

Carbon Risk Premium in Multinational Corporations

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Abstract

We examine how carbon risk premia vary between multinational corporations (MNCs) and domestic firms using U.S. public companies from 2002-2021. While confirming a positive carbon risk premium overall, we find that MNCs with higher emission levels face lower premia than domestic firms, but MNCs with growing emissions face substantially higher premia. This divergence reveals that markets price emission trajectories more severely than static exposure for internationally exposed firms. Voluntary disclosure through the Carbon Disclosure Project reduces premia for emission levels but amplifies penalties for emission growth, indicating transparency makes adverse trends more salient. Geographic analysis shows carbon risk premia concentrate among MNCs with European subsidiaries, providing evidence that transition risk from credible climate regulation drives these effects. Our findings demonstrate that carbon risk pricing is multidimensional, depending critically on measurement approach, disclosure practices, and regulatory exposure.

JEL-Classification: G12, Q51, F23, F64

Keywords: Carbon Risk Premium, Multinational Corporations, Climate Transition Risk

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1 Introduction

Climate change represents one of the defining challenges of the twenty-first century, with profound implications for global financial markets and corporate valuation. As governments worldwide implement increasingly stringent climate policies and investors integrate environmental considerations into their portfolio decisions, the pricing of carbon risk has emerged as a critical question in asset pricing theory. Recent evidence suggests that investors demand a premium for holding stocks of carbon-intensive firms (Bolton and Kacperczyk, 2021), reflecting expectations of future regulatory costs, technological disruption, and potential asset stranding associated with the transition to a low-carbon economy (Giglio, Kelly, and Stroebe, 2021). However, the mechanisms through which carbon risk translates into required returns remain poorly understood, particularly for firms operating across multiple regulatory jurisdictions with heterogeneous climate policy environments.

In this paper, we examine how carbon risk premia vary between multinational corporations (MNCs) and domestic firms, and how this relationship depends critically on the measurement of carbon exposure and the geographic distribution of firm operations. Our analysis addresses a fundamental tension in the literature: while MNCs possess operational flexibility and risk management capabilities that could mitigate carbon transition risk (Papoutsis and Ramadorai, 2021), their exposure to multiple regulatory regimes with varying climate policy stringency may amplify their vulnerability to coordinated global climate action (Seltzer, Starks, and Zhu, 2022). Understanding this trade-off is essential for investors seeking to hedge climate risk and for policymakers evaluating the effectiveness of carbon regulation in an increasingly globalized economy.

Using a comprehensive sample of U.S.-based publicly traded firms from 2002 to 2021, with firm-level carbon emissions data from S&P’s Trucost Environmental database merged with financial data from Compustat, CRSP, and LSEG Refinitiv Worldscope, we document several novel findings that fundamentally reshape our understanding of carbon risk pricing for internationally exposed firms. Our empirical strategy exploits variation in both the level and growth rate of carbon emissions, allowing us to distinguish between static measures of carbon exposure and dynamic trajectories of emission intensity. We further investigate how voluntary disclosure through the Carbon Disclosure Project (CDP) and geographic exposure to stringent regulatory environments influence the carbon risk premium.

Our first key finding reveals a striking divergence between how markets price emission levels versus emission growth rates for MNCs. Consistent with existing literature (Bolton and Kacperczyk, 2021), we find that firms with higher carbon emissions exhibit higher stock returns on average, confirming the existence of a carbon risk premium. However, when we

interact multinational status with the natural logarithm of total emissions (Scope 1 and 2), we document a significant negative coefficient, indicating that MNCs with higher absolute emission levels face a *lower* carbon risk premium relative to domestic firms. Specifically, a one-unit increase in log emissions for MNCs is associated with returns that are 5.7 basis points lower per month compared to domestic firms with similar emission levels. This result suggests that investors perceive large-scale MNC emitters as possessing superior risk management capabilities, economies of scale in implementing abatement technologies, or established relationships with regulators that reduce uncertainty about future compliance costs (Albrizio, Kořluk, and Zipperer, 2017).

Strikingly, this relationship reverses when we measure carbon risk using the growth rate of emissions rather than levels. The interaction between multinational status and emission growth yields a large positive coefficient of 36 basis points per month, indicating that MNCs experiencing rising emissions face substantially higher required returns compared to domestic firms with similar emission trajectories. This finding is consistent with a forward-looking asset pricing framework (Pástor, Stambaugh, and Taylor, 2021) in which emission growth rates serve as more informative signals about future transition risk than current emission stocks. For MNCs, growing emissions may signal strategic misalignment with the global decarbonization trend, inadequate investment in clean technology despite possessing the financial resources to do so, or expansion into carbon-intensive operations precisely when such assets face increasing obsolescence risk.

Our second major contribution examines how voluntary environmental disclosure through CDP moderates the carbon risk premium. We find that MNCs disclosing through CDP exhibit lower overall risk premia, consistent with transparency reducing information asymmetry and the cost of capital (Dhaliwal et al., 2011). Moreover, CDP-disclosing MNCs face a lower carbon risk premium when measured by emission levels—the triple interaction $\text{MNC} \times \text{CDP} \times \text{Log}(\text{Emissions})$ yields a positive coefficient of 14.4 basis points, offsetting much of the negative main effect. This result indicates that transparency enables investors to verify that high-emitting MNCs have legitimate operational reasons for their carbon footprint and credible management strategies, thereby reducing uncertainty premia (Krueger, Sautner, and Starks, 2020).

However, transparency amplifies risk premia when it reveals adverse emission trajectories. The triple interaction $\text{MNC} \times \text{CDP} \times \text{Emission Growth}$ produces a significant negative coefficient of -49.1 basis points per month, indicating that CDP-disclosing MNCs with rising emissions face substantially higher required returns. This finding suggests that while disclosure reduces information asymmetry about emission levels, it simultaneously makes

unfavorable trajectories more salient and verifiable to investors. MNCs that transparently report growing emissions through CDP cannot obscure their divergence from decarbonization pathways behind measurement uncertainty, leading markets to rationally demand higher compensation for confirmed transition risk exposure.

Our third key finding identifies the geographic source of carbon risk premia for MNCs. We partition our sample based on whether firms have subsidiaries in Europe versus other regions, exploiting variation in regulatory stringency across jurisdictions. The results provide compelling evidence that transition risk, rather than physical climate risk or generic regulatory uncertainty, drives the observed pricing patterns. For MNCs with European subsidiaries, the carbon risk premium on emission levels is 43.1 basis points per month, compared to an economically negligible and statistically insignificant 1.2 basis points for MNCs without European exposure. This stark difference reflects Europe’s position as the global leader in climate policy, characterized by the EU Emissions Trading System, mandatory climate disclosures under the Corporate Sustainability Reporting Directive, and the Carbon Border Adjustment Mechanism ([Joltreau and Sommerfeld, 2019](#)).

The European regulatory environment combines both greater policy certainty (clear long-term decarbonization targets) and greater stringency (binding emissions caps, substantial carbon prices) compared to other major jurisdictions. Critically, EU climate policies are embedded in supranational governance structures with strong enforcement mechanisms and limited susceptibility to regulatory capture by individual firms ([Ellerman, Marcantonini, and Zaklan, 2016](#)), making transition risk both higher in magnitude and more certain in trajectory for Europe-exposed MNCs. Our findings suggest that carbon risk premia concentrate precisely where regulatory commitment to decarbonization is most credible, supporting the interpretation that markets price transition risk rather than simply responding to climate sentiment.

These findings make several important contributions to the literature. First, we extend the emerging body of research on carbon risk pricing ([Bolton and Kacperczyk, 2021](#); [Hong, Karolyi, and Scheinkman, 2020](#); [Hsu, Li, and Tsou, 2023](#)) by demonstrating that the carbon risk premium is not monolithic but varies systematically with firm characteristics, measurement approaches, and geographic exposure. Our results highlight the importance of distinguishing between static measures of carbon exposure (emission levels) and dynamic measures (emission growth rates) when assessing climate-related financial risk. This distinction has important implications for both academic research and practical applications in portfolio construction and risk management.

Second, we contribute to the literature on multinational corporations and regulatory

risk (Papoutsis and Ramadorai, 2021; Seltzer, Starks, and Zhu, 2022) by showing that the relationship between international exposure and carbon risk premia is nuanced and context-dependent. While operational flexibility and sophisticated risk management may reduce the risk premium associated with high emission levels, MNCs face amplified penalties when their emission trajectories diverge from global decarbonization trends. This finding suggests that the traditional view of MNCs as better positioned to manage regulatory risk may not apply in the context of climate policy, where coordinated international action and supranational enforcement mechanisms limit firms’ ability to engage in regulatory arbitrage.

Third, our analysis of voluntary disclosure effects contributes to the literature on environmental transparency and firm value (Dhaliwal et al., 2011; Krueger, Sautner, and Starks, 2020; Christensen, Hail, and Leuz, 2021). We show that the value of disclosure depends critically on what information is revealed: while transparency generally reduces risk premia by resolving uncertainty, it can amplify premia when it credibly communicates adverse trends. This conditional effect of disclosure has important implications for debates about mandatory climate reporting requirements and the design of disclosure frameworks that effectively communicate climate risk to investors.

Fourth, our geographic analysis contributes to the political economy literature on climate regulation and regulatory credibility (Aldy and Pizer, 2015; Elliott et al., 2013). By demonstrating that carbon risk premia concentrate among firms exposed to jurisdictions with credible, stringent climate policy, we provide evidence that markets distinguish between symbolic climate commitments and binding regulatory constraints. This finding suggests that the effectiveness of climate policy in influencing corporate behavior through financial markets depends critically on policy credibility and enforcement mechanisms, rather than simply the existence of climate targets or regulations.

Finally, our results have important implications for investors and corporate managers. For portfolio managers seeking to hedge climate risk or construct climate-aware portfolios, our findings indicate that simple measures of carbon intensity may be insufficient—emission trajectories, disclosure practices, and geographic exposure all play crucial roles in determining carbon risk premia. For corporate managers, our results suggest that maintaining high absolute emissions may be less penalized than allowing emissions to grow, particularly for firms with transparent disclosure practices and operations in stringent regulatory environments. This asymmetry between levels and growth rates highlights the importance of credible decarbonization pathways in managing financial market responses to carbon risk.

The remainder of this paper proceeds as follows. Section 2 describes our data sources and variable construction. Section 3 addresses the empirical methodology. Section 4 presents

our main results on the differential carbon risk premium for MNCs and CDP assessment. Section 5 discusses robustness tests and alternative explanations. Section 6 concludes with implications for theory and practice.

2 Data and sample

Our primary dataset covers the period from 2002 to 2021 and consists of U.S.-based publicly traded non-financial and non-utilities firms. The data set is constructed through the integration of four main sources: CRSP for daily and monthly stock return data, LSEG Refinitiv/Worldscope for foreign sales ratio data to identify MNC and non-MNC firms, Compustat North America for firm-level financial data, and Trucost EDX for corporate carbon emissions data. We focus exclusively on firms listed on the New York Stock Exchange, NASDAQ, and the American Stock Exchange, excluding American Depositary Receipts (ADRs) and firms incorporated outside the United States. First, we use the PERMNO and PERMCO unique identifiers to merge return and financial data, that is to provide the link between CRSP and Compustat North America. Furthermore, we rely on the unique firm identifier GVKEY to merge Trucost emissions data. In the final step, we use ISIN identifier to merge LSEG/Worldscope foreign sales ratio data. The resulting panel data provides a comprehensive sample for analyzing the intersection of corporate level carbon risk premium and multinationality over two decades.

2.1 Data on corporate carbon emissions

We obtain firm-level carbon emission data from Trucost EDX, as in studies by [Bolton and Kacperczyk \(2021, 2023\)](#). Trucost EDX, like other leading data providers, relies on the Greenhouse Gas (GHG) Protocol standards to assess corporate GHG emissions.¹ Therefore, Trucost’s GHG Protocol standards-based approach enables companies to assess their GHG emissions in a consistent and comparable manner. This protocol classifies GHG emissions into three main categories²:

- Scope 1: Emissions from sources directly under the company’s control.
- Scope 2: Indirect emissions from the production of electricity, heat or steam that the company does not directly produce but purchases for its operations.

¹see CDP, MSCI, Sustainalytics, Thomson Reuters, Bloomberg, and ISS.

²see [The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard Revised Edition](#)

- Scope 3: Covers all other indirect emissions that occur throughout the value chain. These include the production of purchased goods and services, the life cycle of products, transportation, waste management and outsourced operations. Scope 3 is generally considered the most complex area to measure and monitor.

Trucost EDX provides Scope 1, Scope 2, and Scope 3 emissions in tons (CO2 equivalent) on an annual basis. In addition to Scope 1 and Scope 2, we use upstream Scope 3 emissions in our study. These data, generated using an input-output analysis, include spending rates and emission factors within the economic relationships throughout the supply chain. Trucost has also started to collect downstream Scope 3 data in recent years, but we have not yet been able to use downstream Scope 3 in our analysis due to lack of data.

Furthermore, we calculate the annual firm-level growth of Scope 1, Scope 2, and Scope 3 emissions. We do this to provide an alternative measure for carbon emissions. If the level of emissions have a significant effect on returns, we would expect emission growth to have a significant effect as well.

Finally, to capture firm-level emissions relative to the scale of companies, we also use Scope 1, Scope 2, and Scope 3 emission intensities. For Scope 1, the emission intensities are GHG emissions from sources owned or controlled by the firm divided by the firm’s revenue, for Scope 2, the GHG emissions from the firm’s consumption of purchased electricity, heat, or steam divided by the firm’s revenue, and for Scope 3, the GHG emissions from other upstream activities not included in scope 2 divided by the firm’s revenue, respectively. Data on emission intensities are provided by EDX in tons CO2e/\$M.

2.2 Data on multinationality

In our analysis, we utilize the ratio of foreign sales to total sales, as obtained from LSEG Refinitive, to identify a sample firm as either a MNC or a non-MNC. Consistent with prevailing literature, a firm is classified as an MNC if it possesses a foreign sales ratio exceeding 20 percent; otherwise, it is categorized as a non-MNC.³

³Jang, Wang, and Zhang (2017) classify firms as MNC and DC using foreign income and foreign income tax items reported in the annual financial statements. The Compustat item for these data are PIFO (pretax income-foreign) and TXFO (income taxes-foreign), respectively. We didn’t utilize this definition because of concerns by Jang, Wang, and Zhang (2017) who argue that large multinational firms may not report foreign income in some periods despite their extensive international activities. This may be due to low foreign income or much higher than normal income in the home country. Including firms that have reported foreign income and foreign income tax limits this bias. When we apply this identification, 75% of our sample firms are identified as MNCs. Although our main results remain the same whichever identification is used, this method leaves a low variation in examining heterogeneity across MNCs. Therefore, we rely on foreign sales ration in our analysis.

2.3 Variables in cross-sectional regression

Our empirical analysis utilizes the monthly returns as the dependent variable. Like (Bolton and Kacperczyk, 2021, 2023), we drop observations with returns above 100% to increase the reliability of the results and limit the impact of outliers.

We also consider a number of control variables in our empirical analysis in order to capture firm characteristics. These firm-specific control variables are: LOGSIZE, which is the natural logarithm of market value of equity; B/M, which is book to market ratio calculated as the ratio of book value of equity to market value of equity; ROE, which is return on equity; MOM, which is the average past 12-month returns of a firm; INVEST/A, which is the ratio of capital expenditures to total assets; LOGPPE, which is the natural logarithm of property, plant and equipment; BETA, which is the CAPM-based monthly market beta calculated using firms daily returns; VOLAT, which is the volatility of past 12-month returns of a firm; SALESGR, which is sales growth calculated as the dollar change in annual firm revenues (normalized by the previous month’s market value of equity) and EPSGR, which is the dollar change in annual earnings per share (normalized by the previous month’s stock price).

In addition to all this, we pay attention to whether companies are participating in the Carbon Disclosure Project (CDP) and whether they have issued green patents. For this, we use a dummy variable that takes the value 1 if the company is participating in the CDP in the relevant year, and 0 otherwise. Definitions of all variables are given in Table 1.

[Insert Table 1 here]

2.4 Summary statistics

The final sample covers 243,042 firm-month observations from 2,716 unique firms for the period 2002-2021. To control possible impacts of outliers, we winsorize all financial variables at the 1% level. We report summary statistics for all variables used in the study in Table 2. The mean of Scope 1 and Scope 2 emissions (winsorized) of the sample firms are quite close to each other, at 10.557 and 10.55, respectively. The mean of Scope 3 emission is higher, 12.271, than that of scopes 1 and 2. The same pattern continues in the statistics of the emissions growths and intensities. The means of the annual emission growth are 16% and 26% for scopes 1 and 2, respectively. The mean annual growth in Scope 3 emissions is an astonishing 134% [Insert Table 2 here] The average monthly return (winsorized) of the firms in our sample is 1.16% and the standard deviation is 12.137%. These firms have slightly greater market risk as the mean BETA is 1.191. The mean of the average returns over the

previous-12 months is 0.165%, and the mean volatility of the average returns is 0.118%. In addition, the average logarithmized size (winsorized) of the included firms is 7.92 and the average book to market ratio (winsorized) is 0.424. MNCs account for 47% of the firms in our sample (Mean MNC_D is 0.472). Regardless of whether they are MNC or non-MNC, the mean of foreign sales ratio for all firms in our sample is 25%.

[Insert Table 2 here]

The average monthly return (winsorized) of the firms in our sample is 1.67% and the standard deviation is 12.137%. These firms have slightly greater market risk as the mean BETA is 1.191. The mean of the average returns over the previous-12 months is 0.165%, and the mean volatility of the average returns is 0.118%. In addition, the average logarithmized size (winsorized) of the included firms is 7.92 and the average book to market ratio (winsorized) is 0.424.

3 Empirical Methodology

We divide our methodology for examining the carbon risk premium in relation to multinationality into two sections. First, we test whether the relationship between total carbon emissions and monthly stock returns differs between MNCs and DCs. We use cross-sectional pooled ordinary least squares (OLS) regression. This relationship estimated is given below in equation 1.

$$\begin{aligned} RET_{i,t} = & a_0 + a_1 \log(Emission_{i,t}) + a_2 MNC_{i,t} \\ & + a_3 \log(Emission \times MNC)_{i,t} + a_4 Controls_{i,t-1} + \mu_t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where $RET_{i,t}$ is the return of stock i at month t , $\log(Emissions)_{i,t}$ is the emissions of firm i under Scope 1, Scope 2, and Scope 3 at year t , $MNC_{i,t}$ is a dummy variable that takes the value 1 if the firm is multinational and 0 otherwise, and the control variables are LOGSIZE, B/M, ROE, LEVERAGE, MOM, INVEST/A, LOGPPE, BETA, VOLAT, SALESGR, and EPSGR respectively.

Secondly, we believe that the participation of the firms in our sample within the CDP will have a significant impact on the emissions, MNCs, and return relationship. CDP is a platform that aims to increase transparency regarding global sustainability efforts, and participating companies voluntarily disclose information about their environmental impacts within the CDP. Therefore, participation in CDP reflects a firm's awareness of, transparent management of, and monitoring of its environmental impacts. Considering that investors

demand extra premium for high-emission firms, we argue that participation in CDP could have a mitigating effect on this relationship. We test our expectations by running Equation 2 below:

$$\begin{aligned}
RET_{i,t} = & a_0 + a_1 \log(\text{Emission}_{i,t}) + a_2 \text{CDP}_{i,t} + a_3 \text{MNC}_{i,t} \\
& + a_4 \log(\text{Emission}) \times \text{CDP}_{i,t} + a_5 \log(\text{Emission}) \times \text{MNC}_{i,t} \\
& + a_6 (\text{MNC} \times \text{CDP})_{i,t} + a_7 \log(\text{Emission}) \times \text{CDP} \times \text{MNC}_{i,t} \\
& + a_8 \text{Controls}_{i,t-1} + \mu_t + \varepsilon_{i,t}
\end{aligned} \tag{2}$$

where CDP is a dummy variable that takes the value 1 if the firm is included in CDP and 0 otherwise. The triple interaction term allows us to examine the return-emission relationship between MNCs and non-MNCs within the scope of CDP compliance.

Finally, we are categorizing MNCs according to the countries where their subsidiaries are located. In doing so, we rely on the subsidiary information from the Orbis database and the EPI 2012 regional classification.⁴ Undoubtedly, knowing which regions to have subsidiaries in is as important as being multinational. This is because some countries and regions have strict regulations and practices regarding carbon emissions, while others have more lenient policies or are still in the preparation phase. Therefore, operating predominantly in different regions can be a decisive factor in the emissions-return relationship. Of course, we also don't forget that an MNC might not operate exclusively in one region (which is very likely), but it might have no activity in a particular region at all (which is indeed the case). A distinction made based on this will at least shed light on our curiosity. Equation 3 has been tested below to glean some insight from the regional breakdown.

$$RET_{i,t} = \alpha_0 + \alpha_1 \log(\text{Emissions})_{i,t} + \text{Controls}_{i,t} + \mu_t + \epsilon_{i,t} \tag{3}$$

In almost all of our analyses, we also provide the results of all alternative emission measurements including even intensity and growth emissions, which we present in Table 1. All regressions include year-month fixed effects and Trucost industry fixed effects. We cluster standard errors at the firm and year level.

⁴The EPI 2012 report's regional classification includes the following categories: Americas, Asia & Pacific, Eastern Europe & Central Asia, Europe, Middle East & North Africa, and Sub-Saharan Africa. We focus on the "Europe" and "Americas" regions, and all other regions are categorized under "Others".

4 Results

In this section, we present the regression results. We begin by demonstrating the carbon risk premium for U.S. firms. We then present evidence on the multinationality effect on the carbon risk premium. Our further analysis provides evidence on the extent to which the carbon risk premium is distributed across MNCs and DCs.

4.1 Carbon risk premium and MNCs

We begin by first demonstrating the impact of emissions and multinationality on returns and determining whether there is a difference in returns between MNCs and non-MNCs when emissions are considered. Table 3 presents the OLS results for the moderating effect of multinationality on the relationship between carbon emissions and monthly stock returns based on Equation 1. The results given in Table 3 show that there is a positive significant relationship between annual total emissions and monthly stock returns. This finding, which confirms the existence of a carbon risk premium for U.S. firms, shows that an increase in the LOG TOT EMS12 will also result in an increase in monthly stock returns. According to the results in Model 1, the effect is also economically significant because a one standard deviation increase in the LOG TOT EMS12 leads to a monthly increase of 0.330 percentage points $[(0.131 \times 2.522) = 0.330]$.

The findings regarding the MNC_D dummy variable, which takes the value of 1 for multinational firms and 0 for domestic firms, also indicate the existence of an MNC premium. The results of Model 1 of Table 3 show that the coefficient of the MNC_D dummy variable is 0.241, which is statistically significant at the 1% level. The findings clearly indicate a risk premium for MNCs.

The result for the interaction effect is given in the second column (Model 2) of Table 3. We are interested in whether the carbon risk premium is stronger or weaker for MNCs than that for non-MNCs. According to the findings given in Model 2, the $\text{MNC} \times \text{LOG TOT EMS12}$ interaction variable has a negative and statistically significant coefficient at the 5% level. While the significant positive effect of the LOG TOT EMS12 and MNC_D dummy variables on returns continues, respectively, the coefficient of the interaction term is negative and significant. The carbon risk premium among MNCs is smaller than among non-MNCs. This means, based on the estimated coefficients, that the carbon emission premium is economically smaller for MNCs than for non-MNCs $[(0.153) + (-0.057) = 0.096]$.

[Insert Table 3 here]

Model 3 and Model 4 of Table 3 present the results obtained by running Equation 1 for total emission growth. Our findings regarding the MNC_D dummy variable are consistent across each specification. While the results in Model 3 show that total emission growth increased expected returns. More strikingly, the coefficient of the total emission growth and MNC_D interaction term is positive and significant in Model 4 of Table 3. This result indicates that the premium demanded for high emission growth of MNCs is higher than for non-MNCs. In other words, the smoothing of the demanded yield premium for high-level emissions through geographical diversification is invalid when considering emission growth. While investors perceive non-MNC firms as riskier for level emissions, they cannot ignore the demand for return premium when considering emission growth for MNCs. In this case, regulatory and reputational risks are inevitable for MNCs with emission growth, even if they have spread their carbon risks across different geographies, and they are significantly penalized by investors.

4.2 CDP commitment, emissions, and MNCs

The Carbon Disclosure Project (CDP), as an organization that provides transparency in monitoring climate risks, encourages companies to transparently share their emission data and commitments regarding climate risk and transition risk with investors and the public. Accordingly, CDP is voluntary, and companies within its scope disclose their environmental and climate policies entirely on a voluntary basis. This commitment can be perceived by investors as the company's transparency and its plans for future/potential climate and carbon transition risks; this demonstrates that these risks are well managed and plays a role in reducing expected return.

[Insert Table 4 here]

Table 4 presents the results for the role of CDP commitment in the interaction between multinationality and total emissions. For the total emission level, the interaction term $CDP \times \text{LOG TOT_EMS12}$ is significant and has a negative coefficient in all specifications. That is, firms' commitment to CDP eliminates the positive emission premium. In Model 4, as the total emission increases, firms committed to CDP bear less of the premium compared to those not committed ($CDP \times \text{LOG TOT_EMS12} = -1.996$). Furthermore, the triple interaction $MNC \times CDP \times \text{Log(Emissions)}$ has a positive coefficient and offsets a large portion of the negative main effect.

On the other hand, within the context of total emission growth, increases in carbon emissions for CDP commitment MNCs no longer result in the expected increase in the return

premium (Model 8). This finding is based on the triple interaction for MNC, CDP, and TOT EMS12 and essential because being a multinational company with a CDP commitment builds trust for investors in the future transition.

4.3 Geographical dispersion of MNCs

Finally, in this section, we categorize MNCs based on the countries where their subsidiaries are located. We do this because, while MNCs have large production and service networks located in different countries, we try to take into account the policies, taxes, and other strict regulations that these countries have developed to address climate risks. We rely on the Orbis database for subsidiary information. For regional categorization, we base our classification on the EPI 2012 report. Accordingly, we prioritize companies with at least one subsidiary in the Europe region and group the others under the “non-Europe” category. This method allows us to test whether regional location differences accurately capture the relationship between emissions and expected returns.

[Insert Table 5 here]

Table 5 presents summary statistics of MNCs by region in terms of emissions. Accordingly, the highest mean values for level total emissions level in the non-Europe region and the highest mean values for total emission growth are in the Europe. Panels B provides evidence regarding the relationship between total emission level, total emission growth and expected return by region. The total emissions level results presented in Model 1 show that in Europe, an increase in total emissions increases the expected return. This finding is not valid for the non-European region. As a result, we show that US-based multinational companies operating in Europe face a higher carbon risk premium.

5 Robustness Check

5.1 Endogeneity concern

The most critical concern in our main findings is the potential endogeneity arising from self-selection, which may bias the estimated relationship between multinationality, carbon emissions, and expected returns. MNCs are typically larger and more complex, which may simultaneously affect their emission dynamics and investors’ return expectations. To mitigate these endogeneity concerns, we perform regressions utilizing entropy balancing weights. Entropy balancing allows for the equilibrium of covariates between the treatment and control

groups [Hainmueller \(2012\)](#). For this, we identify multinational firms in the treatment group and apply entropy balancing to ensure they have similar mean and variance characteristics to the control group. The regression findings obtained after the reweighting process are presented in Table A.1 in appendix.

The reweighted regression findings reinforce our previous findings for total level emissions and growth emissions. Table A.1 shows that LOG TOT EMS12 leads to an increase in RET, and that supports the idea that the carbon emission premium is economically smaller for multinational corporations compared to non-MNCs in Model 2 $[(0.081) + (-0.042) = 0.039]$.

On the other hand, the interaction term coefficient in Model 4 of Table A.1 also confirms that growth emissions cause a higher demanded premium. Accordingly, we support the idea that multinational corporations create a less emission premium within total level emissions, but investors demand a higher return for the growth emission.

5.2 Alternative emission measurements

To provide a more detailed perspective, we consider various alternative emission measures. These include individual Scope 1, Scope 2, and Scope 3 emissions, as well as total emissions including Scope 3. Table A.2 in appendix presents the results for all alternative carbon emission measurements.

Our findings are confirmed across almost all specifications for total emissions, including individual carbon emission items and emissions under Scope 3. According to additional findings, the level of emissions that contribute most to the return premium is based on Scope 3 emissions (Model 3). This result is not surprising, since firms do not have direct control over emissions under Scope 3. For growth emissions, total emissions appear to have the highest impact on return.

5.3 The effect of international exposure of MNCs

In this section, we proceed with regressions on the level of international exposure of MNCs. For the level of international exposure, we use the ratio of foreign sales to total sales (FR_SALES). In addition to the MNC dummy variable, we are running Equation 4 to capture the direct impact of changes in foreign sales ratio on stock returns and emissions. We are doing this because we want to show the direct impact of the foreign sales ratio, which we can describe as the level of internationalization, on the emission-return relationship in order to offer a more detailed and dynamic approach.

$$\begin{aligned} \text{RET}_{i,t} = & a_0 + a_1 \log(\text{Emission}_{i,t}) + a_2 \text{FR_SALES}_{i,t} \\ & + a_3 \log(\text{Emission} \times \text{FR_SALES})_{i,t} + a_4 \text{Controls}_{i,t-1} + \mu_t + \varepsilon_{i,t} \end{aligned} \quad (4)$$

Table A.3 presents the OLS results of Equation 4 on carbon emissions and monthly stock returns by the level of internationalization. We report the results based on the foreign sales ratio for all alternative carbon emission measurements. The coefficients of all representative variables of level carbon emissions remain significant in the regression results (Models 1-4). Furthermore, as expected, stock returns increase as international exposure increases.

Our main coefficient of interest, the interaction term $\text{FR_SALES} \times \text{EMISSION}$, is statistically significant, showing a negative coefficient for Scope 1 and Scope 2 level emissions (Models 1-2) and a positive coefficient for growth emissions (Models 5-7-8). Building on our previous findings that the impact of carbon risk premium on MNCs is reduced compared to non-MNCs, we demonstrate that differences or increases (decreases) in MNCs' international exposure levels contribute differently to reducing (increasing) the impact of carbon risk premium based on emission measurement.

5.4 CDP and alternative emission measurements

For companies covered under the CDP, we have also considered total emission intensities as an alternative emission measurement, and the results are presented in Table A.4. While we couldn't find significant results for total emission intensities, we are once again proving that CDP commitment creates a discount for MNCs (Models 3-4).

6 Conclusion

In this paper we document evidence that the carbon risk premium is lower for multinational corporations (MNCs). Firms with higher emissions have higher cross-sectional stock returns. Investors demand a higher return for holding the stock of these firms. While this is true for all corporations, the magnitude of the risk premium is lower for MNCs than domestic corporations. A one-unit increase in log emissions for MNCs is associated with returns that are 5.7 basis points lower than non-MNCs. This is surprising because the overall risk premium is higher for MNCs than domestic firms. We argue that investors perceive MNCs to be better equipped to manage climate transition risks. In addition, we find that CDP commitment mitigates the return premium effect of high emissions. Most importantly, we present evidence that multinational firms with CDP commitments deliver lower returns compared to non-MNCs when considering emission growth.

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Table 1 Variable definitions

This table provides the definitions of all variables used in the analysis. The sample covers U.S.-based publicly traded firms for the period 2002-2021. Firm-level carbon emissions, financial variables and stock market related variables are collected from the S&P's Trucost Environmental, Compustat, CRSP, and LSEG Refinitiv/Worldscope databases respectively.

Variable	Definitions
RET (%)	Monthly Return for each firm. CRSP item: RET
LOG(SCOPE 1)	Firm-level carbon emissions in tonnes per year (CO2 equivalent). Trucost items: bsolute: GHG Scope 1 (di_319413), GHG Scope 2 Location-based (di_319414), GHG Scope 3 Upstream Total (di_319415).
LOG(SCOPE 2)	
LOG(SCOPE 3)	
Δ SCOPE 1 Δ SCOPE 2 Δ SCOPE 3	Emission growth as the annual percentage changes in carbon emissions levels of scope 1, 2, and 3 from year t-1 to year t.
SCOPE 1 INT SCOPE 2 INT SCOPE 3 INT	Firm-level carbon emission intensity as the ratio of carbon emissions levels divided by the company's revenue. Trucost items: Intensity: GHG Scope 1 (di_319407), Intensity: GHG Scope 2 Location-based (di_319408), Intensity: GHG Scope 3 Upstream (di_319409).
LOG TOT_EMS12 (SCOPE 1 + SCOPE 2)	Firm-level total emissions based on GHG Scope 1 and GHG Scope 2.
LOG TOT_EMS123 (SCOPE 1 + SCOPE 2 + SCOPE 3)	Firm-level total emissions based on GHG Scope 1, GHG Scope 2, and GHG Scope 3.
TOT_EMS12 INT (SCOPE 1 + SCOPE 2)	Firm-level total carbon emission intensity based on GHG Scope 1 and GHG Scope 2.
TOT_EMS123 INT (SCOPE 1 + SCOPE 2 + SCOPE 3)	Firm-level total carbon emission intensity based on GHG Scope 1, GHG Scope 2, and GHG Scope 3.
Δ TOT EMS12 (SCOPE 1 + SCOPE 2)	Total emission growth as the annual percentage changes in carbon emissions levels of total GHG Scope 1 and GHG Scope 2 from year t-1 to year t.
Δ TOT EMS123 (SCOPE 1 + SCOPE 2 + SCOPE 3)	Total emission growth as the annual percentage changes in carbon emissions levels of total GHG Scope 1 and GHG Scope 2 from year t-1 to year t.
FR_SALES	Ratio of foreign sales to total sales
MNC_D	MNC is a dummy variable representing multinational firms. It takes the value 1 if the foreign sales ratio if firm i is higher than 20 percent, and 0 otherwise.
CDP	CDP is a dummy variable representing firms included in Carbon Disclosure Project. It takes the value 1 if firm i is included in CDP.
PATENT	PATENT is a dummy variable representing firms have at least one green patent. It takes the value 1 if firm i has patent at time t.
LOGSIZE	Natural logarithm of the market value, which is the stock price times the number of shares outstanding.
B/M	The ratio of book value of equity to market value of equity as of the year end.
LEVERAGE	Ratio of book value of total debt divided by the book value of assets.
MOM	Average of the previous 12-month returns of a firm.
INVEST/A	Ratio of capital expenditures to book value of assets.
ROE	Ratio of net annual income to book value of equity.
LOGPPE	Natural logarithm of property, plant and equipment.
BETA	The CAPM beta calculated over the one-year period using daily return data and rolling-window regression. The t-bill rate and market return come from the Kenneth French data library.
VOLAT	Standard deviation of previous 12-month returns.
SALESGR	Annual change in firm revenues normalized by the previous month's market value of equity.
EPSGR	Annual change in earnings per share normalized by the previous month's stock price.

Table 2 Sample summary statistics

This table reports summary statistics (N, number of observations, means, medians, and standard deviations) for the variables used in the analysis. The definitions of all variables are given in Table 1. The sample covers U.S.-based publicly traded firms for the period 2002-2021. Firm-level carbon emissions, financial variables and stock market related variables are collected from the S&P's Trucost Environmental, Compustat, CRSP, and LSEG Refinitiv/Worldscope databases respectively. All variables are winsorized at the 1st and 99th percentiles.

	N	Mean	Median	SD
RET (%)	243042	1.167	.989	12.137
LOG (SCOPE 1)	243042	10.557	10.548	2.721
LOG (SCOPE 2)	243042	10.55	10.684	2.312
LOG (SCOPE 3)	243042	12.271	12.514	2.334
ΔSCOPE 1	215839	.161	.039	.735
ΔSCOPE 2	215839	.261	.026	1.6
ΔSCOPE 3	215839	1.336	.152	6.263
SCOPE 1 INT	243042	1.414	.184	4.645
SCOPE 2 INT	243042	.378	.223	.52
SCOPE 3 INT	243042	1.812	1.176	1.731
LOG TOT_EMS12 (SCOPE 1 + SCOPE 2)	243042	11.453	11.526	2.522
LOG TOT_EMS123 (SCOPE 1 + SCOPE 2 + SCOPE 3)	243042	12.773	13.003	2.414
TOT_EMS12 INT (SCOPE 1 + SCOPE 2)	243031	1.823	0.440	4.957
TOT_EMS123 INT (SCOPE 1 + SCOPE 2 + SCOPE 3)	243031	3.704	1.837	5.773
ΔTOT EMS12 (SCOPE 1 + SCOPE 2)	213217	.146	0.038	.632
ΔTOT EMS123 (SCOPE 1 + SCOPE 2 + SCOPE 3)	213217	.119	0.041	.448
FR_SALES	243042	.258	0.165	.285
MNC_D	243042	.472	0.000	.499
LOGSIZE	243042	7.915	7.934	1.715
B/M	243042	.424	0.332	.412
LEVERAGE	243042	.218	0.190	.129
MOM	243042	.165	0.151	.441
INVEST/A	243042	.047	0.031	.049
ROE	243042	4.46	10.278	27.259
LOGPPE	243042	5.904	6.097	2.285
BETA	243042	1.191	1.093	.863
VOLAT	243042	.118	0.098	.072
SALESGR	243042	.037	0.030	.283
EPSGR	243042	.014	0.005	.179

Table 3 Total carbon emissions and stock returns

This table reports the results of pooled regressions. The dependent variable is stock returns (RET). Carbon emission is measured with the total of scopes 1 and 2. The definitions of all variables are given in Table 1. The sample covers U.S.-based publicly traded firms for the period 2002-2021. Firm-level carbon emissions, financial variables and stock market related variables are collected from the S&Ps Trucost Environmental, Compustat, CRSP, and LSEG Refinitiv Worldscope databases respectively. All variables are winsorized at the 1st and 99th percentiles. Standard errors reported in parentheses are clustered at the firm and year level. All models include year-month and industry fixed effects. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	RET (1)	RET (2)	RET (3)	RET (4)
MNC_D	0.241*** [0.056]	0.901*** [0.281]	0.220*** [0.058]	0.178*** [0.059]
LOG TOT_EMS12	0.131*** [0.027]	0.153*** [0.029]		
MNC_D* LOG TOT_EMS12		-0.057** [0.022]		
Δ TOT EMS12			0.162*** [0.052]	0.058 [0.063]
MNC_D* Δ TOT EMS12				0.360*** [0.100]
LOGSIZE	-0.081** [0.035]	-0.076** [0.035]	0.042 [0.037]	0.044 [0.036]
B/M	0.214** [0.101]	0.216** [0.101]	0.257** [0.106]	0.254** [0.106]
LEVERAGE	0.126 [0.229]	0.147 [0.228]	0.437* [0.235]	0.438* [0.234]
MOM	-0.240*** [0.087]	-0.242*** [0.087]	-0.291*** [0.094]	-0.300*** [0.094]
INVEST/A	-0.316 [0.708]	-0.294 [0.708]	-1.518** [0.731]	-1.561** [0.730]
ROE	0.010*** [0.001]	0.010*** [0.001]	0.012*** [0.001]	0.012*** [0.001]
LOGPPE	-0.089*** [0.034]	-0.090*** [0.034]	-0.007 [0.030]	-0.008 [0.030]
BETA	0.068** [0.035]	0.067* [0.035]	0.110*** [0.037]	0.111*** [0.037]
VOLAT	-0.006 [0.617]	0.080 [0.619]	1.025 [0.689]	1.035 [0.688]
SALESGR	1.779*** [0.120]	1.775*** [0.120]	1.675*** [0.129]	1.673*** [0.129]
EPSGR	3.958*** [0.226]	3.958*** [0.226]	4.100*** [0.240]	4.114*** [0.240]
Year/month F.E.	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES
adj. R^2	0.224	0.224	0.235	0.235
N	243042	243042	213217	213217

Table 4 CDP coverage and carbon risk premium

This table reports the results of pooled regressions. The dependent variable is stock returns (RET). The definitions of all variables are given in Table 1. The sample covers U.S.-based publicly traded firms for the period 2002-2021. Firm-level carbon emissions, financial variables and stock market related variables are collected from the S&Ps Trucost Environmental, Compustat, CRSP, and LSEG Refinitiv Worldscope databases respectively. All variables are winsorized at the 1st and 99th percentiles. Standard errors reported in parentheses are clustered at the firm and year level. All models include year-month and industry fixed effects. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	RET (1)	RET (2)	RET (3)	RET (4)	RET (5)	RET (6)	RET (7)	RET (8)
LOG TOT_EMS12	0.131*** [0.027]	0.166*** [0.031]	0.160*** [0.031]	0.173*** [0.032]				
MNC_D	0.237*** [0.056]	0.814*** [0.289]	0.699** [0.295]	1.136*** [0.359]	0.218*** [0.058]	0.172*** [0.059]	0.258*** [0.073]	0.239*** [0.074]
CDP	0.053 [0.049]	0.577** [0.293]	0.785** [0.308]	1.778*** [0.465]	0.021 [0.051]	0.034 [0.052]	0.173** [0.077]	0.150* [0.077]
MNC_D*LOG TOT_EMS12		-0.050** [0.023]	-0.034 [0.024]	-0.074** [0.030]				
CDP*LOG TOT_EMS12		-0.042* [0.023]	-0.048** [0.023]	-0.127*** [0.036]				
MNC_D*CDP			-0.225** [0.093]	-1.996*** [0.588]			-0.237*** [0.091]	-0.193** [0.093]
MNC_D*CDP*LOG TOT_EMS12				0.144*** [0.047]				
ΔTOT EMS12					0.162*** [0.052]	0.072 [0.066]	0.076 [0.066]	0.052 [0.069]
MNC_D*ΔTOT EMS12						0.408*** [0.113]	0.398*** [0.113]	0.529*** [0.145]
CDP* ΔTOT EMS12						-0.131 [0.105]	-0.129 [0.105]	0.136 [0.143]
MNC_D*CDP*ΔTOT EMS12								-0.491** [0.209]
CONTROLS	YES	YES	YES	YES	YES	YES	YES	YES
Year/month F.E.	YES	YES	YES	YES	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES	YES	YES	YES	YES
adj. R ²	0.224	0.224	0.224	0.224	0.235	0.235	0.235	0.235
N	243042	243042	243042	243042	213217	213217	213217	213217

Table 5 Total carbon emissions and regional dispersion

This tables reports regional summary statistics (N, number of observations, means, medians, and standard deviations) for the returns and the total emission variables (Panel A) and the results of pooled regressions (Panels B, C, and D). Regional classification of subsidiaries is based on Environmental Performance Index (EPI) 2012. The definitions of all variables are given in Table 1. The sample covers U.S.-based publicly traded firms for the period 2002-2021. Firm-level carbon emissions, financial variables and stock market related variables are collected from the S&Ps Trucost Environmental, Compustat, CRSP, and LSEG Refinitiv Worldscope databases respectively. All variables are winsorized at the 1st and 99th percentiles. Standard errors reported in parentheses are clustered at the firm and year level. All models include year-month and industry fixed effects. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Descriptive Statistics					
Region		N	Mean	Median	SD
Europe	RET (%)	5771	1.432	1.247	10.815
	LOG TOT_EMS12	5771	11.464	11.410	1.955
	ΔTOT EMS12	5486	.1	0.014	.512
Non-Europe	RET (%)	40978	1.332	1.228	10.606
	LOG TOT_EMS12	40978	12.292	12.208	2.122
	ΔTOT EMS12	39137	.066	0.009	.465
Panel B: Regression Results					
	Europe	non-Europe	Europe	non-Europe	
	RET	RET	RET	RET	
	(1)	(2)	(3)	(4)	
LOG TOT_EMS12	0.431** [0.199]	0.012 [0.064]			
ΔTOT EMS12			0.115 [0.268]	0.181 [0.113]	
CONTROLS	YES	YES	YES	YES	
Year/month F.E.	YES	YES	YES	YES	
Industry F.E.	YES	YES	YES	YES	
adj. R^2	0.286	0.285	0.291	0.293	
N	5722	40978	5449	39137	

APPENDIX

Table A.1 Entropy balancing with total emission level and growth

This table reports the results of regressions with entropy balancing weights, which balance covariate distributions between treatment (MNCs) and control groups (DCs). The dependent variable is stock returns (RET). Carbon emission is measured with the total of scoops 1 and 2. The definitions of all variables are given in Table 1. The sample covers U.S.-based publicly traded firms for the period 2002-2021. Firm-level carbon emissions, financial variables and stock market related variables are collected from the S&Ps Trucost Environmental, Compustat, CRSP, and LSEG Refinitiv Worldscope databases respectively. All variables are winsorized at the 1st and 99th percentiles. Standard errors reported in parentheses are clustered at the firm and year level. All models include year-month and industry fixed effects. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	RET (1)	RET (2)	RET (3)	RET (4)
LOG TOT_EMS12	0.062** [0.025]	0.081*** [0.027]		
MNC_D	0.195*** [0.052]	0.696** [0.273]	0.171*** [0.055]	0.142** [0.055]
MNC_D* LOG TOT_EMS12		-0.042* [0.022]		
Δ TOT EMS12			0.253*** [0.053]	0.107 [0.067]
MNC_D* Δ TOT EMS12				0.318*** [0.103]
CONTROLS	YES	YES	YES	YES
Year/month F.E.	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES
adj. R^2	0.238	0.238	0.246	0.246
N	243042	243042	213217	213217

Table A.2 Carbon emissions and stock returns with alternative carbon emission measures

This table reports the results of pooled regressions. The dependent variable is stock returns (RET). The definitions of all variables are given in Table 1. The sample covers U.S.-based publicly traded firms for the period 2002-2021. Firm-level carbon emissions, financial variables and stock market related variables are collected from the S&Ps Trucost Environmental, Compustat, CRSP, and LSEG Refinitiv Worldscope databases respectively. All variables are winsorized at the 1st and 99th percentiles. Standard errors reported in parentheses are clustered at the firm and year level. All models include year-month and industry fixed effects. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	RET (1)	RET (2)	RET (3)	RET (4)	RET (5)	RET (6)	RET (7)	RET (8)
LOG (SCOPE 1)	0.120*** [0.023]							
MNC_D	0.761*** [0.240]	0.950*** [0.283]	0.730** [0.344]	0.772** [0.340]	0.184*** [0.059]	0.203*** [0.058]	0.172*** [0.058]	0.137** [0.059]
MNC_D* LOG (SCOPE 1)	-0.049** [0.020]							
LOG (SCOPE 2)		0.182*** [0.031]						
MNC_D* LOG (SCOPE 2)		-0.067*** [0.025]						
LOG (SCOPE 3)			0.286*** [0.035]					
MNC_D* LOG (SCOPE 3)			-0.041 [0.026]					
LOG TOT_EMS123				0.264*** [0.036]				
MNC_D* LOG TOT_EMS123				-0.042* [0.025]				
ΔSCOPE 1					0.053 [0.055]			
MNC_D* ΔSCOPE 1					0.246*** [0.079]			
ΔSCOPE 2						-0.008 [0.026]		
MNC_D* ΔSCOPE 2						0.052 [0.036]		
ΔSCOPE 3							-0.005 [0.007]	
MNC_D* ΔSCOPE 3							0.040*** [0.009]	
ΔTOT EMS123								0.172* [0.093]
MNC_D* ΔTOT EMS123								0.963*** [0.163]
CONTROLS	YES	YES	YES	YES	YES	YES	YES	YES
Year/month F.E.	YES	YES	YES	YES	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES	YES	YES	YES	YES
adj. R^2	0.224	0.224	0.224	0.224	0.233	0.233	0.233	0.235
N	243042	243042	243042	243042	215839	215839	215839	213217

Table A.3 Foreign sales ratio and carbon risk premium

This table reports the results of pooled regressions. The dependent variable is stock returns (RET). The definitions of all variables are given in Table 1. The sample covers U.S.-based publicly traded firms for the period 2002-2021. Firm-level carbon emissions, financial variables and stock market related variables are collected from the S&Ps Trucost Environmental, Compustat, CRSP, and LSEG Refinitiv/Worldscope databases respectively. All variables are winsorized at the 1st and 99th percentiles. Standard errors reported in parentheses are clustered at the firm and year level. All models include year-month and industry fixed effects. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	RET (1)	RET (2)	RET (3)	RET (4)	RET (5)	RET (6)	RET (7)	RET (8)
LOG (SCOPE 1)	0.123*** [0.023]							
FR_SALES	1.387*** [0.427]	1.590*** [0.495]	1.242** [0.605]	1.376** [0.602]	0.351*** [0.110]	0.382*** [0.110]	0.332*** [0.110]	0.281** [0.111]
FR_SALES * LOG (SCOPE 1)	-0.091** [0.036]							
LOG (SCOPE 2)		0.181*** [0.031]						
FR_SALES * LOG (SCOPE 2)		-0.111*** [0.043]						
LOG (SCOPE 3)			0.287*** [0.034]					
FR_SALES * LOG (SCOPE 3)			-0.067 [0.046]					
LOG TOT_EMS123				0.266*** [0.036]				
FR_SALES * LOG TOT_EMS123				-0.075* [0.044]				
ΔSCOPE 1					0.066 [0.055]			
FR_SALES * ΔSCOPE 1					0.338** [0.133]			
ΔSCOPE 2						-0.007 [0.025]		
FR_SALES * ΔSCOPE 2						0.085 [0.061]		
ΔSCOPE 3							-0.003 [0.007]	
FR_SALES * ΔSCOPE 3							0.061*** [0.014]	
ΔTOT EMS123								0.196** [0.092]
FR_SALES * ΔTOT EMS123								1.417*** [0.163]
CONTROLS	YES	YES	YES	YES	YES	YES	YES	YES
Year/month F.E.	YES	YES	YES	YES	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES	YES	YES	YES	YES
adj. R^2	0.224	0.224	0.224	0.224	0.233	0.233	0.233	0.235
N	243042	243042	243042	243042	215839	215839	215839	213217

Table A.4 CDP coverage and carbon risk premium for total carbon emissions intensity

	RET (1)	RET (2)	RET (3)	RET (4)
TOT_EMS12 INT	-0.004 [0.006]	-0.007 [0.008]	-0.007 [0.008]	-0.005 [0.009]
MNC_D	0.228*** [0.056]	0.237*** [0.060]	0.328*** [0.071]	0.337*** [0.073]
CDP	0.046 [0.049]	0.022 [0.052]	0.190** [0.076]	0.203*** [0.077]
MNC_D* TOT_EMS12 INT		-0.004 [0.010]	-0.003 [0.010]	-0.009 [0.015]
CDP* TOT_EMS12 INT		0.011 [0.010]	0.009 [0.010]	0.004 [0.014]
MNC_D*CDP			-0.279*** [0.088]	-0.304*** [0.094]
MNC_D*CDP* TOT_EMS12 INT				0.013 [0.020]
CONTROLS	YES	YES	YES	YES
Year/month F.E.	YES	YES	YES	YES
Industry F.E.	YES	YES	YES	YES
adj. R^2	0.224	0.224	0.224	0.224
N	243031	243031	243031	243031