Corporate Decarbonization under Financial Constraints: International Evidence

Finance Working Paper N° 877/2023
February 2023

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ECGI Working Paper Series in Finance

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Abstract

Climate change is the biggest environmental challenge facing the world today, and corporate commitments to decarbonization are vital to combat this crisis. Our study investigates whether and how firms reduce their carbon footprints under financial resource constraints. Analyzing firms across 51 countries suggests that firms are less likely to decarbonize and implement carbon abatement strategies when facing financial constraints. However, environmental regulatory stringency, while not government policies that subsidize corporate green investment, can mitigate such adverse effects. Unlike domestic companies, multinational corporations, especially with limited financial resources, can avert strict environmental regulations by shifting their emission-intensive activity to foreign subsidiaries in countries with weaker environmental regulations. Finally, our results suggest that financially-constrained emitters have limited access to international equity and bond markets.

Keywords: Climate Change, Financial Constraints, Carbon Decarbonization, Multinational Corporations, Sustainability

JEL Classifications: G14, G31, M54

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Current Version: January 18, 2023

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ABSTRACT

Climate change is the biggest environmental challenge facing the world today, and corporate commitments to decarbonization are vital to combat this crisis. Our study investigates whether and how firms reduce their carbon footprints under financial resource constraints. Analyzing firms across 51 countries suggests that firms are less likely to decarbonize and implement carbon abatement strategies when facing financial constraints. However, environmental regulatory stringency, while not government policies that subsidize corporate green investment, can mitigate such adverse effects. Unlike domestic companies, multinational corporations, especially with limited financial resources, can avert strict environmental regulations by shifting their emission-intensive activity to foreign subsidiaries in countries with weaker environmental regulations. Finally, our results suggest that financially-constrained emitters have limited access to international equity and bond markets.

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1. Introduction

The devastating consequences of climate change have forced global leaders to take concerted action to tackle this looming crisis. As countries worldwide combat climate change and pledge to net zero emissions by 2050,[1] firms engaging in international business are facing an increasingly challenging task to integrate decarbonization into their business strategies. Based on the conceptual framework on the interactions between environmental regulations and international business (Rugman and Verbeke, 1998; Rugman and Verbeke, 2009), companies may confront two choices to address this challenge. First, firms can develop a "green" firm-specific advantage to improve their environmental and financial performance. Second, firms can avoid local environmental regulatory stringency by shifting their carbon emissions to countries with weak environmental regulations and lower production costs. Prior empirical studies support both options,[2] possibly reflecting firms' active trade-offs to optimize the firm- and country-specific advantages while factoring in their own constraints. This study aims to examine whether and how limited financial resources influence firms' decarbonization policy in response to increasing environmental regulatory pressures. Specifically, we investigate the extent to which financial constraints and cross-country differences in environmental regulatory stringency materially shape corporate climate policies, particularly those of multinational corporations (MNCs) operating beyond national boundaries.

Prior theoretical work predicts that financial constraints significantly influence a firm's capital allocation when making intertemporal decisions (Aghion et al., 2010; Eisfeldt and Rampini, 2007; Xu and Kim, 2022). Any increase in external financing costs makes firms favor projects that enhance cash or save costs in the short run. This prediction is particularly relevant to understanding corporate environmental strategies, which typically involve expending considerable upfront invest-

[1]The 2015 Paris Agreement is a landmark of the multilateral climate change process, which aligns all nations to limit global warming to preferably 1.5 degrees Celsius above the pre-industrial level. According to the Intergovernmental Panel on Climate Change (IPCC) (2020), limiting warming to 1.5 degrees requires reaching net zero carbon dioxide emissions globally around 2050.

[2]See, for example, Attig et al. (2016), Nippa et al. (2021), and Porter and Van de Linde (1995) for evidence of MNCs complying with higher environmental standards in the host countries. On the other hand, studies such as Berry et al. (2021), Li and Zhou (2017) and Strike et al. (2006) document contradicting findings that MNCs exploit the regulatory arbitrage and shift emissions-intensive activities to countries with weak environmental regulations. Interestingly, Bu and Wagner (2016) show evidence of the co-existence of the two strategic choices depending on firm contingencies. They emphasize that corporate environmental strategy "can interact with other firm characteristics, and not accounting for this interaction can result in omitted variable bias, which may result in distorted assessments or even methodological artifacts that negatively affect policy design or firm strategizing."

ments on pollution control measures and/or green technology upgrading. But the outcomes of these investments take time to unfold (Kolk and Pinkse, 2008; Rugman and Verbeke, 1998), and the economic gains largely depend on the firm's home country's environmental regulation stringency. Moreover, the increased cost of financing due to financial constraints diminishes the net present value of long-term benefits accrued to emission abatement investments, making such investments less attractive than other projects that can boost short-term financial performance and relax financial limitations. Given that only a few countries implement net zero carbon emissions laws,[3] we hypothesize that more financially constrained firms are less incentivized to invest in abatement measures and tend to produce more carbon emissions.

We also consider the cross-country heterogeneity in environmental institutions and hypothesize that a country's environmental regulation and support policies can moderate the deterrent effect of financial constraints on corporate decarbonization in different ways. Stringent environmental laws and regulations tend to impose an immediate penalty on a firm's expected environmental pollution, forcing firms to internalize negative externalities. Complementary to laws and regulations, government subsidies promote firms' voluntary eco-friendly investments and compensate them for losses or capital expenditures incurred from green investments. We anticipate this type of government policy to be less effective in lessening the negative effect of financial constraints on corporate decarbonization. Financially constrained firms facing high costs of capital are more incentivized to prioritize near-term financial profits over climate-friendly projects generating significant social benefits at the expense of firm performance. These arguments suggest that the adverse effect of financial constraints can be mitigated in countries with strict environmental laws but not necessarily in countries with generous support policies for green investments.

Our last set of hypotheses puts the explicit comparison between MNCs and purely domestic firms at the center of our conceptual discussion. On the one hand, MNCs need to overcome the liability of foreignness by complying with higher environmental standards in host countries (Kolk and Pinkse, 2008; Nippa et al., 2021; Porter and Van de Linde, 1995). On the other hand, geographically diversified operations allow MNCs to shift polluting activities to countries with weaker

[3]By far, only 16 countries enacted net zero carbon emissions laws around the world (https://eciu.net/netzerotracker). The current scarcity of carbon neutrality legislation suggests that climate regulatory risk can still be framed as a distant concern in many countries.

environmental regulations (Berry et al., 2021; Bu and Wagner, 2016; Strike et al., 2006). We attempt to reconcile this theoretical tension about MNCs' environmental behavior by proposing that their trade-off between the two options hinges on their ability to access financial resources. Consistent with our prior hypothesis, the increased cost of capital due to financial constraints discourages costly pollution control investments. As a result, MNCs with limited access to financial markets have to forgo the benefits of building their competitive advantage by establishing universally strong environmental performance. Instead, they may bypass their home countries' environmental liabilities by outsourcing their pollution to foreign affiliates in host countries with weak environmental regulations. Empirically exploring this issue helps address the highly debated role of MNCs in combating climate change globally.

To test these hypotheses, we analyze a large panel dataset covering firms in 51 countries from 2005 to 2018, supplemented by three distinct quasi-experiments in a difference-in-differences (DiD) estimation framework. Such robustness analysis allows us to identify the causal effect of financial constraints on firms' emissions mitigation. The baseline results suggest that financial constraints significantly increase corporate direct carbon emissions even after controlling for firm-specific characteristics. They are also robust to various identification tests that exploit exogenous shocks to firm-level financial constraints arising from sovereign credit rating downgrades, increased cost of debt during the 2008 financial crisis, and oil price jumps. Overall, these findings confirm the causal effect of financial constraints on corporate carbon decarbonization.

Further analysis suggests that examining corporate decarbonization under financial constraints in an international setting is particularly valuable because of the differing stringency and types of country environmental policies and their interactive relationship with financial constraints. Specifically, we find that the financial constraint effect on carbon emissions is less pronounced in countries that enforce strict environmental laws while unaffected by countries' support policies that promote green investments. The effect is also weaker in countries that commit to climate change mitigation after the Paris Agreement than those that do not. In contrast, the financial constraint impact intensifies for polluting companies relative to non-polluting companies after the US withdrawal from the Paris Agreement.

Finally, our results suggest MNCs' strikingly distinct environmental behavior in response to stringent environmental regulations. Compared with purely domestic companies, financially constrained MNCs do not increase environmental expenditure or green innovation. Instead, these MNCs avoid strict environmental policies by moving their polluting activities to foreign subsidiaries in countries with lower environmental standards. As a consequence, the increased emissions attributable to limited financial resources decrease a firm's ability to raise capital from international equity and bond markets.

Our study contributes to the growing research on the determinants of corporate climate policies. We advance the global strategy literature and conduct a cross-country analysis of corporate climate strategies under imperfect capital markets and financial resource constraints in conjunction with diverse and complex institutional environments. Parallel to our research, two related US studies also examine the effects of financial constraints but using micro-level corporate environmental impact data. Xu and Kim (2022) show that plant-level toxic releases of hazardous pollutants and chemicals increase with the financial constraints of the parent firm. However, different from carbon emissions, toxic releases pose an immediate threat to the environment and public health and are heavily regulated in the U.S. Bartram et al. (2022) study the internal reallocation of greenhouse gas emissions under tight financial constraints for a small number of 511 US public firms from 2010 to 2015. Their study, however, excludes the post-2015 period, when the introduction of the Paris Agreement considerably increased the climate regulatory risk of polluting corporations globally and shifted the balance of decarbonization's financing costs versus regulatory benefits towards a firm's positive climate externality in recent years.

Our research explores the effects of financial constraints on a broad sample of companies over an extended period at the international level. The global setting is crucial because we analyze aggregate carbon emissions at the firm level and consider the differing environmental policy responses across geography. We find that the total amount of carbon emissions and carbon intensity increase with financial constraints on a large sample of international firms in 51 countries. Instead of debating whether businesses are innately eco-friendly, our evidence points to the non-negligible role of financial resources in constraining corporate commitment to a low-carbon transition. More importantly, the adverse effects of a firm's limited financial resources depend on the stringency and types of environmental policies. These findings yield important global policy implications in line with IPCC's (2020) call for providing improved access to climate finance for countries with national budget constraints.

Our work also connects to the research on comparative institutionalism. As emphasized in Aguilera and Grøgaard (2019) and Jackson and Deeg (2008), the institutional environment is complex and multi-dimensional. A large stream of literature stresses how the varieties of institutional environments, including corporate governance (Albuquerque et al., 2019; Cumming et al., 2017), creditor protection (Acharya et al., 2011; El Ghoul et al., 2021), labor regulations (Levine et al., 2020) and government crisis responses (Guedhami et al., 2022), shape corporate policies and outcomes. We focus on one important feature of cross-country differences in institutional arrangements – comparative environmental regulations. Extending existing studies that investigate the real impact of climate regulations on corporate policies (e.g., Brown et al., 2022; Li et al., 2022), we emphasize that both the stringency and types of environmental regulations matter for corporate behavior. Integrating environmental regulations with government subsidizing policies is grounded in Gande et al.'s (2020) theory that highlights the necessity of employing government subsidies in promoting the positive externalities of private firms and also consistent with the wide adoption of the "carrot-and-stick" approach by national governments in facilitating corporate low-carbon transitioning (Adrian et al., 2022). Our work also relates to emerging literature examining corporate environmental footprints beyond national boundaries. Existing evidence suggests that heterogeneous environmental regulations across countries create opportunities for international companies to either transfer their pollution activities overseas (Berry et al., 2021; Li and Zhou, 2017) or build a ubiquitous competitive advantage by complying with stringent environmental standards (Nippa et al., 2021), or both (Bu and Wagner (2016)). Our study offers a possible reconciliation for the mixed evidence by incorporating a firm's financing constraints into the theoretical debate.

Finally, we contribute to the burgeoning research on international corporate diversification (Guedhami et al., 2022; Mansi and Reeb, 2002; Mihov and Naranjo, 2019). While the conventional internalization theory centers on the shareholder wealth effect (Gande et al., 2009), our findings suggest that the internalization theory should further consider the social welfare of nonfinancial stakeholders in the rapidly changing stakeholder environment (Maksimov et al., 2019). We document a dark side of international corporate diversification: multinational firms tend to impose negative environmental externalities on stakeholders of countries with less stringent environmental regulations when financial constraints bind. We further find that increased emissions of MNCs induced by financial constraints make it even harder for them to access finance in international equity and bond markets, alluding to the potential shareholder value destruction of internalization when MNCs fail to embrace the welfare of stakeholders outside their home countries.

2. Related Literature and Hypothesis Development

2.1. Corporate Decarbonization and Financial Constraints

How financing frictions influence firms' investment decisions has been a long-standing question of interest in financial economics. Financing frictions arising from asymmetric information, transaction costs, or agency problems may limit a firm's ability to pledge future expected profits to secure financing from capital markets, thereby financially constraining the firm from funding desired investment opportunities (Stein, 2003). Existing economic theories (Aghion et al., 2010; Eisfeldt and Rampini, 2007) emphasize the distortionary effect of financing constraints on the composition of corporate investment: firms facing financial constraints tend to favor projects that generate more cash or save costs in the short term but reduce long-term profitable projects. This type of trade-off is particularly relevant to corporate climate-related policies that incur upfront costs for abatement measures and green technologies, but the benefits of such investments are shared among the public and materialize over a long investment horizon (Starks et al., 2020; Wang and Bansal, 2012). In support, prior studies show that financially constrained US companies significantly increase toxic releases of hazardous pollutants and chemicals in industrial plants (Xu and Kim, 2022) and relocate polluting plants to US counties with low environmental standards (Bartram et al., 2022).

In an international context, we anticipate financial constraints to continue affecting corporate carbon performance because many countries, especially developing economies, still follow lax emissions standards for economic or political reasons. By far, only 16 countries made their net zero carbon emissions into law, but even these countries plan to meet the target in the distant future by 2045 or later.[4] It is apparent that corporate emissions abatement investments can be long-term.

[4]The 16 countries are Canada, Chile, Denmark, Fiji, France, Germany, Hungary, Ireland, Japan, Luxembourg,

With decreased access to external finance, firms are incentivized to reallocate limited financial resources from the abatement activity that may accrue benefits in the future to other economic activities that enhance short-term financial performance. Admittedly, cutting emissions abatement measures exposes a firm to greater environmental liabilities in regions or countries with strict environmental regulations. But, firms, especially MNCs, can reallocate emissions internally among subsidiaries to evade the vulnerability to local environmental regulations (Eskeland and Harrison, 2003; Li and Zhou, 2017).[5] Collectively, our arguments suggest the following main hypothesis:

Hypothesis 1: More financially constrained firms are likely to produce more carbon emissions.

2.2. Environmental Regulation and Policy

The next set of hypotheses exploits our cross-country settings and focuses on how imperfect capital markets interact with a country's regulatory framework to influence corporate decarbonization. This hypothesis is rooted in North's (1990) political economy of institutions and economic behavior. An important role of the government is to implement policies and enforce regulations that align private economic behavior to optimal social welfare. Devoid of laws, firms could pursue profit-maximizing investments under financial constraints and cause environmental damages borne by the public community. Recognizing that the natural environment is a public good, governments must actively adopt policies to facilitate a corporate transition to a low-carbon economy. Given the complexity and multidimensionality of institutional arrangements (Adrian et al., 2022; Gande et al., 2020; Jackson and Deeg, 2008), we stress the importance of policy types and classify the climate policies into two general categories: (1) laws and regulations that impose legal liabilities on private firms' negative environmental externalities,[6] and (2) support policies that subsidize spending incurred from promoting energy efficiency and developing renewable energy technologies. Examples of the first type of environmental policies include carbon taxes and cap-and-trade schemes.

Portugal, Russia, South Korea, Spain, Sweden, and the United Kingdom. Except for Fiji and Hungary, the rest of the countries is included in our sample. See further details on the following website: https://eciu.net/netzerotracker.

[5]This argument is grounded in an extensive literature that examines the contribution of internal capital markets and resource allocations to firm value. Assuming that a firm's headquarters has the authority to make funding decisions centrally, the headquarters exercises discretion to move budgets across firm units to maximize firm value when financial constraints bind at the overall firm level (Gertner et al., 1994). As a result, internal resource allocation is more valuable to firms with tighter financial constraints (Bartram et al., 2022; Giroud and Mueller, 2019).

[6]According to Bledsoe and Hamilton (2010), environmental liabilities include legal obligations to perform a cleanup, or obligations to refrain from polluting in the future required by the regulators or sanctioned by the court.

These legal regulations are mandatory and effective as they induce immediate regulatory costs on emissions and force firms to internalize their externalities. However, since it is impossible to determine a global carbon tax perfectly aligned with the social cost of carbon in reality (Adrian et al., 2022), support policies are also implemented across countries to compensate for losses incurred by the private sector for phasing out carbon-intensive activities and account for capital expenditures needed to replace these traditional activities voluntarily.[7] As an illustration, the German government adopted the Act on the Phase-out of Coalfired Power Plants and the Structural Reinforcement Act for Mining Regions in July 2020. The Act implemented support policies to compensate coal companies for missed revenues if they volunteer to retire coal-fired power plants from 2020 to 2027.[8]

We anticipate the distinct effects of these two institutional mechanisms on corporate carbon emissions reduction under financial constraints. The first type of climate policy is aligned with the institutional theory that legal institutions shape a firm's organizational practices. Firms' incentives to curtail environmental pollution are largely derived from the perception that abatement costs are incurred in the present but the regulatory and associated reputational costs of pollution imposed by the first set of regulatory measures are mostly incurred at a future date, implying lower expected environmental liabilities when firms apply higher discount rates (Ramadorai and Zeni, 2021; Xu and Kim, 2022). However, strict environmental laws and regulations demand an immediate legal obligation, inflating the present value of expected environmental liabilities. As such, it is no longer optimal for constrained firms to neglect environmental liabilities but to decrease emissions. This discussion leads to the following hypothesis:

Hypothesis 2: The stringency of environmental regulations is effective in mitigating the adverse effect of financial constraints on corporate decarbonization.

Admittedly, the information asymmetries between private firms and the government often preclude complete contracting and invasive regulation (Coase, 1960). Taking the strength of legal institutions as given, Gande et al. (2020) theorize that other supplementing institutions, such as subsidies, may emerge to augment the private profit of corporate investment that generates signif-

[7] Adrian et al. (2022) estimate that the climate financing needs for such compensation are 29.03 trillion dollars, relatively small compared with social benefits estimated to be 106.9 trillion dollars.

[8] Further details about this Act can be found in Adrian et al. (2022) and the German government's press release: https://www.bmwk.de/Redaktion/EN/Pressemitteilungen/2020/20200703-final-decision-to-launch-the-coal-phase-out.html.

icant nonmonetized social benefits. These interacting institutions complement the legal system to encourage *a priori* positive externalities created by private companies. Conceivably, receiving this government support presupposes the private firm's eco-friendly investment in the first place and is voluntary. Therefore, the efficacy of support policies depends on firm-level heterogeneity. Without financial constraints, private firms undertake green investments and build competitive advantage for sustainable long-term growth by leveraging government support. But, with tight financial constraints, firms have to balance short-term financial performance against long-term business benefits broadly shared with nonfinancial stakeholders and society. Following this logic, support policies may not be effective in fostering corporate decarbonization if financial constraints restrict the firm's ability and willingness to finance green projects. These considerations lead to the third hypothesis as follows:

Hypothesis 3: Government support policies are ineffective in moderating the adverse effect of financial constraints on corporate decarbonization.

2.3. Financially Constrained Multinational Corporations

Thus far, we have focused on how financial constraints resulting from imperfect capital markets might affect corporate decarbonization and influence the efficacy of varying climate policies to combat climate change in their respective countries. We next develop theoretical predictions to draw implications for financial constraint effects on corporate carbon footprints across national boundaries through the lens of MNCs.

Positioning in Rugman and Verbeke's (1998) conceptual framework, research in global strategy generally holds two opposing views about the relative environmental performance of MNCs, compared to purely domestic firms (Bu and Wagner, 2016). The pollution haven view draws on the institutional theory and suggests that MNCs exploit cross-country differences in environmental regulations and shift polluting activities to countries with weaker environmental regulations (Berry et al., 2021; Li and Zhou, 2017; Strike et al., 2006). Since combating climate change requires global resolve, MNCs are deemed primary sources of carbon emissions that actively resist energy transition due to their geographic diversity and profit maximization goals (Mabey and McNally, 1999). The opposing view adopts a resource-based perspective and suggests that MNCs have incentives and operational means to develop core competencies on climate change and outperform other less environmentally sensitive firms in global markets (Nippa et al., 2021). However, due to the real-world complexity, empirical evidence has been mixed for these contradictory arguments as MNCs optimize the two strategic choices based on their firm-specific capabilities (Kolk and Pinkse, 2008).

Our study focuses on the limitation of accessing external capital markets and analyzes how tight financial constraints shape their relative environmental performance. On the one hand, the finance literature (e.g., Desai et al., 2008) finds that MNCs can better overcome financial constraints and reallocate resources across overseas subsidiaries via internal capital markets when access to external financing is limited. In addition, the strategic management literature shows that firms tend to increase their investment in stakeholder relations during a financial crisis (Flammer and Ioannou, 2021). The rationale is that such relations are an important aspect of corporate strategy that helps them sustain long-term competitiveness and recover from unfavorable situations (Choi and Wang, 2009; DesJardine et al., 2019). MNCs may leverage their internal capital markets to circumvent financial constraints and develop climate-induced advantages to compete in global markets. MNCs may be more motivated to maintain strong environmental performance because they not only face higher pressures from external stakeholders but also need to reduce the liability of foreignness (Bell et al., 2012) by investing in corporate citizenship in host countries (Attig et al., 2016). Stated formally, we hypothesize the following:

Hypothesis 4a: Financially constrained MNCs reduce carbon emissions to sustain long-term global competitiveness.

On the other hand, profit-maximizing firms must consider financial performance when they commit resources to improve their environmental performance. As discussed in Section 2.1, the increased cost of raising external capital under tight financial constraints makes it unattractive for MNCs to move beyond compliance with local environmental standards. The reluctance to invest in emissions reduction globally is further exacerbated by the irreversibility of such measures, which are closely linked to firm-specific operations and geographical factors and hard to transfer across borders for scope economies (Kolk and Pinkse, 2008; Rugman and Verbeke, 1998). Such irreversibility, in turn, increases the value of MNCs' real options to delay the abatement investment and relocate polluting activities to countries with lower environmental standards until the financing uncertainty resolves (Dixit and Pindyck, 1994). Following this discussion, we state the last hypothesis as follows:

Hypothesis 4b: Financially constrained MNCs increase carbon emissions by exploiting cross-country differences in environmental standards for short-term financial performance.

3. Data and Descriptive Statistics

3.1. Sample Construction

Our paper employs data from several different sources: (i) carbon emissions and green revenue data from S&P Global's Trucost; (ii) firm financial information from Worldscope; (iii) country-level macroeconomic data and Worldwide Governance Indicators from the World Bank's WDI database; (iv) sovereign and corporate credit rating data from Capital IQ S&P Credit Ratings; (v) country-level environmental regulatory indices (SER and EER) from World Economic Forum (WEF); (vi) country-level energy research, development and demonstration (RD&D) budgets from the International Energy Agency (IEA); (vii) firm subsidiary data from the Bureau van Dijk (BvD) ORBIS database; (viii) information on foreign institutional ownership from the Factset Ownership database; and (iv) information on international bond issues from the Security Data Company (SDC) Platinum database. Starting from the initial sample from the TruCost universe, we first exclude countries with fewer than 15 firms and 100 observations. We also exclude firms in the financial service industries and utility industries.[9] Our final sample comprises 41,286 firm-year observations (i.e., 9,313 unique firms) from 51 countries from 2005 to 2018. Table **1** presents cross-country data by showing the number of firm-year observations, average direct carbon emissions, and environment-related institutional variables in each country.

3.2. Measuring Carbon Emissions

Our primary firm-level carbon emissions data are obtained from the S&P Trucost database. Trucost covers corporate carbon and other greenhouse gas emissions data of over 14,000 firms internationally, representing approximately 99% of global market capitalization. Trucost collects

[9]Given that utility industry firms are important polluters, our results are consistent when we include firms in the utility industries.

data from multiple publicly disclosed sources, including company financial reports, environmental data sources (e.g., the Carbon Disclosure Project), and data published on company websites or other public sources. In the absence of disclosures, Trucost utilizes the environmentally extended input-output (EEIO) model to estimate environmental impacts for a company's own operations and across its entire global supply chain.[10]

Trucost follows the Greenhouse Gas Protocol that sets the world's most widely used accounting standards for greenhouse gas emissions. The Greenhouse Gas Protocol distinguishes between two different sources of emissions. They are (1) direct emissions from burning fossil fuels and production processes that are owned or controlled by the company (also known as Scope 1 emissions) and (2) indirect emissions from the consumption of purchased electricity, heat, and steam by the company (i.e., Scope 2 emissions) as well as from upstream and downstream channels of the company's value chain (i.e., Scope 3 emissions). Following prior studies (Bartram et al., 2022; Nippa et al., 2021), we use direct carbon emissions as the main measure for corporate carbon performance. Specifically, a firm's direct emissions measure in a given year, *Emissions*, is defined as the natural log of direct emissions in tonnes of CO_2 equivalent. Our primary dependent variable is intended not to be scaled to align with the ultimate goal set in the Paris Agreement for industries, investors, and governments to reduce overall emissions to fight climate change. We further account for the possibility that a firm's economic growth rather than its climate policy drives changes in emissions by using an alternative carbon intensity measure, defined as the natural log of total direct carbon emissions divided by revenue (*Emissions*†). For robustness, we also use the total emissions (i.e., Scope 1 + Scope 2+ Scope 3 emissions) to measure corporate carbon performance and find consistent results, as shown in Appendix Table A. However, we exclude Scope 2 and Scope 3 emissions from our primary analysis, because Scope 2 emissions are fairly persistent over time (Dai et al., 2021) and Scope 3 emissions are mainly estimates from Trucost's proprietary input-output model (Bolton and Kacperczyk, 2021).

[10] https://www.spglobal.com/spdji/en/documents/additional-material/faq-trucost.pdf.

3.3. Measuring Financial Constraints

Following previous literature (Bartram et al., 2022; Chen and Wang, 2012), we construct several measures of financial constraints based on financial accounting information in a given firm and year: the Kaplan-Zingales (KZ) index (Kaplan and Zingales, 1997), the Whited and Wu (WW) index (Whited and Wu, 2006), firm size (Almeida et al., 2004), and payout (Almeida et al., 2004). For parsimonious modeling, we aggregate the four distinct financial constraint measures into one factor, FC, by computing the first component of the four proxies through the principal component analysis (PCA) and use it as the primary measure of financial constraints in our subsequent analyses.[11]

3.4. Moderating Variables and Control Variables

We consider two important forms of institutional conditions on the environmental front, as discussed in Section 2. For the legal effectiveness of environment-related regulations, we use the de jure law and de facto enforcement based on the country-level stringency of environmental regulations index (SER) and the enforcement of environmental regulations index (EER), which are retrieved from the World Economic Forum. As for the government support policies for green investment that is necessary to transition away from fossil fuels to alternative low-carbon renewable alternatives, we obtain the historical data on the government funding of energy technology research, development, and demonstration across countries from the IEA. Specifically, our proxy for the government's support for energy transition technology, $Subsidy$, is measured by summing up the public funding of technologies in the following three areas: (1) energy efficiency; (2) renewable energy sources; and (3) hydrogen and fuel cells, scaled by a country's GDP.

Turning to the control variables, we employ the following firm-level characteristic variables as controls in our main analyses following Bolton and Kacperczyk (2021) and Ilhan et al. (2021). *Size* is the natural logarithm of total assets in USD. *BM* is the book value of equity to the market value of equity. *Leverage* is the sum of short-term and long-term debt scaled by total assets. *PPE* is defined

[11] The the Kaplan-Zingales (KZ) index is constructed as -1.002×Cash flow+0.283×Tobin's Q+3.139×Total debt−39.368×Dividends−1.315×Cash. The Whited and Wu (WW) index is defined as -0.091×Cash flow−0.062×Positive dividend dummy+0.021×Long-term debt−0.044×Size+0.102×Industry sales growth−0.035×Sales growth. Finally, firm size is defined as the log of total assets. Payout is defined as a firm's dividends scaled by total assets.

as the property, plant, and equipment scaled by total assets. *R&D* is research and development expenses scaled by total assets. *CAPEX* is capital expenditure scaled by total assets. *Sales Growth* denotes the change in annual sales. *Dividend* is defined as dividends scaled by total assets. *HHI* is the sum of each firm's sales-based squared market share within the same 3-digit SIC industry. We also control for country-level characteristics in certain regression models. To proxy for a country's economic strength, we include GDP per capita (*GDP per capita*), annual GDP growth rate (*GDP Growth*), and inflation ($Inflation$).[12] We winsorize all continuous variables at the 1% and 99% levels.

Table **2** reports the summary statistics and correlations matrix of our key variables. For ease of interpretation, we report carbon emissions related variables, *Emissions* and *Emissions*† after taking the log transformation. The average value of *Emissions* is 10.740 (equivalent to 1.339 million tonnes of carbon dioxide). The level of carbon emissions varies across industries and locations, with its sample standard deviation of 2.527 (equivalent to 7.909 million tonnes of carbon dioxide). We also observe a strong, positive correlation of the financial constraint variable, FC, with *Emissions* and *Emissions*†, which provides preliminary support for our first hypothesis.

4. Empirical Analyses

4.1. Baseline Results

We test our hypotheses by estimating the following regression specification at the firm level:

$$Carbon\ Emissions_{i,t} = \beta_0 + \beta_1 FC_{i,t-1} + \gamma FVEC_{i,t-1} + \lambda CVEC_{c,t-1} + \theta_t + \theta_j + \theta_c + \epsilon_{i,t}, \quad (1)$$

where i indexes firms, t indexes years, c indexes countries, and j indexes industries. *Carbon Emissions* represents firm i's direct carbon emissions (*Emissions*) and intensity (*Emissions*†) in year t. FC denotes a firm's financial constraints. $FVEC$ is a vector of firm-level control variables while $CVEC$ is a vector of country-level controls as defined in Section 3. θ_t, θ_j, and θ_c indicate year, industry, and country fixed effects, respectively. These fixed effects effectively capture general time

[12] $Inflation$ is measured based on the consumer price index and captures the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services.

trends or time-invariant industry and country characteristics such as country-level environmental regulations and enforcement. $\epsilon_{i,t}$ is an error term.

Table **3** presents OLS estimation results of Eq. (1). Column (1) reports the results of *Emissions* on FC while controlling for firm-level characteristics as well as year, industry and country fixed effects. The coefficient of FC is 0.092 (t-value = 5.77), suggesting a significantly positive effect of financial constraints on corporate emissions. From an economic perspective, a one-standard-deviation increase in FC leads to a 10.26% increase in direct emissions.[13] For robustness, we further include specific country-level controls (i.e., *GDP per capita*, *GDP Growth*, and $Inflation$) in Column (2), but these controls do not overturn our previous findings. To ensure that the corporate emissions measure is not a simple manifestation of firm size or business growth, the last two columns of Table **3** repeat the analysis with $Emissions\dagger$. Notably, FC remains positively and significantly correlated with $Emissions\dagger$ without or with country-specific control variables in Columns (3)-(4).[14] Economically, a one-standard-deviation increase in FC is associated with a 4.01% increase in carbon emissions intensity.[15] In Appendix Table B, we further find that country-level carbon emissions also increase with the average firm-level financial constraint measure, underscoring the limited financial resources as a key impediment to reaching the net-zero emissions goal for firms and countries.

Thus, the baseline findings support our first hypothesis that emphasizes the impact of financial constraints on corporate decarbonization, suggesting that financially constrained firms may not have the necessary resources to invest in abatement measures. As our findings are qualitatively the same with or without country-specific control variables, we only report results with firm-specific controls and industry-, country-, and year-fixed effects in subsequent analyses.

[13] The percentage increase in carbon emissions given a one-standard-deviation increase in FC is computed as $e^{0.092\times1.062}$-1.

[14] Given that US firms account for 18% of our international sample as shown in Table **1**, we also checked our baseline firm-level results by partitioning the sample into US and non-US subsamples. Consistent with Hypothesis 1, the positive and significant relationship between financial constraints and corporate carbon emissions remains unchanged in both subsamples.

[15] The percentage increase in carbon emissions intensity given a one-standard-deviation increase in FC is computed as $e^{0.037\times1.062}$-1.

4.2. Identification Tests

The endogenous relationship between corporate environmental policy and its financing decision poses an empirical challenge to testing our main hypothesis. For example, Cheng et al. (2014) document that socially irresponsible companies have decreased access to capital markets and face tighter financial constraints, implying a reverse causality from corporate emissions abatement strategy to financial restrictions. To address this endogeneity concern, we conduct three specific identification tests by estimating the following DiD regression model:

$$Emissions_{i,t} = \alpha + \beta_1 Treat_i \times Post_t + \beta_2 Treat_i + \gamma FVEC_{i,t-1} + \theta_t + \theta_j + \theta_c + \epsilon_{i,t}, \tag{2}$$

where $Treat$ indicates the treatment firms defined by the respective exogenous events, while $Post$ is a time dummy that captures the post-event period. The interpretation of our DiD model relies on the coefficient estimate of the interaction between $Treat$ and $Post$, which captures the change in carbon emissions in the affected firms following the exogenous event. Note that the standalone $Post$ variable is absorbed in this setup due to the control of year fixed effects, θ_t.

The first identification strategy exploits sovereign credit rating downgrades as an exogenous shock to certain firms' access to external finance. The rationale of this test follows a sovereign ceiling policy commonly implemented by global rating agencies (Almeida et al., 2017; Wang and Xie, 2022). The policy requires that a firm's credit rating be below the sovereign rating of its country of domicile. To the extent that changes in corporate ratings imposed by sovereign rating downgrades are unrelated to firm fundamentals, the tighter financial constraints stemming from corporate rating downgrades can be deemed exogenous at the time of sovereign rating downgrades. As Almeida et al. (2017) note, the sovereign rating downgrades engender an asymmetric change in corporate credit ratings. Firms with credit ratings at or above their corresponding sovereign ratings before the downgrade are bounded by a sovereign ceiling and more likely to be downgraded after a sovereign rating downgrade than those rated below their sovereign rating. This asymmetric effect allows us to construct the treatment and control sample in the DiD framework. Specifically, $Treat_{Downgrade}$ is a dummy variable that equals one if a firm has a credit rating equal to or above the sovereign rating in year t, where a firm's credit rating refers to its S&P foreign currency long-term ratings in Capital IQ rating database (Kaminsky and Schmukler, 2002) (the treatment group). $Treat_{Downgrade}$ is equal to zero for control firms paired with treatment firms in the same country based on the one-to-one propensity score matching procedure based on observable firm-level characteristics (Almeida et al., 2017). $Post$ is a time indicator that takes the value of one if a country's credit rating is downgraded in year t and zero otherwise. Our analysis focuses on firms with non-investment grade ratings as these firms are more prone to financing difficulties due to rating downgrades (Thomas et al., 2022).

The DiD regression results are reported in Table **4**. Column (1) shows a positive coefficient on the interaction between $Treat_{Downgrade}$ and $Post$ in the $Emissions$ regression. The evidence suggests that firms bounded by the sovereign ceiling significantly produce more carbon emissions than similar firms following a sovereign credit rating downgrade. Moreover, to the extent that bounded firms face tighter financial constraints following the sovereign rating downgrade, this evidence is consistent with the causal effect of financial resources on carbon emissions.

Inspired by Cohn and Wardlaw (2016) and Flammer and Ioannou (2021), the second identification strategy leverages exogenous variations in the cost of debt induced by the 2008 financial crisis. The idea is that a firm with a large portion of debt maturing during the crisis effectively faced a negative cash flow shock and was restrained from accessing finance during a volatile market episode when market liquidity is scarce. Yet, the firm's maturity structure prior to the crisis is plausibly exogenous to its environmental strategy because it was unlikely that firms anticipated the crisis when making debt financing decisions in the preceding years. To exploit this exogenous shock to firm-level financial constraints, we adopt a new DiD framework to focus on firms with more imminent debt obligations during the crisis. Specifically, we restrict the sample period from 2006 to 2008 and introduce a treatment dummy variable, $Treat_{Debt}$, which equals one for treatment firms whose amount of debt maturing in one year is at or above the sample median between September 2007 and January 2008 and equals zero for the remaining control firms. $Post$ indicates the sample period in 2008. Column (2) presents this identification test result. Firms with more debt due during the financial crisis generated more carbon emissions than those without the looming debt financing pressure, supporting the first hypothesis.

The last identification test follows Lamont (1997) by utilizing the Oil&Gas industry (i.e., firms with a two-digit SIC code of 13) as the treatment group in the DiD framework. The companies in this sector are most susceptible to the criticism of climate change. Their cash flows are highly sensitive to oil price fluctuations, primarily determined by macroeconomic conditions but independent of firm fundamentals. We form a control group using the same propensity score matching procedure described above. $Treat_{Oil\&Gas}$ equals one if the firm is in the Oil&Gas industry and zero otherwise. *Post* is set to one if the average oil price in a given year is greater than the 75th percentile of the historical oil price distribution during our sample period, where the oil price information is obtained from the U.S. Energy Information Administration and zero otherwise. In this test, we expect large oil price jumps to deliver a positive cash flow shock to treated firms and lessen their financial constraints. Results in Column (3) show that carbon emissions drop in the Oil&Gas companies following oil price increases, compared to similar companies operating in other industries.

While each of the three identification strategies is open to alternative interpretations, the evidence taken together is difficult to reconcile with any specific alternative. Hence, the findings indicate a causal effect of financial constraints on corporate decarbonization.

4.3. The Moderating Effects of Environmental Regulations and Policies

Our second and third hypotheses draw on the institutional theory and pertain to the role of legal institutions and government policies in influencing corporate climate policies. To test these hypotheses, we expand Eq. (1) by including different measures of country-specific environmental regulations and support policies and their respective interaction term with the financial constraint variable, FC. Table **5** summarizes the results.

To start with, we separate the overall environmental regulations into the de jure law and de facto enforcement using the country-level environmental regulatory stringency index (SER) and environmental regulatory enforcement index (EER). Columns (1) and (2) of Table **5** reveal that the coefficient on $SER \times FC$ is -0.090 and the coefficient on $EER \times FC$ is -0.090, significant at the 1% level. Meanwhile, the coefficient of FC remains significantly positive. The evidence lends support to Hypothesis 2 which predicts that the stringency of environmental regulations and their enforcement mitigate the negative effect of financial constraints on corporate decarbonization.

We then turn to the role of government support policies that aim to encourage companies to engage in green investment projects which could yield low private benefits but high social welfare. The public funding of green technology developments in a given country ($Subsidy$) reflects one such government support policy. Contrary to the mitigating environmental regulatory effect, Column (3) shows a statistically insignificant coefficient on $Subsidy \times FC$, consistent with Hypothesis 3 that government support policies are ineffective on financially constrained firms' corporate decarbonization. Constrained firms are less likely to commit to long-term eco-friendly projects and, thus, may not be the beneficiary of government support policies. The overall results suggest the varying efficacy of diverse environmental institutions contingent on firm heterogeneity and underscore the importance of stringent environmental regulations in aligning social interests with private benefits for companies with limited access to financial markets.

While our proxies for environmental institutions are time-varying, these variables tend to be relatively stable over time. As a result, the observed moderating effects of environmental regulations might reflect other unobservable institutional or economic factors. To alleviate this concern, we exploit the introduction of the 2015 Paris Agreement as a positive exogenous shock to the perceived stringency of environmental regulations on our international sample in a DiD setup. The Agreement is a defining moment for the global collaboration on climate change, which calls for national governments to join the global force in addressing climate change issues of our time. Recent studies (Ramadorai and Zeni, 2021; Seltzer et al., 2022) find supporting evidence that companies face much greater regulatory costs following the Agreement. We implement the test by restricting our sample period to three years before and after the Agreement from 2012 to 2018. To account for the disparate cross-country responses to the Paris Agreement, we use the difference between the net change in a country's total carbon emissions from 2012 to 2015 and that from 2015 to 2018 (ΔCO_2_Paris) as a result of the Agreement-induced change in the stringency of environmental regulations.[16] The dummy variable, $Post$, takes the value of one if observations are after 2015 (i.e., the Agreement's introduction year) and zero otherwise. In Column (1) of Table **6**, we observe a positive and significant coefficient on $Post \times \Delta CO_2\_Paris \times FC$, suggesting that the FC effect

[16] We do not use the changes in SER and EER as these measures are comparatively sticky. In contrast, changes in total carbon emissions directly result from the Agreement-induced change in the stringency of environmental regulations.

weakens in countries that reduced emissions post the Paris Agreement.

We also explore a nested case on the US sample by exploiting the country's withdrawal from the Paris Agreement following 2017 President Trump's election. We introduce *Post*, a post-withdrawal dummy variable which takes the value of one if firm observations are from 2017 onward and zero otherwise. To identify cross-sectional variation within the US, we differentiate companies based on their pollution intensity. Specifically, the dummy variable, $Polluter$, is introduced to indicate whether a firm is in a pollution-intensive industry, defined as industries with a two-digit SIC code in the range of 10-14. This test restricts the sample period from 2015 onward to avoid the potential confounding effect of the environmental regulatory shift due to the 2015 Paris Agreement. Column (2) of the table suggests that constrained companies in pollution-intensive industries significantly increase carbon emissions compared to other firms in more environmentally friendly industries when expected legal liabilities drop following the country's exit from the Agreement under the Trump administration. Combined, the international and single-country evidence related to the Paris Agreement helps to establish the causal effect of environmental regulations on mitigating the adverse impact of financial constraints on corporate decarbonization.

4.4. Financially-Constrained Multinationals and Emissions Abatement

In this section, we test the fourth set of hypotheses on MNCs' climate strategy by augmenting the baseline regression Eq. (1) with an interaction term $MNC \times FC$, where MNC is equal to one for MNCs and zero otherwise. In the international context, we identify MNCs using two definitions. The first definition follows Jang (2017), where a firm is a multinational company if it reports non-zero foreign income in the previous three years. Column (1) of Table **7** shows that when *Emissions* is regressed on MNC alone, the coefficient of MNC is positive and statistically significant. Since the OLS regression model already controls for firm size and other firm characteristics, this evidence indicates more intensive emissions from MNCs than from domestic companies. It resonates with the global concern about MNCs as the major contributor to carbon emissions worldwide (Mabey and McNally, 1999).

Turning to financially constrained MNCs, we find a positive and significant coefficient on the interaction term between MNC and FC. Given a one-standard-deviation change in FC, an average

MNC experiences a 12.99% ($e^{(0.063+0.052)\times 1.062}$-1) increase in carbon emissions, while an average domestic firm experiences a 5.68% increase in carbon emissions ($e^{0.052\times 1.062}$-1). Overall, a one-standard-deviation change in FC is associated with a 7.31% increase in carbon emissions for MNCs than their domestic counterparts. This evidence yields preliminary support for Hypothesis 4b, which states that constrained MNCs take advantage of institutional arbitrage and relocate emissions to countries with lax environmental regulations to save abatement expenses in the short term. For robustness, we adopt an alternative definition of MNCs based on whether a company has at least 5% of revenue generated outside of its home country following Denis et al. (2002). As shown in Columns (3)-(4), our previous findings remain qualitatively unaffected using this alternative MNC definition.

To further substantiate the institutional arbitrage hypothesis (Hypothesis 4b), it is worthwhile to examine the potential sources contributing to the increase in carbon emissions of MNCs. Drawing on prior literature, an MNC can alter its emissions level through three plausible channels: (1) pollution abatement expenditure (Akey and Appel, 2021); (2) green technology upgrading (Hartmann et al., 2021); and (3) shifting polluting activities to weak regulatory environments to avert environmental legal liabilities (Eskeland and Harrison, 2003; Li and Zhou, 2017). MNCs are similar to domestic companies in the first two channels but more advantageous in the third due to their geographic diversification across countries. Our empirical analysis employs a firm's pollution abatement expenditure indicator as a proxy for the first channel and the percentage of EU-Taxonomy-aligned green revenue as a gauge of the second channel in a given firm and year. As shown in the first two columns of Table 8, MNCs do not vary their environmental expenditure or green investment more than domestic companies, conditional on financial constraints.

Investigating the third channel requires a more granular data source with the geographic locations of MNCs' overseas operations. To do so, we resort to the comprehensive subsidiary-level financial information in the BvD ORBIS database. Specifically, we employ the following subsidiary-level equation to detect the internal emissions reallocation by constrained MNCs:

$$\begin{aligned} LogSales_{s,i,t} \ or \ Emissions_{s,i,t} &= \beta_0 + \beta_1 EnvReg_{s,i,t} \times FC_{i,t-1} + \beta_2 EnvReg_{s,i,t} + \beta_3 FC_{i,t-1} \\ &+ \gamma_1 FVEC_{i,t-1} + \gamma_2 SVEC_{s,i,t-1} + \theta_t + \theta_j + \theta_c + \epsilon_{s,i,t}, \quad (3) \end{aligned}$$

where s indexes the subsidiaries of firm i. In addition to the firm-level controls defined in Section 3, $SVEC$ includes the subsidiary's total assets and financial leverage to control for unobservable subsidiary-specific characteristics. The above equation is estimated at the subsidiary level, with standard errors clustered at this level. To succinctly compare environmental regulations across borders, we take the following two steps. First, we aggregate country-level environmental regulation proxies that impose significant effects on corporate decarbonization (i.e., SER and EER) by taking the average of the two variables and denote this aggregate regulatory variable as $EnvReg$. Second, we introduce a dummy variable, $\triangle EnvReg$, which equals one if the parent country's environmental regulation is more stringent than the subsidiary country's. $EnvReg$ in Eq. (3) is equal to $\triangle EnvReg$ when the subsidiary is located abroad, while it is equal to $EnvReg(P)$ when the subsidiary is in the home country of the parent company.

While carbon emissions at the subsidiary level are unavailable, we apply two empirical strategies to infer MNCs' emissions reallocation across geographies. First, we follow Desai et al. (2008) and capture the local economic activities of foreign subsidiaries using its sales (defined as the log of subsidiary sales; denoted as $LogSales$).[17] We regress subsidiary-level sales on $\triangle EnvReg$, FC, and their interaction along with control variables, as shown in Eq. (3). The results are reported in Columns (3) and (5) of Table **8**. Column (3) shows a statistically significant coefficient on $\triangle EnvReg \times FC$, indicating that financially constrained MNCs tend to increase the production activity of foreign subsidiaries, whose countries' environmental regulations are weak to avert environmental liabilities imposed by their home countries.[18] By contrast, we observe a significantly negative coefficient of $EnvReg(P) \times FC$ for subsidiaries located in parents' countries.

In the second empirical strategy, we use an imputed emissions measure. This measure is computed as the product of a parent firm's emissions and the share of the subsidiary's total sales in the parent firm, assuming that emissions generated during the production processes are proportionate to the production output (Desai et al., 2008). Columns (4) and (6) of Table **8** reveal consistent results on how MNCs deploy their environmental strategy under tight financial constraints. The

[17] Desai et al. (2008) also use capital expenditures as a proxy for the local investments made by US MNCs. However, this variable is largely unavailable at the subsidiary level in the BvD ORBIS database.

[18] To alleviate the concerns that the increased sales in foreign subsidiaries are driven by local investment opportunities, we further include country-level proxies for local investment opportunities, including GDP per capita and annual GDP growth rate, and find our results to remain robust.

results show a significant coefficient on $\triangle EnvReg \times FC$, indicating that financially constrained MNCs tend to increase carbon emissions in foreign subsidiaries subject to weaker environmental regulations. Strikingly, the coefficient on $EnvReg(P) \times FC$ is negative and statistically significant, implying that MNCs reduce their domestic emissions when the environmental standards of the home country are high. This evidence contrasts sharply with the increased emissions of purely domestic companies when they face limited access to external finance. MNCs seem to leverage their internationalization and shift emissions activity from countries with high environmental standards to those with relatively lax environmental requirements, evading expected legal liabilities associated with carbon emissions.

4.5. Financial Market Consequences

The final empirical investigation explores the financial market consequences of increased emissions in financially constrained companies. These tests are motivated by the increasing trend of global institutional investors integrating portfolio firms' sustainability issues into their global investment strategies (Dyck et al., 2019; El Ghoul et al., 2018). Following this emerging investment trend, we anticipate decreased access to international capital markets for already financially constrained firms due to their intensified emissions. We test this conjecture by estimating the following equation:

$$\begin{aligned} Consequences_{i,t} \quad = \quad & \alpha + \beta_1 \; Emissions_{i,t-1} \times FC_{i,t-2} + \beta_2 \; Emissions_{i,t-1} + \beta_3 FC_{i,t-2} \\ & + \gamma FVEC_{i,t-1} + \theta_t + \theta_j + \theta_c + \epsilon_{i,t}, \end{aligned} \tag{4}$$

where $Consequences$ alternatively represents foreign institutional ownership (FIO) and the issuance of international bonds ($IBOND$) in a given firm and year. FIO is defined as the number of shares held by foreign institutional investors divided by the total number of shares outstanding based on global institutional ownership data retrieved from the FactSet Ownership database. $IBOND$ is a dummy variable that takes the value of one if the firm issues international bonds and zero otherwise, where international bond issuance data comes from the SDC Platinum Global New Issues database.

Table 9 reports OLS results of Eq. (4). Several findings are noteworthy. First, the estimate of FC coefficient is positive and significant in the FIO regression shown in Column (1). This finding is in line with many countries' goals of liberalizing local financial markets to attract foreign capital and ease local firms' tight financial circumstances (Alquist et al., 2019). Moreover, we find a negative and statistically significant coefficient on $Emissions \times FC$, suggesting that the increased carbon emissions in the presence of financial constraints are associated with low foreign institutional ownership. These results remain unchanged when we use the issuance of international bonds as a proxy for access to global capital markets in Column (4). In addition, we also split the sample into MNCs and domestic firms. We find the coefficient of $Emissions \times FC$ is significantly negative for both subsamples, as shown in Columns (2)-(3) and Columns (5)-(6). The difference in the interaction term coefficient between the two samples is statistically insignificant based on the Wald tests, whose p-values are shown in parentheses beneath the coefficient estimate difference. The collective evidence suggests a negative feedback effect on a firm's access to international capital markets when it fails to decarbonize under financial constraints.

5. Conclusion

In theoretical work that models the interplay between corporate environmental behavior and environmental regulatory policy, it is well recognized that a firm adopts a specific environmental strategy that balances its financial and environmental performance. Despite this intuitive theory, we know little about specific firm characteristics vital for corporate environmental performance. Building on the imperfect capital market assumption, we posit that the availability of financial resources influences firms' environmental policy domestically and internationally. We, therefore, explore the impact of financial constraints on corporate decarbonization in an international setting, where cross-country differences in environmental regulatory stringency and enforcement can materially affect the extent to which limited financial resources influence corporate decarbonization.

Our results show that firms tend to increase direct carbon emissions when facing tighter financial constraints. This base evidence is robust to three identification tests that exploit exogenous shocks to firm-level financial constraints arising from sovereign credit rating downgrades, increased cost of debt during the 2008 financial crisis, and oil price jumps. Further analysis shows that the stringency of environmental regulations, while not government support policies, moderates the effect of financial constraints across geographies. Thus, the differential impact of environmental regulations relative to government support policies facilitates international businesses to exploit the multidimensionality of institutional arrangements. For example, unlike their domestic counterparts, constrained MNCs are less inclined to increase the emissions of local subsidiaries but instead shift their emissions activities to foreign subsidiaries facing less strict regulations.

Our research yields several important implications for global strategy research and practice. Given the inconclusive theoretical and empirical evidence on whether firms design their environmental strategies for competitiveness or exploit regulatory arbitrage spatially, we identify the constrained financing channel that determines the trade-off between the two options. To integrate decarbonization into their business strategies, managers should try to circumvent financial constraints and actively seek low-cost financing options for climate-friendly investments such as green bonds (Flammer, 2021; Zerbib, 2019). In addition, our research opens a new avenue for future global strategy research to link existing multinational theories with the nascent but fast-growing climate finance that aims at mobilizing capital toward green investments. Our study should interest regulators in searching for policy instruments that enable corporate decarbonization. The findings highlight the efficacy of varying environmental policies that depend mainly on businesses' access to financial markets and call for policymakers to develop financial inclusion and help companies build resilience to the climate change impact. Finally, while outsourcing emissions appears to be a convenient solution for constrained MNCs, it is a myopic environmental strategic choice, limiting MNCs' access to international capital markets, possibly protracting their financial constraints. As for regulators, it is important to level the playing field between carbon released by domestic companies and MNCs. One possible policy solution is introducing a carbon border tax commensurate with domestic companies' costs related to a country's climate policy. In December 2022, the European Union government agreed to impose a carbon dioxide emissions tariff on imports of carbon-intensive products. This import tariff will be the world's first carbon border tax to support European industries as they decarbonize.

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Table 1
Country-Level Summary Statistics

This table presents country-level summary statistics over the entire sample period from 2005 to 2018, including the number of observations (N), average direct emissions (Carbon Emissions), stringency of environmental regulation (SER), enforcement of environmental regulation (EER), and government subsidies (Govt Subsidies($)). Carbon emissions are in millions of tonnes. Govt Subsidies ($) are in millions of U.S. dollars. The variables are defined in Section 3.

Country	N	Carbon Emissions	SER	EER	Govt Subsidies($)
Argentina	51	10.04	3.10	2.91	
Australia	1,968	100.58	5.58	5.59	149.79
Austria	183	28.43	6.12	6.03	115.51
Belgium	191	12.47	5.78	5.46	66.42
Brazil	435	119.27	4.99	4.00	294.51
Canada	1,010	60.25	5.12	5.12	275.02
Chile	206	21.07	4.60	4.56	
China	4,224	375.71	3.96	3.76	
Colombia	37	15.27	3.75	3.38	
Denmark	231	32.77	6.09	6.08	119.79
Egypt	172	22.10	2.76	2.50	
Finland	321	14.39	6.19	6.14	188.75
France	1,070	194.30	5.22	4.94	746.83
Germany	1,095	188.21	6.23	6.10	482.71
Greece	88	5.39	3.92	3.33	3.22
Hong Kong	1,265	85.38	4.19	4.24	
India	1,648	327.22	4.05	3.77	
Indonesia	490	52.99	3.66	3.56	
Ireland	215	25.68	5.34	5.10	36.13
Israel	257	6.42	4.59	4.28	
Italy	427	101.31	4.37	3.50	296.05
Japan	1,697	113.94	5.89	5.71	1142.01
Luxembourg	84	170.78	5.90	5.81	8.92
Malaysia	706	44.58	5.04	4.89	
Mexico	315	54.35	3.92	3.45	27.97
Morocco	21	1.82	3.60	3.47	
Netherlands	455	22.96	5.96	5.79	210.17
New Zealand	142	4.04	5.81	5.75	13.13
Nigeria	76	12.72	3.10	2.97	
Norway	308	41.44	5.98	5.85	105.46
Pakistan	145	6.94	3.19	2.91	
Peru	64	1.45	3.76	3.27	
Philippines	178	17.85	3.83	3.28	
Poland	217	14.01	4.44	3.89	85.22
Portugal	88	19.76	5.18	4.55	4.45
Qatar	8	0.05	5.29	5.29	
Russia	240	293.19	3.46	3.09	
Saudi Arabia	6	38.01	4.40	4.36	
Singapore	432	36.07	5.61	5.71	
South Africa	919	95.75	4.61	3.91	
South Korea	3,327	209.48	4.45	4.33	408.32
Spain	313	36.24	4.71	4.41	133.14
Sweden	626	15.71	6.22	6.09	128.18
Switzerland	760	132.49	6.22	6.23	133.05
Taiwan	2,742	139.37	4.81	4.48	
Thailand	486	77.80	3.75	3.61	
Turkey	334	51.34	3.71	3.48	43.88
United Arab Emirates	30	0.72	5.27	5.22	
United Kingdom	3,954	245.25	5.41	5.24	328.09
United States	6,994	586.09	5.26	5.22	2716.65
Vietnam	35	4.17	2.93	3.11	

Table 2
Summary Statistics and Correlation Matrix

This table presents summary statistics and correlation matrix of the variables in our baseline analysis over the entire sample period from 2005 to 2018. The variables are defined in Section 3. All continuous variables are winsorized at the 1% and 99% of their distribution. *, **, *** are significance levels denoted at the 10%, 5%, and 1% levels, respectively.

Variable		Mean	Std. Dev.	Median	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Emissions	(1)	10.740	2.527	10.550	1.000						
Emissions†	(2)	3.396	1.862	3.125	0.757***	1.000					
FC	(3)	0.114	1.062	0.168	0.540***	0.144***	1.000				
Size	(4)	21.530	1.593	21.500	0.622***	0.056***	0.723***	1.000			
BM	(5)	0.629	0.550	0.470	0.131***	0.208***	0.117***	0.067***	1.000		
ROA	(6)	0.083	0.102	0.078	0.017**	-0.065***	-0.075***	-0.018***	-0.360***	1.000	
Leverage	(7)	0.237	0.175	0.225	0.204***	0.109***	0.227***	0.276***	0.023***	-0.207***	1.000
PPE	(8)	0.549	0.407	0.468	0.374***	0.417***	0.175***	0.090***	0.137***	-0.061***	0.151***
R&D	(9)	0.017	0.037	0.000	-0.198***	-0.191***	-0.117***	-0.080***	-0.157***	-0.068***	-0.171***
CAPEX	(10)	0.051	0.048	0.036	0.181***	0.247***	0.040***	-0.015**	-0.056***	0.085***	0.062***
Sales Growth	(11)	0.105	0.274	0.068	-0.027***	0.026***	-0.085***	-0.051***	-0.110***	0.139***	-0.019***
Dividend	(12)	0.001	0.003	0.000	0.088***	0.068***	0.368***	0.107***	0.058***	0.011	-0.024***
HHI	(13)	0.314	0.341	0.165	0.222***	0.094***	0.194***	0.162***	-0.007	0.067***	0.042***
GDP per capita	(14)	35.688	21.526	40.315	-0.085***	-0.196***	-0.044***	0.059***	-0.055***	-0.086***	0.002
GDP Growth	(15)	3.097	2.635	2.623	0.011*	0.111***	-0.022***	-0.054***	-0.050***	0.076***	-0.014**
Inflation	(16)	2.445	2.220	2.075	0.089***	0.160***	0.008	-0.058***	0.030***	0.129***	0.008

		(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Emissions	(1)									
Emissions†	(2)									
FC	(3)									
Size	(4)									
BM	(5)									
ROA	(6)									
Leverage	(7)									
PPE	(8)	1.000								
R&D	(9)	-0.163***	1.000							
CAPEX	(10)	0.529***	-0.100***	1.000						
Sales Growth	(11)	-0.096***	0.011*	0.082***	1.000					
Dividend	(12)	-0.032***	-0.095***	-0.038***	-0.022***	1.000				
HHI	(13)	0.087***	-0.179***	0.016**	-0.043***	0.071***	1.000			
GDP per capita	(14)	-0.011*	0.192***	-0.094***	-0.080***	-0.090***	-0.014*	1.000		
GDP Growth	(15)	-0.064***	-0.100***	0.052***	0.152***	0.050***	-0.073***	-0.474***	1.000	
Inflation	(16)	0.032***	-0.116***	0.140***	0.116***	0.078***	0.069***	-0.441***	0.188***	1.000

Table 3
Financial Constraints and Carbon Emissions

This table reports OLS results of a firm's direct carbon emissions on its financial constraints (FC), while controlling for firm-specific characteristics, with and without country-level controls, and year, industry, and country fixed effects (FE). We measure the firm's direct carbon emissions in its log form ($Emissions$) or log of its intensity ($Emissions\dagger$). The definition of the control variables is detailed in Section 3. All $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the firm level. *, **, *** are significance levels denoted at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable			
	Emissions		*Emissions†*	
Variable	(1)	(2)	(3)	(4)
FC	0.092***	0.089***	0.037***	0.036***
	(5.77)	(5.57)	(2.82)	(2.73)
$Size$	0.869***	0.873***	-0.034***	-0.022*
	(61.53)	(60.59)	(-2.59)	(-1.69)
BM	-0.033	-0.013	0.203***	0.226***
	(-1.03)	(-0.39)	(7.34)	(8.03)
ROA	1.161***	1.072***	-0.205*	-0.298**
	(8.91)	(8.10)	(-1.75)	(-2.52)
$Leverage$	0.097	0.072	0.506***	0.482***
	(1.00)	(0.72)	(5.67)	(5.30)
PPE	1.135***	1.205***	0.995***	1.024***
	(19.99)	(20.15)	(19.93)	(19.74)
$R\&D$	-3.878***	-4.433***	-2.497***	-2.867***
	(-7.96)	(-8.85)	(-5.79)	(-6.43)
$CAPEX$	0.799**	0.973***	0.733***	0.904***
	(2.48)	(2.84)	(2.63)	(3.07)
$Sales\ Growth$	0.103***	0.105***	0.099***	0.106***
	(3.72)	(3.64)	(4.34)	(4.46)
$Dividend$	0.728	-3.102	18.353***	13.825**
	(0.12)	(-0.49)	(3.49)	(2.55)
HHI	0.261***	0.285***	-0.027	-0.015
	(4.00)	(4.33)	(-0.47)	(-0.25)
$GDP\ per\ capita$		-0.106**		-0.057
		(-2.40)		(-1.49)
$GDP\ Growth$		-0.004		-0.004
		(-0.82)		(-0.92)
$Inflation$		0.014**		0.010*
		(2.13)		(1.68)
N	41286	38496	41286	38496
Adjusted R^2	0.724	0.727	0.605	0.612
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes

Table 4
Identification Tests: Financial Constraints and Carbon Emissions

This table presents OLS results of varying shocks to financial constraints, while controlling for the same set of firm-specific variables (*Firm Controls*) and fixed effects employed in Table 3. In Column (1), $Treat_{Downgrade}$ is a dummy variable that equals one if the firm has a credit rating equal to or above the sovereign rating in year t and zero otherwise. *Post* is an indicator variable that takes the value of one if the country's credit rating is downgraded in year t and zero otherwise. In Column (2), we employ the global financial crisis as a shock to financial constraints for firms with high levels of debt maturing in 2008. These firms face greater financial constraints during this period. $Treat_{Debt}$ is an indicator variable which equals to one if the the firm's debt due in one year is at or above the sample median and zero otherwise. We restrict the sample to the period from 2006 to 2008 and set *Post* to one for observations in 2008 and zero otherwise. In Column (3), we employ the oil price fluctuation as a shock to financial constraints for firms in the Oil&Gas industry. We first use the propensity score matching to match the oil industry firms with non-oil industry firms. $Treat_{Oil\&Gas}$ equals one if the firm is in the Oil&Gas industry and zero otherwise. *Post* is set to one if the oil price is higher than the 75^{th} percentile of the historical oil price during our sample period and zero otherwise. The definition of the control variables is detailed in Section 3. All $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the firm level. *, **, *** are significance levels denoted at the 10%, 5%, and 1% levels, respectively.

	Exogenous Shock		
	Sovereign Credit Rating Downgrade	Financial Crisis	Oil Price Fluctuation
Variable	(1)	(2)	(3)
$Treat_{Downgrade} \times Post$	0.582**		
	(2.08)		
$Treat_{Downgrade}$	0.494*		
	(1.69)		
$Treat_{Debt} \times Post$		0.088***	
		(2.64)	
$Treat_{Debt}$		0.083	
		(1.36)	
$Treat_{Oil\&Gas} \times Post$			-0.178*
			(-1.71)
$Treat_{Oil\&Gas}$			0.156
			(1.11)
N	202	5385	3310
Adjusted R^2	0.881	0.760	0.783
Firm Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes

Table 5
Financial Constraints, Carbon Emissions, and Environmental Institutions

This table reports OLS results of a firm's direct carbon emissions on the interaction of financial constraints (FC) and country-level environmental institution, which gauges a country's commitment to climate change and is proxied by SER and EER. SER is the stringency of environmental regulation score, and EER represents the enforcement of environmental regulation score. Both variables are obtained from the World Economic Forum (WEF). *Subsidy* is the country-level energy research, development and demonstration budgets in the following three areas: (1) energy efficiency; (2) renewable energy sources; and (3) hydrogen and fuel cells, scaled by a country's GDP. *Firm Controls* and fixed effects are the same as those in Table 3. The definition of the control variables is detailed in Section 3. All $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the firm level.

	Dependent Variable: *Emissions*		
Variable	(1)	(2)	(3)
$SER \times FC$	-0.090***		
	(-4.53)		
SER	0.022		
	(0.62)		
$EER \times FC$		-0.090***	
		(-5.06)	
EER		-0.020	
		(-0.60)	
$Subsidy \times FC$			-1.638
			(-0.11)
$Subsidy$			7.515
			(0.47)
FC	0.558***	0.549***	0.084***
	(5.40)	(6.05)	(3.21)
N	34082	34082	26809
Adjusted R^2	0.719	0.720	0.746
Firm Controls	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes

Table 6
Changes in Environmental Regulations around the Paris Agreement

This table presents OLS results of shocks to country commitments when firms are financially constrained. In Column (1), we use the adoption of the Paris Agreement as a shock to the stringency of environmental regulation. We restrict the sample period to 2012 to 2018. *Post* is a dummy variable that equals one if firm observations are after the 2015 Paris Agreement and zero otherwise. $\triangle CO2\_Paris$ is the difference between a country's change in total carbon emissions from 2015 to 2012 and from 2018 to 2015. In Column (2), we employ President Trump's withdrawal from the Paris Agreement in 2017 as a shock to the perceived stringency of environmental regulation of U.S. firms. This analysis restricts the sample period to be after 2015 and introduces a dummy variable, *Polluter*, which equals one if the firm is in the pollution-intensive industry (industries with a two-digit SIC code in a range of 10-14) and zero otherwise. *Post* is defined as a post-withdrawal dummy variable which takes the value of one if firm observations are from 2017 onward and zero otherwise. *Firm Controls* and fixed effects are the same as those employed in Table 3. The definition of the control variables is detailed in Section 3. All $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the firm level. *, **, *** are significance levels denoted at the 10%, 5%, and 1% levels, respectively.

	Paris Agreement Adoption	US Withdrawal from the Paris Agreement
Variable	(1)	(2)
$Post\times\triangle CO_2\_Paris\times FC$	0.097*	
	(1.83)	
$Post\times\triangle CO_2\_Paris$	-0.018	
	(-0.31)	
$\triangle CO_2\times FC$	0.056	
	(1.28)	
$\triangle CO_2$	0.004	
	(0.07)	
$Post\times Polluter\times FC$		0.868***
		(3.08)
$Post\times Polluter$		-0.524**
		(-2.17)
$Polluter\times FC$		-0.149
		(-0.78)
$Post\times FC$	-0.045	-0.100
	(-1.59)	(-1.48)
$Polluter$		0.598
		(0.72)
FC	0.161***	0.107
	(5.34)	(1.56)
N	21531	3083
Adjusted R^2	0.723	0.750
Firm Controls	Yes	Yes
Year FE	Yes	Yes
Industry FE	Yes	Yes
Country FE	Yes	Yes

Table 7
Financial Constraints and Carbon Emissions of MNCs

This table reports OLS results of a firm's direct carbon emissions on the interaction between financial constraints (FC) and an MNC indicator. We introduce the *MNC* indicator to denote different definitions of a multinational company. In Columns (1)-(2), *MNC* equals one when the firm reports non-zero foreign income in the previous three years and zero otherwise. In Columns (3)-(4), *MNC* takes the value of one if at least 5% of the firm's sales are from abroad and zero otherwise. *Firm Controls* and fixed effects are the same as those employed in Table 3. The definition of the control variables is detailed in Section 3. All $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the firm level. *, **, *** are significance levels denoted at the 10%, 5%, and 1% levels, respectively.

	Definitions of *MNC*			
	MNC=1 if Foreign Income > 0		*MNC*=1 if International Sales > 5%	
Variable	(1)	(2)	(3)	(4)
MNC	0.197***	0.205***	0.200***	0.212***
	(5.51)	(4.91)	(5.95)	(5.51)
$MNC \times FC$		0.063**		0.069***
		(2.24)		(2.59)
FC		0.052**		0.052**
		(2.02)		(2.22)
N	48534	37271	49652	38075
Adjusted R^2	0.742	0.726	0.741	0.725
Firm Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes

Table 8
Potential Channels of MNCs' Carbon Emissions

This table reports OLS results of possible channels through which MNCs can change their emissions. The possible channels include environmental expenditure, green revenue, and the transfer of emissions across subsidiaries. In Column (1), the dependent variable is the Environmental Expenditure Indicator, which equals one if the firm has non-zero environmental expenditure based on the Refinitiv Asset4 database and zero otherwise. In Column (2), the dependent variable is Green Revenue Indicator, which equals one if the firm has non-zero green revenue in the Trucost database and zero otherwise. We estimate logit regressions at the firm level in Columns (1)-(2). To examine emissions across a firm's subsidiaries, we perform the regression analysis at the subsidiary level. Columns (3)-(6) show OLS results of the log of sales (*LogSales*) and *Emissions* on interactions between *FC*, *MNC*, and the *SER* and *EER* differentials between the parent country and subsidiary country. We take the average of *SER* and *EER* to capture the stringency and enforcement of a country's environmental regulation. In Columns (3) and (4), we consider subsidiaries not located in their parent firms' countries and define a binary indicator, $\triangle$*EnvReg*, that takes the value of one if the parent country's environment policy is more stringent than the subsidiary country's and zero otherwise. In Columns (5) and (6), we consider subsidiaries located in their parent firms' countries and look at the impact of the parent country's environmental regulatory stringency *(EnvReg(P))* on its subsidiary's *LogSales* and *Emissions*, respectively. *EnvReg(P)* is the average of a country's *SER* and *EER* scores. In addition to the same firm-level controls employed in Table 3, we also include the subsidiary's total assets and leverage as control variables in Columns (3) to (6). The definition of the control variables is detailed in Section 3. The regression model controls for varying sets of fixed effects (FE), including industry, country, and year FEs in Columns (1) and (2) and subsidiary industry, subsidiary country, and year FEs in Columns (3) to (6). All $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the firm or subsidiary level. *, **, *** are significance levels denoted at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable					
			Subsidiaries Not Located in Parents' Country		Subsidiaries Located in Parents' Country	
	Env Expenditure Indicator	Green Revenue Indicator	LogSales	Emissions	LogSales	Emissions
Variable	(1)	(2)	(3)	(4)	(5)	(6)
$MNC \times FC$	0.005	0.061				
	(0.05)	(0.85)				
MNC	0.211*	0.063				
	(1.67)	(0.77)				
$\triangle EnvReg \times FC$			0.025**	0.058***		
			(2.21)	(3.05)		
$\triangle EnvReg$			0.027	-0.010		
			(1.40)	(-0.35)		
$EnvReg(P) \times FC$					-0.086***	-0.079***
					(-4.85)	(-3.82)
$EnvReg(P)$					0.045	0.151**
					(0.91)	(2.55)
FC	0.103	0.057	0.000	0.079***	0.381***	0.526***
	(1.17)	(0.83)	(0.00)	(4.54)	(4.36)	(5.19)
N	18645	37110	138028	131185	88101	86750
Adjusted R^2			0.693	0.632	0.274	0.370
Pseudo R^2	0.275	0.364				
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 9
Financial Market Consequences

This table reports OLS results of financial market consequences of the increased carbon emissions due to financial constraints (FC) for the full sample, MNCs, and domestic firms. A firm is defined as an MNC if it reports non-zero foreign income in the previous three years and zero otherwise. We employ two variables as proxies for consequences: (1) FIO: the number of shares held by foreign institutional investors to the total number of shares outstanding; (2) $IBond$: an indicator variable that equals one if the firm issues international bonds and zero otherwise. We estimate a logit regression model when $IBond$ is the dependent variable. *Firm Controls* and fixed effects are the same as those employed in Table 3. The definition of the control variables is detailed in Section 3. The p-values of the Wald tests reported in the third row show the statistical significance of the $Emissions \times FC$ coefficient difference between MNCs and domestic companies. All other $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the firm level. *, **, *** are significance levels denoted at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable					
	FIO			IBond		
	Full Sample	MNCs	Domestic Firms	Full Sample	MNCs	Domestic Firms
Variable	(1)	(2)	(3)	(4)	(5)	(6)
$Emissions \times FC$	-0.002***	-0.002***	-0.002***	-0.049**	-0.037*	-0.120**
	(-4.86)	(-3.88)	(-2.64)	(-2.44)	(-1.66)	(-2.38)
Difference in Coefficients		0.000			0.083	
(p-value)		(0.521)			(0.465)	
$Emissions$	-0.004***	-0.005***	-0.003**	0.148***	0.102**	0.242***
	(-4.41)	(-4.16)	(-2.07)	(3.40)	(2.09)	(2.81)
FC	0.017***	0.017***	0.012**	0.512**	0.364	1.382**
	(3.88)	(3.01)	(2.15)	(2.16)	(1.41)	(2.34)
N	31817	22930	6264	16643	10220	3517
Adjusted R^2	0.311	0.320	0.259			
Pseudo R^2				0.380	0.360	0.407
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Appendix Table A

This table reports the OLS results of a firm's total carbon emissions on its financial constraints (FC), while controlling for firm-specific characteristics, with and without country-level controls, and year, industry, and country fixed effects (FE). We measure the firm's total carbon emissions in its log form ($Total\_Emissions$) or log of its intensity ($Total\_Emissions\dagger$), including Scope 1, 2, and 3 emissions. The definition of the control variables is detailed in Section 3. All $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the firm level.

	Dependent Variable			
	$Total\_Emissions$		$Total\_Emissions\dagger$	
Variable	(1)	(2)	(3)	(4)
FC	0.078***	0.077***	0.024***	0.026***
	(7.15)	(6.93)	(3.63)	(3.68)
$Size$	0.923***	0.919***	0.016**	0.020***
	(99.64)	(96.43)	(2.40)	(2.81)
BM	-0.117***	-0.107***	0.120***	0.132***
	(-5.35)	(-4.76)	(8.24)	(8.88)
ROA	1.483***	1.424***	0.112*	0.045
	(16.54)	(15.62)	(1.91)	(0.76)
$Leverage$	-0.199***	-0.212***	0.205***	0.191***
	(-3.02)	(-3.13)	(4.11)	(3.71)
PPE	0.697***	0.758***	0.564***	0.583***
	(18.36)	(18.72)	(21.14)	(20.79)
$R\&D$	-2.916***	-3.221***	-1.701***	-1.816***
	(-9.54)	(-9.97)	(-7.94)	(-8.03)
$CAPEX$	0.277	0.372	0.220	0.311*
	(1.26)	(1.58)	(1.40)	(1.86)
$Sales\ Growth$	0.009	0.011	0.004	0.010
	(0.47)	(0.51)	(0.35)	(0.77)
$Dividend$	-11.483***	-14.354***	6.579**	2.942
	(-2.90)	(-3.37)	(2.39)	(1.06)
HHI	0.353***	0.370***	0.056*	0.061*
	(8.16)	(8.34)	(1.82)	(1.93)
$GDP\ per\ capita$		-0.082***		-0.031
		(-2.87)		(-1.59)
$GDP\ Growth$		0.000		-0.001
		(0.12)		(-0.41)
$Inflation$		0.006		0.002
		(1.48)		(0.62)
N	41286	38496	41286	38496
Adjusted R^2	0.818	0.818	0.673	0.678
Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes

Appendix Table B

This table reports OLS results of a country's carbon emissions on its financial constraints defined as the cross-sectional average of firm-level financial constraints in a given country and year (*Country FC*). The regression model controls for year and country fixed effects (FE). In addition to country-level controls specified in the baseline model, we also include several proxies for a country's political system and economic environment: the perception of the likelihood of political instability (PVE), the rule of law (RLE), regulatory quality (RQE), and control of corruption (CCE) from the World Bank; the Political Executive Constraints Index (PEC) from Polity IV; the degree of economic freedom (EFI) from the Heritage Index of Economic Freedom Foundation. All $t-$values reflected in parentheses are computed based on standard errors adjusted for clustering at the country level.

	Dependent Variable: Country-Level Emissions			
Variable	(1)	(2)	(3)	(4)
Country FC	0.110***	0.086***	0.081***	0.066***
	(2.95)	(3.57)	(3.25)	(2.77)
GDP per capita		0.429***	0.431***	0.421***
		(8.70)	(8.69)	(9.18)
GDP Growth		-0.002	-0.002	-0.001
		(-0.96)	(-1.12)	(-0.45)
PVE		-0.003	-0.003	-0.002
		(-0.09)	(-0.09)	(-0.05)
RLE		0.016	0.011	0.011
		(0.24)	(0.17)	(0.16)
RQE		0.009	0.023	-0.051
		(0.22)	(0.54)	(-1.31)
CCE		0.015	0.008	-0.026
		(0.29)	(0.16)	(-0.53)
PEC			0.001***	0.001***
			(3.04)	(5.00)
EFI				0.012***
				(4.66)
N	602	602	575	575
Adjusted R^2	0.985	0.991	0.991	0.992
Year FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes

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