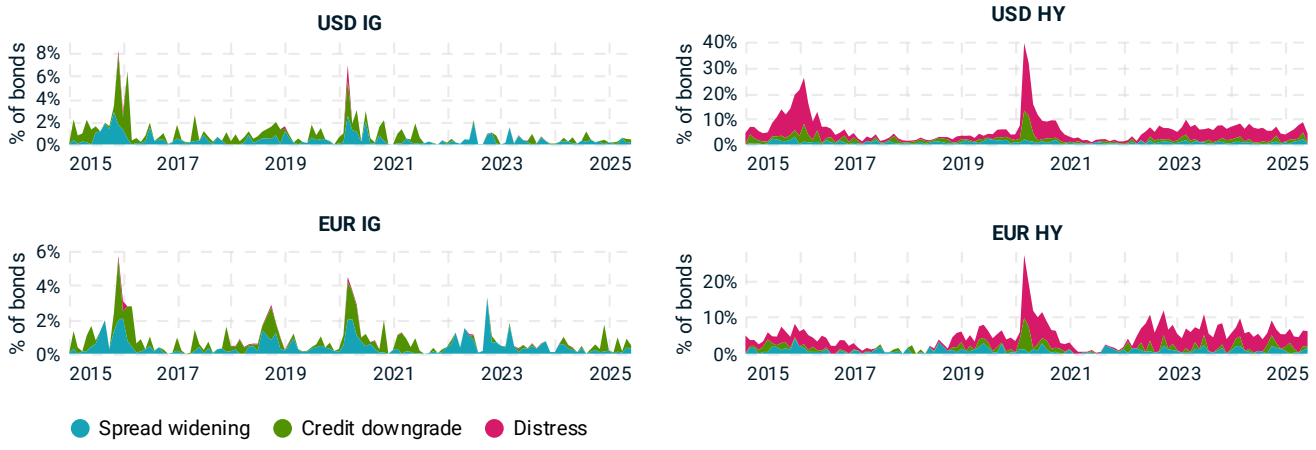
To design the second credit-event flag, we simply flagged bonds that experienced a credit-rating downgrade anytime during the study period.[4]

### Extreme spread widening

To track pronounced, idiosyncratic spread widening, we flagged bonds that met two conditions. They were in the 95th percentile of the bonds whose credit spread widened the most that month and their spreads concurrently exceeded their index average by three times the typical deviation seen in the index. This should have caught bonds that, relative to their index, experienced severe spread widening that pushed their spread into outlier territory, hinting at bond- or issuer-specific stress as the cause.

The chart below shows the distribution of the defined credit events across the studied corporate bond universes. As the charts show, these risks materialized regularly and were especially widespread during times of market stress (e.g., the oil price driven credit market dislocation in late 2015 or the Covid-19 selloff in Q1 2020). Also, as expected, HY bonds were much more likely to experience **distress** compared to IG bonds, however, **credit downgrades** were more evenly distributed (though still more frequent in HY during market stress periods). Sizeable idiosyncratic **spread-widening**, due to its index-agnostic design, could have been observed with similar frequency in both HY and IG space.

**Frequency of the defined credit events across the bond universes**




The analysis is based on monthly data between January 2015 and June 2025. Source: MSCI ESG Research

[3] Extremely speculative or defaulted territory corresponds to CC, C and D credit rating by S&P and Ca, C and D credit rating by Moody's.

[4] A downgrade to a lower credit grade (e.g., to BBB from A or to Baa from A) by either S&P or Moody's.

The credit events happened relatively often and across the board, i.e., even in the higher credit-quality space. Furthermore, we saw more distress in HY in recent years, potentially attributable to higher interest rates (financing costs) that may be particularly hard to digest for issuers with more limited resources.

As these credit events can significantly weigh on returns, investors have a clear incentive to find data and indicators that could help in avoiding them, beyond traditional financial metrics.[5]

## Likelihood of credit events across ESG Rating grades

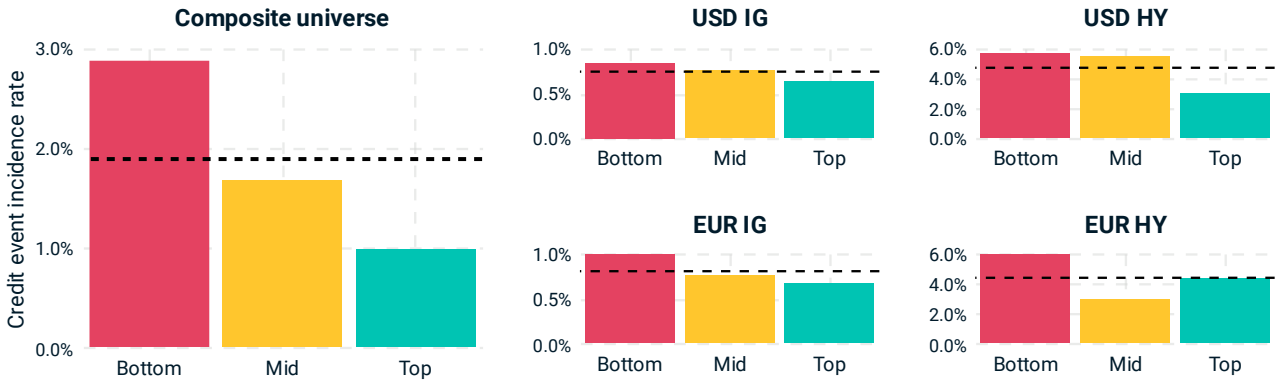
MSCI ESG Ratings are designed to measure companies' resilience to financially relevant, industry-specific sustainability risks and opportunities.[6] These risks include, but are not limited to, utilization of natural resources, capturing technological opportunities, maximizing workforce productivity and managing conflicts of interest among the different stakeholders.

### Incidence rate of credit events

For that reason, we would expect to see an inverse relationship between the issuer's MSCI ESG Rating (and its relevant components) and the incidence rate of credit events. In other words, we would expect issuers that are more resilient to sustainability risks to experience fewer credit events than those more exposed to or less adept at managing these risks.

As the chart below shows, we indeed saw such a relationship during our study period across the bond indexes, which, among other things, account for the differences in credit quality.

**Incidence rate of any of the three defined credit events across ESG-rating terciles**




The analysis is based on monthly data between January 2015 and June 2025. The black dotted line shows the average in each universe. A bond is flagged (once) if it experienced any of the defined credit events. Source: MSCI ESG Research

[5] Even without a credit default, all the defined credit events are related to or accompanied by credit-spread widening, including credit-rating downgrades (Vazza, Kraemer and Gurwitz, 2019). As the average credit spread duration in the composite universe was 5.6 during our study period, each 100 bps of spread widening on average led to a 5.6% drop in the bond price.

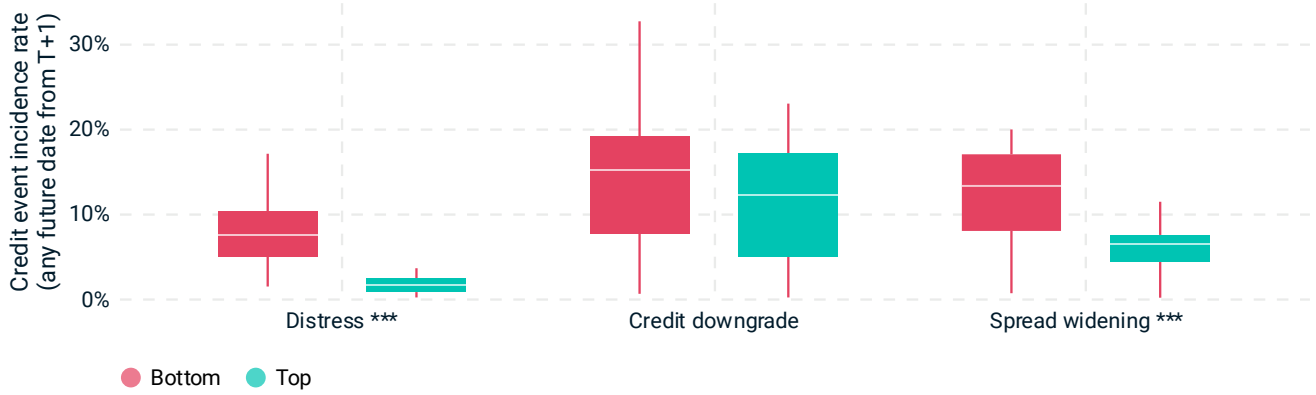
[6] MSCI uses a rules-based methodology to identify industry leaders and laggards, assigning each company an industry-relative letter rating from AAA to CCC based on how well they manage these risks and opportunities relative to peers' ESG Ratings.

However, while the historical distribution can provide insight into the overall relationship between the ESG Ratings and the frequency of credit events, it may suffer from several biases or limitations. Most important, any analytical assessment, such as ratings and scores, may be reactive, not proactive, meaning that they sometimes change only after a relevant event happened, which may be too late for investors to act on the information.

We therefore focused on the predictiveness of sustainability-risk assessment by testing whether bonds of lower-ESG-rated issuers (at time *T*) were more likely to experience credit events at a future date (from *T+1* to *T+ΔT*, where *ΔT* is the remaining observation window for each bond).

Specifically, we used a **two-sample z-test** to check for the difference in proportion of credit events across the ESG-rating terciles (focusing on the top and the bottom terciles) until the end of the study period after each observation date (see Appendix 2 for more details on the methodology).

**Proportion of bonds by ESG Rating tercile to experience a credit event at a future date**




The analysis is based on monthly data between January 2015 and June 2025. Each month (*T*), we divided the bonds into ESG Rating terciles and observed the incidence rate of credit events in each tercile from *T+1* until the end of the observation window (*T+ΔT*). The incidence rate and p-values are based on the monthly mean values over the analysis period. ***, ** and * indicate significance at the 99%, 95% and 90% confidence levels, respectively. Source: MSCI ESG Research

As the chart above shows, bonds of issuers with the lowest ESG Ratings were significantly more likely to experience one of the credit events at a future date than those from the highest-ESG-rated issuers. This relationship also held during the most turbulent period in the study (the COVID-19 sell-off). Bonds that entered the period with high ESG Ratings held up better than the low-rated ones (see Appendix 2).

This points to the forward-looking nature of MSCI ESG Ratings, and sustainability risk in general. The ratings did not seem to only reactively change around or shortly after major negative developments, but captured the likelihood of experiencing a credit event in the future.

Finally, consistent with Wang, Malich and Husi (2025), higher MSCI ESG Ratings were associated with lower credit spreads. However, the correlation of OAS with ESG Rating scores was relatively limited and showed that bonds of high-ESG-rated issuers did not exclusively trade at tighter spreads compared to

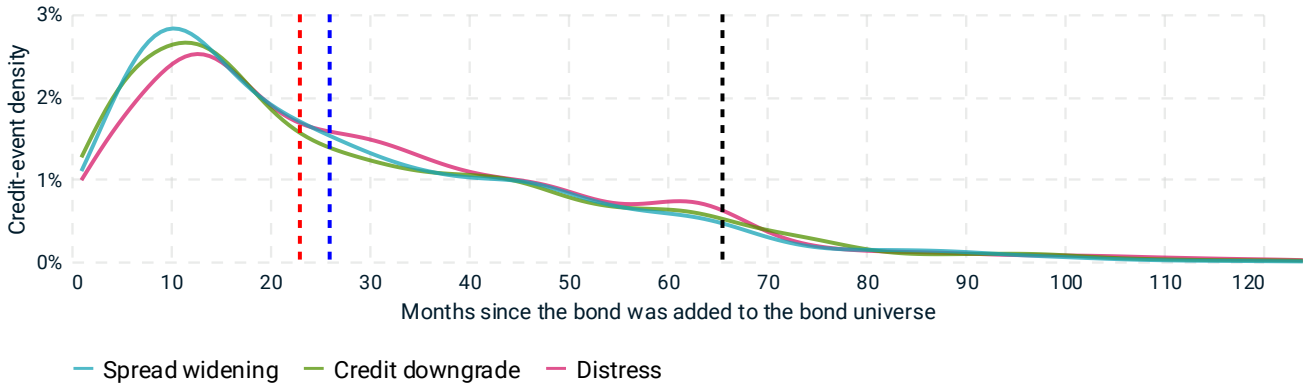
the low-ESG-rated ones (see Appendix 1 for more details). Therefore, ESG Ratings (and data within) may add value in anticipating credit events on top of the information reflected in credit-spread levels.

## Timing of credit events

While these results are encouraging for validating the use of sustainability data to anticipate credit events, they are incomplete because they don't tell us anything about the timing of the events, which limits our ability to model the risk and act on it accordingly.

To gain a better grasp of the time element in our credit-event analysis, we first need to understand the structure and behavior of the bond universe (or one's credit portfolio). While the median time to maturity in our composite bond universe was 5.5 years (66 months), due to bond-index turnover and rebalancing (e.g., because bonds approach maturity, are called or otherwise cease to meet the inclusion criteria), the median time a bond was included in the universe was 2.2 years (26 months).[7] So, if we visualize the credit-event density over the analysis period (or the holding period), we see that they were concentrated early on, as few bonds remained in the universe during the entire 126-month analysis period.

**Timing of credit events since the affected bond was added to the bond universe**




The analysis is based on monthly data between January 2015 and June 2025. The red dotted line shows the median time (in months) in which an affected bond experienced a credit event, the blue dotted line the median number of months a bond was included in the bond universe and the black dotted line the median time to maturity of the bonds in the universe.
Source: MSCI ESG Research

It is interesting to see the bump in event density before the median time to maturity, as particularly HY bonds often start showing signs of distress as the maturity date approaches and it becomes clearer whether the borrower will have trouble repaying the principal amount owed.

[7] "MSCI Corporate Bond Indexes Methodology," MSCI, June 2025.

### Survival analysis

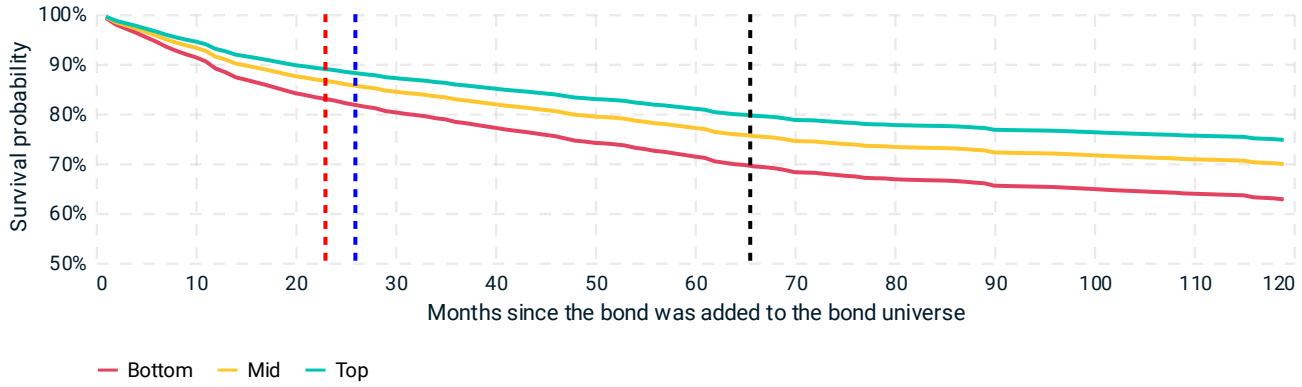
Understanding the bond universe's structure, index-rebalancing mechanisms and the resulting turnover in the universe is key in forming expectations on how credit events may materialize over time, especially for passive investors seeking broad exposure to the corporate-bond market through index-tracking.

For both passive and active credit investors, it may be useful to model the risk through time to form expectations for their desired holding period. We may use a few techniques from survival analysis to model the relationship of events across time horizons and categorical variables.

Using the Cox proportional hazards model, we can model the survival rate of bonds — i.e., the probability of not experiencing a credit event — through time and across covariates, such as the ESG Rating groups. With the time-varying model (acknowledging that ESG Ratings change over time) we can estimate how a bond's current ESG Rating tercile affects its risk of experiencing a credit event in the next month throughout the analysis period (see Appendix 3 for details on the methodology).

At a given point in time (*T*), bonds of issuers in the top ESG Rating tercile were 37% less likely to experience a credit event (at *T+1*) compared to those in the bottom tercile. As the probability of an event, given no prior event, increases over time, we can visualize this relationship over time by building survival curves for each ESG Rating tercile (as shown in the chart below; see Appendix 3 for the results for each bond index separately).

**Cox proportional hazards model and fitted survival curves across ESG Rating terciles**




| | Exp(coef) | SE(coef) | CI (lower) | CI (upper) | z-stat | p-val |
|---|---|---|---|---|---|---|
| **Mid** | 0.770 | 0.034 | 0.720 | 0.824 | -7.631 | 0.000*** |
| **Top** | 0.625 | 0.036 | 0.583 | 0.671 | -13.036 | 0.000*** |

The analysis is based on monthly data between January 2015 and June 2025. The red dotted line shows the median time (in months) in which an affected bond experienced a credit event, blue dotted line the median number of months a bond was included in the bond universe and black dotted line the median time to maturity of the bonds in the universe. The values in the table show the difference and its significance relative to the Bottom ESG Rating tercile. ***, ** and * indicate significance at the 99%, 95% and 90% confidence levels, respectively. Source: MSCI ESG Research

We can also look at this relationship in terms of the expected time to event. Given the right-skewed distribution of credit events (peaks early, then flattens), we may use the log-normal "accelerated failure

time" (AFT) analysis, which produces the group effect estimates in terms of time-to-event acceleration or deceleration (while accounting for the distribution and censoring of data). That is, how much faster or slower we expect the different groups of bonds to be affected. This may be especially useful when working with different holding periods and considering the most severe credit events, such as defaults, which may result in near-zero recovery rates and drag down the performance of the entire portfolio (Altman, Resti and Sironi, 2001).

Compared to the bottom tercile, bonds in the top tercile survive 69% longer unaffected by credit events (see Appendix 3 for more details on the methodology and results per bond index).

Putting it all together, the z-test analysis tells us to expect different proportions of credit events in the top and the bottom ESG Rating groups, the Cox model helps us estimate and visualize the relative hazard between them over our analysis or holding period (top tercile 37% less likely to experience a credit event than the bottom one) and the AFT analysis helps us estimate the relative time during which bonds in the two groups are expected to remain unaffected (top survives for 69% longer).

## Sector-specific sustainability risks

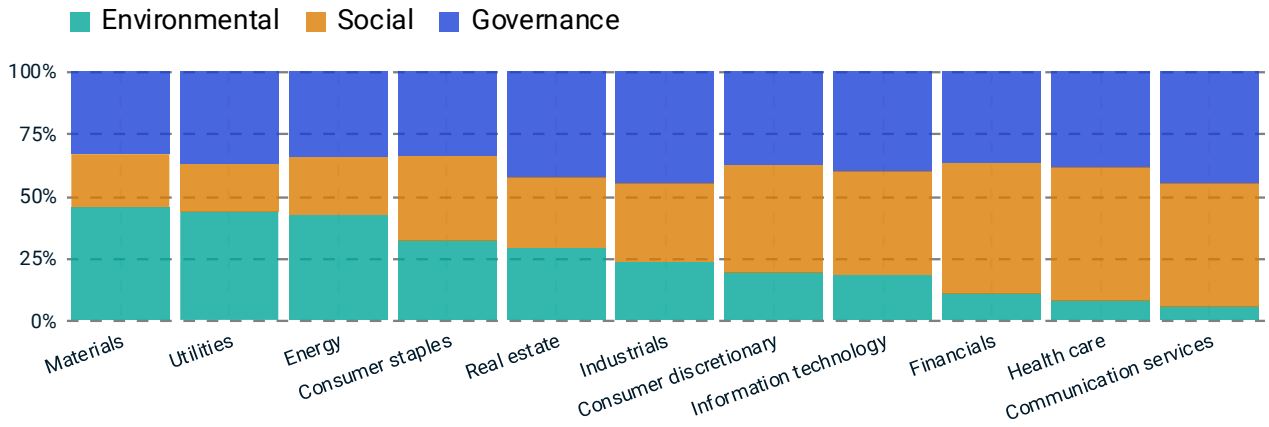
We saw that bonds of issuers with low ESG Ratings were more likely to be affected by credit events and illustrated how we can expect these events to materialize over time. But can we gain better insights by identifying the most relevant risks for different companies and recalibrating our analysis to those?

It is intuitive that companies in different economic sectors, i.e., deriving revenues or having their assets committed to different business activities, are exposed to different risks and pursue different opportunities, including those related to sustainability.

These considerations are reflected in the weight-setting process for key issues in the construction of MSCI ESG Ratings, resulting in notable differences in the E-, S- and G-pillar weights among companies in different sectors (see the chart below).[8]

[8] "MSCI ESG Ratings Methodology," April 2024.

**Environmental-, social- and governance-pillar weight in MSCI ESG Ratings**




Weights as of June 30, 2025. Source: MSCI ESG Research

As the chart above suggests, we'd expect the business performance of issuers (and by extension their financial strength or performance of their bonds and equities) in sectors such as utilities, materials or energy to be more exposed to environmental risks and opportunities. These may include increased costs from pollution taxes and waste-disposal fees, production outages due to unavailability of natural resources or conversely capitalizing on energy efficiency and various cleantech opportunities (Liu et al., 2024 and Zhou et al., 2025).

On the other side of the spectrum, sectors such as communication services, health care or financials may primarily deal with social factors such as fierce competition for talent, strict regulatory protection of consumer rights and health or increasing the reach of their services to different layers of society (Skiera, 2020 and Theodorsson et al., 2022).

We consider governance matters, such as allowing independent oversight of the management, structuring incentives to promote long-term business continuity over short-term risk-taking or setting up mechanisms to prevent conflicts of interest among the different stakeholders to be relevant for all companies. Failures in governance are also often linked to grave, value-destroying incidents, such as fraud or corruption scandals, which may result in eventual closure of the business (Velte, 2023). These considerations are reflected in the substantial weight of the governance pillar across sectors.

Based on the above, we posed and attempted to answer three questions:

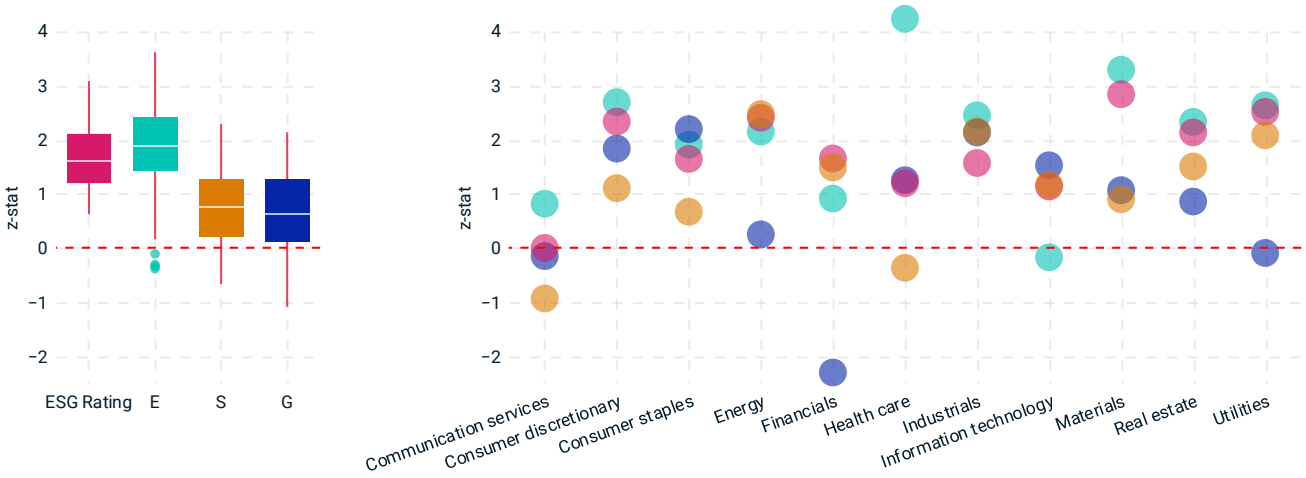
1. Is the overall resilience to sustainability risks — represented by the MSCI ESG Rating — the best tool in predicting credit events?
2. Can we gain more accurate insights from the environmental, social and governance pillars, depending on the sector? If so, which were the most predictive key issues for each sector?

3. Was the strength of governance the best predictor of future credit events, due to its importance across sectors and its link to value-destroying incidents?

To answer these questions, we repeated the two-sample z-test for difference in proportion (focusing on 24-month horizon, as the median affected bond would have been impacted within this timeframe).

We first compared the ESG Rating to the E-, S- and G-pillar scores on how well they differentiated the top and the bottom performers on each metric in terms of future credit events incurred. The ESG Rating, compared to the individual pillar scores, was the most stable predictor across sectors: It had the lowest variability (the range of z-stat across sectors), and it was the only one with positive z-stat (the top tercile having lower credit-event incidence rate than the bottom tercile) in each sector (see the chart below).

**ESG Ratings and E-, S- and G-pillar scores as predictors of credit events per sector**



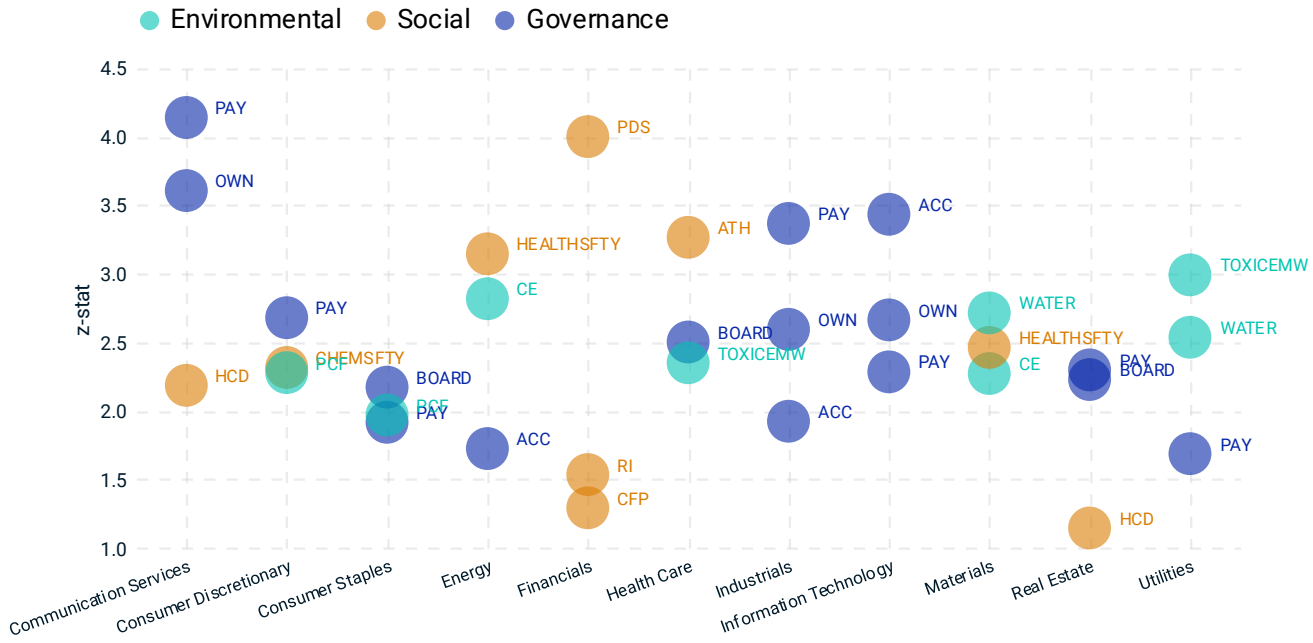

The analysis is based on monthly data between January 2015 and June 2025. The y-axes show the mean result of running the two-sample z-test for the difference in proportion from *T+1* until *T+24 months* each month (*T*) during the analysis period. Left-hand side shows the results per ESG Rating and individual pillar scores for the entire sample; right-hand side shows the same per sector. Source: MSCI ESG Research

In most sectors, however, the ESG Rating was the second-best predictor in terms of separating the top and bottom groups, behind one of the pillar scores, suggesting that digging into the individual pillars could strengthen the analysis.

Indeed, looking at individual key issues within the pillars (see Appendix 4 for details on how MSCI ESG Ratings are constructed), we see that the key issues — representing different sustainability-related risks — may be more useful in predicting the likelihood of credit events in different sectors that face different risks and opportunities.

The chart below displays the three most predictive key issues in each sector in terms of separating the top and the bottom performers on each key issue and the proportion of credit events observed in these groups from *T+1* until *T+24 months* (the more positive the z-stat, the higher the difference between the rate in the bottom group compared to the top group).

**Most predictive key issues per sector**




The analysis is based on monthly data between January 2015 and June 2025. The y-axis shows the mean result of running the two-sample z-test for the difference in proportion from *T+1* until *T+ΔT* each month (*T*) during the analysis period. We display the results for the top three most predictive key issues (in terms of z-stat) per sector. Refer to Appendix 4 for full names of the key issues. Source: MSCI ESG Research

The most predictive key issues in each sector largely met our expectations that were formed based on the weights in MSCI ESG Ratings. That is, environmental key issues appeared more frequently in the sectors expected to be more materially affected by environmental issues, such as materials or utilities, while the social key issues seemed more relevant for sectors such as financials or health care.

Our final expectation was that governance, due to its importance for all companies and its link to value-destroying incidents, could be a strong predictor of future credit events. We indeed saw governance playing an important role, as around half of the top three most predictive key issues across sectors were related to governance.[9] The only sectors where governance was not in the top three leading indicators were financials and materials. This may be somewhat surprising, especially for financials. One possible explanation is that financial companies, especially the regulated ones like banks and insurers, tend to have higher overall scores for corporate governance than other sectors due to more stringent regulatory requirements, which can make it a poorer differentiator in that sector.[10]

[9] Note that the history of governance-related key issues starts in July 2019, whereas other key issues were covered during the entire study period starting in January 2015.

[10] Financials had the highest corporate-governance theme score of any sector during our study period. Their average score was 7.0 (vs. 6.4 for the rest of the sample ex-financials).

The results were largely consistent with those in Wang et al. (2025), which also identified governance key issues to be the most consistent in predicting sharp declines in stock prices.

Finally, after identifying the key issues that may be more predictive of credit events in particular sectors, we can return to the survival analysis, this time looking at individual sustainability risks. For example, based on historical data, we estimate issuers in the communication-services sector with the most robust pay practices to have 56% lower hazard and survive 134% longer without a credit event, clearly separating the top and the bottom performers on this key issue (whereas the chart above shows that the ESG Rating did not seem to be a strong predictor of credit events in this sector during our study period).

Naturally, we cannot rule out some degree of spuriousness or other factor influence, especially as the more granular we go, individual company stories start to play an increasingly important role. However, such analysis may enable us to navigate the deluge of (sustainability and other) data and highlight the most relevant areas for investors to focus on. This information can be complemented by other forms of quantitative (e.g., credit-ratio analysis and forecasting) and qualitative (e.g., a SWOT or Porter's five forces) analysis of the issuer's prospects to gain the most comprehensive view on the latent credit risk in the bond portfolio.

## Conclusion

The findings in this study affirm the financial materiality of sustainability risk in credit markets. Focusing on event risk, we find that bonds of issuers with low ESG Ratings exhibited significantly higher incidence rates of adverse credit events, including distressed valuations, credit-rating downgrades, and extreme spread widening. We observed these results with both IG and HY bonds.

Employing survival analysis techniques, we illustrated that high-ESG-rated bonds not only experienced fewer credit events, but remained unaffected longer — suggesting sustainability data may be useful in modeling both the probability and timing of credit events. Bonds of the high-ESG-rated issuers were 37% less likely to experience a credit event and survived 69% longer without being affected by one during our study period.

Appreciating that issuers from different sectors tackle different sustainability risks, we showed that while ESG Ratings offered stable predictive power, individual environmental, social and governance key issues may at times be more accurate in identifying bonds at most risk.

Governance-related key issues emerged as the most consistently predictive across sectors, adding evidence to the intuitive relationship between sound governance and lower event risk. Environmental and social risks were also important in sector-specific contexts, however, underlining the value of selectively utilizing the data that constitutes the ESG Rating.

Taken together, these findings suggest that integrating sustainability data into credit-risk frameworks may be valuable in portfolio construction and risk monitoring, helping investors identify and avoid latent credit risks before they adversely affect performance. The tools and approaches presented here offer practical pathways to operationalize sustainability data in forward-looking credit risk management.

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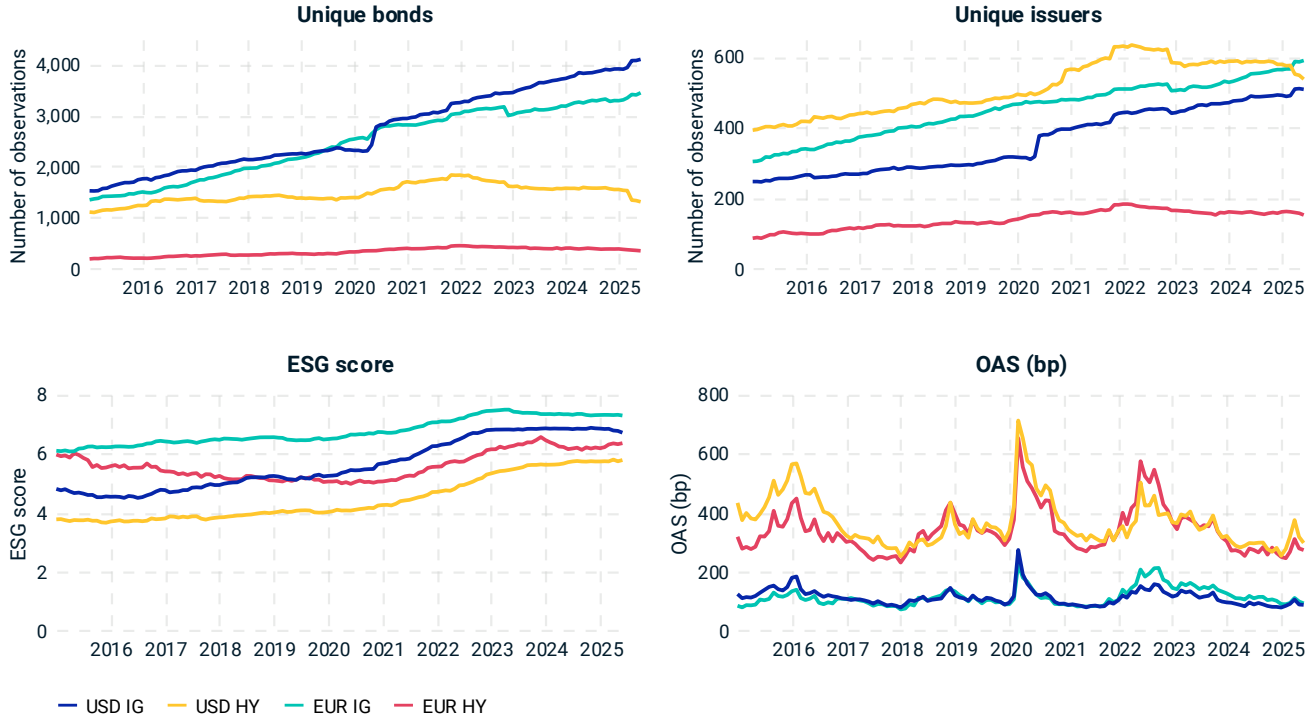
# Appendix

## Appendix 1: Data description

Our analysis covered a 10.5-year period of monthly data between January 2015 and June 2025. The analyzed bond universe contained bonds that were constituents of the MSCI Corporate Bond Indexes during the study period. We excluded bonds of issuers that did not have MSCI ESG Rating at any point during the analysis period. The bonds were equal weighted in the analysis.

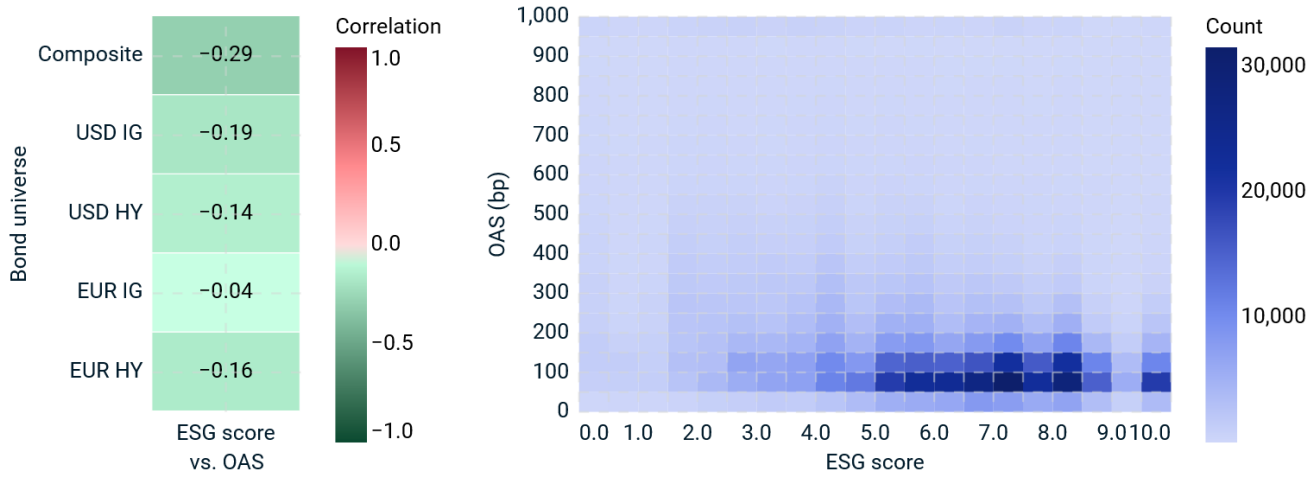
### Key characteristics per bond universe




| Bond universe | No. of bonds (n unique) | No. of issuers (n unique) | MSCI ESG Rating (mode) | Credit rating (mode) | Years to maturity (median) | OAS (bp) (median) |
|---|---|---|---|---|---|---|
| MSCI USD IG Corp. Bond Index | 8,331 | 613 | A | BBB | 6.5 | 95.7 |
| MSCI USD HY Corp. Bond Index | 5,095 | 955 | BB | BB | 5.5 | 310.5 |
| MSCI EUR IG Corp. Bond Index | 7,106 | 698 | AA | BBB | 4.9 | 100.3 |
| MSCI EUR HY Corp. Bond Index | 1,312 | 313 | BBB | BB | 4.5 | 286.6 |
| **Composite bond universe** | **21,034** | **1,887** | **A** | **BBB** | **5.5** | **121.0** |

The analysis is based on monthly data between January 2015 and June 2025. The composite bond universe used throughout the study is an aggregate of MSCI USD and EUR Investment Grade (IG) and High Yield (HY) Corporate Bond Indexes. A bond may appear in more than one index over time (e.g., after a credit-rating change), so the numbers in the composite universe may differ from the sum of individual indexes. Source: MSCI ESG Research

### ESG Rating (score) and OAS correlation and distribution heatmap




The analysis is based on monthly data between January 2015 and June 2025. The composite bond universe used throughout the study is an aggregate of MSCI USD and EUR IG and HY Corporate Bond Indexes. The correlation chart shows the Pearson correlation coefficients between the industry-adjusted score that underlies the MSCI ESG Rating (ESG score) and the OAS, computed for the composite universe and for each sub-universe separately over the study period. Each cell represents the strength and direction of the linear association between the two variables (scale from –1 to +1). The heatmap displays the distribution of OAS across the ESG scores and MSCI ESG Ratings. Each cell shows the count of all observations that fall into the corresponding combination of OAS and ESG score bands. Source: MSCI ESG Research

## Appendix 2: Two-sample z-test for the difference in proportions

The test compares the proportions of a binary outcome (e.g., a credit event) between two independent groups to determine whether the difference is unlikely to have occurred by chance.

We used a two-sided test with the following hypotheses:

*$H_0$: The proportion of credit events at T+1 to T+ΔT in both groups is equal*
*$H_A$: The proportions are different*

Test statistic:

$$z = \frac{p_1 - p_2}{\sqrt{p(1-p) * (\frac{1}{n_1} + \frac{1}{n_2})}}$$

Where:

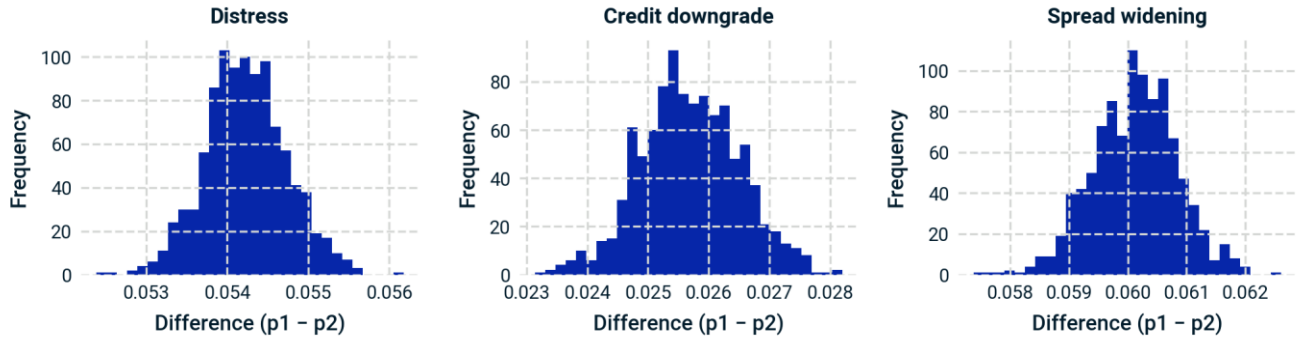
***p1, p2*** are the sample proportions (number of events / sample size), ***p*** is the pooled proportion (total number of events / total sample size), and ***n1, n2*** are the sample sizes.

The z score shows how many pooled standard deviations apart are the proportions in each sample.

**Tested data properties**

The test is appropriate for our dataset, as it assumes a binary outcome for each observation, the groups to be independent and mutually exclusive, and the difference in proportions between the groups to be approximately normally distributed (as shown in the chart and table below).

**Frequency of credit events and difference in proportions**



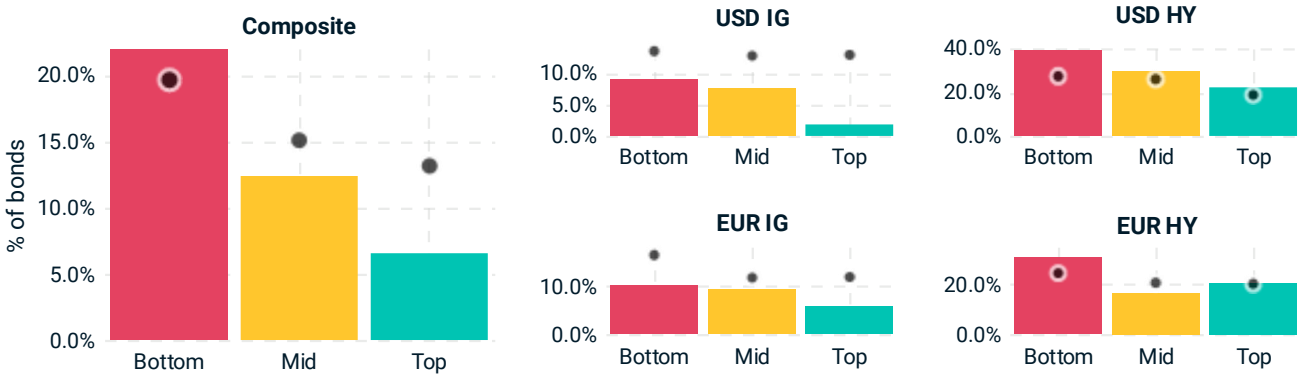

| | Full sample size (n) | | Credit event (n) | | No credit event (n) | |
|---|---|---|---|---|---|---|
| **Credit event type** | **Top** | **Bottom** | **Top** | **Bottom** | **Top** | **Bottom** |
| Distress | 270,743 | 270,094 | 4,214 | 21,201 | 266,529 | 248,893 |
| Credit downgrade | 270,743 | 270,094 | 27,550 | 35,008 | 243,193 | 235,086 |
| Spread widening | 270,743 | 270,094 | 14,968 | 31,276 | 255,775 | 238,818 |
| **Any** | **270,743** | **270,094** | **37,686** | **56,393** | **233,057** | **213,701** |

The histograms show the results of randomly resampling the data from both groups and calculating the difference in event rate (2,000 iterations) to ascertain whether the difference in proportions is approximately normally distributed. The analysis is based on monthly data between January 2015 and June 2025. Source: MSCI ESG Research

### Behavior during market stress

The chart below compares the incidence rate of credit events observed during the stressed period (COVID-19 market sell-off) against the average rate over the entire study period in each bond universe (indicated by black dots). It shows the increased divergence between the top and the bottom tercile under adverse conditions relative to the long-term average.

### Incidence rate of the defined credit events during market stress




The analysis is based on monthly data between January 2015 and June 2025. We divided the bonds into ESG Rating terciles based on February 2020 data (the month before the COVID-19 sell-off started) and observed the incidence rate of credit events during the COVID-19 sell-off months (March – April 2020). The black dots show the long-term average in each universe. A bond is flagged (once) if it experienced any of the defined credit events. Source: MSCI ESG Research

## Appendix 3: Survival-analysis techniques and results

### Cox proportional hazards model

Cox proportional hazards model (Cox, 1972) is a semiparametric model used in survival analysis to estimate the effect of covariates (e.g., the ESG-Rating tercile) on the hazard rate — the instantaneous risk of the event (e.g., a credit event) at a given time.

The Cox model assumes the hazard function as:

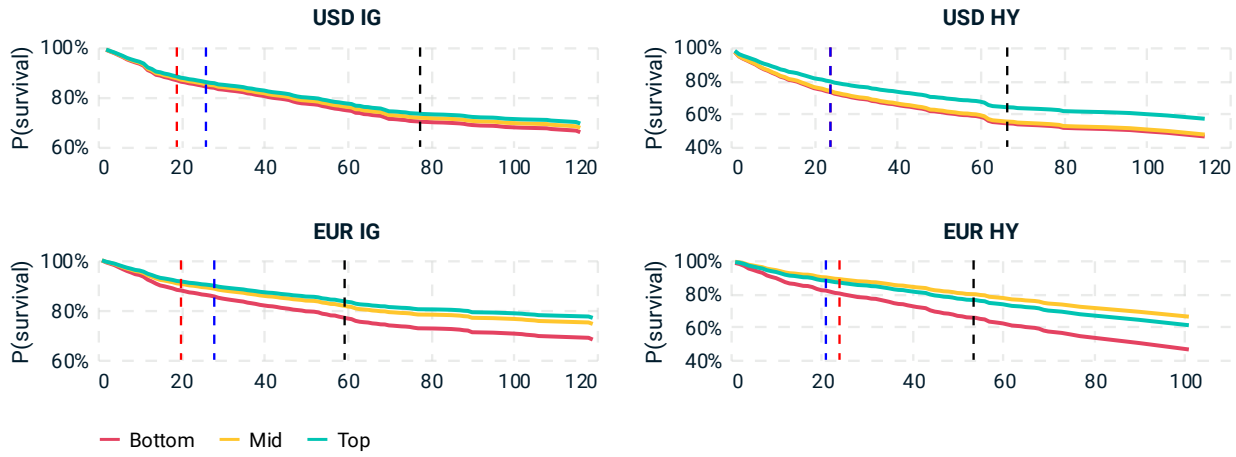
$$H(T|X(T)) = H_0(T) * exp(\beta X)$$

Where:

***H(T|X(T))*** is the instantaneous risk of an event at time *T* given the covariate value at time *T*, ***H₀(T)*** is the baseline hazard function for a reference group, ***β*** is the log hazard ratio estimated from the data and ***X(T)*** is the time-varying covariate.

The model assumes the ratio of the hazard between the groups (e.g., bonds with different ESG Ratings) to be constant — i.e., the hazard to increase or decrease proportionally over time.

**Fitted survival curves across ESG Rating terciles (per bond index)**




| | | Exp(coef) | SE(coef) | Exp(coef) lower | Exp(coef) upper | z-stat | p-val |
|---|---|---|---|---|---|---|---|
| **USD IG** | Mid | 0.937 | 0.058 | 0.836 | 1.050 | -1.126 | 0.260 |
| | Top | 0.876 | 0.062 | 0.776 | 0.989 | -2.142 | 0.032** |
| **USD HY** | Mid | 0.968 | 0.056 | 0.867 | 1.081 | -0.577 | 0.564 |
| | Top | 0.730 | 0.084 | 0.619 | 0.861 | -3.731 | 0.000*** |
| **EUR IG** | Mid | 0.770 | 0.076 | 0.664 | 0.894 | -3.444 | 0.001*** |
| | Top | 0.686 | 0.072 | 0.596 | 0.790 | -5.235 | 0.000*** |
| **EUR HY** | Mid | 0.538 | 0.136 | 0.412 | 0.703 | -4.552 | 0.000*** |
| | Top | 0.644 | 0.133 | 0.496 | 0.835 | -3.311 | 0.001*** |

The analysis is based on monthly data between January 2015 and June 2025. The red dotted line shows the median time (in months) in which an affected bond experienced a credit event, blue dotted line the median number of months a bond was included in the bond universe and black dotted line the median time to maturity of the bonds in the universe. The

values in the table show the difference and its significance relative to the bottom ESG Rating tercile. ***, ** and * indicate significance at the 99%, 95% and 90% confidence levels, respectively. Source: MSCI ESG Research

### Accelerated failure time analysis

The "accelerated failure time" (AFT) model is a parametric model that directly estimates the effect of covariates (e.g., the ESG Rating tercile) on the time to event (e.g., a credit event). The model assumes that covariates accelerate or decelerate the survival time by a constant factor.

The AFT model assumes the time-to-event function as:

$$T = exp(\beta^T X) * T_0$$

Where:

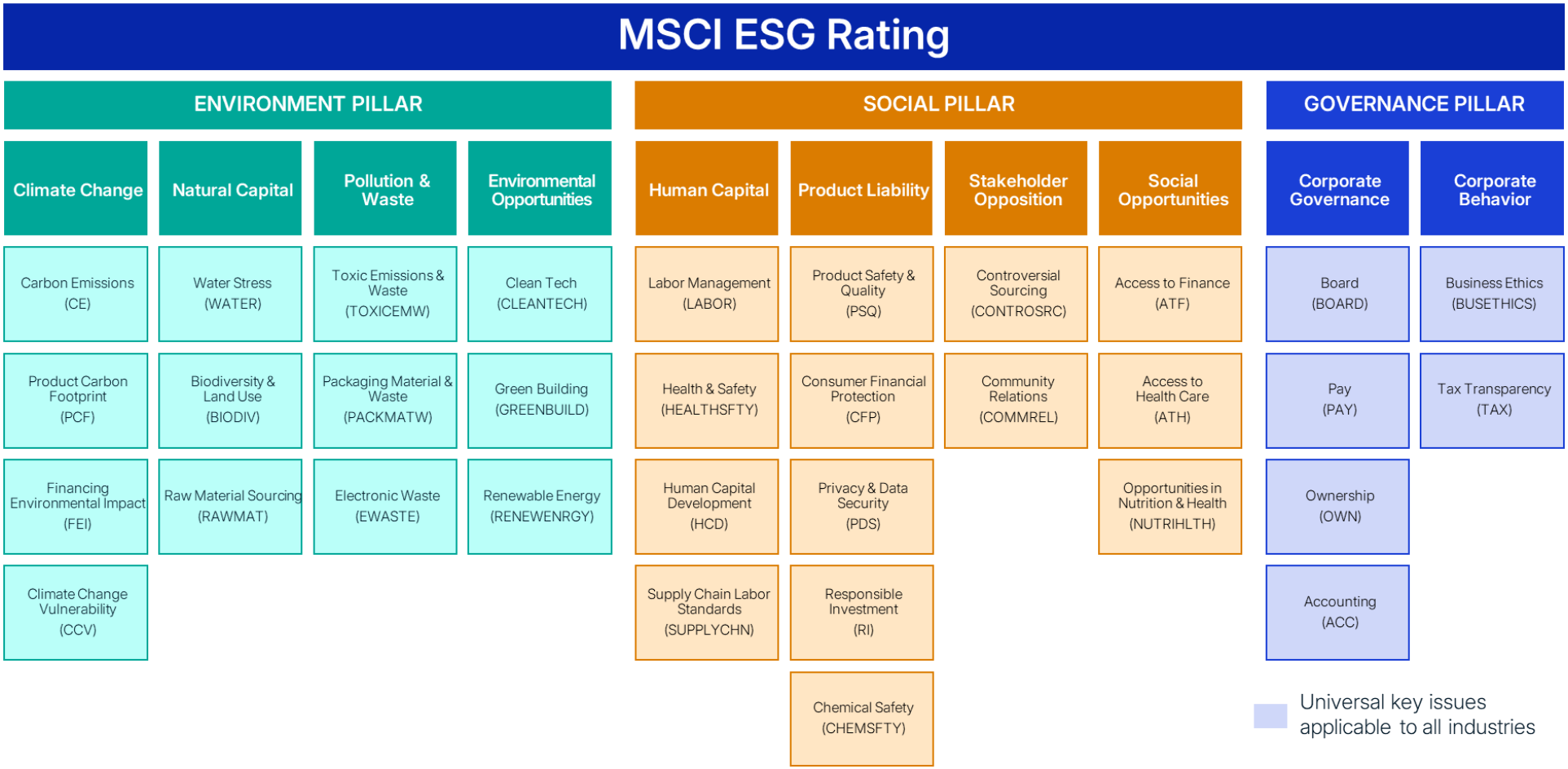
$T_0$ is the baseline survival time, $X$ is the covariate, $exp(\beta)$ is the coefficient that increases or decreases the baseline survival time.

### Results of log-normal AFT analysis across ESG-Rating terciles (per bond index)

| | | Exp(coef) | SE(coef) | Exp(coef) lower | Exp(coef) upper | z-stat | p-val |
|---|---|---|---|---|---|---|---|
| **USD IG** | Mid | 1.18 | 0.06 | 1.04 | 1.33 | 2.56 | 0.010*** |
| | Top | 1.12 | 0.07 | 0.98 | 1.28 | 1.70 | 0.090* |
| **USD HY** | Mid | 0.96 | 0.08 | 0.83 | 1.11 | -0.58 | 0.560 |
| | Top | 1.5 | 0.11 | 1.21 | 1.86 | 3.73 | 0.000*** |
| **EUR IG** | Mid | 1.33 | 0.08 | 1.15 | 1.55 | 3.7 | 0.000*** |
| | Top | 1.37 | 0.07 | 1.19 | 1.59 | 4.32 | 0.000*** |
| **EUR HY** | Mid | 2 | 0.19 | 1.39 | 2.87 | 3.74 | 0.000*** |
| | Top | 1.64 | 0.18 | 1.14 | 2.36 | 2.67 | 0.010* |

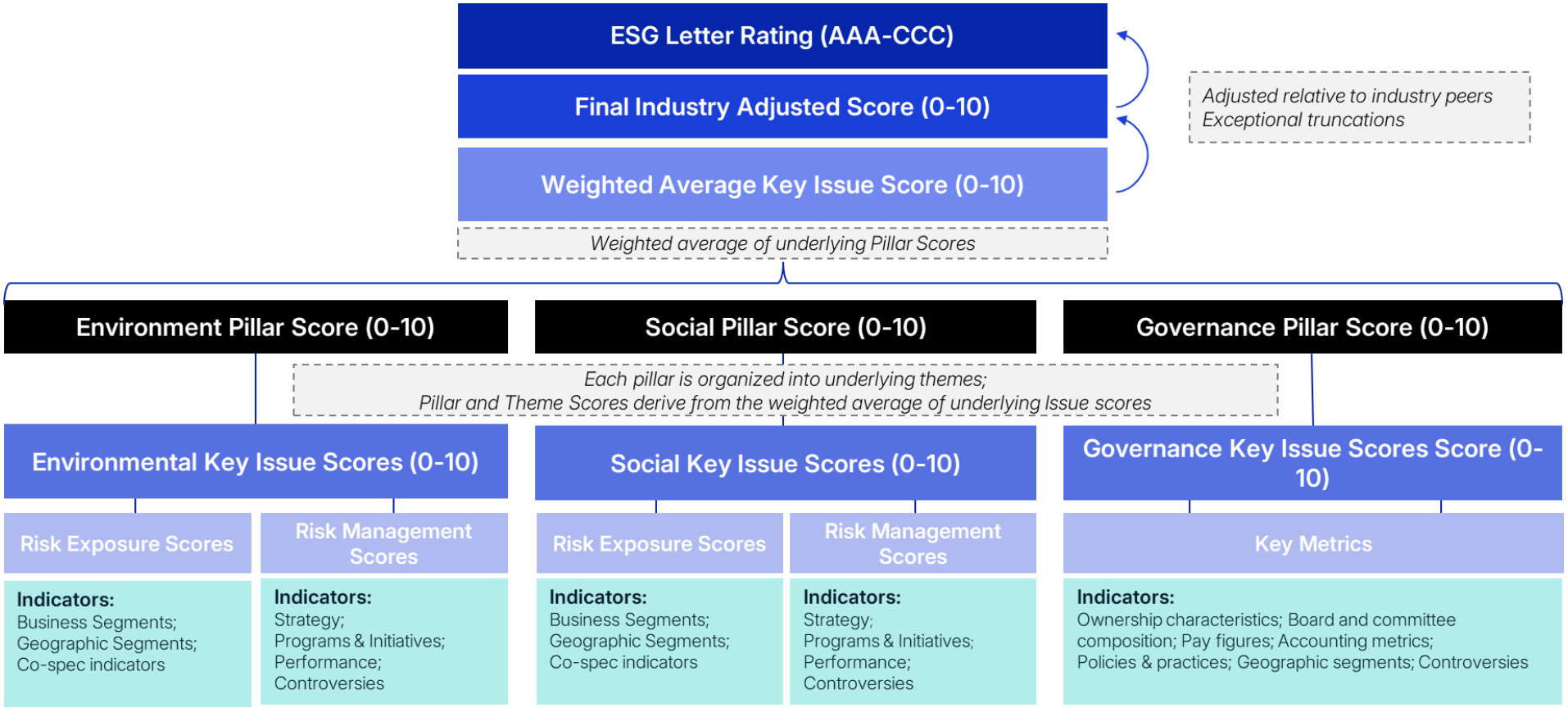
The analysis is based on monthly data between January 2015 and June 2025. We used the log-normal AFT analysis, as the data distribution of credit events is right-skewed (peaks early, then flattens). The values in the table show the difference and its significance relative to the bottom ESG Rating tercile. ***, ** and * indicate significance at the 99%, 95% and 90% confidence levels, respectively. Source: MSCI ESG Research

## Appendix 4: MSCI ESG Ratings key issues




MSCI ESG Research assesses hundreds of datapoints across 33 ESG key issues that focus on the intersection between a company's core business and the industry-specific issues that may create significant risks and opportunities for the company. Key issues are weighted according to impact and time horizon of the risk or opportunity. All companies are assessed for corporate governance and corporate behavior. Names in parentheses are shortened versions used on charts in the body. Source: MSCI ESG Research

**MSCI ESG Ratings construction process**

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