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Family Firms and Carbon Emissions*

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Abstract

This study examines the relationship between family firms and carbon emissions using a large cross-country dataset of 6,600 non-financial firms over the period 2010-2019. We find that family firms emit less carbon than non-family firms, especially after the Paris Agreement. Several factors contribute to this outcome, including governance structure, the degree of family control, R&D spending, and the issuance of green patents. Our study also shows that despite lower carbon emissions, family firms have lower environmental scores, primarily due to their reduced public commitment to emission reduction. Both environmental scores and carbon emissions increase when non-family CEOs are appointed and when family ownership decreases, indicating that agency conflicts may influence these outcomes.

Keywords: carbon emission, ESG, governance, family firms, greenwashing, climate change

JEL Codes: G3; G38; M14

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1. Introduction

Scientific evidence shows that human emissions of greenhouse gases (GHGs), particularly carbon dioxide (CO₂), pose a threat to human habitability (Reilly et al., 2003) and economic activity (Nordhaus, 2019). There is growing evidence that climate risk affects investors' risk perception, leading them to adjust the pricing of stocks, bonds, loans, and real estate (e.g., Bernstein et al., 2019; Bolton and Kacperczyk, 2021; Krueger et al., 2020; Painter, 2020; Seltzer et al., 2023). Additionally, the corporate finance literature identifies several important drivers of a firm's CO₂ emissions, such as gender diversity (Altunbas et al., 2022; Barroso et al., 2024), board and managerial ability (Gaganis et al., 2023), and capital structure (De Haas and Popov, 2019). However, there is limited evidence on how differences in ownership structure affect firms' carbon emissions, particularly regarding the role of family firms in the transition to a low-carbon economy.

Our study aims to fill this void and explore the relationship between family firms and their GHGs emissions.¹ Family firms are a dominant business structure globally, accounting for more than half of global GDP and employing two-thirds of the global workforce (Morck and Yeung, 2004; PwC, 2021). Given their significant economic footprint, understanding the environmental impact of their operations is critical to global GHG reduction initiatives.

Family firms may reduce pollution due to financial and non-financial incentives. Financially, they tend to prioritize the long-term sustainability of their business (Cheng, 2014; Zellweger et al., 2012) and to aspire for intergenerational business transfer (Casson, 1999). Their risk-averse nature (Anderson and Reeb, 2003) and emphasis on maintaining a positive reputation (Sageder et al., 2015; Westhead et al., 2001) might render them more responsive to environmental concerns. Non-financially, family firms might be inclined to uphold their identity and community standing by seeking non-economic benefits, such as placing family members in strategic positions (Gomez-Mejia et al., 2010) or engaging in altruistic and philanthropic activities (Campopiano et al., 2014; Schulze et al., 2003). Moreover, family firms may be more concerned for the fate of future generations, leading them to prioritize environmental stewardship (Homroy, 2023). These intrinsic motivations might impel them to adopt more rigorous decarbonization policies to preserve a specific family identity and demonstrate their commitment to environmental protection. Finally, the specific agency context in family firms

¹ In line with the literature, we employ data that converts all GHG emissions into CO₂ equivalent emissions. To avoid burdening the writing, the remainder of the paper refers to CO₂ equivalent emissions simply as CO₂ emissions. Hence, GHG and CO₂ emissions are used interchangeably in the manuscript.

is likely to influence their environmental strategies. While family owners effectively align shareholder and manager interests, thereby reducing Type I agency costs, they are also more inclined to prioritize personal benefits deviating from strict shareholder wealth maximization, increasing Type II and IV agency costs between controlling and minority shareholders and between family members, respectively (Anderson et al., 2009; Villalonga et al., 2015).

In this study, we investigate the relationship between a firm's family ownership and CO₂ emissions using a sample of 6,600 non-financial companies from 42 countries over the period 2010-2019. We use CO₂-equivalent emissions as a key indicator of firms' environmental performance. This metric includes both CO₂ and other greenhouse gases and is widely recognized as an effective measure for policymakers and the public in evaluating sustainable development efforts. We explore the three scopes of emissions, with a greater focus on Scope 1, which is directly related to firms' activities. Following notably Aswani et al. (2024), we examine emissions from two perspectives: emissions intensity—where emissions are normalized by firm revenues—and absolute emissions levels.

We begin our empirical analysis by regressing the carbon emissions intensities of the firms on the family firm measure, in addition to several firm characteristics and country, industry, and year fixed effects. We hypothesize that due to financial and non-financial motives, family firms view high levels of GHGs as an existing risk to their business, and thus, they are more proactive in reducing their carbon footprint. Our main results confirm that family firms have lower emissions, both direct and indirect, compared to non-family firms. This effect is stable across several specifications. Next, we use the 2015 Paris Agreement as a quasi-exogenous shock in the perception of climate issues to examine shifts in emission intensity for both family and non-family firms around this event. The Paris Agreement raised awareness of the extent of climate risks among all stakeholders, leading to a heightened awareness on the need to undertake actions to mitigate these risks and transition towards a low-carbon economy.² We find that for each emission scope, the effect of family firms is negative and significant, mainly after the Paris Agreement, indicating a larger change in the behaviour of family firms.

We then explore potential mechanisms that might explain the distinct effect of family firms on CO₂ emissions. First, we examine the heterogeneous effect of family ownership on emissions,

² The Paris Agreement established a global framework to reduce GHG emissions and limit global warming to well below 2°C. Since 2016, nearly all countries in the world have ratified the Paris Agreement. This ratification has heightened general awareness of climate change, which has been further strengthened by the growing climate change movements. The increasing environmental activism, which includes institutional investors (Azar et al., 2021), is pressuring more and more companies to reduce and offset carbon emission.

considering different levels of corporate governance across firms. We find that family firms with a governance committee, with larger boards and with more educated and longer-tenured directors are more active in emission reduction. This suggests that specific governance structure and boards composition are conducive to a reduction in carbon emissions. Second, we show that firms that are strongly controlled, managed, and/or governed by family members pollute less than their counterparts. This underlines that family involvement in the business contributes to the reduction in CO₂ emissions. Next, we show that family firms began investing more in R&D after the 2015 Paris Agreement, suggesting that part of our results may be related to innovations and technical changes in the production or service process. Finally, we find that family firms issued more green patents, with these patents receiving more citations, indicating greater efforts to mitigate emissions and higher quality innovations.

Lastly, we examine the extent to which this difference in carbon emissions is reflected in firms' Environmental, Social, and Governance (ESG) scores and public image. We document that family firms exhibit lower environmental scores than non-family firms. When exploring the underlying factors that could explain this situation, we find that family firms commit less to reducing their carbon emissions than other firms. They did not change this behavior after the Paris Agreement. This paradox indicates a lower commitment to public disclosure of environmental performance and a potentially a lower propensity to engage in greenwashing. These results are consistent with the recent findings of Villalonga et al. (2023) and Dyck et al. (2024). Notably, Dyck et al. (2024) show that while family firms take carbon emissions seriously, they do not 'bark' as much about their success and, therefore, obtain lower environmental scores from the main ESG score providers. We offer an empirical explanation of this paradox, which may be attributed to differences in family firms' governance structures and agency conflicts (e.g., Abeysekera and Fernando, 2020; Anderson et al., 2009; Villalonga et al., 2015). We show that the discrepancy between carbon emissions and public image notably appears when family firms appoint an external CEO (i.e., not a family member) and when the share of non-family shareholders increases in the firm. In both of these cases, actual carbon emissions decrease while public commitments to reduce carbon emissions and ESG scores increase. This indicates that the paradox may be related to the resurgence of Type I and Type II agency conflicts within family firms.

We examine the robustness of our results by first ensuring that they do not depend on our measures. We use the absolute emissions levels as an alternative measure of CO₂ emissions and different definitions of family firms. Despite these variations, our main results remain

unchanged. We also document that our main findings are not driven by vendor-estimated emissions, as opposed to firm-disclosed actual emissions, addressing recent concerns raised by Aswani et al. (2024). Furthermore, our additional cross-sectional analysis shows that the positive effect of family ownership on CO₂ emissions holds across high and low emitting sectors and across regions, especially after the Paris Agreement.

To address potential endogeneity concerns and strengthen the robustness of our results, we employ several strategies. First, we include country-by-time and country-by-industry fixed effects and implement Oster's (2019) methodology to assess the role of unobservables on our results. Second, we match family and non-family firms on the basis of observable characteristics, thereby creating comparable samples across multiple dimensions. Third, we implement a dynamic difference-in-differences (DiD) strategy centered on the 2015 Paris Agreement to test that there are no divergent trends in emissions between family and non-family firms before the agreement. All these additional tests provide results consistent with our baseline model.

Our study makes several contributions to the growing literature on climate change and environmental protection. First, our study relates to the growing literature on the environmental outcomes of family business. Huang et al. (2009) survey 235 manufacturing firms in Taiwan and document that family firms are more likely to pursue green technical and managerial innovations in response to internal stakeholder pressure. Saeed et al. (2022) find a positive relationship between the adoption of an effective environmental management system (ISO 14001) and Chinese family firms, especially those affected by reputational concerns and located closer to large cities. Berrone et al. (2010) show that family firms have lower on-site emissions in the US, while Yang et al. (2022) find that they are more likely to apply for green patents in China. Our paper complements this strand of literature by using a large international sample of non-financial firms and employs direct carbon emission measures rather than indirect proxies for carbon pollution. We provide robust evidence that family firms have lower CO₂ emissions compared to similar non-family firms with a significant reduction following the Paris Agreement.³

Second, our study contributes more generally to the corporate social responsibility (CSR) literature by demonstrating the role of family ownership and CEOs on a non-financial outcome.

³ Our estimates are group averages and should be interpreted as such; they do not imply that all family firms display better environmental outcomes. Environmental scandals have also tainted family-owned firms; see, for instance, Bennedsen et al. (2013).

Previous studies on family ownership and CSR have produced contradictory results. On the one hand, the preliminary study by Dyer and Whetten (2006) suggests that family firms are more socially responsible than their counterparts on several dimensions. Similarly, Block and Wagner (2014) find that family ownership has a positive impact on some dimensions of CSR (diversity, employees and product), but at the same time a negative impact on the community component. Cruz et al. (2014) and Abeysekera and Fernando (2020) also conclude that family firms can be both socially responsible and irresponsible. On the other hand, Rees and Rodionova (2015), El Ghouli et al. (2016), Tenuta and Cambrea (2022), and Atiqa et al. (2023) show that family-controlled firms have lower CSR. Our study expands this literature by showing that family firms are less carbon-intensive than non-family firms.

Third, our paper contributes to the growing literature on ESG scores and greenwashing, which finds a large discrepancy between firms' climate commitments and their observed behaviour. For example, Duchin et al. (2022) document how polluting firms divest some of their most polluting assets after scandals without changing their practices, while still retaining access to these assets through their supply chain and gaining higher ESG ratings in the process. Berg et al. (2022a) also show that ESG ratings from different providers are internally inconsistent and that the rating agency's non-environmental perception of the firm influences its environmental rating. We add to this literature by highlighting a paradox between the communication and actual carbon pollution of family firms. Pointing out this stark disconnect between the firms' climate commitments and their activities is an important topic, as an increasing number of stakeholders rely on environmental disclosure and communication to properly assess the environmental impacts of firms (Marquis et al., 2016).

The rest of this paper is organised as follows. Section 2 describes the data and research methods. Section 3 presents the main empirical results, including the impact of the Paris Agreement. Section 4 focuses on different mechanisms that underpin our results, while Section 5 details the effect of family ownership on ESG scores and emissions commitments. Section 6 reports robustness estimates, with a focus on endogeneity concerns. Section 7 concludes the paper.

2. Data and empirical setting

2.1. Databases

To examine the relationship between family firms and pollution, we merge data from three different sources. First, we use the Family Firms, Corporate Governance, and Directors datasets from the NRG Metrics database to identify family firms and other governance and board

measures. NRG Metrics uses publicly available documents to collect information on corporate governance, including the identification of family firms. Customized software programs check the data entry level for inconsistencies and errors through a series of quality control measures.⁴ Previous studies have validated these datasets in both the management and finance literature (e.g., Cho et al., 2019; Delis et al., 2020; Eugster et al., 2024; Marano et al., 2022; Miroshnychenko et al., 2021). Next, the NRG datasets are combined with CO₂ emissions data from Urgentem. Finally, we obtain balance sheet, financial and environmental, social and governance (ESG) data from Refinitiv. We primarily use the International Securities Identification Number (ISIN) as the key identifier for data matching. In cases where an ISIN is not available for a match, we use company name-based matching.

After consolidating the datasets and excluding financial firms, our sample consists of 6,600 unique public companies listed in 42 countries between 2010 and 2019. The final sample consists of an unbalanced panel dataset with 38,498 firm-year observations.⁵ The definition and source of all variables used in this study are detailed in Appendix Table A1.

2.2. *Firms' GHG emissions data*

We obtain firm GHG emissions data from the Urgentem database, an independent provider of climate risk data, acquired by Intercontinental Exchange (ICE). The dataset provides comprehensive information on corporate GHG emissions, including firms' absolute direct and indirect emissions as well as emission intensities. Urgentem adheres to the Greenhouse Gas Protocol, which sets the standard for measuring GHGs.⁶ In particular, Urgentem calculates and provides annual CO₂ equivalent emissions data for listed companies in both developed and emerging markets.

The dataset distinguishes between three sources—or scopes—of emissions. Scope 1 emissions refer to direct emissions from sources owned or controlled by the company and include emissions from fossil fuels used in the production process. Scope 2 emissions result from the consumption of purchased energy (heat, steam and electricity) that is sourced upstream of the company. Finally, Scope 3 emissions include all other indirect emissions that occur in a company's value chain. This dataset has been used in other climate-related studies (e.g., Alogoskoufis et al., 2021).

⁴ See additional information on the NRG Metrics' website: <https://nrgmetrics.com/data-collection>

⁵ The useable sample for the main regression analysis reduces to 25,596 firm-year observations due to missing observations for some of the control variables and the use of lag variables for the controls in our models.

⁶ See for more information: <https://ghgprotocol.org/corporate-standard>

Our primary interest lies in Scope 1 emissions, as these are directly controlled by the firm. Following Ilhan et al. (2021) and Bolton and Kacperczyk (2021), we calculate CO₂ emission intensity by scaling a firm's CO₂ emissions (in tonnes) by its total revenues (in millions of dollars). Garvey et al. (2018) and Aswani et al. (2024) argue that this measure is more appropriate as a proxy for firm carbon efficiency compared to absolute emissions, as it links environmental and economic outcomes. We start by focusing on Scope 1 emissions. Subsequently, we extend our analysis to include Scope 2 and, finally, Scope 3 emissions. The third variable aggregates all scopes, which may be particularly relevant for certain industries such as automotive and manufacturing (Bolton and Kacperczyk, 2021). For robustness, we also use absolute CO₂ emissions of companies (e.g., Azar et al., 2021).

2.3. *Definition of Family Firm*

The literature points to the lack of a generally accepted definition of what constitutes a family firm (e.g., Chrisman et al., 2005; Harms, 2014; Kraus et al., 2011). In our study, we adopt a definition consistent with Villalonga and Amit (2006) and create a family dummy variable that takes the value of 1 if the founder or a member of the founder's family (including descendants) holds an executive position, sits on the board of directors, or owns more than 5% of the firm's equity, either individually or collectively, and 0 otherwise.⁷

Our chosen definition allows for the inclusion of a broader range of family firms compared to a more restrictive definition. It captures the diverse characteristics of family firms, goes beyond the mere percentage of ownership as the sole criterion (Bennedsen et al., 2021). In particular, this definition includes firms where family members have a minimal shareholding but still exercise operational control, as observed in firms such as Toyota and Casio in Japan (Bennedsen et al., 2021). This approach is also consistent with definitions commonly used in US research, which has a more dispersed ownership landscape (e.g., Faccio and Lang, 2002; La Porta et al., 1999).

Table 1 shows the distribution of our sample between family and non-family firms across different regions and industries. Based on our definition, 32% of our sample consists of family firms, and the distribution is similar across North America, Europe, and Asia. This proportion is consistent with the 37% share of family ownership reported in the study by Amit and Villalonga (2014). Looking at the prevalence of family firms across industries, we find the

⁷ For robustness, we also examine alternative definitions of family firms in Section 6.1 as suggested by previous research (e.g., Miller et al., 2007).

highest proportion in technology firms (41%) and the lowest in utilities (12%). The other sectors in the sample range from 20% to 40% in terms of family firm presence. Finally, the proportion of family firms remains stable over time (30.6-33.9%).⁸

[Table 1]

2.4. Firm-level controls

We include several firm-level variables to control for confounding factors that may affect the emissions of firms in our sample (Azar et al., 2021; Bolton and Kacperczyk, 2021). We control for *Size*, which is the natural logarithm of total assets; *MBV*, representing the Market-to-Book value ratio; *PPP*, indicating the ratio of property, plant and equipment to total assets; *CAPEX*, defined as the ratio of capital expenditure to total assets; *ROA*, return on assets, calculated as the ratio of net income to average total assets; *Leverage*, measured as the ratio of total debt to total assets; *Liquidity*, measured by the ratio of total current assets to total current liabilities; and *Age*, determined by the year of incorporation. In order to reduce the impact of outliers, we winsorize all firm-level variables at the 1% and 99% levels. In addition to these firm-level variables, we control for industry, country and year fixed effects in all our regressions.

2.5. Descriptive statistics

Panel A of Table 2 presents the summary statistics for the main variables used in the study.⁹ On average, the emissions intensity of Scope 1 CO₂ emissions is 124 metric tonnes per million USD of firms' revenues. This indicates that each million dollars of revenue, on average, generates 124 tonnes of CO₂. Adding Scope 2 emissions, which accounts for firms' energy consumption, increases the CO₂ emissions intensity to 166 tonnes per million dollars of revenue. When the analysis further includes indirect emissions (Scope 3), the CO₂ emissions intensity rises sharply, with each million dollars of revenue generating, on average, 1,506 tonnes of CO₂. As documented in the literature, Scope 3 emissions tend to capture distinct sources of pollution.

Correlations reported in Panel B of Table 2 show that Scope 1 and 2 exhibit a 98% correlation, while the correlation between Scope 1 and 3 stands only at 59%. Larger firms with higher Market-to-Book ratios, more tangible assets, greater capital expenditures, and higher leverage

⁸ It is worth noting that the number of observations in our sample increases markedly over time, primarily due to the expansion of NRG Metrics' coverage, both in terms of the number of countries and the number of companies within each country.

⁹ Appendix Table A2 presents the mean values for the variables by country and Table A3 shows summary statistics for the additional variables employed in this study, in their chronological order of use.

tend to have higher emission intensities. On the other hand, less profitable and less liquid firms generally emit less CO₂. Finally, our family firm measure is negatively correlated with all three measures of CO₂ emissions.

Panel C of Table 2 highlights significant differences between family firms and non-family firms across different scopes of pollution. Family firms exhibit a Scope 1 emission intensity of 83 metric tonnes per million USD of revenue, compared with 144 metric tonnes for non-family firms. Similar differences exist for Scope 2 and Scope 3 emissions, indicating a distinct environmental impact between the two groups. In terms of financial characteristics, family firms generally tend to be smaller and exhibit lower leverage. They also possess fewer tangible assets (PPP) and are slightly less profitable (ROA). Conversely, they invest more in capital expenditures and maintain higher liquidity reserves. Interestingly, family firms are usually younger. One possible reason for this could be that, at a certain stage, some family firms have no successors to pass the business on to, and they become non-family firms.¹⁰

[Table 2]

Figures 1 and 2 display the average emission intensity (Scope 1) across the two types of firms, across regions and industries, respectively. Generally, European firms appear to have the lowest average emissions. In all three regions, family firms pollute less than non-family firms, with the gap being most pronounced for firms located in North America. Utilities, Oil & Gas, and Basic Materials emerge as the most polluting sectors in terms of intensity. Across all sectors, family firms emit less CO₂ as a proportion of their revenues. In less polluting sectors like Technology, Consumer Services, and Consumer Goods, family firms show a larger relative gap in CO₂ emission intensity compared to non-family firms. Figure 3 reports the evolution of Scope 1 emission intensities over time for both family and non-family firms, showing that family firms consistently emit less CO₂ than non-family firms.

[Figures 1-3]

2.6. Empirical Setup

We employ the following regression equation to investigate the impact of family firms on CO₂ emissions:

$$y_{i,t} = \beta_0 + \beta_1 \text{Family}_{i,t} + \gamma X_{i,t-1} + \delta_{i,t} + \mu_{c,t} + \epsilon_{i,t} \quad (2)$$

¹⁰ To address the concern that differences in firm characteristics between the two groups might be driving the results, section 6.3 also uses a propensity score matching approach. In the matched sample, these differences are no longer statistically significant, and the results hold.

where $y_{i,t}$ represents the CO₂ emission intensity for firm i in year t . The dummy variable $Family_{i,t}$ identifies family firms, while $X_{i,t-1}$ is a vector containing firm-level control variables, lagged by one period to mitigate potential simultaneity issues. We account for time-invariant industry effects, denoted as $\delta_{i,t}$, and common time- and country-specific shocks, denoted as country-year fixed effects $\mu_{c,t}$. $\epsilon_{i,t}$ is the error term. Standard errors are clustered at the firm level. We opt for firm-level clustering over industry-level clustering to avoid biased standard errors, particularly since the number of industry clusters is relatively small (Cameron and Miller, 2015).

Given the minimal within-group variation in family firms, our model does not support the inclusion of firm fixed effects that would remove unobserved (time-invariant) heterogeneity at the firm level. Therefore, a key concern surrounding our identification strategy is the potential correlation between the time-invariant component of the error term and the family firm dummy variable. For example, our control covariates and fixed effects might not fully eliminate the risk associated with the ownership structure's dependence on the location of the firm's activities and the choice of business segments, which are factors that may also impact the firm's emissions. To mitigate these potential endogeneity problems, we employ a difference-in-differences approach, using the 2015 Paris Agreement as the event of interest. Falkner (2016) argues that the regulatory shift following the Agreement was both abrupt and unexpected. The Agreement's date has been used in prior research as a quasi-exogenous shock, altering firms' motivations to reduce their pollution outputs (e.g., Ginglinger and Moreau, 2023; Reghezza et al., 2022).

We adopt this approach, examining changes in emission intensities around the Paris Agreement for both family and non-family firms. More formally, our approach falls within the category of methods where the effect of a variable of interest is inferred by using an exogenous shock that affects the dependent variable and examining the differential responses of the outcome given pre-existing variations in the main variable of interest (see, e.g., Altunbas et al., 2022; Campello, 2003; Fresard, 2010; Gilje and Taillard, 2016). This analysis leads to the following modified model, which extends Equation 1:

$$y_{i,t} = \beta_0 + \beta_1 Family_{i,t} + \beta_2 Paris_t + \beta_3 Family_{i,t} \times Paris_t + \gamma X_{i,t-1} + \delta_{i,t} + \mu_{c,t} + \epsilon_{i,t} \quad (2)$$

In this equation, $Paris_t$ is a dummy variable that takes the value of 1 between 2015 and 2019 and 0 for the years before. We set the treatment date as 2015, rather than the subsequent year of the Agreement's formal approval, since various studies indicate that firms began responding to the new policy as soon as it was publicly announced (Carboni et al., 2017; Schäfer et al.,

2016). The coefficient β_3 is of particular interest, as it captures the distinct impact of the Paris Agreement on both types of firms under the assumption that the emission intensities of family firms would have evolved along similar trends as non-family firms in the absence of the Paris Agreement. All other variables remain consistent with those in Equation (1), and standard errors are clustered at the firm level.

3. Family Firms and Carbon Emissions

This section presents the results of the ordinary least squares (OLS) regressions that relate intensities of carbon emissions to family firm status. It also stresses the impact of the Paris Agreement. Our main model incorporates the full sample of firms, and we progressively consider the three scopes of emissions. The model controls for firm size, capital structure, profitability, age, and tangibility of assets, in addition to country-years and industry fixed effects. Results are reported in Table 3.

[Table 3]

Across all scopes of emissions, family firms display significantly lower levels of emissions intensity (columns 1-3). The effect is economically meaningful. Focusing on direct emissions only (Scope 1), family firms emit 12.8 tonnes less per USD million of revenue than non-family firms. Given an average Scope 1 emission intensity of 124 tonnes per million USD, this represents an average reduction of emission-to-revenue of 10.32%. The effect intensifies when including indirect emissions (Scope 2); family firms have a lower emission intensity of 15.6 tonnes per USD million. When accounting for both direct and indirect emissions, family firms emit 71.5 tonnes per USD million in revenue less than non-family firms. This result supports our main hypothesis regarding the potentially different pollution intensities of family firms. Family firms are consistently less polluting than non-family firms.

Looking at the control variables, larger firms and those with more tangible assets tend to have higher emissions. Profitability is negatively related to emissions, and firms with higher levels of debt emit less. Finally, age does not have a significant impact.¹¹ Overall, the findings indicate that family firms lead to better environmental performance, even when accounting for other potential firm-specific characteristics.

¹¹ In all the specifications, the coefficients for the firm-level control variables are consistent and qualitatively similar. Henceforth, we will not discuss them further in this paper.

We then use the Paris Agreement as a shock to firms' perception of climate-related risks. We employ a difference-in-differences (DiD) methodology to analyze how emission intensities changed around the event for family and non-family firms (see Equation 2). Previous studies (e.g., Ginglinger and Moreau, 2023; Reghezza et al., 2022) have shown that the Paris Agreement, enacted in 2015, serves as a strong and clear exogenous signal for the tightening of future carbon emission regulations. This has led firms to update their beliefs about the impacts of climate change and adjust their carbon emissions accordingly. Columns 4-6 of Table 3 present our findings.

Across the three scopes, the effect of family firms on emissions is negative and significant after the Paris Agreement. For Scope 1 and Scope 1 plus 2 (models 4 and 5), the coefficient is significant at the 1% level, whereas for Scope 1 to 3 (model 6), it is significant at the 10% level. This suggests that the reduction in emissions by family firms may be partly due to their adoption of greener energy sources in their production processes. The variable for *Family* alone is not significant, indicating that, prior to the agreement, there was no statistically significant difference between the two types of firms. The Paris Agreement appears to have triggered a distinct change in behavior and emissions intensities for family firms. Family firms reacted more strongly to the Agreement and reduced their carbon emissions more than non-family firms.

4. Mechanisms

In this section, we evaluate four possible mechanisms that could explain the negative relationship between family ownership and carbon emissions. First, we examine the role played by differences in governance structure. Second, we assess the importance of family control and family involvement. Third, we turn to the transmission of the effect through R&D expenses and, finally, through green patenting. Definitions for all variables used in this section, along with their sources, as well as descriptive statistics and difference-in-means tests, are provided in appendices Table A1 and A3, respectively.

4.1. Governance Structure

To explain our main result, we initially consider the influence of the governance structure, focusing on potential differences in governance between family firms and non-family firms. On one hand, the literature on family firms has identified differences in governance as a key factor

explaining distinct effects between the two types of firms on economic outcomes (e.g., Villalonga and Amit, 2006). Family firms are notably characterized by longer tenures and the presence of family members on the board, which impacts their financial performance (Wilson et al., 2013). On the other hand, the literature has underlined the role of board characteristics on emissions levels (de Villiers et al., 2011). For example, Haque (2017) finds that board independence and board gender diversity are positively associated with CO₂ reduction initiatives. However, no clear relationship is identified between other corporate governance variables and firms' CO₂ emissions.

We focus on six board characteristics: the presence of women on the board (*Board Gender*), the number of board members (*Board Size*), the presence of a governance committee (*Governance Committee*), the expertise of the board (*Board Skills*), the education level of board members (*Board Education*), and the average tenure of board members (*Board Tenure*). First, we check whether our baseline results are maintained when these board characteristics are taken into account. Next, we interact the family firm variable with each of the board characteristics to document their role in explaining our results. Table 4 reports the estimates using Scope 1 emission intensity as the dependent variable.

[Table 4]

The first column includes board characteristics without any interaction. The coefficient of *Family* remains negative and statistically significant, and its magnitude aligns closely with the main results presented in Table 3. This supports the view that the positive effect of family firms on reducing emissions persists even after accounting for board characteristics. Among all the board characteristics, only the presence of a woman on the board contributes to a reduction in emission levels. This supports the findings of Atif et al. (2021) and Altunbas et al. (2022), who also documented a positive effect of board gender diversity on reducing emissions intensity.

The next six models introduce interactions between board characteristics and the family firm indicator. Several dimensions have a clear effect. In comparison with non-family firms, family firms with more extensive board memberships emit less carbon, which may imply that stronger involvement of more family members in supervisory and decision-making positions promotes better environmental practices. Family firms with a governance committee also report lower emissions than non-family firms without such committees, suggesting that dedicated oversight and strategic guidance may enhance the firm's commitment to environmental sustainability. In addition, our results show that, in contrast to non-family firms, family firms with more educated board members (a higher proportion of board members with a Master's degree or PhD) also

have lower carbon emissions. This is not surprising, as people with higher education are usually more aware of and less skeptical about the adverse effects of climate change (Angrist et al., 2024). Furthermore, family firms with longer board tenures demonstrate significantly lower emission levels. This supports the idea that the long-term vision of family firm boards plays a key role in abating emissions. However, not all governance dimensions affect the relationship between family ownership and GHG emissions. Family firms do not benefit from a strong presence of women on the board or from having a higher percentage of board members with industry-specific or finance skills.

4.2. *Family Control and Involvement*

In this section, we explore how different degrees of family control and family involvement in managing the firm's operations might play a role in explaining our results. We measure family control in the firm based on the percentage of family ownership (*Family Share*) (e.g., Gomez-Mejia et al., 2018). We measure family involvement in managing the firm with several board-level variables. First, we use the family representation on the board (Barontini and Bozzi, 2018), proxied by the percentage of family members in the board (*Family Board*). Second, we focus on the appointed CEO and whether he/she is a family member (*Family CEO*) (Naldi et al., 2013) as well as the chairman of the board (*Family Dual*). Goergen et al. (2020) find that firms employ CEO duality to promote clear and consistent leadership, directional clarity, and effective and fast decision-making. We further decompose the last two variables into *Founder CEO/Dual* and *Descendant CEO/Dual*, as family generation might also play a role (Aguilera and Crespi-Cladera, 2012). In terms of specification, we replace the dummy variable *Family* with the percentage of family ownership in order to disentangle the effect of ownership from involvement in the board, while still employing the full sample of firms. A similar approach is adopted by Lozano-Reina et al. (2022). Table 5 presents the results using Scope 1 emission intensity as the dependent variable.

[Table 5]

The first model focuses on the role of family ownership and family control on the board. We also interact the two variables to verify whether the impact of family shareholders varies with different levels of family involvement on the board. To facilitate the interpretation of the constituent term coefficients, we mean-center both variables so they reflect the conditional effect of one term when the other term is at its raw mean (Burks et al., 2019). The results in column 1 show that the coefficients for *Family Share* and *Family Board* are negative and

statistically significant. This indicates that greater representation of families in both the shareholding structure and the board correlates with a reduction in CO₂ emissions. The interaction term between family ownership and the proportion of family board members is positive and statistically significant. This suggests that increasing family ownership and control has diminishing returns in terms of CO₂ reduction. At very high concentrations of family control, the focus may overly shift toward preserving family wealth and status, potentially at the expense of broader societal or environmental considerations.

The second column of Table 5 evaluates the impact of family involvement in top management roles, specifically through the *Family CEO* variable. A consistent narrative emerges here as well: greater family ownership and CEO involvement lead to reduced CO₂ emissions. Furthermore, firms led by family CEOs tend to emit less than their counterparts, suggesting that an embedded family ethos might be environmentally beneficial. Once again, the positive coefficient of the interaction term indicates that the combined effect of family ownership and CEO involvement might soften the reduction in CO₂ emissions, although it never results in a net increase in emissions. In column 3, this effect becomes more pronounced when the family CEO is also the chairman of the board (*Family Dual*). Finally, columns 4 and 5 provide a generational perspective, indicating that emissions tend to decrease more significantly when the firm transitions to descendants. This indicates a positive environmental impact maintained across family generations.

These results show that more family control and more involvement of family members in the firm's operations lead to lower carbon emissions in the cross-section of firms. Several reasons may explain these findings. Exposure to climate change may affect the firm's bankruptcy risk (Feng et al., 2024). Since family firms tend to prioritise longer-term survival in order to pass the business on to the next generation (e.g., Zellweger et al., 2012), this may render contemporaneous reductions in CO₂ emissions more financially attractive. Firms with more family involvement might also have stronger family goals and base more of their decisions on emotional and altruistic motives (Schulze et al., 2003). For instance, they might care more about their descendants living in a polluted world (Homroy, 2023). In more general terms, family involvement and control are positively correlated with family loyalty, reputation (Songini and Gnan, 2015), and values (Chrisman et al., 2012; Stavrou et al., 2007). Given that reducing CO₂ emissions has a high socio-emotional value for the community (Gomez-Mejia et al., 2007), this may explain why firms with more family involvement adopt more rigorous decarbonisation

policies. However, the benefits of increasing family involvement and control in the company do not rise linearly, and at very high levels of concentration, they start to diminish.

4.3. *Research and Development Expenditure*

Higher technological advancement could be one potential mechanism by which family firms achieve lower carbon emissions compared to non-family firms. The existing literature provides diverging evidence on the difference between family and non-family firms in terms of innovation and investment. A large share of research suggests that family firms are reluctant to invest in research and development (Anderson et al., 2012; Chen and Hsu, 2009; Munari et al., 2010; Muñoz-Bullón and Sanchez-Bueno, 2011), while some studies suggest that family firms are more likely to engage in innovative activities (Craig and Dibrell, 2006; De Massis et al., 2018) or find diverging results depending on family firms' characteristics (Block, 2012). Sample size, location, and time period vary widely across these studies. In our case, we examine Research and Development (R&D) expenditure among family firms and non-family firms in the periods before and after the Paris Agreement. Additionally, we investigate whether family firms with higher emission levels are more inclined to invest in R&D.

We run a regression in which we use the ratio of R&D expenditure to a firm's total assets as the dependent variable and incorporate firm-level controls,¹² as well as industry and country-by-time fixed effects. The model also includes a dummy for the family firms and the firms' carbon intensity using Scope 1. As shown in Table 6, results show no significant differences in the propensity to allocate resources towards R&D between family and non-family firms, consistent with the mixed results found in the literature. Specifically, the results in column 1 indicate that family firms do not show a more pronounced inclination toward R&D expenditure, even when controlling for emission levels (column 2).

[Table 6]

Next, we examine the effect of the Paris Agreement on R&D expenditures. In column 3, the coefficient for the interaction term between family firm status and the post-agreement period is positive and significant. Thus, the results indicate an increase in R&D expenditures among family firms relative to non-family firms. This aligns with earlier findings, implying a synergistic effort by family firms to complement emission reductions with greater R&D spending. However, this trend does not appear to be related to the level of carbon emissions of family firms as the triple interaction term is statistically insignificant in column 4.

¹² We exclude CAPEX from the firm-level controls because of its high correlation with R&D expenditures.

In summary, our findings reveal that the reduction in CO₂ emissions by family firms following the Paris Agreement coincides with an increase in R&D expenditures, a trend that occurs regardless of their emission levels.

4.4. *Green patents*

Given the increase in R&D expenditures post-Paris Agreement, we assess whether these investments translate into environmental innovation, specifically through green patents. Patents related to climate change are crucial for catalyzing technological innovations and transforming business models, thereby facilitating the achievement of net-zero carbon emissions (e.g., Bolton et al., 2023; Cohen et al., 2022; Hege et al., 2024). Furthermore, Li et al. (2022) argue that green patents are indicative of a genuine effort by high-emission firms to combat pollution and not merely an act of greenwashing. Increased green patenting should ultimately result in technologies that mitigate the negative environmental impacts of economic activities.

We employ two measures of green innovation outputs: green patent application counts and patent citations (Cohen et al., 2022). The first measure is the total number of green patents applied for by a company in a given year, which reflects the firm's innovation activity. We focus on the application year rather than the grant year as the application year is closer to the actual time of innovation (Mezzanotti, 2021; Reeb and Zhao, 2022). The second measure, patent citations, is calculated as the sum of all forward citations received by all green patents applied for by the firm and reflects the technological importance of these patents (Harhoff et al., 1999; Lerner and Seru, 2022; Trajtenberg et al., 1997).

The data on green patent applications and their citations are obtained from the BvD Orbis IP database. We follow the approach of Hašič and Migotto (2015) and use the Cooperative Patent Classification (CPC) system to identify patents related to climate change mitigation technologies (Y02). We also include non-patenting firms in order to establish the determinants of the patenting choice (Reeb and Zhao, 2022).

We use a Poisson regression model to deal with the count nature of our dependent variables, the firm's total number of green patent applications and forward patent citations, respectively. Poisson regression is suitable for count data because it allows for zero values and provides robust estimates without assuming normally distributed errors (Cohn et al., 2022). In all regressions, we also control for Scope 1 carbon emissions and include firm-level control variables as well as industry and country-by-time fixed effects. Results for green patent

application counts are reported in Panel A of Table 7, and those for patent citations are reported in Panel B.

[Table 7]

The results in Panel A indicate that family firms are associated with a higher number of green patent applications compared to non-family firms. Similarly, Panel B shows that green patents from family firms receive significantly more citations, suggesting that these patents are more impactful. The coefficient for family firms is positive and significant at the 1% level across all specifications in both panels, highlighting the proactive role of family firms in green innovation. However, the positive effect of family ownership on patent applications and citations diminishes in firms with high emission levels, as shown in column 2. Specifically, the interaction term between family firms and emission intensity ratio is negative and significant at least at the 5% level in both panels. This finding suggests that firms with higher emission intensity tend to apply for fewer green patents and produce less influential ones. Finally, the results in columns 3 and 4 reveal that the Paris Agreement does not significantly affect the green patent activity of family firms, regardless of their emission intensity. Overall, these results indicate that family firms are proactive in green patenting and produce high-quality green patents, which may help explain the main findings of this study.

5. Environmental Display: Emission Commitments and ESG Scores

Our main results reveal a lower CO₂ emission intensity for family firms compared with non-family firms. Interestingly, this internal reality may not align with their external communication. We now relate our set of results on carbon emissions with two other environmental metrics: emission commitments and ESG scores, in particular the Environmental (E) component from Refinitiv.

5.1. Environmental Scores and Public Commitments

Firms can adopt GHG targets and commit to environmental objectives. Such declarations serve as an effective means of communicating their environmental stance to stakeholders (Bolton and Kacperczyk, 2022). ESG scores, which have gained significant prominence in the investment landscape over the past decade, are partly assigned based on these declarations. Empirical research suggests that ESG criteria can have a meaningful impact on corporate performance and long-term outcomes (Eccles et al., 2014; Krueger et al., 2020). However, recent studies

reveal that ESG scores may also be prone to a greenwashing bias, potentially failing to reflect the firm’s actual environmental practice (Bartram et al., 2022; Edmans, 2023).

In this section, we examine the relationship between firms’ environmental public stance and their classification as either family or non-family firms. Our objective is to contrast these new findings with our previous results on actual emissions, thereby enriching our understanding of family firms’ public environmental profile. We re-run our main model, using Refinitiv’s ESG scores and public commitments made to reduce GHG emissions as dependent variables. Results are reported in Table 8.

[Table 8]

The first two columns reveal a negative relationship between family firms and ESG scores in general (column 1) and, more specifically, the Environmental score (column 2). These results are aligned with the study by Villalonga et al. (2023) who find that companies owned by founding families or individual stakeholders underperform with respect to ESG, including the Environmental score. Paradoxically, these findings seem at odds with our earlier results, which indicate a reduction in actual GHG emissions for family firms.

To gain a more comprehensive understanding of the factors influencing these results, we disaggregate the Refinitiv Environmental score into its three components: Emissions, Resource Use, and Innovation. These components largely rely on qualitative indicators, such as the level of information disclosure and various emission reduction commitments, with only a handful of indicators based on verified quantitative data. Results in columns 3–5 reveal that family firms consistently display lower subscores across all these three components.

We further investigate whether this discrepancy between actual emissions and ESG scores is driven by either firms’ commitments or their reported emissions. First, we investigate whether family firms are more likely to commit to a reduction in GHG emissions. Using Refinitiv data, we construct the variable *Commitment* which equals one if a firm has made such a commitment, and zero otherwise.¹³ Results in column 6 show that the coefficient of *Family* is negative and statistically significant, implying that family firms are less likely to commit to a reduction in their GHG emissions. The effect is substantial—being a family firm reduces the odds of making a commitment to reduce GHG emissions by 42.07%.¹⁴ Second, we employ the Scope 1 emission

¹³ In unreported results, we also look at the effect of the Paris Agreement on the ESG scores and the issuance of GHG reduction commitments. In general, commitments have strongly increased since the Paris Agreement. However, this change in trend is not specifically observed for family firms.

¹⁴ The results are also consistent when employing a linear probability model specified as in equation (1).

intensity ratio as reported by Refinitiv (*rai_1*). This ratio is the main quantitative indicator used under the Emissions component of the Refinitiv Environmental score. This data includes only firms that are obligated to disclose their emissions, generally due to regulatory requirements and third-party verification. As such, this ratio is likely to be less susceptible to measurement inaccuracies that could arise in estimating emissions for companies that do not report. In line with our baseline results in Table 3, reported emission intensity shows a negative relationship with family firms in column 7. The point estimate is considerably higher, largely due to the average higher emission levels observed in firms that disclose their emissions.

To summarize, family firms display lower combined ESG and E pillar scores. This effect is driven by their lower public commitments to reduce GHG emissions and contrasts with their lower actual GHG emissions. In essence, family firms are less likely to make public commitments but show lower emissions in their operations. This supports the existing literature suggesting that ESG ratings, and particularly the E pillar score, might not adequately capture environmental performance. This seems to be due to the limited emphasis placed on current GHG emissions in the Environmental scores (Berg et al., 2022b; Boffo and Patalano, 2020). Notably, Bingle et al. (2022) argue that ESG disclosure often serves as "cheap talk", providing selective information not necessarily tied to a firm's exposure to climate-related risks. In fact, companies with higher emissions, operating in carbon-intensive sectors, are the ones scrutinized the most by investors, which may incentivize them to disclose and commit more, paradoxically enhancing their ESG rating (Duchin et al., 2022).

While family firms may not emphasize public environmental commitments, they do record significantly lower total carbon emissions. These results help explain prior studies which found that family firms tend to be less concerned with social and environmental issues (Abeysekera and Fernando, 2020; Cruz et al., 2014; Dyer and Whetten, 2006; El Ghouli et al., 2016). Our results illuminate a paradox: while family firms may communicate less about their environmental commitments, they structurally emit less, challenging the narrative that they are less environmentally responsible.

5.2. *An Explanation: The Role of Family Control and Agency Conflicts*

To shed light on this paradox, we explore the role of family control and the related agency conflicts. Generally speaking, the unique governance structure of family firms might insulate them from external investor pressure, so they are less pressurized to make public climate commitments. Family firms experience fewer Type I agency conflicts between shareholders and managers, as families often hold significant control rights and typically exert direct

influence through family members having key positions in the company. Consequently, there is a limited need for management to signal environmental virtue via public environmental display (PED) such as public commitments and ESG scores, as the owners and managers frequently are the same person. This suggests that PED serves as a costly—and imperfect—tool for mitigating Type I agency conflicts. It demands managerial time and effort without necessarily reflecting actual GHG emissions. To validate this viewpoint, we examine what happens to public commitments and ESG scores when family firms are led by non-family CEOs—i.e. when Type I agency conflicts reappear within the firm. Results are reported in Table 9 with Panel A presenting the findings for the emission commitments, Panel B for the combined ESG score, and Panel C for the Environmental ESG score.

[Table 9]

In the first column, across the different panels, we find that externally hired CEOs correlate with greater emission commitments and higher combined ESG and Environmental scores. On the contrary, family CEOs—whether founder (column 2) or descendant (column 3)—correlate with fewer commitments and lower ESG scores. This supports the argument that the extent of information asymmetry between management and ownership, along with the potential for agency conflicts, triggers PED. It seems that external CEOs commit more to emission reductions to showcase environmental stewardship to family owners, even though they do not achieve significant emission reductions. Recalling our earlier findings, family CEOs (both founders and descendants) contribute to lowering emissions intensity, whereas hired CEOs tend to increase CO₂ emissions.

Similarly, we expect family firms with a higher percentage of external shareholders to be more vocal about their environmental commitments. Minority shareholders may find it challenging to assess the firm's actual environmental performance, putting pressure on family owners for a public signal of environmental commitments. This aligns with the notion that PED can serve as an imperfect means to resolve Type II agency conflicts between majority and minority shareholders. The fourth column in the different panels supports this view, showing that family firms with a larger share of minority shareholders (i.e., a lower value of *Family Share*) engage more in public commitments and achieve higher combined and Environmental scores. This supports the view that PED acts as a signal toward non-family shareholders. However, it is worth pointing out that this signal tends to be imperfect, as our previous findings revealed that family firms, especially those with a smaller share of external shareholders, are the ones that tend to have lower pollution levels.

Overall, our results suggest that PED emerges as a tool to resolve potential agency conflicts between both managers and owners (Type I), and minority and majority shareholders (Type II). However, PED is an imperfect signalling mechanism, as emissions tend to increase for firms that commit to reductions. One explanation is that PED diverts resources and focus away from actual emission reduction. Alternatively, external shareholders might worry that genuine environmental actions will expropriate them, even if they recognize the need for a favourable public image—this latter scenario veering closer to outright greenwashing. We leave this question open for future research.

6. Robustness Checks

We conduct a variety of additional tests to validate the robustness of our results, notably addressing potential endogeneity problems. First, we propose alternative measurements for both emission levels and family firms. Second, we expand the set of fixed effects, implement Oster’s (2019) omitted variable test, and propose alternative clustering of standard errors. Third, we conduct a Propensity Score Matching (PSM) approach. Fourth, we propose a dynamic treatment of the Paris Agreement difference-in-differences. Last, we control that our results hold across sectors and regions.

6.1. Alternative Measurements

Our main measure of CO₂ emission is based on emission intensity, which measures tonnes of CO₂ emissions per unit of the firm’s revenues. We present an alternative measure using absolute emissions levels. This serves two purposes. First, it assesses the robustness of our results when using a different definition of pollution. Second, it evaluates not just the efficiency but also the efficacy of emission reductions, in terms of absolute levels. Previous research, such as that by Jenkins (2014), has pointed out distinct mechanisms for pollution efficiency and efficacy. We use the natural logarithm of absolute emissions levels across the different scopes and apply our main model to these new dependent variables. The results, reported in Panel A of Table 10, reveal that the influence of family firms on emissions remains consistent with our main findings. Specifically, family firms exhibit lower absolute levels of emissions after accounting for firms’ characteristics, industry fixed effects, and country-by-time fixed effects.

[Table 10]

The existing literature also highlights that the definition of a family firm is not unique (e.g., Harms, 2014) and can significantly influence empirical outcomes (Miller et al., 2007). We account for this and propose alternative definitions of a family firm and reapply our primary

model using Scope 1 emission intensity as the dependent variable.¹⁵ The results are summarized in Panel B of Table 10. In column 1, we adopt a broader definition as employed by Anderson and Reeb (2003), where there is no 5% minimum ownership threshold for a major shareholder. In columns 2 and 3, we narrow the scope of family's ownership stake, defining a family firm as one where the family is either the largest voteholder or the largest shareholder, respectively. In column 4, we maintain our initial definition but require the presence of at least two family members in roles such as directors, officers, or significant shareholders. Finally, in column 5, a firm is defined as a family firm if the family is the largest voteholder and at least one family member serves on the board. Across all specifications, the coefficient for *Family* remains negative and statistically significant, alleviating concerns regarding the choice of family firm definition in our study.

6.2. *Fixed Effects, Omitted Variable Test, and Clustering*

Next, we turn our attention to fixed effects, omitted variable bias, and clustering choices. Since being a family firm is largely time-invariant, our model cannot directly include firm fixed effects, leading to a potential omitted variable bias.¹⁶ To alleviate this concern, we check the stability of the family firm coefficient by progressively saturating the model with sets of fixed effects likely to capture a wide range of unobservable firm characteristics. We then assess the presence of an omitted variable bias using Oster's (2019) methodology (see, e.g., Degryse et al., 2023; Ghosh et al., 2023).

Oster (2019) explains how to assess potential omitted variable bias using changes in R^2 as new dimensions are added to the model. She introduces the parameter δ , described as the "value for the relative degree of selection on observed and unobserved variables". A δ greater than 1 suggests unobservables might not critically impact the model. Oster's work details δ computation. Results are robust to an omitted variable bias if: i) the coefficient remains stable, and ii) new dimensions account for significant variance, leading to a $\delta > 1$. We adopt her recommendation of a max $R^2 = 1.3R^2$. We implement Oster's (2019) approach and begin by estimating more parsimonious versions of Equation (1), incrementally advancing to more comprehensive specifications. Panel A of Table 11 summarize the results, with the dependent variable being Scope 1 emission intensity.

[Table 11]

¹⁵ The results for the two other measures of emissions intensity are also consistent with the main results and are available upon request.

¹⁶ See Zhang et al. (2022) for a discussion on endogeneity issues in family business research.

The first column offers a simplified model, excluding both fixed effects and control variables. In this base model, the impact of family firms on emissions is both negative and significant, explaining 1.2% of the variance across the population (R^2). The subsequent column incorporates firm-specific controls but omits fixed effects. We then sequentially introduce industry fixed effects (column 3), followed by country-by-time fixed effects (column 4), and finally country-by-time-by-industry fixed effects (column 5). In all specifications except one, the effect of family firms on emissions intensity is negative and statistically significant. The final model records the largest R^2 (51.3% of the variance explained). This most saturated model also features a delta superior to 1 and a coefficient of *Family* negative and significant. It suggests that our results are robust to the effect of unobservables and to a potential omitted variable bias.

Finally, Panel B of Table 11 modify the level of clustering, while the set of fixed effects remains consistent with our main model. In our main model, we cluster at the firm level. We alternatively propose clustering of standard errors at the industry, the industry-country, and the industry-country-year level. In all instances, the coefficient of *Family* remains statistically significant. The evidence suggests that the main findings of the paper are robust, irrespective of how standard errors are clustered.

6.3. Propensity Score Matching

Our results so far suggest that family firms are associated with lower CO₂ emissions in both intensity and absolute levels. To adjust for potential systematic differences in the characteristics of family and non-family firms that could affect these findings, we propose a Propensity Score Matching (PSM) approach. PSM helps to mitigate endogeneity issues by creating matched pairs of treatment and control units with similar observable characteristics (Rosenbaum and Rubin, 1983).

We estimate propensity scores using a logit regression that employs the binary variable *Family* and the vector of covariates specified in Eq. 1. Both treatment and control firms are sourced from the same industry. To construct a subsample of comparable units, we match companies based on their observable characteristics before the finalization of the Paris Agreement in December 2015, utilizing a one-to-one nearest neighbor technique. Specifically, for each family firm, we identify one unique non-family firm, ensuring that the absolute difference in predicted propensity scores does not exceed 0.01. We carry out the matching process without replacement, ensuring a unique pairing between a firm in the treatment group and a firm in the control group.

Panel A of Table A4 in the Appendix underscores that the characteristics of family and non-family firms are statistically different before the implementation of propensity score matching. Panel B demonstrates that, after the propensity score matching, the sample is well-balanced and there are no statistically significant differences between the groups. This establishes the comparability of the two groups in terms of their ex-ante observable characteristics.

[Figure 4]

Similarly, Figure 4 presents the distribution of propensity scores for both groups before and after the matching. The density plot on the left-hand side highlights significant differences in propensity scores between family and non-family firms in the unmatched sample. Conversely, the density plot on the right-hand side shows that the distribution of propensity scores is similar across both groups after matching, reinforcing the effective balancing properties of the employed matching procedure.

[Table 12]

We reassess the link between family firms and CO₂ emissions using the balanced matched sample. Columns 1–3 of Table 12 present the results for emissions intensities across the three different scopes, while columns 4–6 repeat this exercise for absolute emissions. We include the same set of covariates as in our main analysis and account for industry and country-time fixed effects. Consistent with our baseline estimates, family ownership continues to significantly reduce CO₂ emissions. The magnitude of the coefficients is even greater when using the matched samples. Columns 7 and 8 explore the differential impact following the implementation of the Paris Agreement. As with our main findings, most of the reduction in emissions occurs after the Agreement comes into effect. Therefore, utilizing a PSM approach confirms our main findings.

6.4. *Dynamic Treatment – Paris Agreement*

The validity of the DiD estimators hinges on certain assumptions. First, the assignment of the treatment must be independent of CO₂ emission levels. In our context, this is a reasonable assumption as the Paris Agreement targets the broader issues of climate change impacts on economies and societies, rather than focusing on the ownership structure of firms. Second, for the DiD approach to be valid, the outcome trends must be parallel across groups prior to the event (Imbens and Wooldridge, 2009).

To rigorously test these assumptions, we implement a dynamic setting, capturing any pre-trend differences across family and non-family firms. Specifically, we replace the variable *Paris* in

Eq. (2) with a series of dummy variables for both pre-treatment lags (up to 4 years) and post-treatment leads (up to 4 years). This allows us to trace the year-by-year effects of the Paris Agreement on firms' emissions. Fulfilment of the parallel trend assumption is confirmed if the coefficients on the interactions for the years leading up to the event are statistically insignificant.

[Figure 5]

Figure 5 graphically displays the estimated time-varying treatment effects for all years, along with their 95% confidence intervals, adjusted for firm-level clustering. The coefficients of the interaction term ($Family \times Year_t$) are statistically insignificant for all years before 2015, supporting the absence of pre-treatment differences in CO₂ emissions trends between family and non-family firms. This lends credence to the parallel trend assumption—a crucial prerequisite for the validity of our difference-in-differences framework. The pattern of the coefficients for the post-treatment interaction terms demonstrates a significant decline, providing evidence that the Paris Agreement has a significant impact on reducing the emissions of family firms. This result confirms that the emissions from family firms decreased following the implementation of the Paris Agreement and sustained a lower level thereafter.

6.5. *Industries and Region Heterogeneity*

Emissions vary by industry, with certain industries inherently generating more emissions. This disparity affects abatement costs, capacity, and incentives for emission reduction (Huang et al., 2016). Our objective now is to verify that our results can be observed across different sectors, notably both high and low emitting sectors. To this end, we segment our sample into nine distinct sectors: Basic Materials, Consumption of Goods, Consumption of Services, Health Care, Industrial, Oil and Gas, Technology, Telecommunications, and Utilities. Using the GHG Scope 1 emission intensity metric, we re-run our primary model to each sector individually.

[Table 13]

The outcome, displayed in Panel A of Table 13, shows a reduction in emissions intensities associated with family firms that occurs independent of the Paris Agreement date in the Oil and Gas and Health Care industries. Family firms further reduce emissions intensities after the Agreement in the Consumption of Goods, Consumption of Services, and Utilities industries. Essentially, the effect of family ownership can be observed in various industries with different structures and abatement costs.

Second, we want to check that our results are not led by one specific region. Panel B of Table 13 categorizes the sample into three geographical areas: Asia-Pacific, Europe, and North America. Existing literature highlights distinct patterns in family firms' structures (Aminadav and Papaioannou, 2020), emission intensities (Raupach et al., 2007), and reaction to the Paris Agreement (Mani et al. (2018) across these regions. Our results show that, following the Paris Agreement, the effect occurs across all regions, with family firms emitting less than non-family firms. The magnitude of the effect is similar for Europe and North America but is doubled for firms located in the Asia-Pacific region. Results also confirm that there was no significant effect of family firms on emission levels preceding the 2015 Paris Agreement in all three regions.

7. Conclusion

Using a large cross-country dataset, we examine the relationship between family firms and CO₂ emissions using different proxies for emission intensity. Our results establish a link between firm type and a firm's CO₂ emissions. Family firms have lower CO₂ emissions—both direct and indirect—than non-family firms. Additionally, family firms are more responsive to the 2015 Paris Agreement, showing a further decline in their emissions post-agreement.

We explore possible mechanisms that could explain our findings. Looking at the governance characteristics of family firms, we find that several dimensions exert an impact on family firms' carbon emissions. A higher control by the family also makes a positive contribution, and firms managed directly by family members experience an additional reduction in emissions. Conversely, family firms with externally hired CEOs experience an increase in emissions. Furthermore, our study reveals potential channels. Our results indicate that family firms allocate higher amounts of resources to R&D and apply for more green patents that have higher citations, suggesting a greater shift toward innovative green technologies, which could lead to reduced CO₂ emissions.

Interestingly, our study uncovers a paradox concerning the actual emissions of family firms and their environmental communication efforts. Compared to non-family firms, family firms commit less publicly to reducing their carbon footprints and generally receive lower ESG scores. This discrepancy is particularly prominent in firms chaired by family members. Despite lower emission levels, family firms communicate less about their environmental initiatives. A different exposure to agency conflicts and shareholders' pressure seems to play a role in shaping this outcome.

Our study shows that firm ownership structure influences environmental performance, with an impact that differs between hard measures, such as actual carbon emissions and soft measures, such as public commitments. Different governance mechanisms, incentives, and values might explain these differences. Given the looming threat of global warming and climate change, understanding the role of ownership in shaping firms' non-financial incentives and thereby potentially reducing their environmental impact is imperative. Policymakers should take these nuances into account when designing policies to mitigate environmental degradation. Importantly, our research suggests that such policies should prioritize actual emissions over corporate pledges and communications, as there may be a significant gap between the two.

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Figure 1 Average CO₂ emissions across regions

The figure below reports the average Scope 1 carbon emission intensities (tonnes of CO₂ by millions of \$US Revenue) from the year 2010 to 2019, across three different regions, for family and non-family firms.

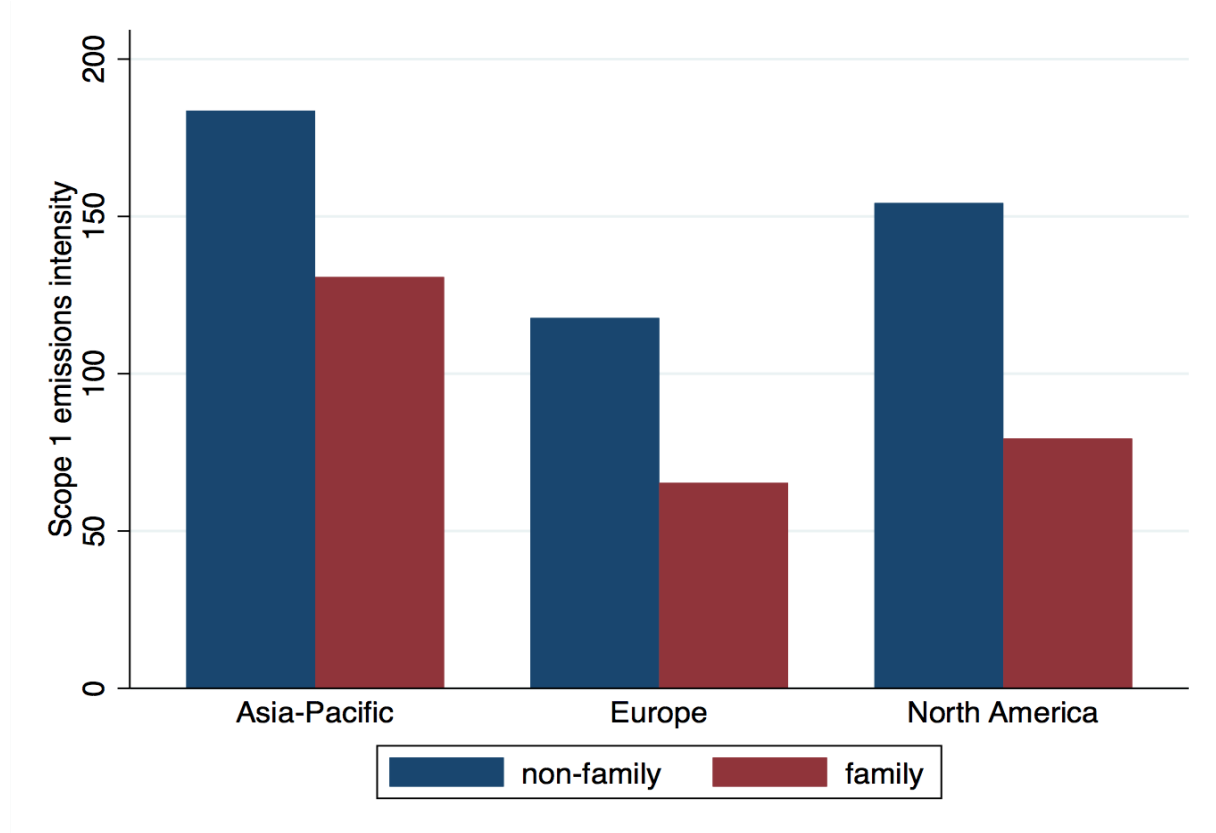


Figure 2 Average CO₂ emissions across sectors

The figure below reports the average Scope 1 carbon emission intensities (tonnes of CO₂ by millions of \$US Revenue) from the year 2010 to 2019, across the different industries, for family and non-family firms.

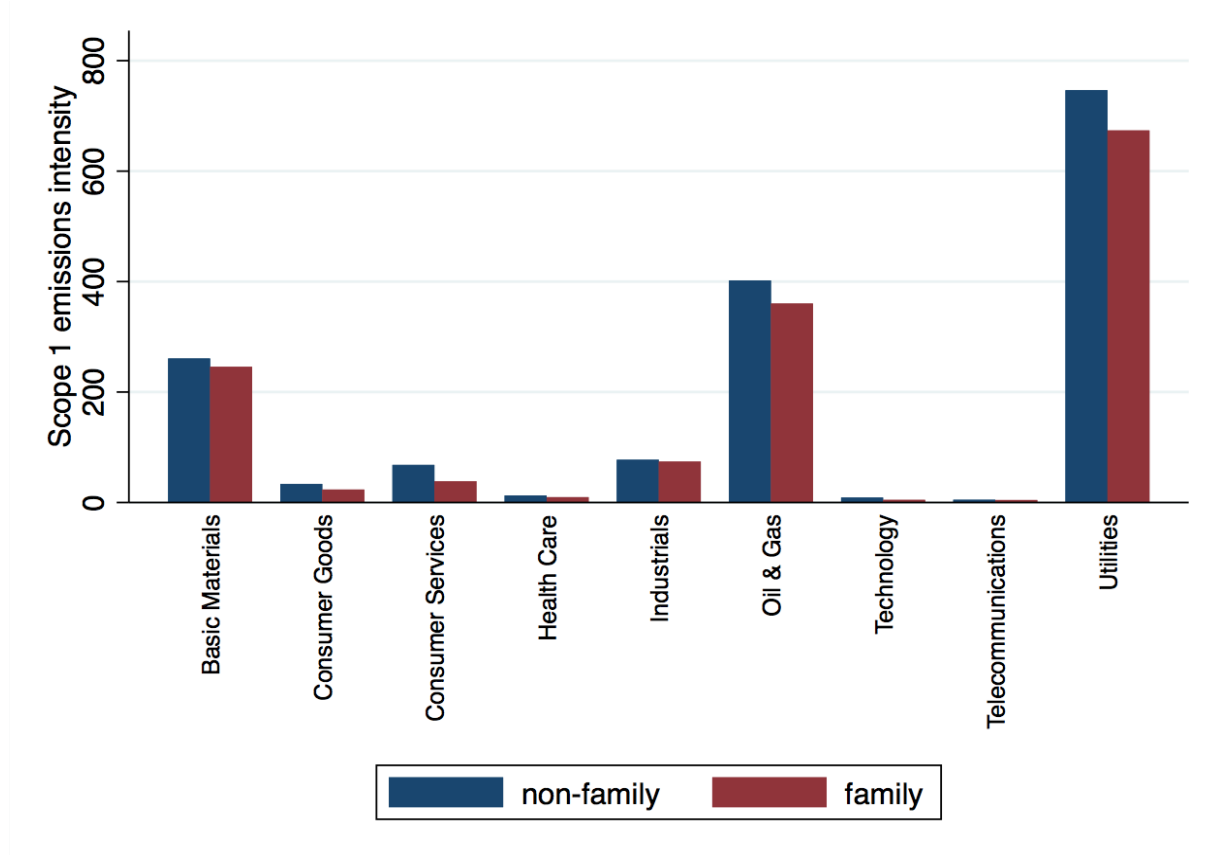


Figure 3 Average CO₂ emissions over time

The figure below reports the evolution of average Scope 1 carbon emission intensities (tonnes of CO₂ by millions of \$US Revenue) over time for family and non-family firms.

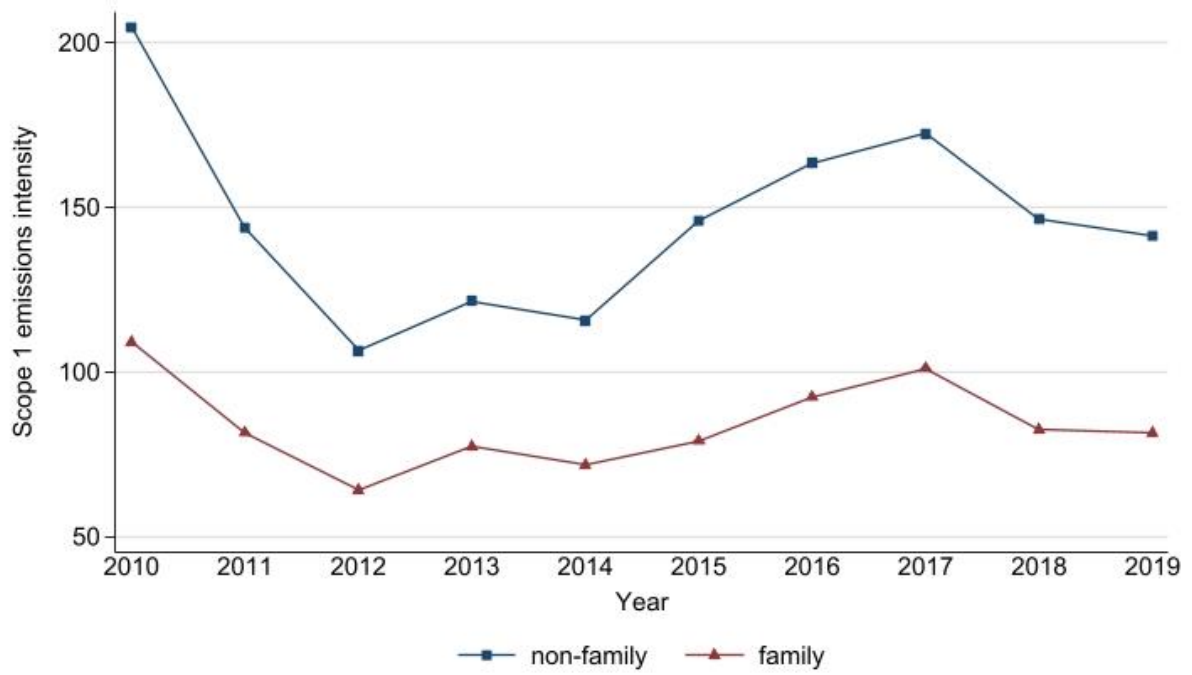


Figure 4 P-scores before and after matching

The figure displays Kernel density function of propensity scores between family firms (red solid line) and non-family firms (blue dashed line) before (left) and after (right) the application of the propensity score matching approach.

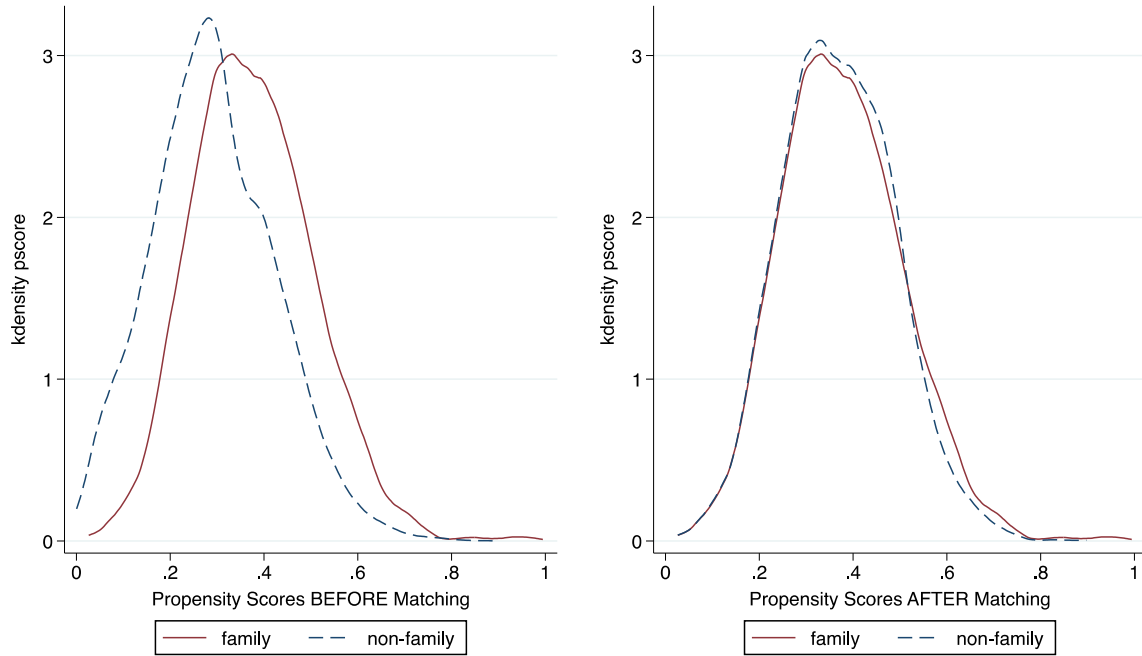


Figure 5 Dynamic treatment effect of the Paris Agreement

The figure displays the dynamic treatment effect of the Paris Agreement on firms' Scope 1 emission intensities (tonnes of CO2 by millions of \$US Revenue) along with the 95% confidence intervals. The point estimate represents the coefficient estimate of the dynamic DID analysis of Scope 1 emission intensities on relative year dummies interacted with *Family*.

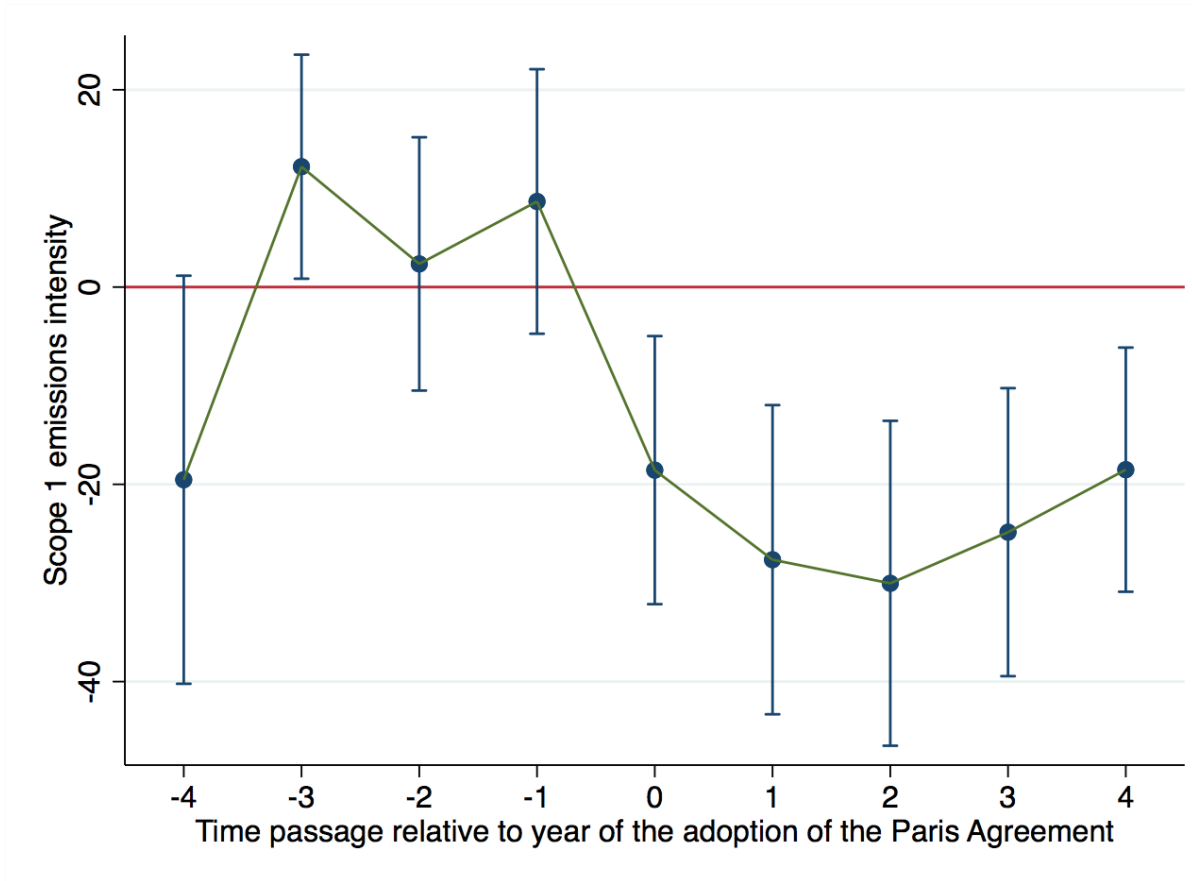


Table 1: Sample distribution

The table reports the number of observations across regions, industries, and years, distinguishing between family and non-family firms in the sample. The descriptive statistics are based on the full sample consisting of 6,600 unique companies for the period 2010–2019.

	No. of observations			Freq. of Family Firms
	All	Family	Non-family	
<i>Panel A: Regions</i>				
Asia-Pacific	7,345	2,367	4,978	32.23%
Europe	16,564	5,429	11,135	32.78%
North America	14,589	4,673	9,916	32.03%
<i>Panel B: Industries</i>				
Basic Materials	3,755	992	2,763	26.42%
Consumer Goods	5,306	2,036	3,270	38.37%
Consumer Services	5,927	2,298	3,629	38.77%
Health Care	3,651	1,420	2,231	38.89%
Industrials	10,273	2,921	7,352	28.43%
Oil & Gas	2,910	765	2,145	26.29%
Technology	3,943	1,630	2,313	41.34%
Telecommunications	925	198	727	21.41%
Utilities	1,808	209	1,599	11.56%
<i>Panel C: Years</i>				
2010	2,104	644	1,460	30.61%
2011	3,571	1,170	2,401	32.76%
2012	3,630	1,180	2,450	32.51%
2013	3,608	1,155	2,453	32.01%
2014	3,661	1,158	2,503	31.63%
2015	3,599	1,135	2,464	31.54%
2016	4,094	1,322	2,772	32.29%
2017	4,106	1,289	2,817	31.39%
2018	5,076	1,723	3,353	33.94%
2019	5,049	1,693	3,356	33.53%
Total	38,498	12,469	26,029	32.39%

Table 2: Descriptive statistics

The table provides summary statistics (Panel A), pairwise correlations (Panel B), and difference-in-means test (Panel C) of the variables employed in the main empirical specifications. The descriptive statistics are based on the full sample consisting of 6,600 unique companies for the period 2010–2019. The variables' definition and their sources are presented in Appendix Table A1.

<i>Panel A: Summary statistics</i>						
	N	Mean	SD	p25	Median	p75
Family	38,498	0.32	0.47	0	0	1
iai_1	38,498	124.41	260.55	5.70	11.30	101.00
iai_1_2	38,498	166.28	293.30	22.30	34.50	164.30
iai_1_2_3	38,498	1,506.36	1,961.88	256.20	673.65	1,837.80
Size	36,977	21.50	1.76	20.23	21.46	22.71
MBV	36,719	58.79	327.22	1.34	2.59	7.08
PPP	36,764	28.03	23.39	8.92	21.65	41.7
CAPEX	36,632	5.27	4.76	2.10	3.91	6.83
ROA	36,434	3.68	10.69	1.39	4.43	8.16
Leverage	36,974	54.97	21.26	40.71	55.73	69.16
Liquidity	36,168	2.05	1.75	1.09	1.54	2.32
Age	34,819	1983	30	1972	1993	2003

<i>Panel B: Pairwise correlations</i>												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Family	1.00											
(2) iai_1	-0.11	1.00										
(3) iai_1_2	-0.11	0.98	1.00									
(4) iai_1_2_3	-0.08	0.59	0.63	1.00								
(5) Size	-0.15	0.24	0.24	0.18	1.00							
(6) MBV	0.00	0.01	0.02	0.05	0.03	1.00						
(7) PPP	-0.05	0.37	0.39	0.39	0.16	0.05	1.00					
(8) CAPEX	0.02	0.20	0.21	0.24	0.01	0.06	0.53	1.00				
(9) ROA	-0.01	-0.04	-0.04	-0.03	0.16	0.08	-0.01	0.06	1.00			
(10) Leverage	-0.09	0.05	0.03	-0.03	0.33	-0.02	0.02	-0.04	-0.11	1.00		
(11) Liquidity	0.08	-0.09	-0.07	-0.02	-0.30	-0.01	-0.17	-0.10	-0.12	-0.55	1.00	
(12) Age	0.12	0.00	0.00	0.01	-0.20	-0.04	0.02	0.08	-0.10	-0.05	0.08	1.00

<i>Panel C: Difference-in-means test</i>					
	Family firms		Non-family firms		Difference
	N	Mean	N	Mean	
iai_1	12,469	83.01	26,029	144.24	-61.24***
iai_1_2	12,469	118.85	26,029	189.00	-70.15***
iai_1_2_3	12,469	1,268.03	26,029	1,620.53	-352.50***
Size	11,942	21.13	25,035	21.68	-0.55***
MBV	11,890	58.59	24,829	58.89	-0.31
PPP	11,917	26.34	24,847	28.85	-2.51***
CAPEX	11,824	5.40	24,808	5.20	0.20***
ROA	11,774	3.46	24,660	3.79	-0.33***
Leverage	11,942	52.24	25,032	56.27	-4.03***
Liquidity	11,650	2.25	24,518	1.95	0.31***
Age	11,012	1988	23,807	1980	8***

Table 3: The impact of family ownership on emissions intensity

This table reports the OLS regression results of family firms on firms' emissions using data for 2010–2019. The dependent variables represent Scope 1, 2 and 3 emission intensity. *Family* is a dummy variable equal to 1 for family firms and 0 otherwise. *Paris* is a dummy variable equal to 1 for the time period between 2015–2019 and 0 otherwise. All regressions include industry and country-time fixed effects, and a constant term. Table A1 provides detailed definitions of the variables. Robust standard errors clustered at the firm level are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	iai_1 (1)	iai_1_2 (2)	iai_1_2_3 (3)	iai_1 (4)	iai_1_2 (5)	iai_1_2_3 (6)
Family	-12.805** (5.207)	-15.603*** (5.706)	-71.552* (37.466)	-0.663 (5.345)	-2.303 (5.929)	-34.043 (44.509)
Paris×Family				-23.813*** (5.263)	-26.083*** (5.795)	-73.562* (42.220)
Size	21.609*** (2.116)	25.373*** (2.377)	146.754*** (14.060)	21.631*** (2.116)	25.396*** (2.376)	146.820*** (14.062)
MBV	-0.033 (0.022)	-0.032 (0.025)	-0.484* (0.250)	-0.033 (0.022)	-0.032 (0.025)	-0.483* (0.250)
PPP	0.857*** (0.093)	1.078*** (0.103)	4.434*** (0.598)	0.859*** (0.093)	1.080*** (0.103)	4.441*** (0.598)
CAPEX	2.029*** (0.579)	2.378*** (0.628)	16.676*** (3.939)	2.025*** (0.579)	2.373*** (0.628)	16.663*** (3.939)
ROA	-1.420*** (0.166)	-1.720*** (0.183)	-993*** (1.352)	-1.431*** (0.166)	-1.732*** (0.183)	-9.228*** (1.353)
Leverage	-0.501*** (0.136)	-0.589*** (0.153)	-3.966*** (1.024)	-0.501*** (0.136)	-0.589*** (0.153)	-3.964*** (1.023)
Liquidity	-1.773 (1.361)	0.074 (1.532)	15.579 (10.722)	-1.747 (1.358)	0.102 (1.530)	15.659 (10.717)
Age	0.007 (0.109)	0.026 (0.125)	0.922 (0.785)	0.007 (0.109)	0.026 (0.125)	0.921 (0.784)
Observations	25,596	25,596	25,596	25,596	25,596	25,596
Firms	5,016	5,016	5,016	5,016	5,016	5,016
R ²	0.469	0.476	0.456	0.470	0.476	0.456
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 4: Family firms, board characteristics and direct emission intensity

This table reports the OLS regression results of family firms on firms' emissions conditional on board characteristics using data for 2010–2019. The dependent variables represent Scope 1 emission intensity. *Family* is a dummy variable equal to 1 for family firms and 0 otherwise. *Board Gender* is a dummy variable equal to one if the CEO is a woman, zero otherwise. *Board Size* records the number of board members. *Board Skills* is the percentage of board members with industry-specific skills. *Board Tenure* is the average board tenure in years. *Governance Committee* is a dummy variable indicating the presence of such a committee. *Board Education* is the ratio of directors with master or PhD degrees to board size. All specifications include constant, industry, and country-time fixed effects, as well as firm-level control variables, as in Table 3. Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	iai_1 (1)	iai_1 (2)	iai_1 (3)	iai_1 (4)	iai_1 (5)	iai_1 (6)	iai_1 (7)
Family	-10.577** (5.265)	-18.640** (7.346)	15.358 (14.332)	-4.310 (7.678)	-28.751** (11.628)	-1.799 (7.110)	11.619 (10.719)
Board Gender	-0.665*** (0.211)	-0.725*** (0.255)					
Family×Board Gender		0.382 (0.338)					
Board Size	1.725** (0.729)		2.322*** (0.855)				
Family×Board Size			-2.228* (1.256)				
Governance Committee	-1.783 (10.483)			6.183 (11.446)			
Family×Board Governance Committee				-17.424* (9.958)			
Board Skills	-0.046 (0.144)				-0.257 (0.168)		
Family×Board Skills					0.355 (0.238)		
Board Education	0.009 (0.154)					0.161 (0.188)	
Family×Board Education						-0.509** (0.243)	
Board Tenure	-0.829 (0.609)						0.559 (0.836)
Family×Board Tenure							-2.714** (1.098)
Observations	25,393	25,456	25,462	25,612	25,462	25,462	25,402
Firms	5,001	5,012	5,013	5,016	5,013	5,013	5,003
R ²	0.467	0.467	0.467	0.466	0.467	0.467	0.467
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5: Family control and involvement

This table reports the OLS regression results of different proxies for family values on firms' Scope 1 emission intensity using data for 2010–2019. *Family Share* is a continuous variable that records the percentage of family ownership in the firm. *Family Board* (F. Board) is the ratio of the number of family members in the board to the total number of board members. In the first model only, both *Family Share* and *Family Board* are centered with the sample mean. *Family CEO* (F. CEO) and *Family Dual* (F. Dual) are dummy variables equal to 1 if the founder or descendant is the CEO or the CEO and Chairman, respectively, and 0 otherwise. *Founder CEO* (F.CEO) and *Descendant CEO* (D. CEO) are dummy variables equal to 1 if the founder or the descendant is the CEO, respectively, and 0 otherwise. *Founder Dual* (F.Dual) and *Descendant Dual* (D.Dual) are dummy variables equal to 1 if the founder or the descendant is the CEO and Chairman, respectively, and 0 otherwise. All specifications include constant, industry, and country-time fixed effects, as well as firm-level control variables, as in Table 3. Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	iai_1 (1)	iai_1 (2)	iai_1 (3)	iai_1 (4)	iai_1 (5)
Family Share	-0.399*	-0.476**	-0.304*	-0.481**	-0.306*
	(0.275)	(0.197)	(0.171)	(0.197)	(0.171)
F. Board	-0.699***				
	(0.283)				
Family Share ×F. Board	0.027***				
	(0.010)				
F. CEO		-12.389**			
		(6.272)			
Family Share ×F. CEO		0.702**			
		(0.282)			
F. Dual			-16.315**		
			(8.316)		
Family Share ×F. Dual			0.503*		
			(0.281)		
F. CEO				0.768	
				(7.228)	
Family Share ×F. CEO				0.305	
				(0.318)	
D. CEO				-37.385***	
				(10.940)	
Family Share ×D. CEO				1.283***	
				(0.376)	
F. Dual					-9.807
					(9.321)
Family Share ×F. Dual					0.395
					(0.351)
D. Dual					-32.118**
					(15.391)
Family Share ×D. Dual					0.751*
					(0.419)
Observations	22,275	25,596	25,596	25,596	25,596
Firms	4,463	5,016	5,016	5,016	5,016
R ²	0.464	0.469	0.469	0.470	0.469
Firm controls	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes	Yes

Table 6: Family firms and R&D

This table reports the OLS regression results of family firms on firms' Research and development (R&D) expenses using data for 2010–2019. The dependent variables represent R&D expenses scaled by total assets. *Family* is a dummy variable equal to 1 for family firms and 0 otherwise. *iai_1* is the scope 1 emission intensity in CO₂ tonnes per USD million of revenues. *Paris* is a dummy variable equal to 1 for the time period between 2015–2019 and 0 otherwise. All specifications include the set of control variables as in Table 3 (except CAPEX expenditures due to an high collinearity with R&D expenditures), constant, industry, and country-time fixed effects. Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	R&D (1)	R&D (2)	R&D (3)	R&D (4)
Family	0.315 (0.304)	0.427 (0.349)	-0.133 (0.358)	-0.009 (0.285)
iai_1	-0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	0.001 (0.001)
Family×iai_1		-0.001 (0.001)		-0.001 (0.001)
Paris×Family			0.869** (0.372)	0.855** (0.322)
Paris×iai_1				-0.001 (0.001)
Paris×Family×iai_1				-0.000 (0.002)
Observations	8,949	8,949	8,949	8,949
Firms	1,987	1,987	1,987	1,987
R ²	0.450	0.450	0.451	0.451
Firm controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes

Table 7: Family firms and green patents

This table presents the Poisson regression results for family firms' green patent applications and forward patent citations using data from 2010 to 2019. The dependent variables correspond to the number of green patent applications (Panel A) and the number of forward patent citations (Panel B). *Family* is a dummy variable equal to 1 for family firms and 0 otherwise. *iai_1* is the scope 1 emission intensity in CO₂ tonnes per USD million of revenues. *Paris* is a dummy variable equal to 1 for the time period between 2015–2019 and 0 otherwise. All specifications include constant, industry, and country-time fixed effects, as well as firm-level control variables, as in Table 3. Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
<i>Panel A: Green patent applications</i>				
Family	0.532** (0.246)	0.697*** (0.258)	0.508** (0.210)	0.663*** (0.196)
iai_1	-0.001*** (0.001)	-0.001*** (0.000)	-0.001*** (0.001)	-0.001*** (0.000)
Family×iai_1		-0.005** (0.002)		-0.004* (0.002)
Paris×Family			0.070 (0.221)	0.101 (0.247)
Paris×iai_1				0.000 (0.000)
Paris×Family×iai_1				-0.003 (0.002)
Observations	20,611	20,611	20,611	20,611
Firms	4,098	4,098	4,098	4,098
Pseudo R ²	0.605	0.607	0.605	0.607
<i>Panel B: Green patent citations</i>				
Family	0.731*** (0.281)	0.923*** (0.292)	0.761*** (0.274)	0.964*** (0.269)
iai_1	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)	-0.003*** (0.001)
Family×iai_1		-0.008*** (0.003)		-0.008** (0.003)
Paris×Family			-0.333 (0.481)	-0.442 (0.469)
Paris×iai_1				-0.001 (0.001)
Paris×Family×iai_1				0.001 (0.005)
Observations	14,920	14,920	14,920	14,920
Firms	3,054	3,054	3,054	3,054
Pseudo R ²	0.782	0.784	0.782	0.785
Control variables	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes

Table 8: The impact of family firms on ESG rating, commitments and reported emissions

This table reports the OLS regression results of family firms on firms' ESG rating using data for 2010–2019. The dependent variables represent ESG combined (ESG), and ESG environmental (ESGE) ratings, respectively. ERE/EM/EI stands for ESGE subcategories: resource use (ERE), E emissions (EEM), and E environmental innovation (EEI). Refinitiv's ESG scores range from 0 to 100, with higher scores indicating better performance in ESG dimensions. Commitment equals 1 if the firm announced an emission reduction target and 0 otherwise. Rai_1 represents Refinitiv reported Scope 1 emission intensity. Family is a dummy variable equal to 1 for family firms and 0 otherwise. All specifications include control variables as in Table 3 and constant, industry, and country-time fixed effects. Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	ESG (1)	ESG _E (2)	ERE (3)	E _{EM} (4)	E _{EI} (5)	Commitment (6)	rai_1 (7)
Family	-3.881*** (0.598)	-3.812*** (0.811)	-4.342*** (0.972)	-3.066*** (0.954)	-2.370** (1.033)	-0.546*** (0.206)	-77.505** (38.852)
Observations	18,287	18,278	18,209	18,209	18,209	17,941	7,860
Firms	3,962	3,961	3,935	3,935	3,935	3,953	1,723
R ²	0.358	0.506	0.441	0.482	0.279	0.334	0.362
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: Family control, commitments, and ESG scores

This table reports OLS regression results of commitments to reduce emissions (Panel A), total ESG scores (Panel B), and Environmental ESG score (Panel C) on CEO type, using data from 2010 to 2019. The reported independent variables are dummy variables that capture the type of CEO. *Hire* corresponds to a hired CEO, who is not part of the family. *Founder* and *Descendant* are family members CEO, respectively from the first or following generations. *Family Share* is a continuous variable that records the percentage of family ownership in the firm. All specifications include constant, industry, and country-time fixed effects, as well as firm-level control variables as in Table 3, which are not presented here for brevity. Appendix Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)
<i>Panel A: Emission commitments</i>				
Hire	0.076*** (0.019)			
Descendant		-0.084*** (0.032)		
Founder			-0.053*** (0.019)	
Family Share				-0.001*** (0.000)
Observations	16,263	17,129	17,129	17,939
Firms	3,615	3,901	3,901	3,954
R ²	0.335	0.338	0.337	0.334
<i>Panel B: ESG combined score</i>				
Hire	5.725*** (0.777)			
Descendant		-5.887*** (1.421)		
Founder			-4.811*** (0.809)	
Family Share				-0.106*** (0.022)
Observations	17,451	17,451	17,451	18,287
Firms	3,908	3,908	3,908	5,016
R ²	0.365	0.360	0.360	0.756
<i>Panel C: ESG environmental score</i>				
Hire	6.145*** (0.984)			
Descendant		-5.865*** (1.752)		
Founder			-5.465*** (1.057)	
Family Share				-0.073*** (0.028)
Observations	17,443	17,443	17,443	18,278
Firms	3,906	3,906	3,906	3,961
R ²	0.513	0.510	0.511	0.503
Control variables	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes

Table 10: Alternative measurements

This table reports the OLS regression results of family firms on firms' emissions using alternative measurements for the dependent variables and family firms. In Panel A, the dependent variables represent the natural logarithm of the absolute level of Scope 1, 2 and 3 emissions instead of emission intensity. In Panel B, alternative definitions for *Family* are employed. All specifications include control variables as in Table 3 and constant, industry, and country-time fixed effects. Appendix Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

<i>Panel A: Absolute emissions</i>					
	aai_1 (1)	aai_1_2 (2)	aai_1_2_3 (3)		
Family	-0.212*** (0.045)	-0.143*** (0.035)	-0.098*** (0.031)		
Observations	25,596	25,596	25,596		
Firms	5,016	5,016	5,016		
R ²	0.757	0.790	0.781		
Firm controls	Yes	Yes	Yes		
Industry FE	Yes	Yes	Yes		
Country×Time FE	Yes	Yes	Yes		
<i>Panel B: Alternative definitions of family firms</i>					
	iai_1 (1)	iai_1 (2)	iai_1 (3)	iai_1 (4)	iai_1 (5)
Family (alt. def. 1)	-12.928** (5.194)				
Family (alt. def. 2)		-12.700* (6.507)			
Family (alt. def. 3)			-12.038* (6.616)		
Family (alt. def. 4)				-17.843*** (6.764)	
Family (alt. def. 5)					-13.855** (6.535)
Observations	25,596	25,596	25,596	25,596	25,596
Firms	5,016	5,016	5,016	5,016	5,016
R ²	0.469	0.469	0.469	0.469	0.469
Firm controls	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes	Yes

Table 11: Omitted variable bias and clustering

This table reports the OLS regression results of family firms on firms' emissions using alternative specifications for the fixed effects (Panel A) and for the level of clustering (Panel B). The dependent variables represent Scope 1 emission intensity. *Family* is a dummy variable equal to 1 for family firms and 0 otherwise. All regressions include a constant term and firm controls (except for column 1). Oster's (2019) delta is reported at the bottom of the table. This delta "can be interpreted as the degree of selection on unobservables relative to observables that would be necessary to explain away the result". A delta superior or equal to one suggests results are robust to an omitted variable bias. The maximum R² is computed as 1.3R². Table A1 provides detailed definitions of the variables. Robust standard errors are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

<i>Panel A: Fixed effects and Oster's (2019)</i>					
	iai_1 (1)	iai_1 (2)	iai_1 (3)	iai_1 (4)	iai_1 (5)
Family	-61.238*** (6.313)	-36.412*** (6.806)	-6.538 (5.198)	-12.805** (5.207)	-13.424*** (5.197)
Observations	38,498	25,618	25,618	25,596	25,028
Firms	6,516	5,016	5,016	5,016	4,955
R ²	0.012	0.141	0.447	0.469	0.513
Cluster	Firm	Firm	Firm	Firm	Firm
Firm controls	No	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	No	No
Country×Time FE	No	No	No	Yes	No
Country×Time×Industry FE	No	No	No	No	Yes
Assumed R ² _{max}		0.183	0.581	0.61	0.667
Delta		4.96	0.41	0.89	1.25
<i>Panel B: Clustering</i>					
	iai_1 (1)	iai_1 (2)	iai_1 (3)		
Family	-12.805** (4.220)	-12.805** (5.002)	-12.805*** (2.553)		
Observations	25,596	25,596	25,596		
Firms	5,016	5,016	5,016		
R ²	0.469	0.469	0.469		
Cluster	Industry	Country#Industry	Country#Industry#Time		
Firm controls	Yes	Yes	Yes		
Industry FE	Yes	Yes	Yes		
Country×Time FE	Yes	Yes	Yes		

Table 12: Propensity scores matching analysis

This table reports the OLS regression results of family firms on firms' emissions using data for 2010–2019. The dependent variables represent Scope 1, 2 and 3 emission intensity in columns 1-3 and 7 and the logarithm of absolute emissions in columns 4-6 and 8. *Family* is a dummy variable equal to 1 for family firms and 0 otherwise. *Paris* is a dummy variable equal to 1 for the time period between 2015–2019 and 0 otherwise. All specifications include control variables as in Table 3 and constant, industry, and country-time fixed effects. Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	iai_1 (1)	iai_1_2 (2)	iai_1_2_3 (3)	aai_1 (4)	aai_1_2 (5)	aai_1_2_3 (6)	iai_1 (7)	aai_1 (8)
Family	-16.608*** (6.027)	-19.982*** (6.576)	-95.362** (43.428)	-0.233*** (0.052)	-0.159*** (0.040)	-0.101*** (0.035)	-7.213 (5.411)	-0.172*** (0.051)
Paris×Family							-21.397*** (6.107)	-0.138*** (0.044)
Observations	19,623	19,623	19,623	19,623	19,623	19,623	19,623	19,623
Firms	2,909	2,909	2,909	2,909	2,909	2,909	2,909	2,909
R ²	0.434	0.453	0.462	0.724	0.760	0.748	0.434	0.725
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 13: Emissions, industry and geographical heterogeneity

This table reports the OLS regression results of family firm on firms' emission for different economic sectors and geographical areas using data for 2010–2019. The dependent variables represent Scope 1 emission intensity. *Family* is a dummy variable equal to 1 for family firms and 0 otherwise. *Paris* is a dummy variable equal to 1 for the time period between 2015–2019 and 0 otherwise. All regressions include firm controls, industry fixed effect (except in Panel A), country-time fixed effects, and a constant term. Panel A divides the sample by industry; Panel B divides the sample by region. Table A1 provides detailed definitions of the variables. Robust standard errors are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

<i>Panel A: Industry heterogeneity</i>									
	Basic Materials	Cons. Goods	Cons. Services	Health Care	Industrials	Oil & Gas	Technology	Telecom.	Utilities
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Family	-24.515 (19.671)	-3.500 (3.991)	-6.707 (16.715)	-4.654* (2.721)	-12.675 (10.463)	-41.510** (18.028)	-1.354 (2.185)	1.370 (1.250)	16.478 (77.451)
Paris×Family	34.100 (27.588)	-9.690** (3.766)	-23.430** (11.900)	-1.587 (3.503)	1.852 (9.587)	9.509 (23.638)	-1.434 (1.679)	-1.533 (1.281)	-177.086** (83.401)
Observations	2,602	3,355	3,952	2,170	6,887	1,866	2,503	575	1,118
Firms	459	614	798	581	1259	363	584	103	197
R ²	0.177	0.040	0.139	0.147	0.164	0.412	0.281	0.044	0.266
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	No	No	No	No	No	No
Country×Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Panel B: Regions heterogeneity</i>									
	Asia-Pacific	Europe	North America						
	(1)	(2)	(3)						
Family	-1.841 (15.773)	10.976 (8.301)	-3.239 (6.647)						
Paris×Family	-46.580*** (16.859)	-21.339*** (7.888)	-20.053*** (7.010)						
Observations	5,132	10,295	10,169						
Firms	837	1,849	2,340						
R ²	0.412	0.428	0.562						
Firm controls	Yes	Yes	Yes						
Industry FE	Yes	Yes	Yes						
Country×Time FE	Yes	Yes	Yes						

Appendix

Table A1: Variables

This table reports the definitions and sources of the variables employed in the study.

Variable	Description of variables	Source
Emission Variables		
iai_1	Intensity Average Inference Scope 1 (tCO ₂ e/\$m Revenue)	Urgentem
iai_1_2	Intensity Average Inference Scope 1 & 2 Total (tCO ₂ e/\$m Revenue)	Urgentem
iai_1_2_3	Intensity Average Inference Scope 1, 2 & 3 Total (tCO ₂ e/\$m Revenue)	Urgentem
aai_1	Log of Absolute Average Inference Scope 1 (tCO ₂ e)	Urgentem
aai_1_2	Log of Absolute Average Inference Scope 1 & 2 Total (tCO ₂ e)	Urgentem
aai_1_2_3	Log of Absolute Average Inference Scope 1, 2 & 3 Total (tCO ₂ e)	Urgentem
Ownership Variables		
Family	Equals 1 if the founder or descendant or family member is director or officer or large shareholder >5%, 0 otherwise	NRG
Family Share	The ratio of the number of shares held by the family to total shares outstanding	NRG
Family (alt. def. 1)	Equals 1 if the founder or descendant or family member is director or officer or large shareholder, 0 otherwise	NRG
Family (alt. def. 2)	Equals 1 if the family is the largest voteholder, 0 otherwise	NRG
Family (alt. def. 3)	Equals 1 if the family is the largest shareholder, 0 otherwise	NRG
Family (alt. def. 4)	Equals 1 if there are at least two family members as board member or executive officer or large shareholder >5%, 0 otherwise	NRG
Family (alt. def. 5)	Equals 1 if the family is the largest voteholder and at least one member of the family is board member, 0 otherwise	NRG
Financial Variables		
Size	Logarithm of total assets	Refinitiv
MBV	Price to book value per share calculated by dividing the company's latest closing price by its book value per share	Refinitiv
PPP	Property, plant and equipment divided by total assets	Refinitiv
CAPEX	Capital expenditure divided by total assets	Refinitiv
ROA	Net income before extraordinary items divided by average total assets	Refinitiv
Leverage	Total long-term debt divided by total assets	Refinitiv
Liquidity	Total current assets divided by total current liabilities	Refinitiv
Age	Date of Incorporation (registration)	Refinitiv
R&D	Research and development (R&D) expenses divided by total assets	Refinitiv
Governance Variables		
Board Gender	Percentage of females on the board	NRG
Board Size	Total number of board members	NRG
Board Skills	Percentage of board members with industry specific or finance skills	NRG
Board Tenure	Average length of the board tenure in years	NRG
Governance Committee	Equals 1 if the company registers a governance committee, 0 otherwise	NRG
Board Education	Ratio of directors with master or PhD degrees relative to board size	NRG
Family Board	The ratio of the number of family members in the board to the total number of board members	NRG
Family CEO	Equals 1 if the founder or descendant is the CEO, 0 otherwise	NRG
Family Dual	Equals 1 if the founder or descendant is the CEO and Chairman, 0 otherwise	NRG
Founder CEO	Equals 1 if the founder is the CEO, 0 otherwise	NRG
Descendant CEO	Equals 1 if the descendant is the CEO, 0 otherwise	NRG

Founder Dual	Equals 1 if the founder is the CEO and Chairman, 0 otherwise	NRG
Descendant Dual	Equals 1 if the descendant is the CEO and Chairman, 0 otherwise	NRG
Environmental Variables		
Paris Agreement	Equals 1 for the time period between 2015–2019, 0 otherwise	
Commitment	Equals 1 if the firm announced emission reduction target	Refinitiv
ESG	Refinitiv ESG Combined Score is an overall company score based on the reported information in the environmental, social and corporate governance pillars (ESG Score)	Refinitiv
ESG_E	The environmental pillar measures a company's impact on living and non-living natural systems, including the air, land and water, as well as complete ecosystems	Refinitiv
E_{RE}	Resource use category score reflects a company's performance and capacity to reduce the use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management.	Refinitiv
E_{EM}	Emission category score measures a company's commitment and effectiveness towards reducing environmental emission in the production and operational processes.	Refinitiv
E_{EI}	Environmental innovation category score reflects a company's capacity to reduce the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies and processes or eco-designed products.	Refinitiv
rai_1	Intensity Average Reported Scope 1 (tCO ₂ e/\$m Revenue)	Refinitiv
Patents	The number of green patent applications (CPC Y02) applied for by a company in a given year.	Orbis IP
Citations	The total number of forward citations received by all green patents (CPC Y02) applied for by a company in a given year.	Orbis IP

Table A2: Descriptive statistics by country

The table provides mean values of the main variables employed in the study by country. The mean values are based on the observation for each country in the sample for the period 2010–2019. The variables' definition and their sources are presented in Table A1.

Country	Firms	N	iai_1	iai_1_2	iai_1_2_3	Size	MBV	PPP	CAPEX	ROA	Leverage	Liquidity	Age
Australia	299	1,737	169.87	238.85	2,803.46	20.73	4.43	52.09	7.25	3.08	45.92	2.33	1988
Austria	45	299	148.37	193.63	1,933.23	21.27	1.58	80.77	6.35	3.88	58.63	1.91	1952
Belgium	80	533	62.00	95.44	904.41	20.72	2.37	65.77	5.20	1.38	54.70	2.70	1977
Canada	384	2,133	255.79	332.30	3,113.80	21.34	3.02	78.29	8.13	1.80	47.60	2.90	2000
China	72	462	172.65	229.25	3,662.48	22.88	16.01	51.19	5.83	5.87	54.34	3.02	1997
Croatia	6	58	88.04	112.98	1,121.29	20.80	11.91	97.58	4.91	5.02	44.87	2.41	1995
Cyprus	3	17	398.97	425.55	2,357.29	19.58	0.57	69.00	4.03	3.89	54.50	4.36	1972
Czech Republic	7	53	161.42	205.61	1,099.14	21.37	42.98	85.88	6.49	8.81	50.57	1.95	1998
Denmark	81	477	88.47	116.03	1,043.73	20.60	29.94	55.65	4.98	5.22	49.16	2.01	1967
Finland	105	658	73.51	113.04	1,222.66	20.57	2.22	60.24	4.35	4.17	55.04	2.41	1977
France	346	2,051	75.73	109.03	1,142.78	21.47	2.46	44.97	4.30	1.63	60.10	2.37	1983
Germany	299	2,055	72.10	109.96	1,118.60	21.14	2.26	48.34	5.04	3.29	57.31	2.02	1994
Greece	83	435	174.21	213.22	1,943.88	20.45	1.05	69.66	4.06	2.20	56.28	5.13	1979
Hong Kong	40	316	192.97	240.58	1,626.80	22.71	22.79	50.61	5.28	7.66	48.38	2.99	1986
Hungary	7	44	25.02	51.10	725.51	20.47	312.89	112.66	7.81	4.20	43.32	2.03	1976
Iceland	2	9	111.34	123.62	1,585.23	20.07	14.43	32.76	7.18	6.05	38.66	1.20	1971
India	86	753	241.98	305.58	3,466.59	22.26	313.34	42.40	6.59	9.21	53.58	3.94	1970
Indonesia	49	339	201.90	259.44	10,043.13	21.44	2976.65	67.17	7.28	7.99	52.43	3.36	1982
Ireland	39	221	138.19	172.93	1,576.30	20.89	2.11	46.32	4.76	2.99	52.08	2.60	1984
Italy	184	1,157	116.84	145.33	1,444.01	21.05	2.02	54.39	4.48	2.89	62.00	2.99	1981
Japan	205	1,817	108.58	157.19	1,465.79	23.27	159.48	74.03	4.60	3.46	57.86	3.20	1941
Luxembourg	1	3	6.42	15.91	967.08	23.02	2.57	10.36	2.54	9.97	50.78	0.50	1973
Malaysia	39	261	235.96	283.80	1,829.17	22.20	24.23	74.95	6.21	7.00	52.67	2.95	1988
Malta	3	13	9.28	38.12	803.92	20.01	39.31	7.24	7.37	11.86	50.11	2.19	2002
Netherlands	107	568	80.02	117.70	1,522.88	21.46	2.43	46.21	4.41	2.49	58.81	2.40	1975

New Zealand	30	172	225.54	248.54	1,319.27	21.22	5.14	74.50	5.74	5.00	49.10	2.91	1990
Norway	157	760	149.61	182.21	1,831.99	20.58	20.66	58.23	6.92	1.25	56.73	3.75	2000
Philippines	32	263	297.29	351.11	3,713.19	21.88	112.31	59.76	6.13	6.46	60.68	2.68	1971
Poland	27	193	263.84	312.32	5,153.59	21.61	6.30	76.66	6.38	3.55	49.79	1.88	2002
Portugal	35	244	140.02	178.64	1,679.34	21.49	1.38	71.93	4.40	2.39	69.14	4.41	1987
Romania	5	47	236.86	295.48	3,213.81	20.53	4.40	99.87	6.63	4.27	50.37	1.79	1992
Russian Federation	55	398	388.30	473.64	2,901.19	22.81	100.09	76.80	8.33	7.88	51.90	1.90	2003
Singapore	68	471	101.06	132.31	1,751.93	21.54	4.17	51.87	5.33	5.26	53.08	4.71	1987
Slovenia	11	69	90.17	114.81	1,598.26	20.94	0.67	112.33	5.56	2.41	50.73	4.48	1986
South Korea	23	202	87.30	142.34	1,532.44	23.16	1537.64	65.19	6.64	4.66	51.73	2.68	1973
Spain	104	675	127.96	167.31	1,953.89	21.67	4.17	61.33	4.51	3.24	66.14	4.05	1974
Sweden	223	1,232	42.07	67.51	922.40	20.27	26.86	35.02	4.37	3.77	51.25	2.29	1976
Switzerland	166	1,045	60.54	89.21	972.53	21.02	3.44	54.46	4.33	3.13	50.41	1.68	1971
Taiwan	23	164	36.37	104.90	1,997.81	22.82	71.93	79.17	6.39	6.18	49.78	2.27	1988
Thailand	56	388	231.99	277.70	3,224.21	21.53	116.51	72.71	6.37	7.05	55.35	4.10	1983
United Kingdom	505	3,250	96.06	139.05	1,544.52	21.19	2.90	50.98	5.19	5.12	57.20	1.94	1981
United States	2,508	12,456	108.78	143.75	1,464.66	21.69	4.68	48.40	4.74	3.44	55.10	2.61	1986

Table A3: Descriptive statistics – additional variables

The table provides summary statistics (Panel A) and difference-in-means tests (Panel B) of the additional variables employed in the study. Variables characterizing only family firms are not presented in Panel B. The descriptive statistics are based on the full sample consisting of 6,600 unique companies for the period 2010–2019. The variables' definition and their sources are presented in Table A1.

<i>Panel A: Summary statistics</i>						
	N	Mean	SD	p25	Median	p75
Board Gender	24,323	17.15	12.81	8.33	16.67	25.00
Board Size	24,324	9.93	3.26	8	9	12
Board Skills	24,325	52.65	22.29	37.50	53.85	69.23
Board Tenure	24,028	7.60	3.79	4.89	6.95	9.61
Family Share	38,498	6.92	16.55	0	0	1.20
Family Board	33,743	6.28	11.54	0	0	11.11
Family CEO	36,167	0.17	0.38	0	0	0
Family Dual	36,167	0.09	0.29	0	0	0
Founder CEO	36,167	0.11	0.31	0	0	0
Descendant CEO	36,167	0.06	0.24	0	0	0
Founder Dual	36,167	0.07	0.25	0	0	0
Descendant Dual	36,167	0.03	0.17	0	0	0
R&D	12,656	6.20	8.95	0.91	2.92	7.82
Patents	32,479	3.62	30.11	0	0	0
Citations	32,479	7.31	128.04	0	0	0
ESG	24,964	45.13	18.85	30.34	44.49	59.29
ESG _E	24,945	39.55	28.72	12.18	39.26	63.87
Commitment	24,480	0.39	0.49	0	0	1
E _{RE}	24,844	43.77	33.23	10.00	44.09	73.75
E _{EM}	24,844	43.60	33.26	9.67	43.64	73.55
E _{EI}	24,844	25.80	31.32	0	1.72	50.00
aai_1	38,498	10.29	2.87	8.35	10.14	12.21
aai_1_2	38,498	11.34	2.45	9.69	11.24	12.93
aai_1_2_3	38,498	13.86	2.41	12.31	13.92	15.47
rai_1	10,554	319.53	930.88	4.16	16.70	160.54
Family (alt. def. 1)	38,498	0.33	0.47	0	0	1
Family (alt. def. 2)	38,498	0.18	0.39	0	0	0
Family (alt. def. 3)	38,498	0.18	0.38	0	0	0
Family (alt. def. 4)	38,498	0.17	0.37	0	0	0
Family (alt. def. 5)	38,498	0.16	0.37	0	0	0

Panel B: Difference-in-means test

	Family firms		Non-family-firms		Difference
	N	Mean	N	Mean	
Board Gender	6,998	15.59	17,325	17.78	-2.19***
Board Size	6,998	9.58	17,326	10.08	-0.50***
Board Skills	6,998	53.17	17,327	52.44	0.73**
Board Tenure	6,862	9.52	17,166	6.84	2.68***
R&D	3,863	8.10	8,793	5.37	2.73***
Patents	10,287	2.37	22,192	4.21	-1.84***
Citations	10,287	4.76	22,192	8.49	-3.73**
ESG	7,132	39.98	17,832	47.19	-7.21***
ESG _E	7,120	31.70	17,825	42.68	-10.98***
Commitment	6,970	0.27	17,510	0.44	-0.17***
E _{RE}	7,102	35.70	17,742	47.01	-11.31***
E _{EM}	7,102	35.77	17,742	46.74	-10.97***
E _{EI}	7,094	19.11	17,723	28.47	-9.36***
aai_1	12,469	9.51	26,029	10.67	-1.16***
aai_1_2	12,469	10.69	26,029	11.66	-0.96***
aai_1_2_3	12,469	13.26	26,029	14.15	-0.88***
rai_1	2,242	193.73	8,312	353.47	-159.74***

Table A4: Pretreatment firm characteristics and matching procedure

This table shows firm-specific characteristics, averaged for the pretreatment period (2010-2014), for the control and the treatment group. The table is divided in two panels. Panel A reports descriptive statistics for the unmatched sample of firm covariates employed in the main analysis, whilst Panel B reports descriptive statistics for the matched sample. The PSM applies a logit model and one-to-one nearest neighbor, imposing a tolerance level on the maximum propensity score distance (caliper) between the control and the treatment group equal to 0.01. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

	Treated (1)	Control (2)	t-test (3)
<i>Panel A: Before matching</i>			
Size	21.31	21.83	-17.09***
MBV	71.36	63.33	1.17
PPP	49.30	58.21	-11.65***
CAPEX	6.13	5.64	5.05***
ROA	5.62	4.96	4.01***
Leverage	50.77	55.35	-12.03***
Liquidity	2.16	1.92	8.28***
Age	1985.7	1978.7	12.66***
<i>Panel B: After matching</i>			
Size	21.33	21.29	1.27
MBV	64.46	60.69	0.47
PPP	49.83	49.67	0.19
CAPEX	6.05	5.97	0.64
ROA	5.50	5.42	0.42
Leverage	51.23	51.59	-0.77
Liquidity	2.14	2.12	0.43
Age	1985.4	1985.3	0.13