SUPPORTING INFORMATION FOR:

Schoeffel, A., Mueller, L., Kiesel, F., Trautmann, C. & Schiereck, D. Carbon Intensity Disclosure and Corporate Credit Spreads. *Journal of Industrial Ecology.*

Summary

This supporting information outlines and reports several robustness checks. First, we run a standardized regression to compare the magnitude of regression coefficients per standard deviation increase. We further re-run the regression while controlling for Merton model probabilities of default, as some papers (e.g. Xia & Zulaica, 2022) rely on default probabilities in the estimation of their models. We also re-run our main regression model with a wide variety of model specifications including Scope 1 emissions and intensity and a carbon data release lag of zero, six or ten months.

Supporting Information S2: Robustness checks

S2.1 Standardized regression

Given the varying scales of independent variables in our baseline regression models, it might be challenging to compare the magnitudes of their impact on corporate bond yield spreads, especially across different studies. Therefore, we re-run our main model for the full sample and full period using standardized values for all non-binary variables. We z-score transform all variables by deducting the respective mean and dividing by their standard deviation. Table S2.I shows that equity volatility has the biggest impact on spreads per standard deviation increase, followed by time to maturity, price dispersion, and leverage ratio. The carbon performance measures have a comparably moderate impact per standard deviation increase that is comparable to the effect of issue size. Nevertheless, our finding of a carbon discount remains robust in a standardized regression framework, for all specifications.

[Insert Table S2.I about here]

S2.2 Controlling for Merton model default probabilities

The methodology used in this paper is aligned with the literature on the determinants of corporate bond yield spreads (e.g., Elton et al., 2001; Campbell & Taksler, 2003; Chen et al., 2007). This strand of literature does not typically use credit ratings or implied probabilities of default from the Merton model to proxy for credit risk. Instead, researchers aim to include and identify the variables that should influence these secondary measures of credit risk. To ensure comparability with existing and established studies, we follow these procedures.

However, the paper from Xia and Zulaica (2022) investigates the relationship between carbon performance and bond yield spreads with a different methodology and sample selection. They derive their methodology from Gilchrist and Zakrajsek (2012) who examine credit spreads and business cycle fluctuations from a broader economic perspective. Hence, their main model is built around the probability of default as the main independent variable. While Xia and Zulaica (2022) show that their result of a carbon premium holds for an alternative model specification that is closer to pertinent bond research, such as Elton et al. (2001), Campbell and Taksler (2003), or Chen et al. (2007), their analysis also deviates from ours in terms of sample construction. First, we account for the lag of carbon data by ten additional months to account for the carbon data publication lag that occurs in practice (Zhang, 2024). Second, we do not use estimated data from Trucost following the argumentation of Aswani et al. (2024a, 2024b) and Busch et al. (2022).

To account for the differences in methodology and test whether the inclusion of a measure of firms' probability of default would alter our results, we compute Merton model probabilities of default and add them to our regression. While Xia and Zulaica (2022) primarily use Bloomberg probabilities of default, they show that their results hold for Merton model probabilities, as well. We follow their approach in calculating these probabilities as detailed in Supporting Information S1. Table S2.II shows our results for Table IV after controlling for Merton model probabilities of default. The results are almost identical to those of Table IV, suggesting that our results are robust and not driven by our methodology or choice of control variables.

[Insert Table S2.II about here]

S2.3 Alternative carbon performance measure specification

Given the substantial debate that carbon performance measures and their precise specification thereof have attracted, we test our results for robustness regarding the specification of our carbon measures. In total, we run 72 regressions for twelve different carbon performance measure specifications. The twelve specifications derive from two types of measures (i.e., intensity and emissions), two emission scopes used for their calculation (i.e., Scope 1 emissions and combined Scope 1 & 2 emissions), and three lag lengths to account for the carbon data release lag (January, July, and October), where the lag of 10 months, i.e., October following the year accounts for the average distance[1]. We re-run the regression from Table IV for all specifications and for both rating classes and periods. Table S2.III shows that our results are robust to the use of Scope 1 and combined Scope 1 & 2 emissions and all lengths of carbon data release lag.

[Insert Table S2.III about here]

[1] The interested reader is referred to Figure 1 in Zhang (2024) for graphical illustration of the data release lag distribution in the US sample.

Table S2.I Standardized full sample carbon performance regressions.
For the full sample and period, and each carbon performance measure CP the regression is

$$Spread_{ijt} = \beta_0 CP_{it} + \theta' X_{jt} + \xi' Y_{it} + FE + \varepsilon_{ijt},$$

where j is for bond of firm i and t is time measured in months. X and Y are vectors of issue- and issuer-specific controls. The dependent and independent variables are all z-score standardized by deducting their mean and dividing by their standard deviation. This table shows the coefficients and standard errors in parentheses for all independent variables. The data are US corporate bond transactions from TRACE. Model 1 shows the model results using logged carbon intensity as the regression parameter. Model 2 shows the results using logged carbon emissions. The sample period is from 2017-2022. Standard errors are double clustered by time and firm, and adjusted for heteroskedasticity. Significance at 10% is * , at 5% **, at 1% ***, and at 0.1% ****.

	Model 1	Model 2
log Intensity Scope 1&2	−0.05**	
	(0.03)	
log Emissions Scope 1&2		−0.07****
		(0.02)
E-Score	−0.03****	−0.03***
	(0.01)	(0.01)
Price Dispersion	0.22****	0.23****
	(0.02)	(0.02)
Age	0.03	0.03
	(0.02)	(0.02)
Amount issued	−0.04****	−0.04****
	(0.01)	(0.01)
Coupon	0.14****	0.14****
	(0.02)	(0.02)
Maturity	0.27****	0.27****
	(0.01)	(0.01)
Equity volatility	0.30****	0.29****
	(0.03)	(0.03)
Operating income to sales ratio	−0.00	−0.01
	(0.02)	(0.01)
Leverage ratio	0.20****	0.21****
	(0.02)	(0.02)
Long-term debt-asset ratio	−0.03**	−0.04***
	(0.01)	(0.01)
Pre-tax interest coverage D1	−0.00	−0.00
	(0.02)	(0.02)
Pre-tax interest coverage D2	0.03	0.03*
	(0.02)	(0.02)
Pre-tax interest coverage D3	0.01	0.01
	(0.01)	(0.01)
Pre-tax interest coverage D4	0.00	0.00
	(0.00)	(0.00)
Redeemable	0.04****	0.04****
	(0.01)	(0.01)
Observations	209,106	209,106
R Squared	0.77	0.77
Adjusted R Squared	0.77	0.77
Time Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Rating Fixed Effects	Yes	Yes

Table S2.II Carbon performance regressions controlling for Merton default probabilities. For each sample S and each carbon performance measure CP a regression is run

$$Spread_{ijt}^{S} = \beta_0^S CP_{it} + \theta^{S\prime} X_{jt} + \xi^{S\prime} Y_{it} + FE + \varepsilon_{ijt},$$

where j is for bond of firm i in sample S and t is time measured in months. X and Y are vectors of issue- and issuer-specific controls. In total, six regressions are run (two carbon performance variables × three samples (full sample, A, BBB)). Controls include the Merton model probability of default, calculated as described in Supporting Information S1.3. The carbon performance variables are described in detail in Section 3 and are lagged by 10 months after the year they describe. The data are US corporate bond transactions from TRACE. Panel A shows coefficients for the full sample from 2017-2022. Panel B shows coefficients for 2017 to 2019, and Panel C shows results for 2020 to 2022. Standard errors are double clustered by time and firm, adjusted for heteroskedasticity. Significance at the 10% level is marked * , at 5% marked **, at 1% marked ***, and at 0.1% ****.

Panel A: 2017-2022

	Full Sample		Rating A		Rating BBB	
log Intensity Scope 1&2	−2.22* (-1.13)		−4.74*** (-1.51)		−0.50 (-1.38)	
log Emissions Scope 1&2		−3.40**** (-0.84)		−3.56*** (-1.21)		−2.05* (-1.05)
E-Score	−0.17**** (-0.05)	−0.13*** (-0.05)	−0.01 (-0.06)	0.03 (-0.06)	−0.20*** (-0.06)	−0.17*** (-0.06)
Merton PD	0.90**** (-0.20)	0.91**** (-0.20)	0.24** (-0.09)	0.26*** (-0.09)	0.78**** (-0.20)	0.77**** (-0.20)
Price Dispersion	85.68**** (-7.56)	86.22**** (-7.51)	46.99**** (-8.91)	47.78**** (-9.09)	87.81**** (-7.28)	88.27**** (-7.22)
Age	0.37 (-0.35)	0.42 (-0.35)	0.58 (-0.35)	0.60* (-0.35)	−0.26 (-0.34)	−0.23 (-0.33)
Amount issued	−0.01**** (0.00)	−0.00**** (0.00)	−0.01**** (0.00)	−0.00*** (0.00)	−0.00**** (0.00)	−0.00*** (0.00)
Coupon	9.19**** (-1.06)	9.05**** (-1.05)	7.25**** (-0.96)	7.18**** (-0.95)	11.75**** (-1.10)	11.68**** (-1.11)
Maturity	2.90**** (-0.10)	2.93**** (-0.11)	2.76**** (-0.08)	2.76**** (-0.08)	3.14**** (-0.13)	3.15**** (-0.13)
Equity volatility	161.81**** (-22.09)	154.97**** (-22.28)	40.47** (-18.71)	40.52** (-18.65)	159.22**** (-25.95)	154.87**** (-25.74)
Operating income to sales ratio	−4.11 (-9.61)	−8.60 (-8.21)	32.72* (-18.45)	23.43 (-17.20)	−17.23* (-10.16)	−17.59** (-8.69)
Leverage ratio	128.80**** (-14.33)	137.26**** (-15.07)	74.94**** (-19.21)	78.85**** (-19.72)	91.34**** (-18.50)	100.28**** (-19.71)
Long-term debt-asset ratio	−16.73** (-7.95)	−20.11** (-7.90)	−6.40 (-10.93)	−6.71 (-11.74)	−16.88 (-11.47)	−19.25* (-11.19)
Pre-tax interest coverage D1	0.10 (-1.11)	0.07 (-1.11)	0.41 (-1.55)	0.45 (-1.61)	−0.43 (-1.24)	−0.47 (-1.22)
Pre-tax interest coverage D2	1.09 (-0.69)	1.17* (-0.68)	−0.98 (-0.91)	−0.88 (-0.94)	−0.85 (-0.79)	−0.84 (-0.77)
Pre-tax interest coverage D3	0.39 (-0.34)	0.35 (-0.33)	−0.19 (-0.35)	−0.26 (-0.37)	1.44* (-0.77)	1.43* (-0.80)
Pre-tax interest coverage D4	0.04 (-0.06)	0.01 (-0.05)	0.07 (-0.09)	0.01 (-0.09)	−0.21 (-0.29)	−0.18 (-0.27)
Redeemable	14.24**** (-3.60)	13.96**** (-3.77)	13.59*** (-4.44)	13.19*** (-4.53)	4.50 (-5.94)	4.69 (-6.03)
Observations	209,106	209,106	73,865	73,865	107,090	107,090
R Squared	0.78	0.78	0.72	0.72	0.72	0.73
Adjusted R Squared	0.77	0.78	0.72	0.72	0.72	0.73
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Rating Fixed Effects	Yes	Yes	No	No	No	No
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: 2017-2019

	Full Sample		Rating A		Rating BBB	
log Intensity Scope 1&2	−2.92*** (-0.95)		−3.38*** (-1.23)		−2.75** (-1.27)	
log Emissions Scope 1&2		−3.18**** (-0.78)		−2.40* (-1.21)		−2.63*** (-0.90)
E-Score	−0.16*** (-0.05)	−0.12** (-0.05)	−0.01 (-0.08)	0.00 (-0.08)	−0.20*** (-0.07)	−0.16** (-0.07)
Merton PD	0.50** (-0.20)	0.51** (-0.20)	0.08 (-0.06)	0.09 (-0.06)	0.51** (-0.19)	0.53*** (-0.19)
Observations	92,814	92,814	33,844	33,844	46,183	46,183
R Squared	0.77	0.77	0.73	0.72	0.72	0.72
Adjusted R Squared	0.77	0.77	0.73	0.72	0.72	0.72
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Rating Fixed Effects	Yes	Yes	No	No	No	No
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Panel C: 2020-2022

	Full Sample		Rating A		Rating BBB	
log Intensity Scope 1&2	−1.58 (-1.43)		−5.78*** (-1.91)		0.58 (-1.62)	
log Emissions Scope 1&2		−3.58*** (-1.04)		−4.16*** (-1.22)		−1.93 (-1.33)
E-Score	−0.16*** (-0.06)	−0.12** (-0.06)	−0.04 (-0.08)	0.02 (-0.08)	−0.21*** (-0.07)	−0.18** (-0.07)
Merton PD	1.04**** (-0.24)	1.05**** (-0.23)	0.39*** (-0.14)	0.41*** (-0.14)	0.86**** (-0.23)	0.85**** (-0.23)
Observations	116,292	116,292	40,021	40,021	60,907	60,907
R Squared	0.78	0.78	0.72	0.72	0.73	0.73
Adjusted R Squared	0.78	0.78	0.72	0.72	0.73	0.73
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Rating Fixed Effects	Yes	Yes	No	No	No	No
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Table S2.III

Robustness test with regard to carbon measure specification.

For each sample S and carbon performance measure specification CP the regression is run

$$Spread_{ijt}^{S} = \beta_0^S CP_{it} + \theta^{S\prime} X_{jt} + \xi^{S\prime} Y_{it} + FE + \varepsilon_{ijt},$$

where j is for bond of firm i in sample S and t is time measured in months. X and Y are vectors of issue- and issuer-specific controls. In total, 72 regressions are run (3 samples × 2 periods × 12 carbon performance measure specifications). The twelve carbon measure specifications derive from two measures (intensity, emissions) × two Scope definitions (Scope 1, Scope 1 & 2) × three carbon data release lags (January, July, or October of year the data relates to). This table shows for each regression the coefficient and significance level for the carbon performance measure specification and set of fixed effects. The data are US corporate bond transactions from TRACE. Panel A shows the coefficients for the period from 2017-2019, and Panel B for the period from 2020 to 2022. Standard errors are double clustered by time and firm, and adjusted for heteroskedasticity. For the full sample rating-fixed effects are added to the industry- and time-fixed effects. Significance at the 10% level is marked * , at 5% marked **, at 1% marked ***, and at 0.1% ****.

Panel A: pre-2020				
Lag	Scope	Full sample	Rating class A	Rating class BBB
Intensity				
Jan	Scope 1	-1.96**	-2.27**	-2.19**
Jan	Scope 1 & 2	-2.96***	-3.41**	-2.77**
Jul	Scope 1	-1.94**	-2.24**	-2.27**
Jul	Scope 1 & 2	-2.96***	-3.37***	-2.78**
Oct	Scope 1	-1.95**	-2.25**	-2.31**
Oct	Scope 1 & 2	-2.99***	-3.39***	-2.79**
Emissions				
Jan	Scope 1	-2.03***	-1.58*	-1.78**
Jan	Scope 1 & 2	-3.24****	-2.50**	-2.63***
Jul	Scope 1	-1.96***	-1.50*	-1.81**
Jul	Scope 1 & 2	-3.20****	-2.41*	-2.60***
Oct	Scope 1	-1.95***	-1.47*	-1.83**
Oct	Scope 1 & 2	-3.20****	-2.38*	-2.57***
Panel B: post-2020				
Lag	Scope	Full sample	Rating class A	Rating class BBB
Intensity				
Jan	Scope 1	-1.17	-4.03**	-0.24
Jan	Scope 1 & 2	-1.21	-5.28**	0.49
Jul	Scope 1	-1.47	-4.22**	-0.46
Jul	Scope 1 & 2	-1.75	-5.48***	0.06
Oct	Scope 1	-1.59	-4.41***	-0.50
Oct	Scope 1 & 2	-1.98	-5.70***	-0.08
Emissions				
Jan	Scope 1	-2.39**	-2.94***	-1.72
Jan	Scope 1 & 2	-3.40***	-3.73***	-2.09
Jul	Scope 1	-2.36**	-3.05***	-1.67
Jul	Scope 1 & 2	-3.43***	-3.82***	-2.12
Oct	Scope 1	-2.34**	-3.19***	-1.62
Oct	Scope 1 & 2	-3.41***	-3.94***	-2.11

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