Do Scope 3 Carbon Emissions Impact Firms' Cost of Debt?*

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Abstract

Do firms that report more carbon emissions—particularly scope 3 emissions—face a higher cost of borrowing in credit markets? In this paper, we find that firms that disclose scope 3 emissions face a lower cost of borrowing in credit markets and estimate a *scope 3 disclosure premium* of −20 basis points on average. However, credit markets do not significantly discriminate the quantitative amount of reported scope 3 emissions despite penalizing scope 1 + 2 carbon generation. Is this trend because markets reward advertised rather than actual pollution reduction efforts—greenwashing—or because scope 3 data is not yet mature enough to provide reliable information? While the literature has documented evidence of investors rewarding greenwashing, we find substantial discrepancies in firms' scope 3 disclosures across time, regions, and sectors. We show that these discrepancies are mainly concentrated in downstream data. Based on these findings, we highlight possible areas of engagement between firms and investors or policymakers that would be beneficial to all stakeholders.

Keywords: credit, carbon emissions, scope 3

JEL Codes: G12, Q53, Q54

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1 Introduction

How do firms' scope 3 carbon emissions affect their cost of borrowing? Do investors respond to firms' scope 3 disclosures at all? Do lenders penalize firms that report higher scope 3 emissions? We address these questions in this paper, in addition to highlighting possible areas of engagement between firms, investors, and policymakers aimed at limiting emissions.

Our first main finding is that firms that disclose scope 3 carbon emissions face a lower cost of borrowing in credit markets. This result holds true even for firms with high scope 1 + 2 emissions.[1] Leveraging a novel dataset by combining data on

- scope 3 subcategory-level emissions from the CDP (formerly, the Carbon Disclosure Project)
- scope 1 + 2 emissions from S&P Trucost
- credit and financial variables from Refinitiv Eikon Starmine Weighted Average Cost of Capital database

we find that firms that disclose scope 3 emissions receive a 20 basis point discount on their cost of borrowing on average, similar to Kleimeier and Viehs (2018) and in line with the trends documented in Friede, Busch, and Bassen (2015). We refer to this lower cost of borrowing as the *scope 3 disclosure premium* (of −20 basis points). The premium is particularly pronounced for firms in Europe and Asia Pacific but less so for firms in North America.[2] However, we find evidence that the scope 3 disclosure premium is starting to materialize for firms in North America. This finding is in line with Chava (2014) and Goss and Roberts (2011) who show that environmental and CSR performance can have a material effect of firms' cost of borrowing, respectively. Similarly, Dhaliwal et al. (2011) show that voluntary disclosures can reduce cost of equity for firms; our result shows that the same pattern extends to debt markets as well.

Our second main finding is that credit markets do not significantly discriminate the quantitative amount of reported scope 3 emissions despite being materially sensitive to scope 1 + 2 emissions. This finding is true for firms across regions and sectors. Thus, the two findings together suggest that firms stand to benefit by disclosing their scope 3 emissions without being penalized by investors for disclosing (higher) emissions. In fact, this result suggests that emissions-conscious investors and policymakers could engage with firms on estimating and

[1] Throughout this paper, we combine scope 1 and scope 2 emissions, denoted as scope 1 + 2.

[2] In this paper, we group countries by region per MSCI's methodology as follows: Developed North America (DNA) = Canada, United States; Developed Europe (DE) = Austria, Belgium, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom; Developed Asia Pacific (DAP) = Australia, Hong Kong, Japan, Singapore, South Korea, New Zealand; Emerging Market (EM) otherwise.

reporting the latter's scope 3 emissions. While Bolton and Kacperczyk (2021) find that stocks of firms with higher emissions earn higher returns, we find that lenders in the credit market demand similar compensation for their exposure to climate risk but only for scope 1 + 2 emissions and *not* for scope 3 emissions, despite upstream scope 3 emissions being "on average, 11.4 times greater than those produced through [their] direct operations," per CDP (2021). Importantly, our evidence is in line with Zerbib (2019) who finds that investors' pro-environmental preferences have a limited effect on bond pricing at this stage of market development. As a result, there is no *dis*incentive for investors to support the debt financing of the most carbon-virtuous firms, mirroring the evidence from Mercereau, Neveux, et al. (2020) who show that equity investors can respond to climate change without necessarily forgoing returns.

Why might lenders not charge scope 3 polluters a higher rate for borrowing as compensation for exposure to climate risk? Our third main finding is that actual scope 3 emissions reported by firms are not robust nor consistent. We show that cost of borrowing is positively related with some scope 3 subcategories (particularly upstream subcategories) and negatively with others (particularly downstream subcategories). Using granular data from the CDP directly, we dig deeper and find substantial discrepancies in firms' disclosures across time, region, and sectors posing challenges for investors, policymakers, and researchers in interpreting the data. Specifically, firms are more likely to report emissions for upstream subcategories than downstream categories with marked variability of emissions across subcategories from one year to the next, especially for downstream subcategories.

This finding presents the second avenue for engagement: encouraging firms to not merely disclose scope 3 emissions overall but doing so in a transparent manner by subcategories (particularly downstream) so that stakeholders can meaningfully engage on limiting emissions, as highlighted in Mercereau and Melin (2020). Despite being dominant contributors to emissions, firms in the energy, materials, and utilities sectors are no more likely to report scope 3 emissions than firms in other sectors. This dearth of disclosures in these specific sectors provides another opportunity for engagement. Given these weaknesses in voluntary disclosures, our findings augment those of Baker et al. (2018) who show that the green premium only extends to bonds that are externally certified as green.

The rest of the paper is structured as follows: section 2 describes the dataset and provides summary statistics, section 3 shows evidence of scope 3 disclosure premium, section 4 demonstrates the effect of actual emissions on the cost of borrowing, and section 5 highlights the intricacies of scope 3 data from the CDP. Section 6 concludes.

2 Data and Summary Statistics

We combine three datasets:

- scope 3 from CDP
- scope 1 + 2 from S&P Trucost
- credit and financial variables from Refinitiv Eikon Starmine Weighted Average Cost of Capital database (similar to Sharfman and Fernando (2008), for example).

We include 2720 firms from the MSCI All Country World Index, and consider yearly data from 2015 to 2020.[3] We have credit data from 2015 onward while the last carbon disclosures are available for 2020 at the time of writing. Table 1 provides summary statistics for the key variables in our study. Our main dependent variable is a firm's long term cost of borrowing as measured by the spread between a proxy of its long term (10-year) yield and risk-free rate in the primary country of its operation.[4] Importantly, we restrict our sample to firms with a debt-to-asset ratio of more than 5% since only such companies are meaningfully participating in public debt markets and have good quality data available. Other financial variables that we will use include (logs of) assets, market cap, and credit ratings which are standard in the literature. In the remainder of this section, we highlight our process for building a panel dataset using the multiple sources.

Table 1 also highlights the scope-related variables we use in our study. Specifically, we consider logs of absolute scope 1 + 2 and scope 3 emissions and logs of scope 1 + 2 and scope 3 (revenue) intensities.[5] Importantly, we gather scope 3 emissions data from the CDP which surveys member firms on their emissions and goals to reduce them. Specifically, the CDP questionnaire asks firms about their scope 3 emissions pertaining to 17 subcategories e.g. business travel, employee commuting, use of sold products, etc.[6] A firm may report the number of tons of CO_2 emitted during the past year for a certain subcategory, or respond by stating that the subcategory is not relevant to it, relevant but not calculated, or not evaluated at all. We restrict our analysis to firms and years in which they report actual emissions for at least a fifth of the 17 subcategories, i.e. CDP Response Rate > 20%. Since firms are still learning and determining their scope 3 emissions, their disclosed data can be noisy and we believe

[3]2720 firms for 6 years (2015-2020 inclusive yields a panel of 16,320 potential firm-year observations.

[4]Yield spreads are quoted in the data and reported in the tables here in percentage points. We refer to premia/discounts in basis points in-text as per convention.

[5]Throughout, we refer to $\frac{\text{scope}}{\text{revenue}}$ as intensity.

[6]For a full list of scope 3 subcategories in the CDP questionnaire, see section 4.2.

	Observations	Mean	St. Dev.	Min	25%	50%	75%	max
Financial Variables								
Long Term Credit Spread	15093	1.3	1.5	-4.0	0.6	1.4	2.1	7.0
Log (Assets)	15500	16.1	1.9	4.8	14.9	16.1	17.2	22.3
Log (Market Cap)	15063	9.1	1.3	-5.1	8.4	9.0	9.8	14.5
Debt-to-Assets	12817	30.2	19.4	5.0	17.2	28.1	39.7	391.2
Credit Rating (Numerical)	15366	7.0	2.8	1.0	5.0	7.0	9.0	20.0
Scope Variables								
Log (Scope 1 + 2)	9746	12.8	2.4	-6.6	11.2	12.6	14.3	19.7
Log (Scope 3)	5839	13.4	3.2	-1.2	10.9	13.7	15.9	23.8
Log (Scope 1 + 2 Intensity)	8675	3.9	2.1	-4.9	2.5	3.7	5.3	11.1
Log (Scope 3 Intensity)	5343	4.2	2.9	-6.9	1.9	4.7	6.4	15.3
CDP Response Rate	16320	12.7	20.9	0.0	0.0	0.0	23.5	94.1
Temperature Variables								
Temperature (Trucost)	5399	3.4	1.7	0.0	1.8	4.8	5.0	5.0
Temperature (SB2A)	2185	2.9	0.6	0.5	2.5	3.0	3.2	6.5
Temperature Bottom Up (SB2A)	348	2.8	1.0	0.5	2.3	2.6	3.1	6.8

Table 1: This table shows summary statistics for the key variables used in this paper. CDP response rate refers to the number of scope 3 subcategories a firm responded to with a positive number as opposed to a non-response, expressed as a percentage of the 17 scope 3 subcategories in the CDP questionnaire. Long term credit spread refers to the a firms' nominal cost of borrowing minus the risk-free rate in its primary country of operation. Credit rating is a numerical ranking of firms' creditworthiness from Starmine.

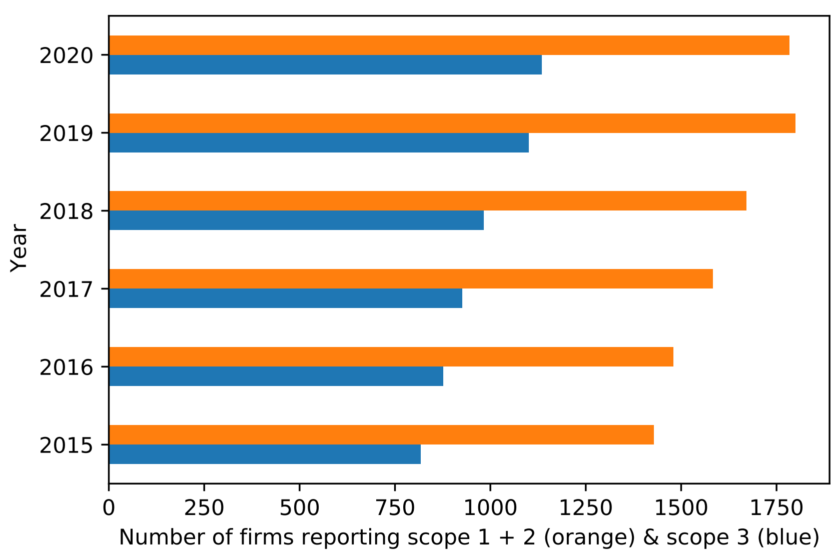

Figure 2: This figure shows the number of firms reporting scope 1 + 2 (orange) is increasing over time in our panel. Similarly, the number of firms globally reporting scope 3 (blue) emissions via CDP is also increasing over time in our panel. However, the number of firms reporting scope 3 is markedly and consistently less than those reporting scope 1 + 2.

that such a filter improves the quality of the results presented here..[7] We further discuss the intricacies of scope 3 data from the CDP in Section 5

Figure 2 shows the number of firms in our panel dataset that disclose scope 1 + 2 and scope 3 emissions. For both scopes, we see that the number of firms reporting has increased over the years. However, the number of firms reporting scope 3 emissions is markedly less than the number of firms reporting scope 1 + 2. While more firms are indeed disclosing their emissions, the sectoral composition for both scopes remains robust across years, see Figure 3.[8] The top two sectors that tend to report both scope emissions are the financial and industrial sectors, about 15%, respectively, either driven by market incentives or regulatory requirements due to a preference for allocating capital to greener activities by investors and policymakers. We highlight the role of market incentives in Section 3. While the sectoral composition for both scopes is roughly constant over time, Figure 4 shows that emerging market firms make up a larger share of scope 1 + 2 reporters. However, the same cannot be said for scope 3. This trend suggests that firms are catching up in terms of emission disclosures, either due to market incentives or regulatory requirements.

Since we source scope 1 + 2 and scope 3 data from different sources, it is critical to check for coherence. As a sanity check, we ask how correlated are the two scopes from the two different sources? We find that while scope 1 + 2 and scope 3 are not strongly correlated in absolute terms, they exhibit a strong positive correlation (0.59) in logs, see Figure 5. This motivates us to use log of scopes in the rest of the paper. We also find that the trends observed in the full sample are not solely determined by disclosures by firms in the energy, materials, and utilities sectors which are carbon-intensive sectors due to their production process. Figures A2 and A1 show that the broader trends between scope 1 + 2 and scope 3 are not dominated in carbon-intensive sectors alone. In fact, firms' emissions across scopes are highly correlated across sectors and the trends pervade the broader economy.

Table 1 also summarizes temperature metrics (specifically, implied temperature rise (ITR)) for firms in our sample, where available.[9] In particular, we source temperature data from Trucost and SB2A (Science-Based 2°C Alignment) from Iceberg Datalab. We also include the bottom-up ITR metric from the latter.[10] Figures 5 and A2 show that the Trucost metric lines

[7]Our regression analysis is based on an unbalanced panel as balancing the dataset would eliminate many firms who have only recently started reporting scope 3 emissions.

[8]We use the GICS classification for sectors throughout.

[9]We only have temperature data for 2019 in our sample.

[10]This data is available for fewer firms, primarily in the energy, materials, and utilities sectors.

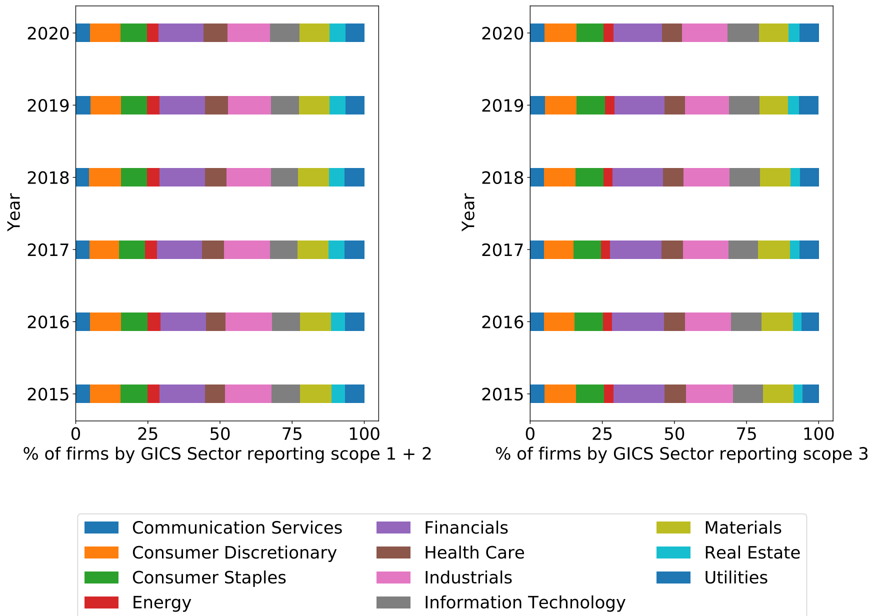

Figure 3: The left panel shows the decomposition of the firms reporting scope 1 + 2 by their GICS sector, the right panel shows the same for scope 3. Despite the number of firms reporting all scopes increasing over the years, the sectoral make up across years has not changed significantly.

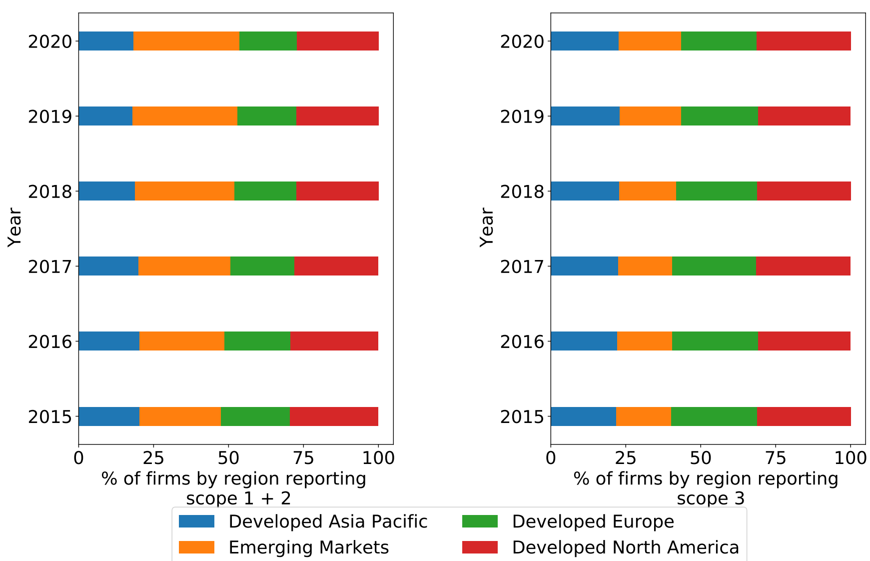

Figure 4: The left panel shows the decomposition of firms reporting scope 1 + 2 by region, the right panel shows the same for scope 3. For scope 1 + 2, we see more firms in emerging markets reporting over the years but the regional decomposition for scope 3 has remained the same.

up with scope data more coherently, showing (mild) positive correlations, than SB2A ITR data. Figure A1 indicates that the latter is more robustly correlated with scope emissions for energy, materials, and utilities sectors. However, scope-ITR correlations are weak, particularly for scope 3 (sourced from CDP), suggesting limited usefulness of ITR data for our study.

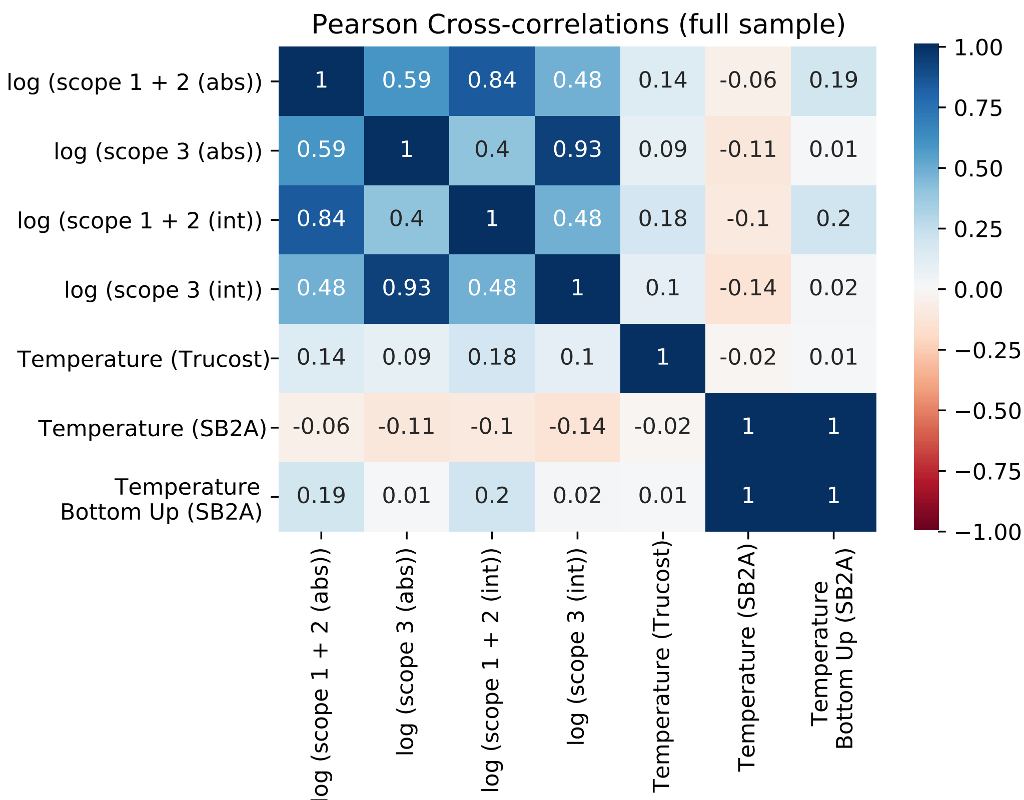

Figure 5: This figure shows a heatmap indicating the correlations between log scope 1 + 2 and log scope 3 in absolute and (revenue) intensity terms. The correlation between scope 1 + 2 and scope 3 in logs is notable.

3 Scope 3 Disclosure Premium

Our main econometric specification is

$$\text{cost of borrowing}_{irst} = \beta_0 + \beta_1 \mathbf{1}(\text{scope } 3_{irst} > 0) + \beta_2 \log\left(\frac{\text{scope } 1+2_{irst}}{\text{revenue}_{irst}}\right) + \gamma X_i + FE_{rs} + \beta^t \mathbf{1}[T=t] + \varepsilon_{irst}, \quad (1)$$

where cost of borrowing$_{irst}$ refers to the credit spread faced by a firm i in region r in sector s in year t. $\mathbf{1}(\text{scope } 3 > 0)$ is an indicator variable that is 1 if a given firm has reported positive scope 3 emissions, 0 otherwise. Thus, β_1 is our primary coefficient of interest here. We also include the firms log of scope 1 + 2 (revenue) intensity. Additionally, X_i refers to firm-level controls including debt-to-assets, credit rating, and (logs of) assets, market cap, FE_{rs} refers to region and sector fixed effects, $\mathbf{1}[T = t]$ are time dummies for year fixed effects, and ε_{irst} is the firm-level error term.

We find that overall, firms that disclose their scope 3 emissions face a lower cost of borrowing in long term credit markets despite being penalized for scope 1 + 2 emissions. Specifically, firms reporting scope 3 emissions receive a discount of about 20 basis points on their long term credit spread while being (marginally) penalized for higher scope 1 + 2 emissions, see Table 6. This trend is particularly robust for firms borrowing in the EU and Asia Pacific debt markets, with a scope 3 disclosure premium of about −18 and −74 basis points and a scope 1 + 2 penalty of 6 and 4 basis points, respectively. However, while we do not observe a similar trend in the US debt market, we show evidence that such a trend is starting to emerge in the US as well.

Concretely, we estimate the following relationship in the cross-section of US firms

$$\text{cost of borrowing}_{irs} = \beta_0 + \beta_1 \mathbf{1}(\text{scope } 3_{irs} > 0) + \beta_2 \log\left(\frac{\text{scope } 1+2_{irs}}{\text{revenue}_{irs}}\right) + \gamma^t X_i + \xi_s \mathbf{1}(\text{sector}) + \varepsilon_{irs}, \quad (2)$$

where the coefficient of interest is β_1: how much change in cost of borrowing is associated with disclosing scope 3 emissions? We estimate equation 2 for all firms in the US for each year between 2015 and 2020 (inclusive).[11] Figure 7 shows the evolution of β_1 during the study window: firms reporting scope 3 emissions benefited from a lower cost of borrowing in the US debt market in 2019 and 2020, unlike earlier years. Overall, the existence of a scope 3 disclosure premium presents an opportunity for all market participants. Allocating resources towards determining its scope 3 emissions is not a futile nor a 'feel-good' exercise for a firm, in fact we find that such a firm stands to benefit by being able to borrow at a discount of about 20 basis points on average.

Lastly, Table 8 breaks down the disclosure premium by sector. We find that the premium is most pronounced in the real estate, consumer staples, and consumer discretionary sectors as opposed to energy, materials, and utilities which are more scope 3-intensive sectors due to their production process. Noticeably, most sectors see a small penalty for higher scope 1 + 2 emissions with financials being a notable exception.

[11] Note that equation 1 is estimated using the panel structure of the dataset, equation 2 is a simple OLS estimation procedure repeated every year.

	Dep. Var: Long Term Credit Spread				
	Full Sample	DNA	DE	DAP	EM
Disclosed Scope 3 Emissions	-0.21***	-0.06	-0.18**	-0.74***	0.03
	(0.03)	(0.04)	(0.08)	(0.08)	(0.06)
Log (Scope 1 + 2 Intensity)	0.02	0.06***	0.04	-0.00	-0.03*
	(0.01)	(0.01)	(0.03)	(0.03)	(0.02)
Controls	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y
Region FE	Y	N	N	N	N
Time FE	Y	Y	Y	Y	Y
Obs	7002	1923	1569	1294	2216
R^2	0.24	0.37	0.09	0.17	0.06
F-stat	114.12	71.25	9.95	16.37	8.51

Table 6: This table shows the scope 3 disclosure premium by region. We find a marked and robust disclosure premium for firms overall: firms that disclose scope 3 emissions via the CDP face a lower cost of borrowing in credit markets. This discount is particularly true for firms with operations in the EU and Asia Pacific regions.

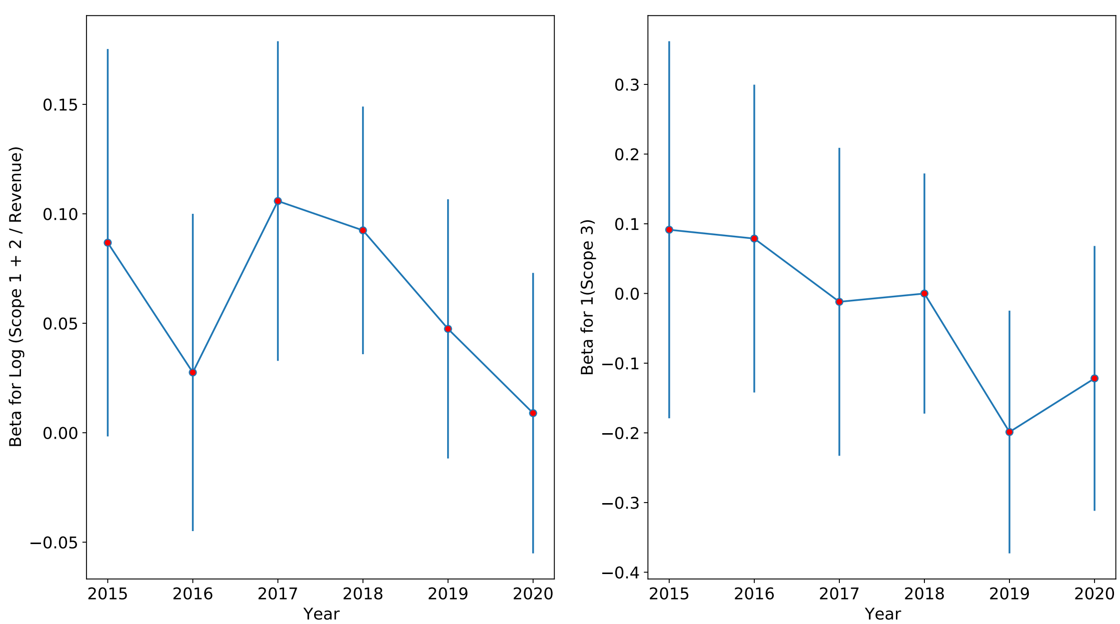

Figure 7: This figure shows the evolution of the disclosure premium in the US. While absent in the early years of the study window, firms borrowing in the US debt market are also benefiting from the scope 3 disclosure premium since 2019, in line with their EU and Asia Pacific counterparts.

	Dep. Var: Long Term Credit Spread												
	Full Sample	Full Sample excl. Financials	Communication Services	Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care	Industrials	Information Technology	Materials	Real Estate	Utilities
Disclosed Scope 3 Emissions	-0.21***	-0.25***	-0.10	-0.26***	-0.32***	-0.19	0.11	-0.25*	-0.20**	-0.09	-0.13	-0.47***	0.08
	(0.03)	(0.04)	(0.19)	(0.10)	(0.12)	(0.15)	(0.09)	(0.13)	(0.09)	(0.10)	(0.10)	(0.12)	(0.12)
Log (Scope 1 + 2 Intensity)	0.02	0.02*	-0.06	0.09**	0.03	0.01	-0.07**	0.05	-0.01	0.16***	0.05	-0.02	0.03
	(0.01)	(0.01)	(0.08)	(0.03)	(0.05)	(0.06)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	N	N	N	N	N	N	N	N	N	N	N
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Obs	7002	6174	363	745	661	341	828	531	1164	580	844	414	531
R^2	0.24	0.26	0.29	0.39	0.19	0.23	0.13	0.26	0.32	0.43	0.28	0.48	0.27
F-stat	114.12	121.03	15.61	51.28	16.92	10.72	12.98	19.92	59.76	47.51	36.08	40.82	21.59

Table 8: This table shows the the scope 3 disclosure premium by GICS sector. We find a marked and robust disclosure premium for firms in the real estate, consumer staples, and consumer discretionary sectors.

4 Lenders' Mixed Response to Scope 3 Emissions

So far, we have shown that disclosing scope 3 emissions is associated with a 20 basis points discount in the credit market for firm, potentially rewarding firms more than the costs associated with determining its carbon emissions, or at the very least compensating them to some degree. Importantly though, how do investors respond to the actual quantity of scope 3 emissions? We find that higher scope 3 emissions—on aggregate, or on a more granular basis—are not necessarily associated with a higher cost of borrowing.

4.1 Total Scope 3 Emissions

Specifically, we estimate the following econometric specification where the controls are the same as in equation 1.

$$\text{cost of borrowing}_{irst} = \beta_0 + \beta_1 \log\left(\text{scope } 3_{irst}\right) + \beta_2 \log\left(\text{scope } 1 + 2_{irst}\right) + \gamma X_i + FE_{rs} + \beta^t \mathbf{1}[T = t] + \varepsilon_{irst} \quad (3)$$

Tables 9 documents that investors do not materially penalize firms that emit more, regardless of the firm's region of operation and controlling for scope 1 + 2 emissions; Table 10 shows the result also prevails in intensity terms.

	Dep. Var: Long Term Credit Spread				
	Full Sample	DNA	DE	DAP	EM
Log (Scope 3)	0.01	-0.00	-0.05	0.05	0.03
	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)
Log (Scope 1 + 2)	0.01	0.10***	-0.07	-0.02	0.01
	(0.02)	(0.02)	(0.04)	(0.05)	(0.05)
Controls	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y
Region FE	Y	N	N	N	N
Time FE	Y	Y	Y	Y	Y
Obs	3007	794	896	764	553
R^2	0.28	0.40	0.09	0.14	0.09
F-stat	57.95	29.66	4.97	7.38	3.07

Table 9: This table shows the relationship between log of scope 1 + 2 and log of scope 3 with long term credit spreads by region. We find that scope 3 emissions are not significantly related with a firms' cost of borrowing.

	Dep. Var: Long Term Credit Spread				
	Full Sample	DNA	DE	DAP	EM
Log (Scope 3 Intensity)	0.01	-0.00	-0.05	0.04	0.02
	(0.01)	(0.01)	(0.03)	(0.03)	(0.03)
Log (Scope 1 + 2 Intensity)	0.01	0.07***	-0.06	-0.00	-0.01
	(0.02)	(0.02)	(0.04)	(0.04)	(0.05)
Controls	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y
Region FE	Y	N	N	N	N
Time FE	Y	Y	Y	Y	Y
Obs	3007	794	896	764	553
R^2	0.28	0.37	0.09	0.14	0.09
F-stat	61.02	28.93	5.22	7.73	3.21

Table 10: This table shows the relationship between log of scope 1 an 2 (revenue) intensity and log of scope 3 (revenue) intensity with long term credit spreads by region. We find that scope 3 emissions are not significantly related with a firms' cost of borrowing on per dollar of revenue basis.

We dig deeper into this result by investigating the relationship between firms' cost of borrowing and their scope emissions by sector. Tables 11 and 12 document the results: we do not find a systematic relationship between emissions and cost of borrowing (Table 12 estimates the relationship in intensity terms). We estimate that of the 11 GICS sectors, only consumer staples, industrials, and materials exhibit a statistically significant relationship between cost of borrowing and scope 3 emissions, albeit to varying degrees. In fact, we see that even within these three sectors, consumer staples records a negative relationship (−17 basis points) whereas industrials and materials both record a positive relationship (+7 basis points). On the other hand, higher scope 1 + 2 emissions lead to a penalty in most sectors, particularly real estate and IT. The coefficient on log scope 1 + 2 is negative only for industrials, suggesting scope 1 + 2 data is more streamlined and robust than scope 3 data which is more intricate and requires greater attention to detail in interpreting the results.

	Dep. Var: Long Term Credit Spread												
	Full Sample	Full Sample Excl. Financials	Communication Services	Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care	Industrials	Information Technology	Materials	Real Estate	Utilities
Log (Scope 3 (Absolute))	0.01	0.02	-0.03	-0.05	-0.17***	-0.12	0.01	-0.07	0.07**	0.03	0.07*	-0.02	0.02
	(0.01)	(0.01)	(0.10)	(0.04)	(0.04)	(0.08)	(0.04)	(0.06)	(0.03)	(0.04)	(0.04)	(0.06)	(0.05)
Log (Scope 1 + 2 (Absolute))	0.01	0.01	-0.04	0.06	-0.01	0.03	-0.07	0.13	-0.10**	0.20***	0.01	0.43***	-0.08
	(0.02)	(0.02)	(0.20)	(0.06)	(0.07)	(0.14)	(0.06)	(0.11)	(0.05)	(0.05)	(0.06)	(0.09)	(0.06)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	N	N	N	N	N	N	N	N	N	N	N
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Obs	3007	2725	161	361	353	110	282	219	496	293	426	105	201
R^2	0.28	0.30	0.36	0.44	0.31	0.51	0.23	0.43	0.29	0.55	0.35	0.66	0.39
F-stat	57.95	60.39	7.98	26.60	14.91	9.75	8.01	15.38	20.02	34.38	22.43	17.26	11.75

Table 11: This table shows the relationship between log of scope 1 + 2 and log of scope 3 with long term credit spreads by sector. We find that scope 3 emissions are not significantly related with a firms' cost of borrowing.

	Dep. Var: Long Term Credit Spread												
	Full Sample	Full Sample excl. Financials	Communication Services	Consumer Discretionary	Consumer Staples	Energy	Financials	Health Care	Industrials	Information Technology	Materials	Real Estate	Utilities
Log (Scope 3 (Intensity))	0.01	0.02	-0.04	-0.02	-0.14***	-0.06	0.01	-0.07	0.07**	0.03	0.07*	-0.03	0.02
	(0.01)	(0.01)	(0.10)	(0.04)	(0.04)	(0.08)	(0.04)	(0.05)	(0.03)	(0.04)	(0.04)	(0.06)	(0.05)
Log (Scope 1 + 2 (Intensity))	0.01	0.02	0.02	0.02	-0.03	0.21	-0.08	0.07	-0.09**	0.14***	0.01	0.32***	-0.08
	(0.02)	(0.02)	(0.19)	(0.06)	(0.07)	(0.14)	(0.05)	(0.09)	(0.05)	(0.05)	(0.06)	(0.07)	(0.06)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	N	N	N	N	N	N	N	N	N	N	N
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Obs	3007	2725	161	361	353	110	282	219	496	293	426	105	201
R^2	0.28	0.30	0.35	0.43	0.28	0.44	0.23	0.43	0.29	0.55	0.35	0.64	0.39
F-stat	61.02	63.59	8.81	28.62	14.95	8.40	8.83	16.90	22.29	37.01	24.98	18.15	13.13

Table 12: This table shows the relationship between log of scope 1 an 2 (revenue) intensity and log of scope 3 (revenue) intensity with long term credit spreads by sector. We find that scope 3 emissions are not significantly related with a firms' cost of borrowing on per dollar of revenue basis.

4.2 Upstream and Downstream Emissions

To that end, we leverage the micro-level nature of our CDP data to zoom in on the relationship between scope 3 subcategories and cost of borrowing. Scope 3 comprises of 17 subcategories

1. Purchased goods and services
2. Capital goods
3. Fuel-and-energy-related activities (not included in Scope 1 or 2)
4. Upstream transportation and distribution
5. Waste generated in operations
6. Business travel
7. Employee commuting
8. Upstream leased assets
9. Downstream transportation and distribution
10. Processing of sold products
11. Use of sold products
12. End of life treatment of sold products
13. Downstream leased assets
14. Franchises
15. Investments
16. Other (upstream)
17. Other (downstream)

where subcategories 1-8 and 16 combined are referred to as *upstream* subcategories and subcategories 9-15 and 17 are referred to as *downstream* subcategories. As part of the CDP's annual questionnaire, firms report their scope 3 emissions for each of these subcategories. They can either report a positive number for a subcategory or a qualitative response: 'relevant, but not calculated' if the subcategory is applicable to the firm but it has not estimated its emissions for the subcategory, 'not relevant' if the firm believes the subcategory is not applicable to its business, and lastly 'not evaluated' i.e. the firm has not determined whether the subcategory is even relevant to it or not.

Let upstream_subcategories and downstream_subcategories be vectors of the individual subcategories.

	Dep. Var: Long Term Credit Spread		
	Both Streams	Upstream Only	Downstream Only
Log (Total Upstream)	-0.04***	-0.04***	
	(0.01)	(0.01)	
Log (Total Downstream)	0.00		-0.00
	(0.01)		(0.01)
Controls	Y	Y	Y
Sector FE	Y	Y	Y
Region FE	Y	Y	Y
Time FE	Y	Y	Y
Obs	2670	4058	2747
R^2	0.30	0.29	0.29
F-stat	53.25	82.37	56.55

Table 13: This table shows the relationship between cost of borrowing and (logs) of total upstream and downstream scope 3 emissions. While we find a mild negative effect of upstream emissions, we find no material relationship between downstream emissions and cost of borrowing.

We estimate the following relationship

$$\begin{aligned}\text{cost of borrowing}_{irst} = \beta_0 + \beta_1 \log &\sum_{\text{subcategories}} \left(\text{upstream\_subcategories}_{irst}\right) \\ + \beta_2 \log &\sum_{\text{subcategories}} \left(\text{downstream\_subcategories}_{irst}\right) \\ + \beta_3 \log &\left(\text{scope } 1 + 2_{irst}\right) + \gamma X_i + FE_{rs} + \beta^t \mathbf{1}[T = t] + \varepsilon_{irst}\end{aligned} \tag{4}$$

where we have effectively split scope 3 into the sum of its upstream and downstream components. Table 13 shows that only upstream emissions are a statistically significant determinant of a firm's cost of borrowing while downstream plays very limited role. In fact, even upstream emissions, while significant, displayed a muted magnitude (-4 basis points). However, we leverage the novel depth our data and dig deeper by looking at each of the 17 individual subcategories.

4.3 Emissions by Scope 3 Subcategories

Which of the subcategories is driving the overall result between scope 3 and cost of borrowing? We estimate the following relationships

$$\begin{aligned}\text{cost of borrowing}_{irst} = \beta_0 &+ \mathrm{B}^{\text{up}} \cdot \log\left(\text{upstream\_subcategories}_{irst}\right) \\ &+ \beta_2 \log\left(\text{scope } 1 + 2_{irst}\right) + \gamma X_i + FE_{rs} + \beta^t \mathbf{1}[T = t] + \varepsilon_{irst}\end{aligned} \tag{5}$$

$$\text{cost of borrowing}_{irst} = \beta_0 + \mathrm{B}^{\text{down}} \cdot \log\left(\text{downstream\_subcategories}_{irst}\right) + \beta_2 \log\left(\text{scope } 1+2_{irst}\right) + \gamma X_i + FE_{rs} + \beta^t \mathbf{1}[T=t] + \varepsilon_{irst} \tag{6}$$

where B^{up} and B^{down} are vectors of regression coefficients, each element for each of the up- and downstream subcategories, respectively. Column (1) of Tables 14 and 15 documents the results for these 'full' regressions. Since few firms have consistently disclosed emissions for all upstream or downstream categories ($N = 356$ for upstream, $N = 40$ for downstream) over the entire study window, we also investigate the link between each individual subcategory and cost of borrowing; the remaining columns of Tables 14 and 15 document these results.

We find that within the upstream subcategories, fuel-and-energy-related activities (not included in Scope 1 or 2) (+19 basis points), waste generated in operations (−11 basis points), and upstream leased assets (−9 basis points) are significantly related with cost of borrowing. However, the signs for the latter two subcategories are reversed and when estimated in isolation, we do not find any significant relationship between these subcategories and cost of borrowing. Only fuel-and-energy-related activities is robustly related to borrowing cost in an intuitively plausible manner.

On the other hand, in line with previous results, we find that none of the downstream subcategories are significant determinants of borrowing cost when taken together, although we would note the small sample size ($N = 40$). Individually, processing and use of sold products increase the cost of borrowing by +8 and +5 basis points, respectively, while end of life treatment, franchises, and investments are negatively related to cost of borrowing which is counterintuitive. Regardless of direction, these findings warrant extra attention in interpretation.

Overall, our results show that more firms report upstream emissions than downstream emissions, upstream emissions may play a bigger role in determining credit terms for firms, but importantly, some subcategories have an inconsistent and non-robust relationships with cost of borrowing as indicated by the sign on the regression coefficient changing direction. The lack of robustness is aggravated by small sample sizes which can cause outliers to have material impacts on the results. We now document these inconsistencies in scope 3 microdata and highlight avenues for engagement for investors, policymakers, and researchers with firms on scope 3 emissions.

	Dep. Var: Long Term Credit Spread									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log (Scope 1 + 2)	-0.04	0.00	-0.02	-0.06***	0.00	0.02	0.02	0.02	0.00	0.09
	(0.07)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.14)
Log (Purchased goods and services)	-0.08	-0.02								
	(0.05)	(0.01)								
Log (Capital goods)	-0.04		-0.00							
	(0.03)		(0.01)							
Log (Fuel-and-energy-related activities (not included in Scope 1 or 2))	0.19***			0.08***						
	(0.05)			(0.02)						
Log (Upstream transportation and distribution)	-0.03				-0.02*					
	(0.03)				(0.01)					
Log (Waste generated in operations)	-0.11***					-0.02				
	(0.03)					(0.01)				
Log (Business travel)	-0.03						0.01			
	(0.05)						(0.02)			
Log (Employee commuting)	-0.02							-0.02		
	(0.06)							(0.02)		
Log (Upstream leased assets)	-0.09***								-0.02	
	(0.03)								(0.02)	
Log (Other (upstream))										-0.05
										(0.05)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Obs	356	2671	1800	2494	2185	2487	2842	2397	595	122
R^2	0.53	0.29	0.34	0.29	0.30	0.29	0.28	0.30	0.41	0.40
F-stat	13.38	54.32	46.18	50.33	45.89	49.41	55.00	50.65	19.52	3.40

Table 14: This table shows the relationship between cost of borrowing and scope 3 upstream subcategories in log. Column (1) includes all upstream subcategories (except Other (upstream)) while Columns (2)-(10) include only one subcategory each. Fuel and energy related activities (not included in Scope 1 or 2) is a robustly significant determinant of cost of borrowing ($+19 basispoints$). There is some evidence that waste generated in operations and upstream leased assets may also play a significant role in cost of borrowing but the evidence is not robust (and signs are flipped).

	Dep. Var: Long Term Credit Spread								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log (Scope 1 + 2)	2.86**	-0.00	-0.10	0.01	0.09**	-0.02	0.04	0.07	-0.08
	(1.04)	(0.04)	(0.07)	(0.03)	(0.04)	(0.05)	(0.08)	(0.05)	(0.12)
Log (Downstream transportation and distribution)	-0.25	-0.03*							
	(0.36)	(0.02)							
Log (Processing of sold products)	-0.22		0.08***						
	(0.18)		(0.02)						
Log (Use of sold products)	0.18			0.05***					
	(0.12)			(0.01)					
Log (End of life treatment of sold products)	-0.05				-0.05***				
	(0.05)				(0.01)				
Log (Downstream leased assets)	0.25					-0.03			
	(0.23)					(0.02)			
Log (Franchises)							-0.14***		
							(0.04)		
Log (Investments)	0.22							-0.05**	
	(0.15)							(0.02)	
Log (Other (downstream))									-0.15***
									(0.04)
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sector FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Region FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Obs	40	1454	418	1475	1227	560	239	592	99
R^2	0.96	0.28	0.38	0.32	0.35	0.40	0.55	0.30	0.56
F-stat	21.60	28.18	11.82	33.56	32.86	17.59	13.12	12.15	4.65

Table 15: This table shows the relationship between cost of borrowing and scope 3 downstream subcategories in log. Column (1) includes all downstream categories; no firm reports all downstream subcategories, hence (1) does not have a coefficient for investments and other (downstream) and the sample size even with the remaining subcategories is small ($N = 40$). Columns (2)-(9) estimate the relationship with individual subcategories one-by-one. Scope 3 emissions from processing and use of sold products tend to increase borrowing costs (+8 and +5 basis points, respectively). End of life treatment, franchises, and investments also appear to be significant determinants of borrowing cost but the results are not robust.

5 Discrepancies in Scope 3 Data

5.1 CDP Response Rate

Unlike other studies (e.g. Bolton and Kacperczyk (2021) etc.) that use aggregated scope 3 emissions data at the firm-level, we leverage scope 3 subcategory-level data directly from the CDP's annual questionnaire. Investigating the microdata, we find that many firms either do not report data for all subcategories that are relevant to their business model (despite peer firms doing so, see Figures 17 and 18) or reallocate emissions across subcategories. We define CDP Response Rate for firm i in year t as the fraction of scope 3 subcategories (17 total: 15 plus 'upstream (other)' and 'downstream (other)') for which a firm reported positive emissions i.e.

$$\text{CDP Response Rate}_{it} = \frac{\sum_{s=1}^{17} \mathbf{1}(\text{scope 3 subcategory}_{ist} > 0)}{\text{Total Number of Scope 3 Subcategories}} \times 100$$

Figure 16 shows the distribution (and sample size) of firms' CDP Response Rate between 2015 and 2020 (inclusive). As the figure shows, merely 818 firms reported scope 3 emissions of which very few (less than 300 firms) reported emissions for more than half the subcategories (little mass on the right side for the distribution) and the average response rate was 31%. By 2020, the average response rate is almost 40% and a meaningful mass of the distribution lies towards the right. However, noise remains: many firms report for less than three subcategories, and those too inconsistently over time.

Therefore, to mitigate the effect of this noise on the results, we only include the firms that report positive emissions for at least a fifth of the 17 scope 3 subcategories. Formally, the filter is that CDP Response Rate$_{it} > 20\%$ i.e. more than three subcategories. We find that the results presented above are robust to small variations ($\pm 5\%$) in this threshold.

5.2 Firm-Specific Examples

We now show why relationships between cost of borrowing at the scope-, stream-, and subcategory-level are not broadly robust, warrant attention from stakeholders, and an avenue for engagement.[12]

Figure 17 shows subcategory-level emissions from Microsoft and Alphabet as reported to the CDP between 2015 and 2020. The two firms have markedly different scope 3 profiles despite being in the same sector (technology) and region (North America). Between 2015-2018

[12] This discussion also shows why CDP Response Rate filter was needed in the first place.

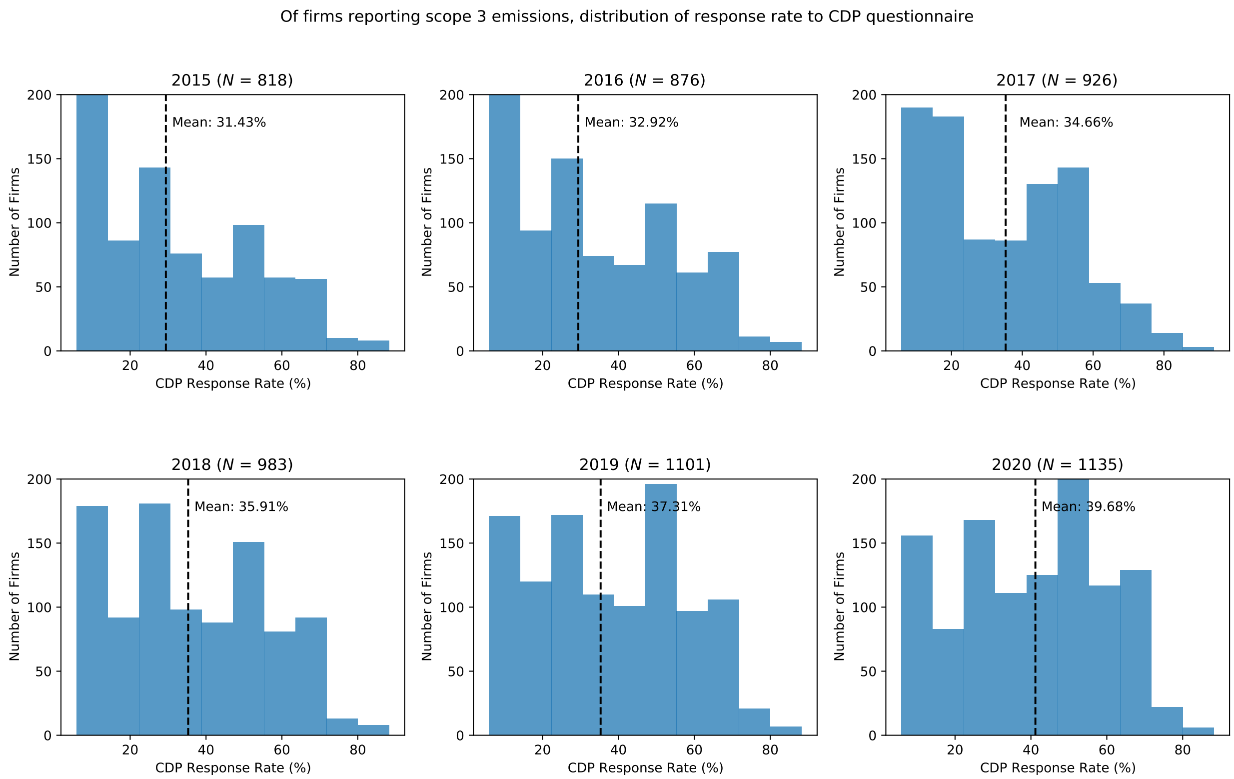

Figure 16: This figure shows the distribution of firms' response rate to scope 3 subcategories as part of the CDP questionnaire for each year 2015 to 2020. We define the response rate as the percentage of the 17 total scope 3 subcategories to which the firm responded with a positive value for emissions. From 2015 to 2020, the response rate has increased as indicated by the mass of the distribution shifting to the right: more firms report emissions for more subcategories. In particular, in 2015, firms reported quantitative values for 31% of subcategories on average; in 2020 that figure had crept up to almost 40%.

and 2019-2020, Microsoft reports halving its emissions under purchased goods and services while almost quadrupling its emissions under capital goods. On the other hand, downstream transportation and distribution and downstream leased assets show marked volatility and no discernible pattern in either direction over the years. Similarly, Alphabet's reporting under purchased goods and services and upstream leased assets is noisy while it discloses downstream emissions in 2015 and 2016 but none thereafter. However, its emissions classified as other (upstream) increase dramatically and remain elevated. Since the firm does not disaggregate them by subcategory, it is challenging for stakeholders to identify and engage with the firm on specific fronts.

These concerns around data quality are not limited to a single sector. Figure 18 shows the subcategory-level emissions profile for the top 10 oil producers (by emissions) in 2020. We see that Shell reports significant positive emissions for use of sold products, purchased goods and services, and fuel and energy related activities (not included in scope 1 and 2) among upstream subcategories. However, other oil producers—even those in the same region as Shell, e.g. Total—do not report their emissions with such specificity or magnitude. In fact, we find that many such firms do not report materially or consistently for other subcategories despite being dominant contributors to overall emissions due to their production process. Perhaps some subcategories are indeed irrelevant for the firms' business or there are no emissions to report but the marked variation across similar firms warrants extra attention from stakeholders to ensure that this is in fact the case and not an anomaly in reporting.

5.3 Data Biases across Time, Subcategories and Sectors

In the interest of space we have highlighted two specific instances of discrepancies in firms' subcategory-level emissions; however, many more firms report anomalous values. We now systematically highlight the strengths and weaknesses of the scope 3 data. Figure 19 shows the share of responses for the average firm in the sample (conditional on reporting any scope 3 emissions). We find that among the firms that do respond to the CDP questionnaire, firms increasingly provide a value for their emissions. In 2015, the average firm in the sample responded positively for 31% of the subcategories; in 2020, the metric had increased to 40%. Importantly, on average the share of firms saying that they had not evaluated a given subcategory at all declined from 20% to 10% as a fraction of all subcategories. These trends indicate that firms are increasingly evaluating their scope 3 emissions. However, the quality of the disclosures can be wanting at times.

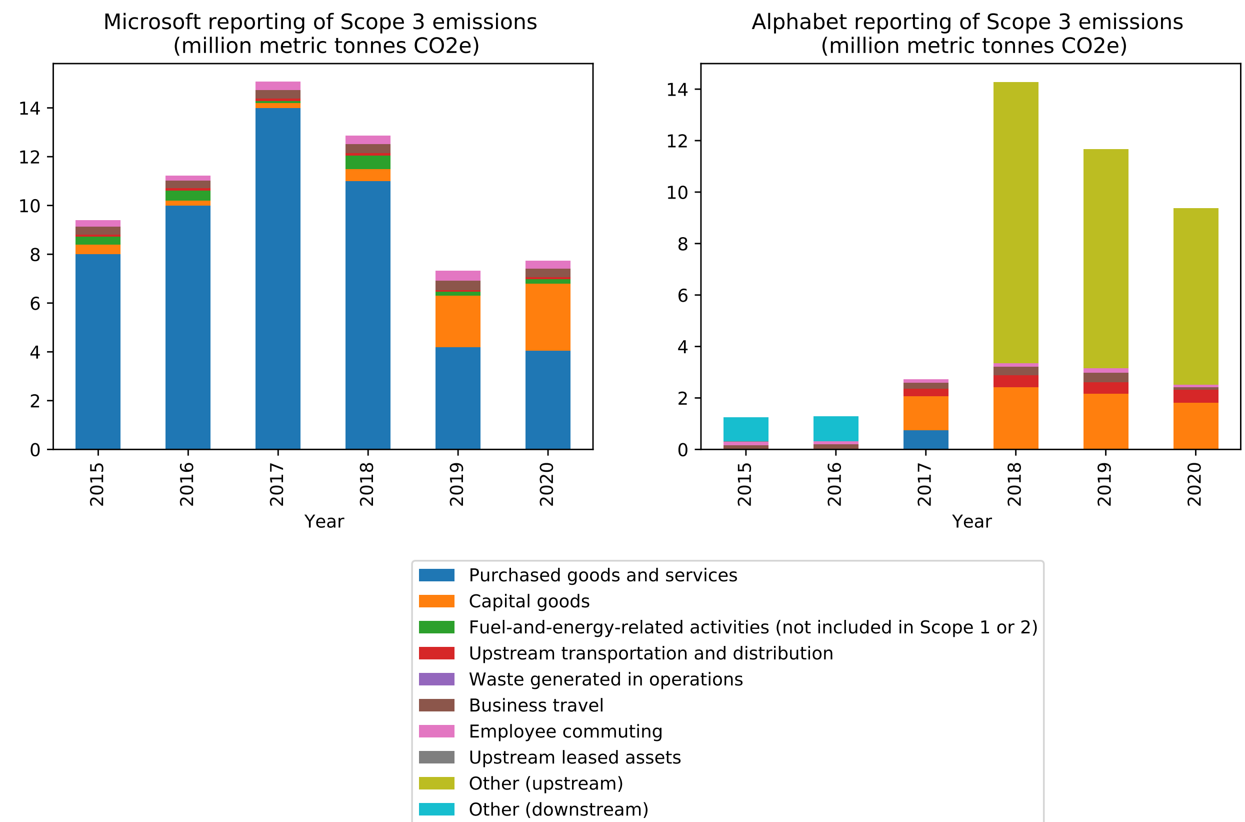

Figure 17: The left panel of this figure shows subcategory-level scope 3 emissions for Microsoft between 2015 and 2020. Between 2015 to 2018 and 2019 to 2020, the company reports halving its emissions under purchased goods and services while quadrupling emissions under capital goods. The right panel of this figure shows subcategory-level scope 3 emissions for Alphabet. The company initially reports downstream emissions in 2015 and 2016 but not thereafter. However, emissions due to capital goods and other (upstream) starts being reported in 2018 and multiplies by 3.5 Alphabet's overall scope 3 disclosed emissions.

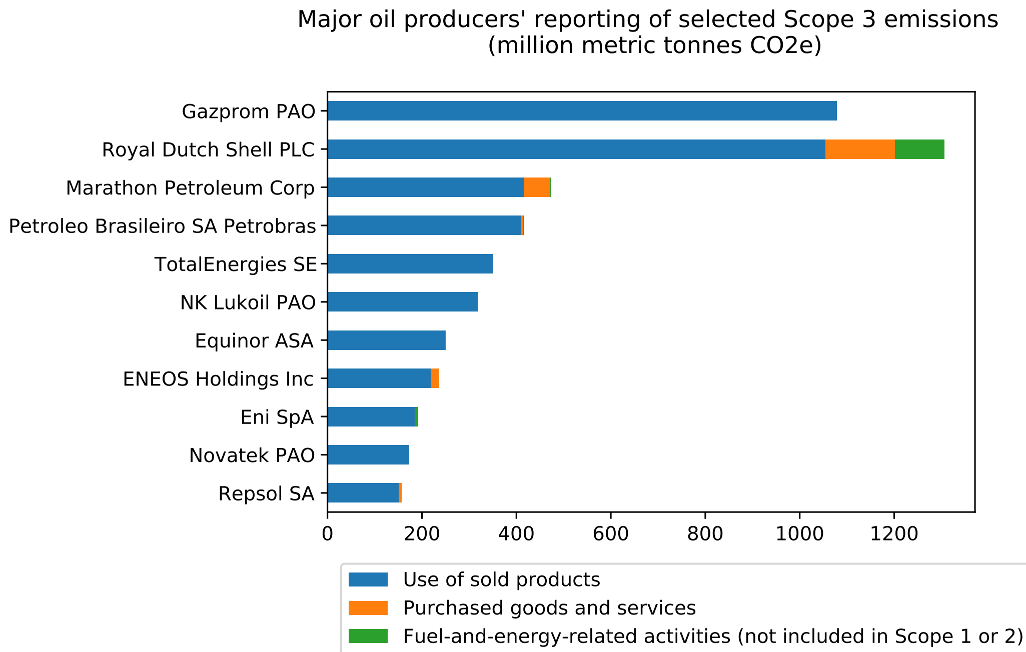

Figure 18: This figure shows three key subcategories of scope 3 disclosures for major oil producers in 2020. Not surprisingly the 'Use of sold product' segment accounts for a heavy scope 3 contribution. However other subcategories appear often undisclosed, while Royal Dutch Shell figures indicates that they account for more than 20% of their scope 3 emissions.

Which subcategories are driving this increase in CDP response seen in Figure 19? Figure 20 shows that the trend is primarily driven by uptick in response to upstream subcategories. Even historically firms are more likely to report on upstream subcategories than downstream subcategories, but over time response in upstream has increased while downstream has remained largely stagnant. Apart from business travel—which already has high reporting rates—and upstream leased assets, all other upstream subcategories have witnessed higher (positive) response rates over the years. However, only use of sold products and end of life treatment for sold products have seen improved response rates during the study window among downstream subcategories.

Moreover, the quality of downstream subcategories data warrants particular attention from stakeholders. Despite fewer firms reporting on downstream subcategories, see Figure 20, downstream emissions make up for the majority share of overall scope 3 emissions, see Figure 21: in 2015, upstream emissions were approximately 20% of scope 3 emissions while the remaining 80% came from downstream subcategories. Additionally, as the left panel of Figure 21 shows, capital goods are a significant share of upstream emissions in 2020. However, that

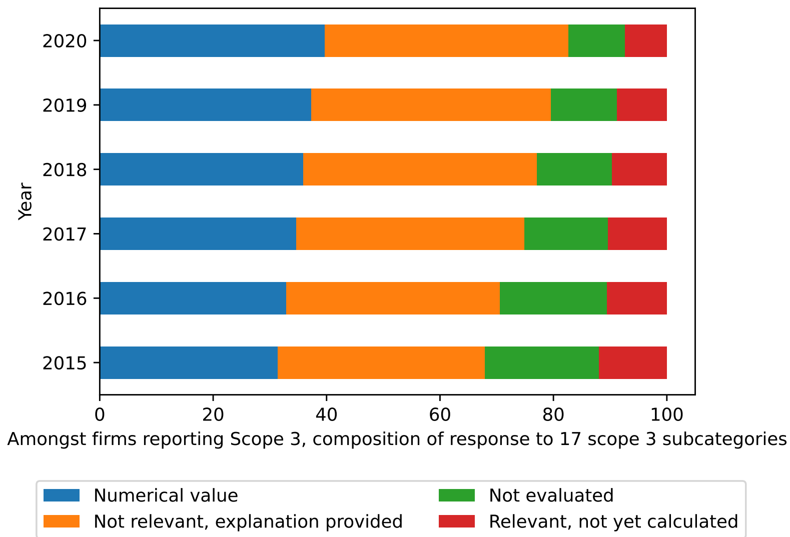

Figure 19: This figure shows the composition of responses to scope 3 by subcategories, conditional on a firm reporting. For a given subcategory, a firm may report actual quantitative emissions (numerical value) or a qualitative response: 'not evaluated,' 'relevant, not yet calculated,' or 'not relevant, explanation provided' in which case a qualitative explanation may be provided. The exact language for these preset qualitative responses change slightly across years. Firms increasingly evaluate and calculate more scope 3 subcategories.

finding is an artifact of a single firm reporting a large amount in 2020 despite never having reported in that category previously. On the other hand, the right panel in Figure 21 indicates that the composition of both streams is volatile but especially so for downstream with use of sold products having the largest share but not showing any discernible trend. Given the small sample of firms reporting on downstream subcategories, and its large magnitude, a few outlier observations can skew results dramatically. Thus stakeholders should consider engaging with firms on estimating the latter's scope 3 emissions, particularly in downstream subcategories.

Lastly, we note that sectors that are dominant contributors to emissions overall—energy, materials, and utility—report more on scope 1 and 2 than other sectors, but this is not the case for scope 3, see Figure 22. Given the role these sectors have in overall emissions, investors and policymakers could engage with firms in these sectors to determine their scope 3 emissions and disclose it via the CDP so that resources can be opimally allocated. Given the scope 3 disclosure premium documented above, firms have an incentive to disclose their emissions and investors and policymakers with an eye towards limiting emissions could benefit by engaging with firms in these sectors to evaluate their scope 3 emissions, particularly with respect to downstream subcategories.

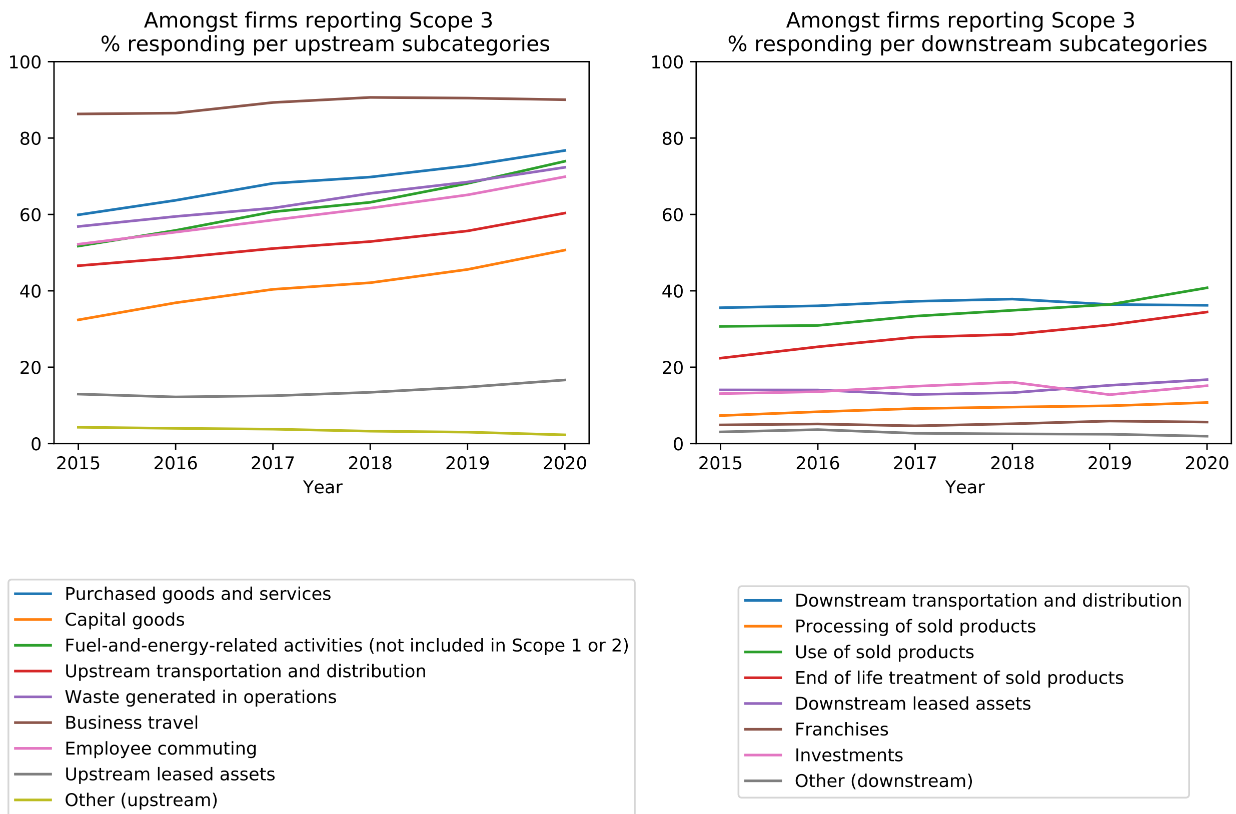

Figure 20: The left panel in this figure shows the percentage of firms reporting positive emissions for scope 3 upstream subcategories, conditional on reporting any scope 3 emissions. The share of firms responding for most upstream subcategories has gradually increased from 2015 to 2020. The right panel in this figure shows the percentage of firms reporting positive emissions for scope 3 downstream subcategories, conditional on reporting any scope 3 emissions. The share of firms responding for most downstream categories has remained flat between 2015 and 2020 with the exception of use of sold products and end of life treatment of sold products. Overall, firms report disproportionately more on upstream subcategories than downstream subcategories.

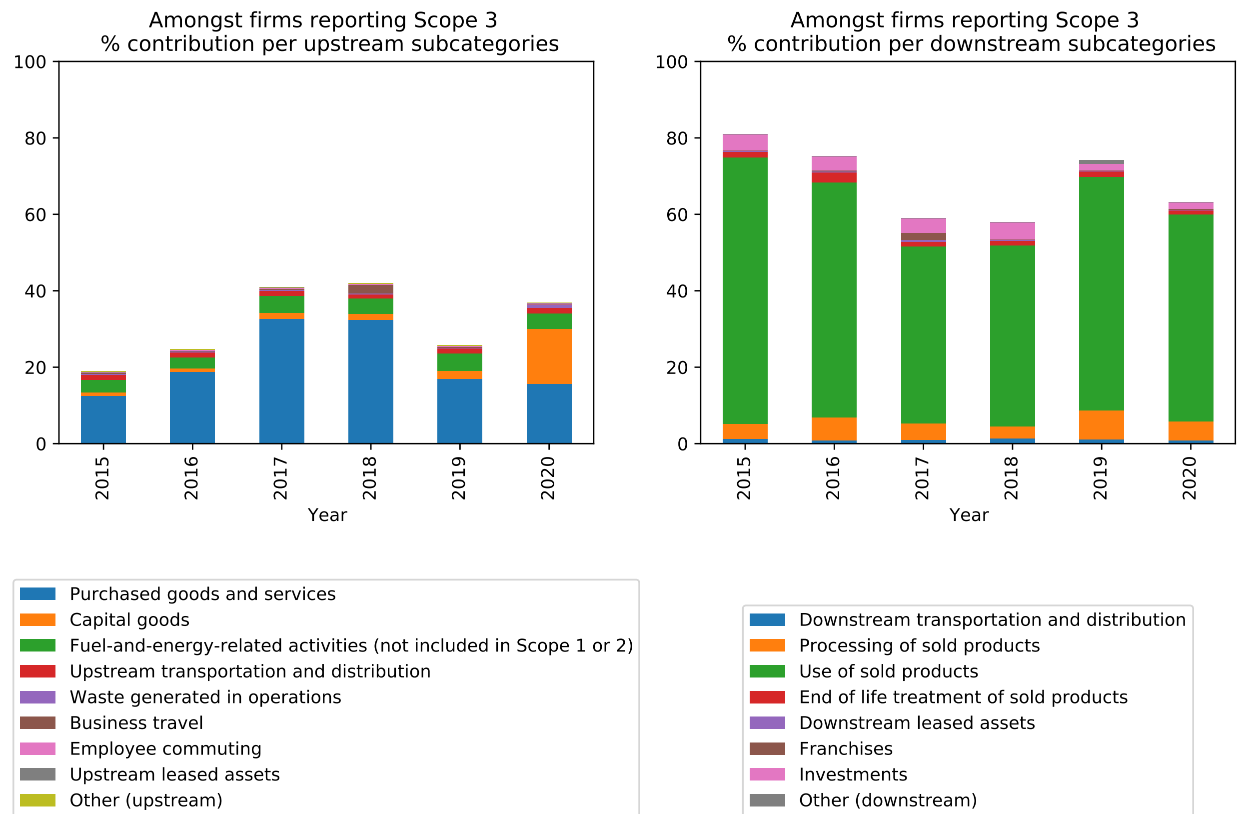

Figure 21: The left panel in this figure shows the composition of upstream emissions by share of each upstream category in a given year. Note the significant variation in composition year-on-year: capital goods are an outsized fraction of upstream emissions in 2016 despite being a small share in 2015 and 2017. Upstream leased assets spike in 2018 despite small shares in previous years. The right panel in this figure shows the composition of upstream emissions by share of each downstream category in a given year. Use of sold products is the largest contributor to downstream emissions but its magnitude shows marked variation across years. Similarly, investments spike up in 2017 relative to other years.

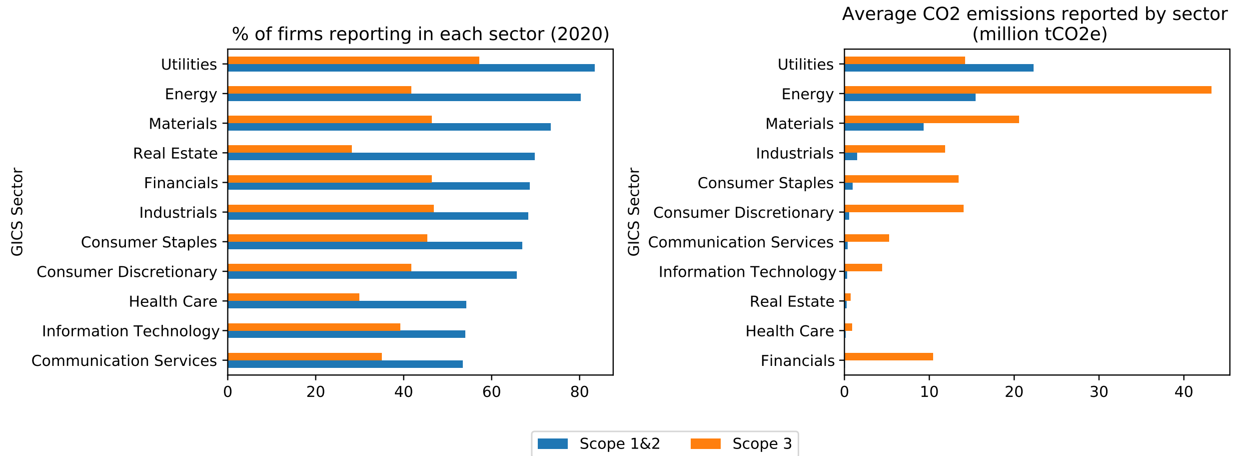

Figure 22: This figure shows the share of firms reporting scope 1 and 2 and scope 3 in each sector. While highly-polluting sectors –like energy, materials, and utilities– report and emit more than other sectors on scope 1 and 2, on scope 3 distinctions are less pronounced across sectors.

6 Conclusion

To sum up, we find that firms that disclose scope 3 emissions receive a discount in credit markets, a *scope 3 disclosure premium* of -20 basis points, particularly in Europe and Asia Pacific while the trend is starting to emerge in North America as well. Moreover, firms that report higher scope 3 emissions do not face a higher cost of borrowing. While we find that some scope 3 data subcategories, particularly upstream, are positively related with cost of borrowing, the evidence is not robust due to discrepancies in how firms have reported scope 3 emissions over the years. Moreover upstream data is more stable and readily available than downstream, investors and policymakers can engage with firms to encourage the latter to concretely estimate and report their scope 3 emissions—including downstream contributions, that tend to be preponderant—via the CDP. This engagement should be more focused on firms in the energy, materials, and utilities sectors which, unlike scope 1 and 2, do not report scope 3 emissions more than other sectors despite potentially being the dominant contributors to emissions overall. Given the disclosure premium, this engagement can be fruitful for firms as well who, as we find, would be rewarded by the credit market for allocating resources towards estimating their scope 3 emissions.

References

Baker, Malcolm et al. (2018). *Financing the response to climate change: The pricing and ownership of US green bonds*. Tech. rep. National Bureau of Economic Research.

Bolton, Patrick and Marcin Kacperczyk (Nov. 2021). "Do Investors Care About Carbon Risk?" en. In: *Journal of Financial Economics* 142.2, pp. 517–549. DOI: 10.1016/j.jfineco.2021.05.008.

CDP (2021). *Transparency to Transformation: A Chain Reaction*. Tech. rep. CDP.

Chava, Sudheer (May 2014). "Environmental Externalities and Cost of Capital." In: *Management Science* 60.9, pp. 2223–2247. DOI: 10.1287/mnsc.2013.1863.

Dhaliwal, Dan S. et al. (Jan. 2011). "Voluntary Nonfinancial Disclosure and the Cost of Equity Capital: The Initiation of Corporate Social Responsibility Reporting." In: *The Accounting Review* 86.1. Publisher: American Accounting Association, pp. 59–100. DOI: 10.2308/accr.00000005.

Friede, Gunnar, Timo Busch, and Alexander Bassen (Oct. 2015). "ESG and Financial Performance: Aggregated Evidence from More than 2000 Empirical Studies." In: *Journal of Sustainable Finance & Investment* 5.4, pp. 210–233. DOI: 10.1080/20430795.2015.1118917.

Goss, Allen and Gordon S. Roberts (July 2011). "The Impact of Corporate Social Responsibility on the Cost of Bank Loans." en. In: *Journal of Banking & Finance* 35.7, pp. 1794–1810. DOI: 10.1016/j.jbankfin.2010.12.002.

Kleimeier, Stefanie and Michael Viehs (2018). "Carbon disclosure, emission levels, and the cost of debt." In: *Emission Levels, and the Cost of Debt (January 7, 2018)*.

Mercereau, Benoît and Lionel Melin (Aug. 2020). "Optimizing Portfolios across Risk, Return, and Climate." en. In: *The Journal of Impact and ESG Investing* 1.1. Publisher: Institutional Investor Journals Umbrella, pp. 115–131. DOI: 10.3905/jesg.2020.1.1.115.

Mercereau, Benoît, Guillaume Neveux, et al. (Feb. 2020). "Fighting Climate Change as a Global Equity Investor." en. In: *Journal of Asset Management* 21.1, pp. 70–83. DOI: 10.1057/s41260-020-00150-9.

Sharfman, Mark P. and Chitru S. Fernando (June 2008). "Environmental risk management and the cost of capital." In: *Strategic Management Journal* 29.6, pp. 569–592. DOI: 10.1002/smj.678.

Zerbib, Olivier David (Jan. 2019). "The Effect of Pro-Environmental Preferences on Bond Prices: Evidence from Green Bonds." en. In: *Journal of Banking & Finance* 98, pp. 39–60. DOI: 10.1016/j.jbankfin.2018.10.012.

A Appendix

A.1 Correlation Tables Within High and Low Emission Sectors

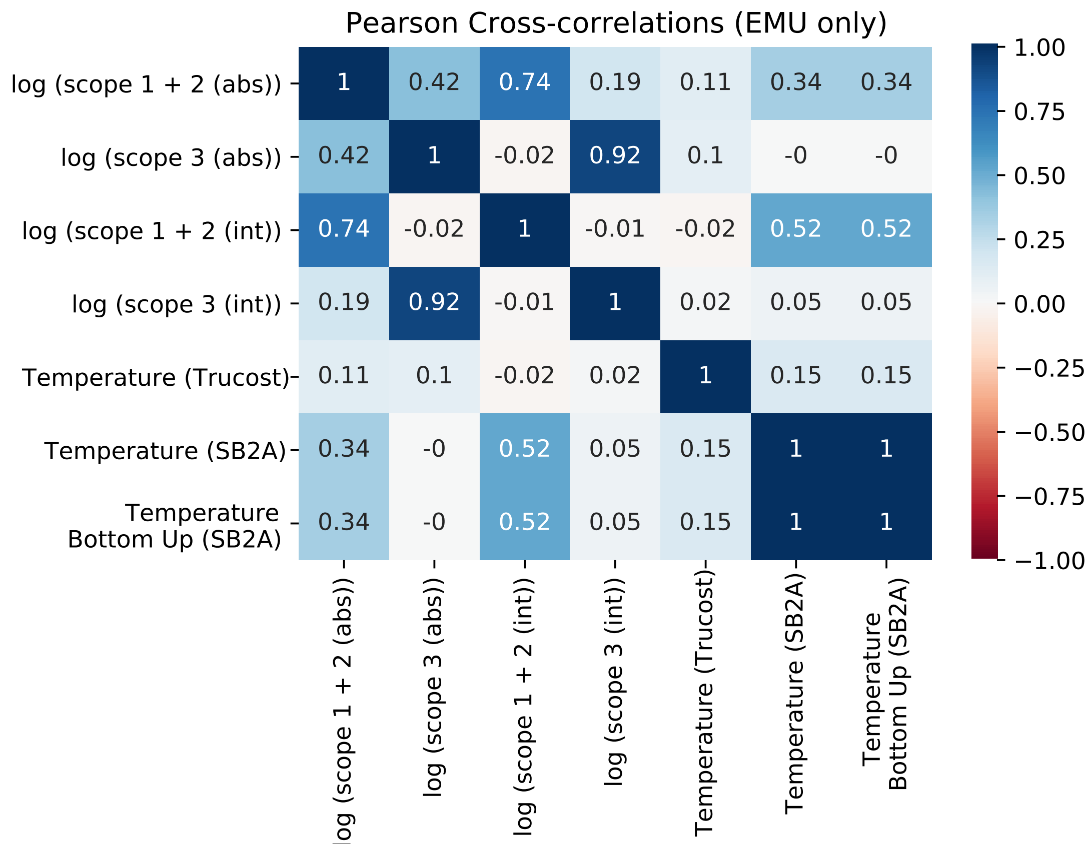

Figure A1: This figure shows a heatmap showing the correlations between scope 1 + 2, their logs, and their log (revenue) intensities, respectively but only for firms in the energy, materials, and utilities (EMU) sectors which tend to be have high emission by virtue of their production process. The correlations for these sectors are in line with those for the larger sample, suggesting that the trends are not entirely due to high emission sectors.

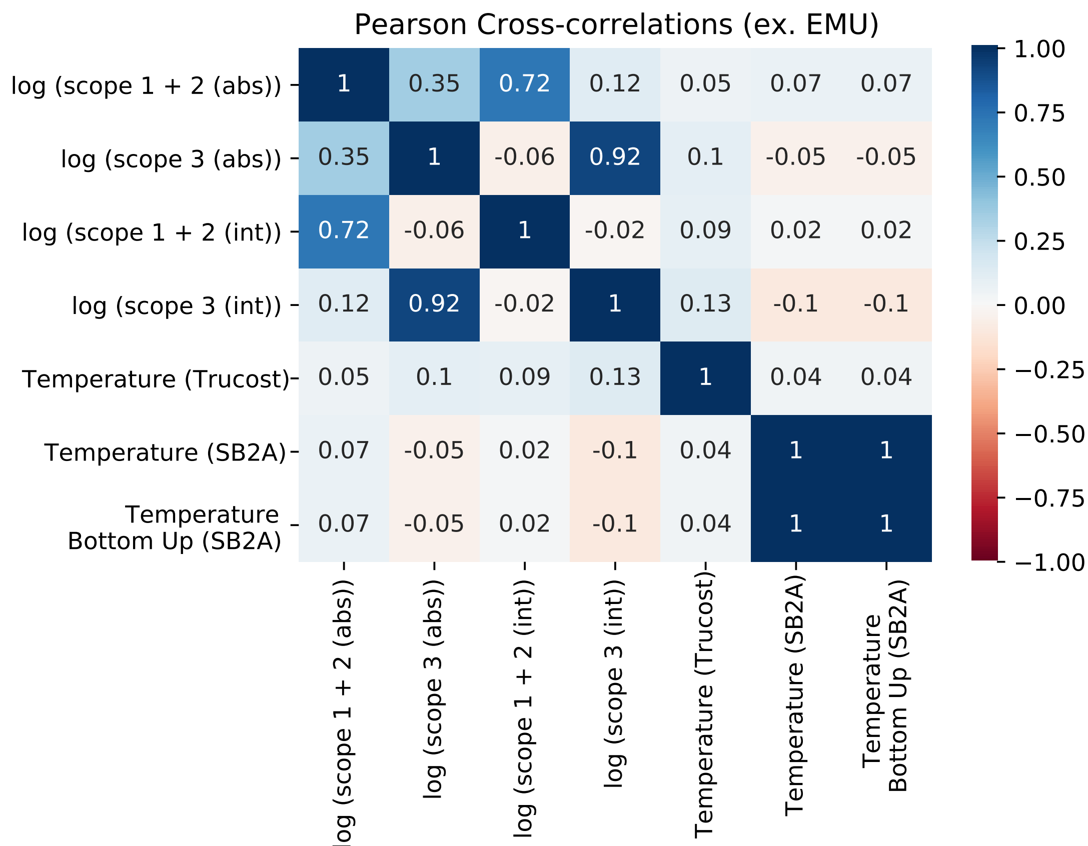

Figure A2: This figure shows the a heatmap indicating the correlations between scope 1 + 2, their logs, and their log (revenue) intensities, respectively, but for the sample excluding energy, materials, and utilities (ex. EMU). The correlations are very similar to the ones for the full sample, suggesting that the patterns are not only dominant in high emission sectors but pervade the economy more broady.

A.2 Results by Data Source: CDP and Refinitiv

We used microdata on scope 3 emissions from CDP questionnaires to estimate our benchmark results. We show that our estimates are robust to the other source of scope 3 data: Refinitiv.

We create three samples:

- CDP only: include all firms that have scope 3 emissions data through the CDP (but not through Refinitiv)
- Refinitiv only: include all firms that have scope 3 emissions data through Refinitiv (but not through CDP)
- CDP + Refinitiv: include all firms that report scope 3 emissions through either channel. If emissions available through both sources then use CDP numbers.

Table A3 shows the results for equation 1 for the three samples highlighted above. Using the universe of firms in CDP indicates a scope 3 disclosure premium of 21 bps while using Refinitiv suggests 11 bps. Either way indicates a robust and meaningful scope 3 disclosure premium. Note that the total sample size here remains the same since the indicator variable, $\mathbf{1}(\text{scope } 3 > 0)$, for all firms for which scope 3 is not available through a given source (CDP or Refinitiv) is zero.

Similarly, Table A4 shows the results for equation 3 for the three data samples. Based on CDP, there is no marked relationship between log of scope 3 and a firm's cost of borrowing. While Refinitiv suggests there might be a statistically significant relationship (- 3 bps), we note that the magnitude is small and the sign in the opposite direction of what would be expected. Table A5 reports the estimates in intensity terms and the results are similar to that for absolute terms. We find mild negative coefficients for log(scope 3/revenue) (-1 bps for CDP, -3 bps for Refinitiv) suggesting that there is no marked and meaningful penalty on firms emitting more (or less) carbon via scope 3.

	Dep. Var: Long Term Credit Spread		
	CDP Only	Refinitiv Only	CDP + Refinitiv
Disclosed Scope 3 Emissions	-0.21***	-0.11***	-0.21***
	(0.03)	(0.03)	(0.03)
Log (Scope 1 + 2 (Intensity))	0.02	0.01	0.02
	(0.01)	(0.01)	(0.01)
Controls	Y	Y	Y
Sector FE	Y	Y	Y
Region FE	Y	Y	Y
Time FE	Y	Y	Y
Obs	7002	7002	7002
R^2	0.24	0.23	0.24
F-stat	114.12	112.34	114.12

Table A3: This table shows the scope 3 disclosure premium by data source. The first column shows the premium for all firms for which scope 3 emissions are available through CDP. Similarly, the second column reports the estimates using all firms in Refinitiv. Lastly, the third column reports the premium for firms whose scope 3 emissions are available through either source. In the case where a firm's emissions is available through both, we use the CDP value. Both data sources indicate a material scope 3 disclosure premium: 21 bps for CDP and 11 bps for Refinitiv.

	Dep. Var: Long Term Credit Spread		
	CDP Only	Refinitiv Only	CDP + Refinitiv
Log (Scope 3 (Absolute))	0.01	-0.03***	-0.03***
	(0.01)	(0.01)	(0.01)
Log (Scope 1 + 2 (Absolute))	0.01	0.04**	0.03**
	(0.02)	(0.02)	(0.01)
Controls	Y	Y	Y
Sector FE	Y	Y	Y
Region FE	Y	Y	Y
Time FE	Y	Y	Y
Obs	3007	3868	4904
R^2	0.28	0.27	0.26
F-stat	57.95	69.37	86.27

Table A4: This table shows the relationship between logs of scope 1 and 2 and scope 3 with cost of borrowing by data source. The first column includes all firms in CDP (but not in Refinitiv), the second column includes all firms in Refinitiv (but not in CDP), and the third column includes firms whose scope 3 emissions are available through either source. If data is available through either source, we use CDP values. Regardless of data source, investors do not seem to demand a climate risk compensation from firms polluting more on scope 3.

	Dep. Var: Long Term Credit Spread		
	CDP Only	Refinitiv Only	CDP + Refinitiv
Log (Scope 3 (Intensity))	-0.01*	-0.03***	-0.02*
	(0.01)	(0.01)	(0.01)
Log (Scope 1 + 2 (Intensity))	0.05***	0.03**	0.05***
	(0.02)	(0.02)	(0.02)
Controls	Y	Y	Y
Sector FE	Y	Y	Y
Region FE	Y	Y	Y
Time FE	Y	Y	Y
Obs	4135	3868	4135
R^2	0.29	0.26	0.29
F-stat	86.99	72.89	86.99

Table A5: This table shows the relationship between logs of scope 1 and 2 and scope 3 with cost of borrowing by data source in intensity (revenue) terms. The first column includes all firms in CDP (but not in Refinitiv), the second column includes all firms in Refinitiv (but not in CDP), and the third column includes firms whose scope 3 emissions are available through either source. If data is available through either source, we use CDP values. Regardless of data source, investors do not seem to demand a climate risk compensation from firms polluting more on scope 3; in fact the estimates are very mildly) negative for scope 3 as opposed to scope 1 and 2.