https://doi.org/10.1016/j.ribaf.2023.101888

A cross-country analysis of corporate carbon performance: an international investment perspective

Short running title: Cross-country carbon performance

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Abstract:

In this study, we examine corporate carbon performance globally from the perspective of country-level dispersion. The average carbon performance of listed companies in the non-OECD countries increases more after the Paris Agreement than that of listed companies in the OECD countries. However, under an increasing trend of average country-level carbon performance, the dispersion of corporate carbon performance is reduced more in the OECD countries vis-à-vis the non-OECD countries. In addition, international equity ownership is negatively associated with the dispersion of country-level corporate carbon performance in the post-Paris Agreement period. This finding supports our conjecture that sophisticated foreign investors from developed countries exert a significant positive influence on the carbon management efficiency of domestic firms in developing countries.

Keywords: ESG, Carbon Performance, International ownership, OECD

JEL Classifications: F64, O16, Q01, Q56, G15

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1. Introduction

Carbon-related issues have long been a popular research topic in economics. The recent emergence of climate finance research[1] adds a new dimension to environmental research by relating carbon and climate issues with corporate financial performance. Furthermore, the availability of various commercial ESG data for academic research accelerates research knowledge accumulation of climate research using firm-level ESG measures intended for asset managers and buy-side analysts to seek alphas. Our study takes advantage of this recent expansion of global commercial data on firm-level carbon performance to explore the role of international investments on carbon performance at the country level. Following the recent direction of financial research, our study goes beyond carbon emission analysis by relating corporate performance in managing carbon to international investments in equity ownership of listed firms globally.

Ample literature documents the economic effects and financial impacts of carbon emissions (e.g., Grossman and Krueger, 1991, 1995; Zoaka et al., 2022; Lewandowski, 2017; Flammer et al., 2021). From a stakeholder's perspective, listed firms are major players in producing carbon. Corporate governance and management are expected to influence corporate carbon performance in a significant manner. Accordingly, numerous studies explore what types of board governance and characteristics may affect climate disclosure and carbon performance (e.g., Peters and Romi, 2014; Haque, 2017). Moreover, some studies focus on the specific environmental effort at the board level and its positive impact on carbon performance (e.g., Moussa et al., 2020; Haque and Ntim, 2022).

On the other front, previous studies have documented that more sophisticated international (foreign) investors from developed countries exert significant influence on domestic firms in developing countries. For instance, listed firms in emerging stock markets benefit from information environment improvement (Bae et al., 2006), and experience higher growth, greater investment, profitability, and efficiency, whilst lower leverage (Mitton, 2006). In addition,

[1] For instance, see the Special Issue on Climate Finance in *The Review of Financial Studies*, vol. 33 (3) from March 2020.

international investors can provide some stabilizing and monitoring effects as well as help to reduce the cost of equity capital for local firms in developing markets (Li et al., 2011; Errunza and Ta, 2015).

In this study, we take the view that the carbon performance of listed firms can be affected by the maturity of corporate management and control of carbon risk. Logically, compared with listed firms in developing countries, listed firms in developed countries should have a stronger sense and commitment to carbon risk control. To raise this climate risk awareness at the corporate level, international equity investments can be a strong catalyst. Through equity ownership, international investors from developed countries bring in management know-how including higher standards on carbon performance to achieve business sustainability for their investees. Consequently, we argue that international equity ownership exercises a positive influence on corporate carbon performance at the country level.

Unlike firms' financial performance, for which international accounting standards and stock prices provide a set of objective and quantitative indicators, measuring corporate carbon performance is not as straightforward. The main research challenge is the lack of a standardized carbon performance measure which can be used for firms in different industry sectors and different countries. To overcome this measurement issue, we explore different commercial ESG datasets designed mainly for the asset management industry and investment purposes. These datasets include Asset4 by Refinitiv, Sustainalytics by Morningstar, and ESG Intangible Value Assessment (IVA) by MSCI.

The key selection criterion is to allow us to adopt a single corporate carbon management measure that includes both carbon-related climate risk exposure and the corresponding management strategies of listed firms globally. In addition, the measure must adjust for firm-specific, industry-specific, and country/regional-specific carbon risk environments in rating the carbon management performance. It is because management strategy and actions should be commensurate with the level of exposure. For instance, a firm with high carbon risk exposure should also have very strong carbon management, whereas a firm with limited carbon exposure can have a relatively modest approach to handling the exposure. Under MSCI's evaluation metrics, a highly exposed firm with poor management will score worse than a company with the same

management practices but with lower carbon exposure[2]. We recognize the limitations (such as having no control over the scope and weighting of relevant items considered in the scoring) of using a third-party rating instead of constructing our measure from raw data. Notwithstanding, we believe that the benefit of adopting the MSCI's carbon performance score exceeds the problem of our inability to collect global data for listed firms on carbon performance. We also understand that other related climate measures can be used for our analysis. As an initial attempt in dealing with carbon performance on a global scale, we limit our focus to the MSCI Key Issue score for carbon performance for the current study.

In short, previous studies link corporate governance practices and characteristics directly to carbon emissions. In our study, we take a different perspective on corporate carbon performance by adopting a composite measure of carbon emission exposure and the corresponding risk management reflected in the data provided by MSCI. Through such a standardized carbon performance measure for listed firms globally and a measure of the dispersion of corporate carbon performance in a country, we can examine how international investments affect corporate carbon performance at the country level. To the best of our knowledge, no study has explored the effect of international equity ownership on the management of carbon emissions for listed firms on a global scale.

Furthermore, we adopt the country-level carbon performance measurement framework through the dispersion lens (the Theil index). Abiad et al. (2008) employ this index to measure the efficiency of capital allocation and argue that the dispersion of marginal returns should decrease if capital allocation to all firms is improved. Based on this line of argumentation, we propose that a lower carbon performance dispersion of listed firms in a given country implies an improvement in carbon management for the country if the average carbon performance shows an upward trajectory. Consequently, we aggregate the firm-level carbon performance measure into the country-level carbon performance measure by calculating the dispersion of corporate carbon performance in a country for a given year. Following the literature, the dispersion is calculated by using two measures of inequality, the mean logarithm of deviations and the Theil index, (e.g., Abiad et al., 2008; Acemoglu and Dell, 2010; Delis et al., 2014; Chancel and Piketty, 2015). Under

[2] For a detail discussion of the MSCI rating methodology on carbon emission as a Key Issue under the Climate Change theme of the Environment pillar, please see Appendix 3.

the condition that the variation in corporate carbon performance within a country decreases while average firms achieve a high carbon performance, the dispersion variables can measure the overall efficiency of improving corporate carbon management in a country (Cho, 1988; Abiad et al., 2008)[3]. Carbon performance at the country level is then examined in the setting of OECD (or developed) versus non-OECD (or developing) countries as well as ex-post versus ex-ante the Paris Agreement.

Our results can be summarized as follows. First, after the Paris Agreement, the average carbon performance of listed companies in the non-OECD countries increases more than that of listed companies in the OECD countries, whereas the dispersion of corporate carbon performance decreases more across the OECD countries vis-à-vis the non-OECD countries. Such results imply that developed countries have larger efficiency to improve carbon performance than developing countries after the passing of the Paris Agreement. Second, foreign investors' ownership is negatively associated with the dispersion of corporate carbon performance in the post-Paris Agreement period. This finding, in turn, is consistent with previous studies that foreign investors play a significant role in improving corporate governance, ESG performance and carbon performance of domestic firms (Aggarwal et al., 2011; Bena et al., 2017; Dyck et al., 2019; Azar et al., 2021). Third, the decrease in the dispersion of corporate carbon performance after the Paris Agreement is larger in non-OECD countries than in OECD countries. In sum, this study shows that more sophisticated foreign investors from developed countries exert significant influence on domestic firms from developing countries in improving their efficiency of carbon management. Thus, our study brings additional insight into the carbon literature by employing a unique combination of carbon management data and the dispersion (Theil index) approach to measure corporate carbon management efficiency within a country in a global approach.

The remaining parts of the paper are organized as follows. Section 2 provides a literature review on carbon-related studies. Section 3 shows the hypotheses and methodology. Sections 4 and 5 report the empirical results and conclusion, respectively.

[3] We interpret the reduction in the variation in corporate carbon performance as an improvement in the efficiency of carbon management in a country (see Abiad et al., 2008). Another possibility is that firms' carbon management in a country may deteriorate, which also leads to a lower dispersion of corporate carbon performance scores. However, this possibility can be ruled out as corporate carbon performance is increasing over time in most developed and developing countries.

2. Literature Review

2.1 Country-level CO2 emissions and economic growth

Many researchers have been investigating the impacts of economic activities on the environmental pollution of greenhouse gasses (hereafter GHG). Grossman and Krueger (1991, 1995) demonstrate that economic activities bring negative impacts on the environment in the early phase of economic development but countries will gradually pay more attention at a later stage. Thus, Grossman and Krueger (1991, 1995) are the first to find evidence of an inverted U-shaped relationship between economic development and air pollution, labelled as the *Environmental Kuznets Curve* (hereafter EKC) hypothesis.

Notwithstanding, the research findings on the association between economic growth (income) and carbon emissions are mixed. For example, Omri et al. (2014) document bi-directional association in the sample of MENA countries, whereas Khan et al. (2019) report a positive effect of economic development on CO2 emissions in a global sample of 193 economies. Zoaka et al. (2022) show a positive long-run effect of economic growth on CO2 emissions in BRICS economies based on the 1980-2018 period. In a study of 12 Middle East and North African region countries, Cheikh et al. (2021) suggest that the impact of energy consumption on carbon emissions is positive and larger (smaller) for low- and high- (medium) income countries, whereas the significantly negative effect of GDP growth on the environment is conditional on high energy consumption growth. On the contrary, e.g., Acheampong, (2018) and Shoaib et al. (2020) find evidence of a negative relationship between economic growth and carbon emissions across developing and developed countries alike. Based on data from 36 African countries, Twerefou et al. (2017) find support for the EKC hypothesis. Other studies also document the nonlinear inverted-U-shaped relationship between income per capita and carbon emissions, consistent with the EKC hypothesis (e.g., Strazicich and List, 2003; Danish and Ulucak, 2020).

Developed economies tend to have strong institutional frameworks, whilst developing countries often lag in institutional quality. Many studies find that institutional quality has strongly beneficial environmental effects, e.g., through the implementation of stringent and enforceable environmental policies (Dasgupta and De Cian, 2018), thereby significantly mitigating carbon

emissions (Bhattacharya et al., 2017; Danish and Ulucak, 2020; Hassan et al., 2020). On the other hand, weak institutional frameworks create convivial habitats for corruption, inept bureaucracy, and disregard for environmental issues (e.g., Danish et al., 2019a).

Furthermore, there is ample empirical evidence suggesting a strong negative relationship between the consumption of renewable energy and CO2 emissions regardless of the economic development stage of the countries (e.g., Dong et al., 2018; Li and Su, 2017; Dong et al., 2017; Danish et al., 2019b; Zoaka et al., 2022). Akram et al. (2020) confirm that the consumption of renewable energy significantly reduces CO2 emissions in a sample of 66 developing economies.

2.2 Corporate-level carbon emissions across developed versus developing countries

Another strand of literature investigates GHG emissions from the corporate perspective. According to the *stakeholder* and the *natural resources* theories (Donaldson, 1995; Hart, 1995) corporations engaging in environmental issues should experience multifaceted benefits e.g., enhanced reputation, efficiency gains, and access to new green markets. However, empirical evidence on the benefits of enhanced carbon emissions is inconclusive (e.g., Misani and Pogutz, 2015). For instance, Lewandowski (2017) find that improved carbon performance hurts firms' stock market performance while Choi and Luo (2021) show the opposite effect. In addition, Gutierrez-Lopez et al. (2022) document a positive association between listed firms' carbon performance and their distance-to-default in a sample of 16 EU member countries from 2005 to 2019. Elmawazini et al. (2022) present evidence that U.S.-listed firms characterized by better environmental technology innovation enjoy the cheaper cost of equity capital. Mumtaz and Yoshino (2021) examine IPOs in Pakistan Stock Exchange between 1995 and 2018. Their results suggest that in the short- (long) run, companies with lower carbon emissions achieve lower returns (perform better) than companies with higher emissions.

Scholars tend to agree that firms willing to improve their CO2 emissions and performance face different costs, barriers and incentives when operating in industrialised versus developing countries. Such differentiations can be attributed to e.g., the usage of fossil fuels vis-à-vis green sources of energy (Welsby et al., 2021), technological progress (Milindi and Inglesi-Lotz, 2022), environmental regulation (Jeswani et al., 2008), institutional quality (Danish and Ulucak, 2020), and urbanization (Poumanyvong and Kaneko, 2010). For instance, Jeswani et al. (2008) suggest that entities from the developing country (Pakistan) face greater obstacles in reducing (enhancing)

GHG emissions (energy efficiency) compared to entities from the industrialized country (the U.K.). More recently, Muttakin et al. (2022) conclude that firms in countries with strong democratic institutions are negatively associated with carbon emission intensity.

There is ample evidence highlighting that corporations from industrialized countries with stringent environmental regulations (e.g., national carbon emission trading schemes in the EU[4]) have been "*outsourcing*" carbon emissions to upstream and downstream firms in developing countries with loose (and often poorly enforced) regulation along the global supply chain (e.g., King and van den Bergh, 2021; Singhania and Saini, 2021). Consequently, the CO2 emissions are transferred from industrialized (e.g., the EU members) to developing (e.g., China) economies.

Numerous studies explore what types of board governance and characteristics may affect climate disclosure and the performance of firms. Peters and Romi (2014) confirm a positive relationship between proactive environmental-related board actions and carbon disclosure. Other studies examine board characteristics and gender diversity and show a positive effect on carbon performance (e.g., Haque, 2017). In addition, some literature focus on the specific environmental effort at the board level and its impact on carbon performance. For instance, Moussa et al. (2020) confirm that a stronger board environmental orientation can improve carbon performance while Haque and Ntim (2022) claim that emission reduction initiatives, environmental innovations, and efficient use of resources, display a positive relationship with carbon performance.

2.3 Corporate carbon emissions and investment performance

As of April 2021, over 4,000 institutional investors (from 60 countries with over UDS120 trillion in assets under management) participate in the *Principles for Responsible Investment* and commit to incorporating ESG into their investment decisions (UNPRI, 2021). The empirical literature examining the influence of institutional investors' motives, strategies and effect on firms' carbon dioxide-related efforts and performance (ex-post the Paris agreement), is fast growing.

Flammer et al. (2021) find that environmentally oriented long-term institutional investors have the strongest positive effect on corporates' disclosure of their climate change risks, which, in turn, triggers a positive reaction from the US stock market. Bolton and Kacperczyk (2021, 2022) find

[4] The EU has long been in the vanguard in terms of the strictest regulations/legislations/initiatives battling global warming by promoting and more recently also enforcing renewable energy, whilst penalizing and taxing GHG emissions and fossil fuels (see e.g., European Commission, 2022a, 2022b, 2022c).

that institutional investors employ an exclusionary screening strategy towards the industries with the heaviest direct CO2 emissions intensity, suggesting that institutional investors exert successful pressure on firms to make environmental commitments. In a survey study, Krueger et al. (2020) report that 29% of 439 institutional investors make efforts to decrease their portfolios' CO2 footprint, with risk management and active engagement (divestment) being the most (least) popular strategies. On the other hand, Basse Mama and Mandaroux (2022) document that European institutional investors are more likely to divest from than engage with the highest carbon emitters. On a similar note, according to Benz et al. (2021) international mutual funds display a substantial aversion toward carbon-intensive corporations. Azar et al. (2021) document that the institutional ownership by the largest mutual funds (i.e., BlackRock, Vanguard, and State Street Global Advisors), is negatively and significantly associated with CO2 emissions of the MSCI World Index constituents.

3. Hypotheses and Methodology

3.1 Hypotheses Development

In 2016, 196 countries signed the Paris Climate Agreement in a global effort to reduce GHG emissions to limit the long-term temperature rise to well below 2°C and preferably to 1.5°C (UNFCCC, 2022). Bolton and Kacperczyk (2022) show that in the follow-up to joining major global disclosure systems such as the CDP (*Carbon Disclosure Project*) and the SBTi (*Science-Based Targe*t *Initiative*), corporations decrease CO2 emissions. On an optimistic note, Andersson et al. (2016) argue that while the Kyoto Protocol failed, the Paris agreement is built on a bottom-up approach and should be more successful with the support of various economic actors and private projects like the *Portfolio Decarbonization Coalition* (hereafter PDC) to drive economic decarbonization (PDC, 2022)[5].

The Paris Agreement is the first legally binding treaty that brought 196 countries to join forces to combat climate change. All nations put forward a target to achieve zero emissions and are committed to undertaking serious efforts to limit global warming (Jacquet and Jamieson, 2016).

[5] As of 2022, PDC has secured USD800 billion of decarbonization commitments from 32 institutional investors (PDC, 2022).

Publicly listed firms are motivated to reduce carbon emissions after the Paris Agreement because of the actions adopted by governments (e.g., mandatory disclosure of carbon emissions by exchanges) and also pressures from responsible investors (Azar et al., 2021; Benz et al., 2021; Bolton and Kacperczyk, 2022). It is expected that a majority of publicly listed firms exerting efforts to reduce carbon emissions after the agreement will lead to a lower dispersion of corporate carbon performance. This leads us to the first hypothesis.

H1: The dispersion of corporate carbon performance is reduced after the Paris Agreement.

Developing countries may face more challenges in mitigating carbon emissions because they ought to pay more attention to economic development, which, in turn, increases energy demand and carbon emissions (Han and Chatterjee, 1997; Kobayakawa, 2021). Furthermore, compared to firms from industrialized countries, firms from developing countries experience greater costs, more barriers, and fewer incentives when trying to reduce CO2 emissions (e.g., Cadez et al., 2019). This can be attributed to e.g., low institutional quality, limited access to renewable energy, lack of environmental regulation, technologies and professional expertise (e.g., Jeswani et al., 2008; Danish and Ulucak, 2020; Welsby et al., 2021; Milindi and Inglesi-Lotz, 2022).

Zhang (2022) employs a sample of listed firms from 60 developed and developing countries to study the reaction of stock prices to changes in climate risk during the 2000-2021 period. Her results indicate that stock prices in markets from developed countries react negatively to climate risk, whereas the price reaction in markets from developing countries is insignificant. Furthermore, Zhang (2022) shows that investors in developed markets reward green firms (with GHG emissions disclosure, targets and policies) but punish brown firms during periods of heightened climate risk. Thus, her findings suggest that the markets/investors in developing countries have low sensitivity (or are insensitive) to the issues of climate risk and the environmental performance of firms. Against this backdrop, we expect that after the Paris Agreement the efficiency of carbon management in listed firms to increase less in developing countries than in developed countries. This leads us to the second hypothesis.

H2: The dispersion of corporate carbon performance is reduced less in developing countries after the Paris Agreement.

Prior studies find that foreign institutional investors can drive local firms to foster long-term investment (Bena et al., 2017), and improve the quality of corporate governance (Aggarwal et al., 2011) and ESG (Dyck et al., 2019). Azar et al. (2021) show that the institutional ownership by the largest three funds, i.e., BlackRock, Vanguard, and State Street Global Advisors, is negatively associated with carbon emissions in the firms covered by the MSCI index in the global market. As such, Azar et al. (2021) document a significant association between institutional investors' pressure and their investees curbing carbon emissions. Yu et al. (2020) examine the sample of 1,925 non-financial firms from 47 countries during the 2012-2016 period and find that greenwashing behaviour attributed to ESG disclosure is abated by several factors including monitoring by institutional investors. Aggarwal et al. (2011) find that the increase of foreign institutional ownership is positively related to the improvement of corporate governance around the world.

In light of the above-outlined empirical evidence, it is expected that the engagement from foreign institutional investors could drive listed firms to improve their carbon performance, especially after the Paris Agreement. Thus, in the third hypothesis, we argue for a greater decrease in the dispersion of carbon performance across firms when foreign ownership is more widespread in a country, ex-post the Paris Agreement.

H3: The dispersion of corporate carbon performance is reduced more in the countries with a large prevalence of foreign ownership after the Paris Agreement.

It has been well documented that international equity investments from developed countries exercise a significant financial effect on domestic firms in emerging countries. For instance, Bae et al. (2006) suggest that emerging stock markets benefit by improving their information environment when they become more open to foreign equity investors. In a study of over 1,100 firms from emerging stock markets, Mitton (2006) finds that firms allowing foreign ownership participation experience higher growth, greater investment, profitability, and efficiency, whilst lower leverage. Li et al. (2011) show that large foreign shareholders provide significant benefits to emerging stock markets through stabilizing and monitoring roles.

In a sample of 18 emerging markets, Errunza and Ta (2015) demonstrate a 26.3% reduction in the cost of equity capital when local firms become partially investable by foreign investors. A further 12.51% reduction is documented when these local firms subsequently become unrestricted

for international ownership, indicating strong economic benefits of market liberalization policies (Errunza and Ta, 2015). In a study of the Chinese stock market, Huang et al. (2022) argue that institutional investors can mitigate the negative impact of controlling shareholders' pledging their stocks as collateral for personal loans through the ESG performance of these firms. Accordingly, it is expected that the effect of foreign ownership on the improvement of the efficiency of carbon management should be larger for developing countries.

H4: The dispersion of corporate carbon performance is reduced more in developing countries with a large prevalence of foreign ownership.

3.2 Sample and data sources

The data on corporate carbon management were collected from the MSCI ESG Intangible Value Assessment (IVA) database which has been widely used in CSR studies (e.g., Ferrell et al., 2016; Liang and Renneboog, 2017; Tashman et al., 2019). The MSCI IVA database provides an overall ESG score as well as separate scores for the environment (E), social (S) and governance (G) pillars, and additional scores for key issues in each pillar. For instance, key issues in the environmental pillar include carbon emissions, water stress, toxic emissions and waste. This study focuses on the carbon emissions score. There are some advantages to using carbon emissions scores from MSCI instead of raw carbon emission data. First, MSCI provides carbon emissions scores of publicly listed firms in the global markets, which cover more than 680,000 equity and debt securities (Busch et al., 2022). As such, the MSCI constitutes the largest data provider of ESG in the world (Eccles and Stroehle, 2018) and covers more listed firms than other data providers such as Asset4. Second, MSCI assigns scores (from 0 to 10) to measure firms' carbon emissions performance, which makes it easily comparable within and across industries and countries. Accordingly, the data fit with our analysis which aims to examine the efficiency of corporate carbon management over time in an international approach. After removing missing observations, there are 20,712 listed firms and 91,884 firm-year observations from 64 countries used to calculate the country-level efficiency measure of carbon management in a sample[6] covering the 2010-2020 period.

[6] We require that each country has at least 30 listed firms. In addition, a country should have relevant carbon and economic data (e.g., greenhouse gas emissions, GDP growth, etc.) from the World Bank. Thus, we remove the

Carbon emission is a key issue under the environmental pillar of the MSCI ESG rating for publicly listed firms. Specifically, MSCI calculates a firm's exposure to carbon emissions risk and its performance to manage carbon risk from raw data such as an annual report, sustainability disclosure, government and academic datasets, media, etc. The scores of risk exposure and risk management are then combined into a '*Key Issue Score*' such that "a higher level of exposure requires a higher level of demonstrated management capability to achieve the same overall Key Issue Score" (MSCI, 2022). Accordingly, the MSCI's carbon emissions score ranges from 0 to 10 where 0 (10) indicates very poor (very good) performance. The details of the carbon emissions score are given in Appendix 2.

The index of the prevalence of foreign ownership in a country (*FOROWN*) is extracted from the World Economic Forum Global Competitiveness Index (Porter et al., 2008; Ekici et al., 2016). Other country-level data, such as total GHG emissions, the ratio of renewable energy consumption to total final energy consumption, the ratio of the market capitalization of listed domestic companies over GDP, annual GDP growth, GDP per capita in USD and industry value added, are collected from the World Bank's Development Indicators dataset[7].

Table 1 reports the number of firms with MSCI carbon emissions scores for each of the years during the sample period (2010-2020). We can observe that the number of firms increases from 1,855 in 2010 to 14,346 in 2020. Furthermore, in each of the sampled years, the majority of the observations are from OECD countries. Specifically, the sample is the most and least unbalanced (in terms of the ratio of OECD to non-OECD firms) in 2010 and 2020, respectively, i.e., the coverage of firms in non-OECD countries improves significantly faster over time. MSCI gradually covers the majority of listed firms in the OECD countries, which provides a carbon performance rating to 90.33% of listed firms in these countries in 2020.

[Insert Table 1 here]

3.3 Variables and econometric specification

We use the listed firms' MSCI carbon emissions scores to calculate the average corporate carbon emissions score in a country in a year (*CARBON*). We measure the annual efficiency of

following jurisdictions: Bahamas, Bermuda, British Virgin Islands, Cayman Islands, Colombia, Costa Rica, Curacao, Isle of Man, Macau and Panama. The full list of 64 countries is provided in Appendix 1.

[7] For the list of all variables and their definitions see Appendix 3.

carbon management in a country by the dispersion of corporate carbon performance scores of listed firms in that country. We follow previous studies (e.g., Abiad et al., 2008; Acemoglu and Dell, 2010; Chancel and Piketty, 2015) and use two inequality indices: the Theil index (*THEIL*) and the mean logarithmic deviation index (*MLD*) as proxies of the dispersion. If listed firms in a country all improve carbon performance, naturally this dispersion decreases. In our analysis, a smaller value of the inequality indices represents a higher efficiency to improve carbon performance in a country. In a similar spirit, Abiad et al. (2008) measure the allocative efficiency of capital in a country by the dispersion of Tobin's Q of listed firms in the country[8].

The Theil index is calculated as per equation (1).

$$Theil\ Index\ = \sum_{i=1}^{i=n} \frac{1}{n_t} \frac{y_{it}}{\mu_t} \log\left(\frac{y_{it}}{\mu_t}\right) \quad (1)$$

Where μ_t is equal to the population mean of carbon emissions score in year *t*, n_t is equal to the total population in year *t*, and y_{it} stands for the carbon emissions score for firm *i* in year *t*.

The mean logarithmic deviation (*MLD*) index is calculated by the following equation (2).

$$MLD_t = log(\mu_t) - \sum_{i=1}^{i=n} \frac{1}{n_t}\ log(y_{it}) \quad (2)$$

Where μ_t is equal to the population mean of carbon emissions score in year *t*, n_t is equal to the total population in year *t*, and y_{it} stands for the carbon emissions score for firm *i* in year *t*. In the robustness tests, we also measure country-level carbon performance in a country by the average (or median) value of the carbon emissions scores of listed firms in the country each year.

We divide the sample period into two subperiods, namely before (2010-2015) and after the passing of the Paris Agreement (2016-2020). Accordingly, we employ the binary dummy variable (*PARIS*) equal to one for the period 2016-2020 and zero for the period 2010-2015. Countries in the sample are classified into developed and developing countries, based on whether they belong to OECD[9]. In the untabulated results, we also classify countries according to the income group by

[8] They argue that if government control is removed, credit can be reallocated from firms with a lower return to the capital to firms with higher return to capital. The financial liberalization thus should reduce the dispersion of expected returns to firms and lead to a lower inequality of Tobin's Q across firms in a country in a year. Similarly, we argue that if carbon policies are effectively implemented in a country, firms with poor carbon performance should catch up with those with good carbon performance, leading to a lower dispersion of corporate carbon performance.
[9] Please see OECD (2022) for the full list of OECD country members.

the World Bank and find similar results. International investor ownership in a country is measured by the prevalence of foreign ownership (*FOROWN*) from the World Economic Forum Global Competitiveness Index (Porter et al., 2008; Ekici et al., 2016). The index ranges from 1 to 7 where 1 (7) stands for very rare (the highest) foreign ownership. Following prior research, we also construct a set of country-level variables that may affect the overall carbon performance in a country (e.g., Zoaka et al., 2022). Specifically, we include the natural logarithm of GHG emissions (*LNGHG*), the percentage of renewable energy consumption in total energy consumption (*RENEW*), the ratio of the market cap of listed firms to GDP in a country in a year (*MCAPGDP*), the natural logarithm of industry value-added (*LNINDUVA*), the ratio of trade to GDP (*TRADE*), annual GDP growth rate (*GDPGROWTH*) and the natural logarithm of GDP per capita (*LNGDPPER*)[10].

Table 2 shows the summary statistics of country-level variables in our sample. The mean value of the country-level annual average corporate emission score (*CARBON*) is 7.106. The average values of the Theil index and the MLD index are 0.055 and 0.050, respectively. High ranges in *CARBON* (0.90-9.63), *THEIL* (0-0.36) and *MLD* (0-0.45) variables indicate significant differences in cross-country corporate carbon performance during the 2010-2020 period. Additionally, the average value of the prevalence of foreign ownership in a country (*FOROWN*) is relatively high and stands at 4.980. On average, 19.6% of total energy consumption comes from renewable energy in the sampled countries, with a maximum (minimum) value of 87% (zero). This, in turn, indicates a large heterogeneity in the prevalence of renewable sources of energy around the world.

[Insert Table 2 here]

The first hypothesis is tested by the following model.

$$THEIL_{i,t} = \alpha_0 + \beta_1 PARIS_t + \sum_{k=1}^{7} \varphi_k X_{k,i,t-1} + Country\ F.E. + \varepsilon_{i,t} \quad (3)$$

Where the dependent variable is the dispersion of corporate carbon emissions scores in a country *i* and year *t*, measured by the Theil index (*THEIL*).[11] α_0 is a constant term, β_1 and φ_k are

[10] The country-level data come from the World Bank's Development Indicators. Occasionally, there are some missing values for some countries in some years. We use linear interpolation to fill the missing values. The World Bank does not provide GHG emissions data for Hong Kong, Puerto Rico and Turkey. Therefore, we manually collect the data from the official websites of these economies.

[11] To conserve space, we only report the results from the Theil index. The results from the mean logarithmic deviation index (MLD) are similar and available upon request.

the coefficients of true unknown parameters to estimate. The key independent variable is the *PARIS* dummy variable. $X_{i,t-1}$ is a vector of seven country-level variables (*LNGHG, RENEW, MCAPGDP, LNINDUVA, TRADE, GDPGROWTH, LNGDPPER*) lagged one year. The country fixed effects (*Country F.E.*) are also included in the model to control for the time-invariant country characteristics. $\varepsilon_{i,t}$ is the error term. In line with the first hypothesis, we expect the estimated coefficient on *PARIS* to be negative and statistically significant, indicating that in general, all countries improve the efficiency of carbon management (reflected in a reduction of the dispersion of carbon emissions scores) after the Paris Agreement. The same model is also run separately for OECD countries and non-OECD countries, which tests whether the improvement of the efficiency of carbon management after the Paris Agreement differs between developed and developing countries (second hypothesis)[12]. Hypothesis 2 is further tested by the following model.

$$THEIL_{i,t} = \alpha_0 + \beta_1 NONOECD * PARIS_t + \sum_{k=1}^{7} \varphi_k X_{k,i,t-1} + Country\ F.E. + Year\ F.E. + \varepsilon_{i,t} \quad (4)$$

Where the key variable is the interaction term of the dummy variable equal to one if a firm is from a non-OECD country and zero otherwise (*NONOECD*) and the *PARIS* dummy variable. As per hypothesis 2, the estimated coefficient on this variable is expected to be statistically significant and positive, indicating that the dispersion of carbon emission scores is reduced less in developing countries after the Paris Agreement. Country and year fixed effects are included in this model[13]. Thus, the dummy variables of non-OECD countries (*NONOECD*) and the Paris Agreement (*PARIS*) are absorbed.

The third hypothesis is tested by the model below.

$$THEIL_{i,t} = \alpha_0 + \beta_1 FOROWN_{i,t-1} + \sum_{k=1}^{7} \varphi_k X_{k,i,t-1} + Country\ F.E. + Year\ F.E. + \varepsilon_{i,t} \quad (5)$$

Where the key independent variable is the prevalence of foreign ownership (*FOROWN*). Accordingly, $X_{i,t-1}$ is a vector of eight country-level variables (*LNGHG, RENEW, MCAPGDP, LNINDUVA, TRADE, GDPGROWTH, LNGDPPER*) lagged one year. The model is run separately for the full period (2010-2020), the pre-Paris Agreement period (2010-2015) and the post-Paris

[12] The estimated results based on equation (3) testing the first and the second hypothesis are presented in columns (1) and (2 and 3) of Table 4, respectively.
[13] The estimated results based on equation (4) testing the second hypothesis are presented in column (4) of Table 4.

Agreement period (2016-2020)[14]. The estimated coefficient on this variable is expected to be statistically significant and negative in the post-Paris Agreement period, which confirms the third hypothesis that the dispersion of corporate carbon performance is reduced more after the Paris Agreement for countries with more prevalent foreign ownership.

The last hypothesis is tested by the following model.

$$THEIL_{i,t} = \alpha_0 + \beta_1 FOROWN_{i,t-1} + \beta_2 FOROWN_{i,t-1} * NONOECD_t + \sum_{k=1}^{7} \varphi_k X_{k,i,t} + Country\ F.E. + Year\ F.E. + \varepsilon_{i,t} \quad (6)$$

The variable of the prevalence of foreign ownership (*FOROWN*) is included, while the key variable in equation (6) is the interaction term between the *FOROWN* term and the *NONOECD* dummy variable. In line with hypothesis 4, it is expected that the estimated coefficient on this variable to be statistically significant and negative, indicating that non-OECD (developing) countries improve the efficiency of carbon management more than OECD (developed) countries if foreign ownership is more prevalent. The model is also separately run for the pre- and post-Paris Agreement periods. The estimated results based on the above model are presented in Table 6.

4. Empirical Results

Table 3 reports the average carbon performance scores (*CARBON*) and the dispersion of the scores (*THEIL* and *MLD*) in the OECD and non-OECD countries before and after the Paris Agreement. We can observe that the *CARBON* values in both samples have been increasing/improving after the Paris Agreement. Moreover, the *CARBON* values are significantly higher in firms located in the OECD countries than those in the non-OECD countries in both subsample periods, which is what we would expect. Furthermore, The *CARBON* of firms in the OECD countries reached 7.942 after the Paris Agreement, while for firms in the non-OECD countries the *CARBON* value is equal to 7.636 in the same period, indicating that firms in both OECD and non-OECD countries achieved relatively good carbon management ability after these countries committed to reducing carbon emissions as per the Paris Agreement. Overall, the gap in the *CARBON* between the two samples has narrowed substantially, with the non-OECD firms

[14] The estimated results based on equation (5) testing the third hypothesis for the full period, the pre-Paris Agreement period and the post-Paris Agreement period are presented in columns (1 and 4), (2), and (3) of Table 5, respectively.

catching up with the OECD firms. The differences in carbon performance scores between OECD firms and non-OECD firms are larger (smaller) in the pre- (post-) Paris Agreement period and are equal to 0.395 (0.307). Furthermore, on average, non-OECD firms encountered a slightly larger increase in carbon performance scores (1.432) than OECD firms (1.344) ex-post Paris Agreement vis-à-vis the ex-ante Paris Agreement. Importantly, Table 3 shows that all of the above-outlined disparities are statistically significant at the 1% or the 5% level.

Table 3 also reports the Theil index of corporate performance scores in the OECD and non-OECD countries before and after the Paris Agreement. We can observe that both groups of countries reduced the dispersion of corporate performance scores after the Paris Agreement, indicating that overall carbon management efficiency has improved in both developed and developing countries. Such initial results support the first hypothesis. However, the reduction in the Theil index is statistically significant (at the 1% level) only in the OECD countries, whilst the magnitude of the reduction is much larger across the OECD countries. This, in turn, is consistent with the second hypothesis and suggests that in the wake of the Paris Agreement, OECD (developed) countries have been more successful than non-OECD countries in pushing publicly listed firms to manage their carbon emissions. In addition, Table 3 shows that the Theil index is higher in the OECD countries than in non-OECD countries in the period before the Paris Agreement, probably because some firms in the OECD countries have very poor carbon management (the outliers) whereas other firms have excellent management. Moreover, the dispersions of carbon management scores are similar between both groups of countries after the Paris Agreement.

The results from the MLD index are similar in that the dispersion of corporate carbon management score is reduced more (with the reduction being more statistically significant) in the OECD countries after the Paris Agreement. Summing up, although on average firms in the non-OECD (developing) countries have encountered slightly higher improvement in the carbon management scores than their peers in the OECD countries, the dispersion of carbon management scores is reduced more in the OECD countries after the Paris Agreement.

[Insert Table 3 here]

4.1 Paris Agreement and the dispersion of corporate carbon performance

The dependent variable is the *THEIL* index proxying for the dispersion of corporate carbon performance, which, as we argue, can be seen as a measure of the efficiency of a country's policies to manage carbon emissions in publicly listed firms. In other words, if carbon policies are effectively implemented in a country, we would expect the firms with poor CO2 performance to catch up with those firms whose CO2 performance is good, thereby lowering the dispersion of corporate carbon performance in a country. In Table 4 we test the first two hypotheses (H1 and H2) based on equations (3) and (4).

Looking at column (1), the estimated coefficient on the *PARIS* dummy variable is statistically significant and carries a negative sign, thereby corroborating hypothesis 1. More specifically, the estimated coefficient equals -0.006, which indicates that on average, we would expect the Theil index to decrease by 0.006 in the aftermath of the signing of the Paris Agreement, corresponding to a sizeable decrease of 10.91% in the average value of the sample's Theil index. Moving on to column (2) presenting the results for OECD countries, we can observe that in comparison with column (1), the estimated coefficient on the *PARIS* term is larger in magnitude (-0.012) and has higher statistical significance. However, the estimated coefficient on *PARIS* is positive and insignificant in non-OECD countries (see column (3)). These estimated results, in turn, support hypothesis 2. Additionally, our findings are in line with prior studies on country-level carbon emissions (e.g., Han and Chatterjee, 1997; Nguyen Van, 2005; Aldy, 2006; Kobayakawa, 2021). Column 4 shows the estimated results from the regression model based on the full sample but with the *NONOECD*PARIS* interaction variable allowing us to test hypothesis 2 in the full sample. The estimated coefficient on the interaction term equals 0.028 and is statistically significant at the 1% level. Therefore, the estimated coefficient suggests that on average, post-Paris Agreement the *THEIL* index in non-OECD countries will be 0.028 higher compared with the OECD countries (corresponding to a massive 50% of the average value of the Theil index in the sample), holding all else constant. Thus, the documented difference between the dispersion in carbon performance of listed firms operating in OECD (developed) and non-OECD (developing) economies is statistically and economically significant and renders support to hypothesis 2.

Concerning other explanatory variables, we can observe that the estimated coefficient on the *LNGHS* variable (natural log of the country's total greenhouse gas emissions) is positive and statistically significant in the non-OECD samples. This, in turn, highlights the strong and positive

association between the aggregate level of greenhouse emissions and the efficiency of corporate carbon management only in non-OECD countries. Moreover, Table 4 shows, statistically and economically significant, the negative effect of the market capitalization on the Theil index, in the full sample and OECD countries. These results are generally consistent with the findings of Nguyen et al. (2021) that market capitalization negatively impacts carbon emissions. We can also infer a statistically significant but positive association between trade and the dispersion of corporate carbon performance scores.

[Insert Table 4 here]

4.2 Prevalence of foreign ownership and the dispersion of corporate carbon performance

Table 5 displays the estimated results from the model testing hypothesis 3 shown in equation (5). The results are robust and provide firm support for hypothesis 3. Specifically, the estimated coefficient on the *FOROWN* variable is statistically significant (at the 1% level) only in column (3) for the post-Paris Agreement period of 2016-2020. The estimated coefficient means that on average, in the aftermath of the Paris Accord on Climate if the prevalence of foreign ownership increases by one notch (e.g., from 4 to 5), the dispersion of firms' carbon performance in the country is reduced by 0.028, ceteris paribus. This translates into a massive decrease of 56% in the average dispersion of corporate carbon performance during the post-Paris Agreement period[15].

Furthermore, the results from columns (1) and (2) show that the coefficients on the *FOROWN* term are insignificant in the regressions based on the full sample period (2010-2020) and the 2010-2015 subperiod alike. Additionally, we can observe that in column (4) the estimated coefficient on the *FOROWN*PARIS* interaction variable is significantly negative, which is consistent with hypothesis 3. In other words, the presented results confirm that the prevalence of foreign ownership significantly reduces the dispersion of corporate carbon performance. Summing up, Table 5 offers robust support for hypothesis 3 by suggesting that after the Paris Agreement, foreign investors are more committed to environmental issues, and successfully pressure their investees on improving their carbon performance. Thus, our study corroborates Azar et al. (2021)'s findings.

[Insert Table 5 here]

[15] The average value of the Theil index during the 2016-2020 subperiod is 0.050.

In Table 6 we present the empirical results based on equation (6). Column (1) reports results based on the full sample, whilst columns (2) and (3) yield the output corresponding to the pre-Paris Agreement and the post-Paris Agreement subperiods, respectively. The results are robust and consistent with hypothesis 4. Specifically, the estimated coefficients on the *FOROWN*NONOECD* interaction variable in columns (1) and (3), carry negative signs and are statistically and economically significant. For instance, the coefficient on the interaction term in column (1) indicates that on average, for the same increase of one notch (e.g., from 3 to 4) in the *FOROWN*, the dispersion of corporate carbon performance decreases by an additional 0.020 in the non-OECD countries compared with the OECD countries. The effect of the prevalence of foreign investors, however, is not significantly different between OECD countries and non-OECD countries before the Paris Agreement.

Interestingly, the estimated coefficient on the interaction term in column (3) is around twice the size and statistically significant at the higher (1%) level, compared with the coefficient from the full period in column (1). As for the economic interpretation of the coefficient on the *FOROWNER*NONOECD* in column (3), a one-notch increase in the prevalence of foreign investors after the Paris Agreement reduces the dispersion of corporate carbon performance by 0.038 more in the non-OECD countries, holding all else constant. Such an estimated effect corresponds to 76% of the average value of the Theil index in that period. Therefore, Table 6 strongly supports hypothesis 3 and indicates that the decreasing effect of foreign investors' prevalence on the *THEIL* index (proxying for the efficiency of carbon management) is stronger in the non-OECD countries after the Paris Agreement. The results are also consistent with the recent study by Azar et al. (2021) indicating that foreign investors are committed to pressing firms to reduce carbon emissions after the Paris Agreement.

[Insert Table 6 here]

5. Conclusion

According to Generation Investment Management (2021), 40% of greenhouse gases emissions were emitted by publicly listed companies in the global market. Accordingly, listed companies play a very important role in limiting global temperature rise, i.e., the main goal of the Paris Agreement. This research investigates the efficiency of improving carbon management in

the listed companies from 64 countries during the 2010-2020 period. Unlike previous studies that focus on the individual firm's carbon emissions (e.g., Azar et al., 2021), we employ corporate carbon performance (including a firm's exposure to carbon risk and its ability to manage carbon risk) to construct country-level efficiency of corporate carbon management based on a sample of 20,712 listed firms and 91,884 firm-year observations. The efficiency of carbon management is measured by the dispersion of corporate carbon management scores from MSCI, following the spirit of previous studies (e.g., Abiad et al., 2008; Acemoglu and Dell, 2010; Chancel and Piketty, 2015). Specifically, we investigate the changes in the carbon management performance of listed firms in the OECD (developed) and non-OECD (developing) countries before and after the Paris Agreement and examine how international investments affect the efficiency of carbon management at the country level.

Our empirical analyses reveal that after the Paris Agreement, the average carbon performance of listed companies in the non-OECD countries increases more than in the OECD countries, indicating that carbon performance in developing countries caught up with developed countries in recent years. Moreover, we find that ex-post the Paris Agreement, the dispersion of corporate carbon performance is reduced more in the OECD countries than in the non-OECD countries. Combining the findings of increasing average country-level carbon performance with a lower dispersion, we can conclude that the reduction in the variation in corporate carbon performance in OECD countries is an improvement in the efficiency of carbon management.

Furthermore, we document that the prevalence of foreign investors is negatively associated with the dispersion of corporate carbon performance but is only significant in the period after the Paris Agreement. Consistent with previous studies (e.g., Azar et al., 2021), foreign investors appear to drive listed firms to improve carbon performance, as many institutional investors are committed (or wish to be perceived as such) to a positive impact on climate change. Furthermore, the observed effect of foreign ownership on corporate carbon performance is stronger in non-OECD countries, especially after the Paris Agreement. In short, our study brings additional insights into the role of international investors in improving corporate carbon performance in developing countries in two dimensions. First, we adopt the MSCI corporate carbon performance ratings (instead of carbon emissions) to explore carbon performance at the country level. Second,

we employ the carbon dispersion (Theil index) methodology to measure corporate carbon management efficiency within a country under an OECD vis-à-vis non-OECD setting.

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Table 1: the number of firms in each year (2010-2020)

	N of firms			% of listed firms		
Year	All	OECD	Non-OECD	All	OECD	Non-OECD
2010	1,855	1,702	153	6.05%	8.34%	1.64%
2011	1,845	1,710	135	5.88%	8.15%	1.50%
2012	2,924	2,590	334	8.21%	10.84%	3.76%
2013	6,880	5,909	971	28.99%	47.47%	9.15%
2014	7,090	6,212	878	28.08%	47.99%	8.17%
2015	6,956	5,904	1,052	31.23%	53.07%	10.95%
2016	10,725	9,047	1,678	42.72%	73.33%	16.49%
2017	11,605	9,700	1,905	45.69%	79.75%	17.51%
2018	13,453	10,067	3,386	53.95%	88.86%	24.02%
2019	14,208	10,419	3,789	49.25%	81.50%	27.02%
2020	14,343	10,659	3,684	45.54%	79.13%	22.75%

Table 2: summary statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
CARBON	637	7.106	1.54	0.90	9.63
THEIL	637	0.055	0.05	0.00	0.36
MLD	637	0.050	0.04	0.00	0.45
PARIS	637	0.499	0.50	0.00	1.00
NONOECD	637	0.469	0.50	0.00	1.00
FOROWN	637	4.980	0.73	2.68	6.57
LNGHS	637	12.030	1.67	6.51	16.36
RENEW	637	0.196	0.19	0.00	0.87
MCAPGDP	637	0.826	1.47	0.03	13.50
LNINDUVAL	637	3.231	0.38	1.83	4.30
TRADE	637	0.987	0.79	0.21	4.43
GDPGROWTH	637	0.026	0.03	-0.10	0.25
LNGDPPER	637	9.753	1.18	6.86	11.73

Table 3: average corporate carbon emissions scores and the dispersion in OECD versus non-OECD groups of countries before and after the Paris Agreement

Period	OECD	Non-OECD	Diff. (OECD - Non-OECD)	t-stat
Average carbon performance score:				
Before Paris Agreement (2010-2015)	6.598	6.203	0.395	(1.97)**
After Paris Agreement (2016-2020)	7.942	7.636	0.307	(3.34)***
Diff. (After - Before)	1.344	1.432		
t-stat	(10.09)***	(8.00)***		
Theil index:				
Before Paris Agreement (2010-2015)	0.065	0.053	0.012	(1.84)*
After Paris Agreement (2016-2020)	0.050	0.050	-0.000	(-0.04)
Diff. (After - Before)	-0.015	-0.003		
t-stat	(-2.74)***	(-0.53)		
MLD index:				
Before Paris Agreement (2010-2015)	0.063	0.052	0.010	(1.61)
After Paris Agreement (2016-2020)	0.042	0.040	0.002	(0.68)
Diff. (After - Before)	-0.020	-0.013		
t-stat	(-4.23)***	(-2.48)**		

***1%, **5%, *10%

Table 4: Paris Agreement and the dispersion of corporate carbon performance

	(1)	(2)	(3)	(4)
Dep. Var. = THEIL	All	OECD	Non-OECD	All
PARIS	-0.006	-0.012	0.005	
	(-1.71)*	(-1.98)**	(1.00)	
NONOECD * PARIS				0.028
				(3.87)***
LNGHS	0.036	-0.046	0.054	0.010
	(1.35)	(-0.89)	(1.77)*	(0.39)
RENEW	-0.007	-0.111	0.110	-0.043
	(-0.07)	(-0.65)	(1.05)	(-0.46)
MCAPGDP	-0.011	-0.027	-0.006	-0.014
	(-2.02)**	(-2.43)**	(-1.03)	(-2.04)**
LNINDUVAL	-0.017	0.018	-0.009	0.022
	(-0.63)	(0.41)	(-0.23)	(0.74)
TRADE	0.029	0.043	0.030	0.036
	(1.87)*	(1.73)*	(1.69)*	(2.48)**
GDPGROWTH	-0.038	-0.154	0.153	0.019
	(-0.45)	(-1.27)	(1.49)	(0.22)
LNGDPPER	-0.019	-0.010	-0.030	-0.029
	(-1.44)	(-0.40)	(-1.90)*	(-1.81)*
Constant	-0.149	0.668	-0.353	0.125
	(-0.43)	(0.96)	(-0.90)	(0.37)
Country Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	No	No	No	Yes
N	637	338	299	637
R-squared	0.4036	0.3155	0.5542	0.4474

***1%, **5%, *10%. The t-statistics reported in parentheses are estimated from robust standard errors.

Table 5: the effect of foreign ownership on the dispersion of corporate carbon performance before and after the Paris Agreement

	(1)	(2)	(3)	(4)
Dep. Var. = THEIL	All	PARIS=0	PARIS=1	All
FOROWN	-0.002	0.012	-0.028	0.002
	(-0.27)	(0.87)	(-2.58)**	(0.24)
FOROWN * PARIS				-0.009
				(-2.05)**
LNGHS	0.033	-0.048	-0.024	0.027
	(1.21)	(-0.79)	(-0.57)	(1.00)
RENEW	-0.077	-0.327	-0.076	-0.047
	(-0.83)	(-1.55)	(-0.64)	(-0.50)
MCAPGDP	-0.014	-0.036	-0.001	-0.014
	(-2.01)**	(-2.84)***	(-0.14)	(-1.99)**
LNINDUVAL	0.003	0.045	-0.048	0.010
	(0.09)	(0.63)	(-1.26)	(0.35)
TRADE	0.022	0.016	-0.027	0.023
	(1.43)	(0.65)	(-1.10)	(1.50)
GDPGROWTH	-0.001	-0.012	-0.051	-0.019
	(-0.01)	(-0.08)	(-0.58)	(-0.22)
LNGDPPER	-0.030	-0.032	0.037	-0.023
	(-1.85)*	(-0.74)	(1.63)	(-1.33)
Constant	-0.040	0.830	0.317	-0.071
	(-0.11)	(1.11)	(0.53)	(-0.20)
Country Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
N	637	319	318	637
R-squared	0.4336	0.4713	0.8250	0.4368

***1%, **5%, *10%. The t-statistics reported in parentheses are estimated from robust standard errors.

Table 6: the effect of foreign ownership on the dispersion of corporate carbon performance in the OECD and non-OECD countries

	(1)	(2)	(3)
Dep. Var. = THEIL	All	PARIS=0	PARIS=1
FOROWN	0.006	0.011	0.004
	(0.68)	(0.56)	(0.42)
FOROWN * NONOECD	-0.020	0.001	-0.038
	(-1.90)*	(0.04)	(-4.01)***
LNGHS	0.033	-0.048	0.006
	(1.22)	(-0.80)	(0.15)
RENEW	-0.052	-0.329	-0.010
	(-0.55)	(-1.56)	(-0.09)
MCAPGDP	-0.013	-0.036	0.001
	(-1.92)*	(-2.84)***	(0.22)
LNINDUVAL	0.002	0.045	-0.034
	(0.07)	(0.64)	(-0.92)
TRADE	0.021	0.016	-0.031
	(1.39)	(0.65)	(-1.26)
GDPGROWTH	0.013	-0.013	-0.069
	(0.14)	(-0.08)	(-0.86)
LNGDPPER	-0.027	-0.032	0.042
	(-1.65)*	(-0.73)	(1.93)*
Constant	-0.074	0.830	-0.208
	(-0.21)	(1.10)	(-0.38)
Country Fixed Effect	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
N	637	319	318
R-squared	0.4370	0.4713	0.8411

***1%, **5%, *10%. The t-statistics reported in parentheses are estimated from robust standard errors

Appendices

Appendix 1: the list of countries/economies in the cross-country analysis

OECD Country/Economy:		Non-OECD Country/Economy:	
Australia	Korea, Rep.	Argentina	Pakistan
Austria	Luxembourg	Brazil	Peru
Belgium	Mexico	China	Philippines
Canada	Netherlands	Cote d'Ivoire	Puerto Rico
Chile	New Zealand	Cyprus	Qatar
Czech Republic	Norway	Egypt	Romania
Denmark	Poland	Hong Kong	Russian
Finland	Portugal	India	Saudi Arabia
France	Slovak Republic	Indonesia	Singapore
Germany	Spain	Kazakhstan	South Africa
Greece	Sweden	Kenya	Sri Lanka
Hungary	Switzerland	Kuwait	Thailand
Ireland	Turkey	Malaysia	Tunisia
Israel	United Kingdom	Malta	Ukraine
Italy	United States	Mauritius	United Arab Emirates
Japan		Morocco	Zambia
		Nigeria	
Total:	31	Total:	33

Appendix 2: MSCI ESG Key Issue Hierarchy

The following table is extracted directly from P.4 of the Executive Summary of MSCI ESG Ratings Methodology. This table lists a total of 35 ESG key issues, which are classified into 10 themes and three pillars. For simplicity, we reproduce the key issues under the environment pillar. For this pillar, there are four different themes and 13 key issues as listed below. Carbon Emissions is one of the key issues under this pillar.

Pillar	**Themes**	**ESG Key Issues**	
Environment	Climate Change	Carbon Emissions Product Carbon Footprint	Financing Environmental Impact Climate Change Vulnerability
	Natural Capital	Water Stress Biodiversity & Land Use	Raw Material Sourcing
	Pollution & Waste	Toxic Emissions & Waste Packaging Material & Waste	Electronic Waste
	Environmental Opportunities	Opportunities in Clean Tech Opportunities in Green Building	Opportunities in Renewable Energy

Key Issue Assessment: The MSCI ESG rating model measures both risk exposure and risk management. Risk exposure is scored on a 0-10 scale. The rating reflects whether a company has developed strategies and demonstrated a strong track record of performance in managing its specific level of risks or opportunities. While Key Issues are first measured quantitatively in each industry, each firm's exposure to each issue varies. Therefore, MSCI ESG Ratings compute firm-level exposure to key ESG risks based on a detailed breakdown including business segments, operation locations, and reliance on outsourced production or government contracts. To rank high on a Key Issue, management needs to perform according to the level of exposure. In other words, a company with high exposure is expected to have very strong management. Therefore, a highly exposed company with poor management will score worse than a company with the same management practices but with lower ESK risk exposure. On the other hand, a company with limited exposure can have a more modest approach to receive the same rating.

Appendix 3: variable definitions

Variable	Definition
CARBON	Average corporate carbon emissions score in a country in a year
THEIL	Theil index measures the inequality of carbon performance in a country in a year
MLD	MLD index measures the inequality of carbon performance in a country in a year
PARIS	Dummy variable, equal to one for years after 2015 and zero otherwise
NONOECD	Dummy variable for non-OECD countries
FOROWN	The prevalence of foreign ownership in a country in a year, ranging from 1 to 7
LNGHS	Natural log of total greenhouse gas emissions in a country in a year
RENEW	The ratio of renewable energy consumption to total final energy consumption in a country in a year
MCAPGDP	The ratio of the market cap of listed firms to GDP in a country in a year
LNINDUVAL	Natural log of industry value-added in a country in a year
TRADE	The ratio of trade to GDP in a country in a year
GDPGROWTH	GDP growth rate in a country in a year
LNGDPPER	Natural log of GDP per capita in the current US dollar in a country in a year