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 6,610 non-financial companies over the period 2010-2019. We document that family firms emit lower levels of carbon, both direct and indirect, compared to non-family firms. This points to a stronger commitment to environmental protection among family firms. Differences in governance structure, familial values, and higher R&D expenditures partly explain our results. Paradoxically, we find that family firms and family CEOs commit less publicly to a reduction in their carbon emissions and have lower ESG scores, although emitting less carbon. This suggests a lower participation in the public display of such an outcome and a lower tendency to greenwashing.

Keywords: carbon emission, ESG, governance, family firms, greenwashing, climate change
JEL Codes: G3; G38; M14

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*This paper was previously circulated under the title "Family Ownership and Carbon Emission. The authors appreciate the comments of Morten Bennedsen, Izidin El-Kalak, Joseph Fan, Jacquelyn Humphrey, Benjamin Maury, Svetlana Mira, Pierluigi Murro, Wojtek Paczos, Bartolomé Pascual-Fuster, Patrick Roger, Andrea Zaghinie, reviewers at the JCF SI Conference on Ownership and Corporate Social and Sustainable Policies, and participants at the AEFIN Conference in Malaga, FEBS Conference in Chania, AFFI Conference in Bordeaux, FMA European Conference in Aalborg, the 3rd International Corporate Governance Conference in Cardiff, International Conference in Banking and Financial Studies in Caserta and SFA Meeting in Puerto Rico.
We acknowledge support from the National Science Centre, Poland, research grant no. 2019/33/B/HS4/00369.

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1. Introduction

Scientific evidence shows that human emissions of greenhouse gases (GHGs), particularly carbon dioxide (CO_2), pose a threat to human habitability (Reilly et al., 2003) and economic activity (Nordhaus, 2019). Reducing pollution and GHG emissions are key objectives for achieving sustainable development and preserving ecosystems and biodiversity. Institutional investors are increasingly demanding compensation for investments in companies with high GHG emissions (Bolton and Kacperczyk, 2021). As a result, companies with higher emissions face higher financing costs —a trend that may escalate in the future. However, the financial drivers of a firm's greenhouse gas emissions are not yet fully understood (Busch and Lewandowski, 2018).

In this study, we explore the relationship between family firms and their CO_2 equivalent 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 CO_2 reduction initiatives. Family owners represent a unique shareholder type (Anderson and Reeb, 2004; Bennedsen and Fan, 2014; Cheng, 2014; Chrisman et al., 2005), characterised by different financial and environmental objectives and specific agency conflicts. These characteristics may influence their level of emissions.

First, family firms are likely to be more attracted to the distant financial benefits associated with reducing pollution. The literature shows that most firms still seek financial gains when adopting environmental strategies (e.g., Hillman et al., 2009; Liedong et al., 2017; Mellahi et al., 2016). Pollution and climate change affect the long-term survival of companies. Zellweger et al. (2012) and Cheng (2014) document how family-owned firms focus on more long-term goals, notably due to the desire to transfer the business to the next generation (Casson, 1999). This reduces the discount factor of the long-term investment horizon, making a concurrent reduction in pollution emissions more attractive. Family firms are also more risk averse as they hold an undiversified portfolio (Anderson and Reeb, 2003; Cheng, 2014). In turn, they may be more concerned about the negative impacts of climate change on their business and take more radical action. Family firms also place a higher value on reputational costs (Sageder et al., 2015; Westhead et al., 2001). This means that family firms may be more responsive to institutional

[1] In line with the literature, we employ data that converts all GHG emissions into CO_2 equivalent emissions. To avoid burdening the writing, the remainder of the paper refers to CO_2 equivalent emissions simply as CO_2 emissions. Hence, GHG and CO_2 emissions are used interchangeably in the manuscript.

pressures, such as government or regulatory scrutiny, fear of media investigation or social pressure (Berrone et al., 2010), and may be more likely to voluntarily adopt environmental measures that go beyond what is required by regulators and/or their peers.

Second, family firms may also adopt specific environmental measures for non-financial reasons. Family firms tend to seek non-economic benefits such as placing family members in strategic positions (Gomez-Mejia et al., 2010) and avoiding equity dilution (Schulze et al., 2003a). They are also more willing to engage in altruistic and philanthropic activities (Campopiano et al., 2014; Schulze et al., 2003b). Family owners are strongly tied with their company (Kepner, 1983), have stronger value-based leadership (Bennedsen and Chevrot-Bianco, 2021), seek to preserve a specific family identity (Deephouse and Jaskiewicz, 2013; Zellweger et al., 2010), and receive recognition from the community (Corbetta and Salvato, 2004). In general, Gomez-Mejia et al. (2007) suggest that family firms are more prone to strategic decisions deviating from economic benefits to satisfy emotional or social needs. Reducing GHG emissions is a way of demonstrating to the public that the firm's actions are appropriate and beneficial to the community, rather than focused solely on profitability. These non-financial motives may encourage family firms to adopt more stringent decarbonisation policies than their non-family counterparts in order to demonstrate their commitment to environmental protection.

Third, these financial and non-financial motives are likely to be influenced by the specific agency context in which family firms evolve. Agency theory is a commonly used framework in the finance literature when it comes to ownership structure. On the one hand, family owners can act as monitors in the firm (Villalonga et al., 2015) and ensure that the interests of shareholders and managers are aligned, thereby reducing Type I agency (Jensen and Meckling, 1976). Based on this alignment hypothesis, we would expect family firms to pursue environmental investments that do not affect shareholder wealth maximisation (Abeysekera and Fernando, 2020). On the other hand, family owners may use their dominant position position (Anderson et al., 2003) to extract private benefits of control (DeAngelo and DeAngelo, 2000) and pursue personal goals that may deviate from shareholder wealth maximisation, increasing Type II agency costs between controlling and minority shareholders (Anderson et al., 2009). This potential behaviour is facilitated by the distinct governance systems that usually exist in family firms. Based on this entrenchment hypothesis, we might expect family firms to pursue non-economic strategies, such as investing in non-value-adding environmental projects, motivated by personal interests rather than shareholder wealth maximisation (Abeysekera and Fernando, 2020).

In this study, we propose to investigate the relationship between family firms and GHG emissions. In line with the literature, we consider CO_2 equivalent emissions, which includes both CO_2 emissions and other GHG emissions in one measure. CO_2-equivalent emissions are one of the most understandable measures of sustainable development for policy makers and the public. Our dataset consists of a comprehensive sample of 6,610 non-financial companies from 44 countries over the period 2010-2019. Our sample includes information on each firm's ownership and management structure, which we relate to its CO_2 emissions and firm-level controls. We examine emissions from two perspectives: emissions intensity, which we normalise by firm revenues, and absolute emissions levels. We also use a three-scope framework to capture both direct and indirect emissions. However, we place more emphasis on direct emissions (Scope 1), as these are more readily observable by the firms' stakeholders.

Our main result shows that family firms have lower emissions, both direct and indirect, compared to non-family firms, after controlling for firm characteristics and country, industry and year fixed effects. This result implies a more concerted effort towards environmental stewardship by family firms. Cross-sectional analysis shows that the positive effect of family ownership on CO_2 emissions is mainly concentrated in three sectors with fundamentally different emission intensities (Consumption of Goods, Health Care, and Oil and Gas) and in North America.

We use the 2015 Paris Agreement as a quasi-exogenous shock to examine shifts in emission intensity for both family and non-family firms around this event.[2] We find that for each emission scope, the effect of family firms is negative and significant mainly after the Paris Agreement, suggesting a larger change in behaviour for family shareholders. This response is observed in all three regions (Europe, North America and Asia) and is more pronounced in high emitting sectors (Utilities) and sectors with higher abatement costs (Consumption and Services).

[2] The Paris Agreement set out a global framework to reduce GHG emissions and limit global warming to well below 2°C. Since 2016, almost all countries in the world have ratified the Paris Agreement. The ratification of the Paris Agreement has increased the general awareness on 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 forcing more and more companies to reduce and offset carbon emission.

We then explore some underlying factors that might explain the distinct effect of family firms on CO_2 emissions. First, we analyse whether the results can be attributed to differences in the governance structure of family and non-family firms. We find that family firms with longer tenured boards show an additional reduction in emissions, suggesting that the long-term vision of family firms plays an important role. Notably, the fact that family firms have lower GHG emissions persists even after controlling for several board characteristics, suggesting that governance is only part of the explanation. Second, we show that firms that are strongly controlled, managed and/or governed by family members pollute less than their counterparts. This suggests that family involvement in the business plays a role in reducing CO_2 emissions. Third, we show that family firms also started to invest 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, our study examines whether this different behaviour is related to a higher commitment of family firms to reduce CO_2 emissions - especially after the 2015 Paris Agreement. Our results are surprising in that they point in the opposite direction. We found that family firms commit less to a reduction in their greenhouse gas emissions than other firms. Moreover, they did not change this behaviour after the Paris Agreement. This paradox suggests a lower commitment to public disclosure of environmental performance. Although family firms pollute less, they do not commit more to doing so. We complete this analysis by looking at firms' environmental, social and governance (ESG) scores, focusing in particular on the Environment score. Consistent with the findings of Villalonga et al. (2023), we confirm that family firms have lower ESG and Environment scores. This is despite the fact that, according to our analysis, their actual emissions are significantly lower compared to non-family firms. These results show that family firms are less inclined to communicate about their environmental performance—even though they perform better—suggesting a lower propensity to greenwashing.

We examine the robustness of our results by first ensuring that they do not depend on our measures. We use alternative measures of CO_2 emissions, including both the carbon emissions intensity ratio and absolute emissions levels, as well as alternative definitions of family firms. Despite these variations, our main results remain unchanged.

To address potential omitted variable bias and limitations in causal interpretation due to the static nature of family firms at the firm level, 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 use a two-stage least squares method, instrumenting family ownership with CEO tenure and the country-average number of children in the family. Fourth, we implement a dynamic difference-in-differences (DiD) strategy centred on the 2015 Paris Agreement. This approach confirms that there are no divergent trends in emissions between family and non-family firms before the agreement, while family firms show a significant reduction in emissions after the agreement. These additional tests mitigate endogeneity concerns and strengthen the robustness of our results.

Our study makes several contributions to the growing literature on climate change and environmental protection. First, using CO_2 emission intensity as a proxy for pollution, it shows that family firms have lower GHG emissions compared to non-family firms.[3] Our results also show a different change in behaviour and emission levels between the two groups following the Paris Agreement. So far, the literature has presented results based on indirect proxies for pollution. Huang et al. (2009) survey 235 manufacturing firms in Taiwan and find that family firms are more likely to pursue green technical and managerial innovations in response to internal stakeholder pressure. Saeed et al. (2022) examine the adoption of ISO 14001 certification - which defines the standards required for an effective environmental management system (EMS) - by Chinese firms. They find a positive relationship between ISO 14001 adoption and family firms, and a stronger effect for family firms that are more affected by reputational concerns and for firms located closer to large cities. Focusing on polluting industries, Berrone et al. (2010) find 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.

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. The results show that family firms and family CEOs not only pollute less than non-family firms, but also communicate less about it, especially in terms of ESG scores. 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,

[3] Our estimates are group averages and should be interpreted as such. They do not mean that all family firms display better environmental outcomes. Environmental scandals also tainted family-owned firms. See for instance Bennedsen et al. (2013).

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 Ghoul et al. (2016), Tenuta and Cambrea (2022), and Atiqa et al. (2023) show that family-controlled firms have lower CSR. Our study contributes to reconciling these different views by examining the effective environmental outcomes of family firms, which are found to be better on average than those of non-family firms.

Third, our paper contributes to the growing literature on ESG 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 pollution of family firms. On the one hand, we document that family firms and family CEOs disclose less favourable environmental performance indicators than non-family firms and firms with hired CEOs. On the other hand, we show that family firms and firms with family CEOs have better environmental performance. Pointing out this discrepancy 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 the different channels that underpin our results, while Section 5 details the effect of family ownership on 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 dataset from the NRG Metrics database to identify family firms. NRG Metrics uses publicly available documents to collect information on corporate governance, including the identification of family firms. Customised 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 and Wang, 2023; Marano et al., 2022; Miroshnychenko et al., 2021).

Next, the NRG Family Firm dataset is combined with CO_2 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 6,610 unique public companies listed in 43 countries between 2010 and 2019. The final sample consists of an unbalanced panel dataset with 38,498 firm-year observations. 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, now acquired by Intercontinental Exchange (ICE). The dataset provides comprehensive data on corporate carbon emissions, including aspects such as direct and indirect emissions and emissions intensity. Urgentem adheres to the Greenhouse Gas Protocol, which sets the standard for measuring greenhouse gas emissions.[5] The database calculates and provides annual CO_2 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] See for more information: https://ghgprotocol.org/corporate-standard

While our primary interest is in Scope 1 emissions, our initial analysis includes all three scopes to assess a company's CO_2 emission intensity. Following Ilhan et al. (2021) and Bolton and Kacperczyk (2021), we calculate CO_2 emission intensity by scaling a firm's CO_2 emissions (in tonnes) to its total revenues (in millions of dollars). As Garvey et al. (2018) argue, this measure can serve as a proxy for firm efficiency in terms of GHG emissions and economic performance. We start by focusing on Scope 1 emissions, then 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 CO_2 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 the family dummy variable. This variable takes the value of 1 if the founder or a member of the founder's family 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. For robustness, we also examine alternative definitions of family firms as suggested by previous research (e.g., Miller et al., 2007).

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, going 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 worldwide, 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 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.

[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.[6] On average, the emissions intensity of Scope 1 CO_2 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 CO_2. Adding Scope 2 emissions, which accounts for firms' energy consumption, increases the CO_2 emissions intensity to 166 tonnes per million dollars of revenue. When the analysis further includes indirect emissions (Scope 3), the CO_2 emissions intensity rises sharply, with each million dollars of revenue generating, on average, 1,506 tonnes of CO_2. 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 tend to have higher emission intensities. On the other hand, less profitable and less liquid firms generally emit less CO_2.

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

[6] Appendix Table A2 presents the summary statistics for the additional variables, in their chronological order of use.

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, suggesting 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. Additionally, they are usually older.

[Table 2]

Figures 1 and 2 display the average emission intensity (Scope 1) across the two types of firms, across region and industries, respectively. Generally, European firms appear to be the least polluting on average. In all three regions, family firms tend to 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 fewer CO_2 as a proportion of their revenues. Family firms in less polluting sectors like Technology, Consumer Services, and Consumer Goods display a larger relative gap in CO_2 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 CO_2 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 CO_2 emissions:

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

where $y_{i,t}$ represents the CO_2 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). Robustness tests present alternative clusterings.

Given the minimal within-group variation in family firms, our model does not allow 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 time-invariant component of the error term and right-hand side regressors, including family firm dummy variable. To address this issue, we employ a difference-in-differences analysis, 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, 2019; Reghezza et al., 2022). We adopt this approach, examining changes in emission intensities around the Paris Agreement for both family and non-family firms. This analysis leads to the following modified model, which extends Equation 1:

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

In this equation, *Paris* 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 family firms. All other variables remain consistent with those in Equation (1), and standard errors are clustered at the firm level.

3. Family Ownership and Carbon Emissions

This section first presents the results of the ordinary OLS regressions and then focuses on the impact of the Paris Agreement using the difference-in-differences approach.

3.1. Ordinary OLS regression results – main results

Our main model incorporates the full sample of firms and relates family ownership to emissions intensity. We progressively consider the three scopes of emissions. Results are reported in Table 3.

[Table 3]

Across all scopes of emissions, family firms display significantly lower levels of emissions intensity. 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 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. The model controls for firm size, capital structure, profitability, age, and tangibility of assets, in addition to country-years and industry fixed effects. Among the control variables, larger firms and those with more tangible assets tend to have higher emissions, both in terms of intensity and absolute levels. Profitability is negatively related to emissions, and firms with higher level of debt emit less. Finally, age does not have a significant impact.[7] Overall, the findings suggest that family firms lead to better environmental performance, even when accounting for other potential firm-specific characteristics.

In a second step, we investigate the impact of family firms across various industries and geographic locations. It is important to recognize that GHG emissions vary significantly by industry, with certain sectors inherently generating more emissions. This disparity affects abatement costs, capacity, and incentives for emission reduction (Huang et al., 2016). To account for these differences, 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 emissions intensity metric[8], we re-run our primary model to each sector individually. The outcome, displayed in Panel A of Table 4, reveals that family firms are specifically associated with lower Scope 1 CO_2 emission intensity in three sectors: Consumption of Goods, Health Care, and Oil and Gas. In contrast, its impact is statistically insignificant in the other sectors. Moving to a geographical context, Panel B of Table 4 categorizes the sample into three regions: Asia-Pacific, Europe, and North America. Existing literature highlights distinct patterns both in family firms' structures (Aminadav and Papaioannou, 2020) and emission intensities (Raupach et al., 2007) across these regions. Our findings underscore that the impact of family firms on emission intensity is significant only in North America.

[7] 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.

[8] We applied alternative GHG emission metrics using the different scopes and observed a consistent pattern of results. To maintain brevity, these results are not presented in the table but are available upon request.

[Table 4]

In summary, our findings illuminate that family firms are negatively correlated with emission intensity, even when accounting for potential systematic differences among firms. However, this relationship is more nuanced when examined across industries. Such variations may be attributed to factors like inherent environmental footprints characteristic of each industry, diverse regulatory landscapes, and the rate of technological advancement. Similarly, regional disparities in our findings may stem from differences in regulatory frameworks, stages of economic development, technological availability, and prevailing cultural values. It is conceivable that family firms in certain regions place a greater emphasis on long-term sustainability and community goodwill compared to their counterparts elsewhere. In the subsequent sections, we delve deeper into these observations, dissecting their underlying causes and implications.

3.2. Difference-in-Differences – the Effect of the Paris Agreement

We use the Paris Agreement as a shock to firms' perception of climate-related risks. In line with previous studies (e.g., Ginglinger and Moreau, 2019; Reghezza et al., 2022), we argue that the Paris Agreement, enacted in 2015, serves as a strong and clear exogeneous signal for the tightening of future carbon emission regulations. We employ a DiD methodology to study the changes of emission intensities around the event for family and non-family firms (see Equation 2).

[Table 5]

Table 5 presents 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 1 and 2), the coefficient is significant at the 1% level, whereas for Scope 1 to 3 (model 3), it is significant at the 10% level. This implies that family firms not only directly reduced their emissions but also increasingly adopted greener energy sources in their production processes. The variable *Family* alone is not significant. This suggests 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 levels for family firms.

We further explore this result, looking at the impact of the Paris Agreement across industries and regions. Panel A of Table 6 reports the results for different sectors. Family firms further reduces emissions intensities after the Agreement in the Consumption of Goods, Consumption of Services, and Utilities sectors. There is no different effect attributable to the Paris Agreement in the Health Care and Oil and Gas industries. This pattern leads to two conclusions. First, family firms responded to the Paris Agreement in a manner that was more pronounced in certain sectors, and notably those with higher abatement costs, such as Consumption of Services. Second, the reduction in emissions intensities associated with family firms in certain sectors occurs independently of the Agreement date. This is notably the case for Oil and Gas industry and Health Care.

[Table 6]

Panel B of Table 6 reports the effect of the Paris Agreement across world regions. As observed by Mani et al. (2018), the impact of the Agreement may differ globally. In all three regions, the Paris Agreement resulted in a significant impact of family firms on emissions intensity. Family firms emitted less following the agreement compared with non-family firms. The magnitude of the effect is similar for Europe and North America but is doubled for firms located in Asia-Pacific region. On the contrary, there is no significant effect of family firms on emission levels preceding the 2015 Paris Agreement in all three regions.

The findings suggest that the Paris Agreement significantly shaped the behavior of family firms. Prior to the Agreement, there was generally no significant differences in emissions between the two types of firms, except in a few sectors. However, post-Agreement, a consistent trend emerges across the entire sample, spanning various sectors and regions: family firms are associated with a notable reduction in emission intensity. It appears that family firms were more responsive to the expectations set forth by the Paris Agreement.

4. Channels

We propose to investigate the role of three channels that might explain our results: governance structure, family involvement, and increased investment in research and development (R&D). We examine each explanation in turn. Appendix Table A1 provides definitions for all variables used in this section, along with their sources.

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 CO_2 reduction initiatives. However, no clear relationship is identified between other corporate governance variables and firms' CO_2 emissions. Consequently, the empirical results on the impact of corporate governance on CO_2 emissions remain ambiguous.

We focus on four board characteristics: the presence of a woman on the board (*Board Gender*), the number of board members (*Board Size*), the expertise of the board (*Board Skills*), and the average tenure of board members (*Board Tenure*). First, we verify whether our results are maintained when these board characteristics are considered. Next, we interact the family firm variable with each board characteristics to document their role in explaining our results. Table 7 reports the estimations.

[Table 7]

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 boards 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 four next models introduce interactions between boards characteristics and the family firm variable. While the presence of women on the board, larger boards, or more skilled boards do not exert a distinct impact for family firms, those with boards having a longer tenure display an additional decrease in their emissions intensity. This supports the idea that the long-term vision of family firm boards plays a pivotal role in cutting emissions.

4.2. Family Involvement

Part of our results may be explained by family involvment and distinct family values. As pollution and climate change affect the long-term survival rate of firms, family firms focused on passing the company to the next generation might prioritize long-term survival (e.g., Zellweger et al., 2012). This makes immediate reduction in CO_2 emissions financially more appealing. Family firms with strong family values are also likely to base some decisions on emotional and altruistic motives (Schulze et al., 2003b). Given that reducing CO_2 emissions carries high socio-emotional value for the community (Gomez-Mejia et al., 2007), this could encourage family firms to adopt more rigorous decarbonization policies. Existing research suggest that CEO characteristics also affect corporate climate-related values (Altunbas et al., 2022; Lewis et al., 2014). For example, Homroy (2023) finds that CEOs who have raised a daughter reduce the GHG emission of a company by 10%, while maintaining profitability. This suggests that CEOs' familial values may also play an important role in reducing firms' GHG emissions.

Building on the approach of Lozano-Reina et al. (2022), we explore the relationship between family involvement and CO_2 emissions by considering factors such as family control, governance involvement, and management participation. These dimensions of family involvement correlate positively with family loyalty and reputation (Songini and Gnan, 2015), which are key elements underpinning family values (Chrisman et al., 2012; Stavrou et al., 2007). As family involvement in the firm expands, the pursuit of family goals and vision is likely to become more pronounced, with familial bonds and interests playing an increasingly important role in decision-making (Gomez-Mejia et al., 2007).

We measure family control in the firm based on the percentage of family ownership (*Family Share)* (e.g., Gomez-Mejia et al., 2018).[9] We then explore the impact of family involvement in governance using the family representation on the board (Barontini and Bozzi, 2018), proxied by the percentage of family members in the board (*Family Board*). Finally, we investigate the impact of family involvement in management by focusing 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). We expect family firms with a large ownership stake, strong board representation, and family members serving as both CEO and chairman to prioritize family values. Table 8 presents the results using Scope 1 emissions intensity as the dependent variable.

[Table 8]

[9] 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. A similar approach is adopted by Lozano-Reina et al. (2022).

The first model focuses on the role of family ownership and family control on the board, as well as their combined effect. Since both *Family Share* and *Family Board* are continuous variables, we center them to facilitate a clearer understanding of their interaction effects. By doing this, the individual coefficients represent the effects of each predictor when the other is at its mean. In column 1, both the coefficients for *Family Share* and *Family Board* are negative and statistically significant. This suggests that greater representation of families in both the shareholding structure and the board correlates with a reduction in CO_2 emissions. The interaction term between family ownership and the proportion of family board members is positive and statistically significant. Nonetheless, the total effect remains negative at the sample mean. A possible explanation could be that, 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 8 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 leads to reduced CO_2 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 CO_2 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 hints at a positive environmental legacy maintained across family generations.

4.3. Research and Development Investments

Technological advancement is central to addressing paramount societal challenges, including climate change (Jaffe et al., 2005; Steffen et al., 2022). One potential explanation for why family firms emit less than their non-family counterparts may lie in higher investment in R&D, particularly in the search of environmentally-friendly solutions. Using the EBRD-EIB-WB Enterprise Surveys, Agostino and Ruberto (2021) demonstrate a positive correlation between family ownership and proactive pollution prevention and control measures, a trend observed across over 40 developing nations spanning Europe, Central Asia, the Middle East, and North Africa.

The pursuit of green R&D often requires a long-horizon perspective from management (Faleye et al., 2014). Our previous results have already highlighted that family firms with longer board duration emit less, suggesting that this long-term environmental vision is more prevalent among family firms. This focus might translate into higher R&D expenditures to mitigate carbon emissions. We explore this possibility by examining the extent to which firms' R&D expenses (scaled by total assets) differ for family firms in general, as well as in the periods before and after the Paris Agreement. We also investigate whether family firms with higher emission levels are more inclined to invest in R&D.

[Table 9]

Results are detailed in Table 9,. The dependent variable is the ratio of R&D expenditure to a firm's total assets. The regression incorporates firm-level controls, excluding CAPEX due to its high correlation with R&D. The model specification includes a family firm dummy and a carbon intensity ratio. Results in column 1 indicate that family firms do not display a more pronounced inclination toward R&D expenditure. This is also the case for highly polluting firms. Further analysis in column 2 confirms this absence of difference, even for family firms with a significant direct carbon impact. Regarding the control variables, larger firms with more assets and higher profitability tend to allocate less to R&D. In contrast, firms characterized by high liquidity and a 'glamour' status invest more.

Columns 3 and 4 focus on the consequences of the Paris Agreement. Earlier findings highlighted a post-Agreement shift in behavior, with family firms reducing emissions more than their non-family counterparts. We investigate whether R&D expenses follow a similar trend. Column 3 assesses the specific impact of the Agreement on R&D expenses of family firms through an interaction term. The positive and significant coefficient indicates a post-Agreement shift: family firms have increased their R&D expenses compared to non-family entities. This aligns with our core findings, implying a synergistic effort by family firms to complement emission reductions with greater R&D spending. Column 4 explores whether this trend is especially noticeable for high-emission family firms post-Agreement. The insignificant result for the triple interaction term reveals a nuance: while family firms did increase R&D expenses after the Agreement, this uptick was not pronounced enough to distinguish the most polluting family firms.

In summary, our findings reveal that the reduction in CO_2 emissions by family firms following the Paris Agreement coincides with an increase in R&D expenditures. This trend occurs regardless of their emission levels. Although R&D expenditures serve as a rough proxy for green investments, this pattern suggests that family firms recognize the strategic importance of R&D in addressing environmental challenges. This finding takes on increased significance when considered in conjunction with our earlier results, which highlighted a decrease in emission intensity among family firms after the Paris Agreement.

5. Environmental Display: Emission Commitments and ESG Scores

Our main results reveal a lower CO_2 emission intensity for family firms compared with non-family firms. Interestingly, this internal reality may not align with how it is externally communicated. To examine the firm's environmental communication, we consider two key metrics: its emission commitments and its ESG score, in particular the Environmental (E) component. We obtain ESG data 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 utilize firms' ESG scores, with a focus on the Environmental score, as well as their public commitments to reduce GHG emissions. We re-run our main model, using Refinitiv's ESG scores and public commitments made to reduce GHG emissions as dependent variables.

[Table 10]

Results are reported in Table 10. Columns 1 and 2 reveal a negative relationship between family firms and ESG scores in general (Column 1) and specifically concerning the Environmental score (Column 2). In terms of environmental scoring, family firms fare worse. These results are aligned with the study by Villalonga et al. (2023) who find that companies owned by founding family or individual stakeholders underperform with respect to ESG, including the

Environmental score. Paradoxically, these findings seem at odd 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.[10] Results in column 6 of Table 10 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%.[11] Second, we employ the Scope 1 emissions 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 stems from their lower public commitments to reduce GHG emissions, and contrasts with 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 exiting literature suggesting that ESG ratings, and particular E pillar score, might not adequately capture environmental performance

[10] 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.

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

(Berg et al., 2022b; Boffo and Patalano, 2020). Notably, Bingler 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.

While family firms may not emphasize public environmental commitments, their business model, governance, values, and longer time horizons likely drive greater focus on environmental responsibility, translating into lower emissions in their day-to-day activities. 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 Ghoul 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 pressures for public environmental commitments. Family firms experience fewer Type I agency conflicts between owners and managers, as families often hold significant control rights and typically exert direct influence through a family member serving as CEO. Consequently, there is limited need for management to signal environmental virtue via public environmental display (PED, e.g., public commitment and ESG scores), as the owners and managers frequently are the same person. This suggest 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.

[Table 11]

Results are reported in Table 11 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. 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 CO_2 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 of Table 11 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 that this signal tend 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 signaling mechanisms, 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 favorable 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) ommited 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. Lastly, we apply an instrumental variable approach.

6.1. Alternative Measurements

Our main measure of CO_2 emission is based on emission intensity, which measures tonnes of CO_2 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 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 12, 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 12]

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.[12] The results are summarized in Panel B of Table 12. 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 on 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-

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

effects, leading to a potential omitted variable bias.[13] 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" (p. 188). A δ greater than 1 suggests unobservables might not critically impact the model. Oster's work details δ computation. Results are robust to an ommited 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. Columns 1 to 5 in Table 13 summarize the results, with the dependent variable being Scope 1 emissions intensity.

[Table 13]

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, followed by country-by-time fixed-effects, and finally country-by-time-by-industry fixed-effects. 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 ommited variable bias.

Finally, columns 6 to 8 of Table 13 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 level, and the industry-country-year level. In all instances, the coefficient of *Family* remains

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

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 CO_2 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 of family firm 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 A3 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 14]

We reassess the link between family firms and CO_2 emissions using the balanced matched sample. Columns 1–3 of Table 14 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 CO_2 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 difference-in-differences estimators hinges on certain assumptions. First, the assignment of the treatment must be independent of CO_2 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 treatment and control groups prior to the event (Imbens and Wooldridge, 2009).

To rigorously test these assumptions, we implement a dynamic setting, capturing any pre-trends difference. 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. Fulfillment 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 CO_2 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. Endogeneity – 2SLS approach

The matching procedure ensured that we were comparing like with like when evaluating differences in CO_2 emissions between family and non-family firms. However, the possibility of reverse causality—where the level of emissions influences the choice of maintaining concentrated family ownership—cannot be entirely ruled out. For instance, some families may choose to reduce their ownership stakes due to a reluctance to operate in sectors with high emissions. These sectors are often dominated by large international fossil fuel conglomerates or state-owned enterprises. This potential reverse causality introduces an additional layer of complexity and warrants further exploration to robustly establish the causal link between family firms and reduced CO_2 emissions.

To address this endogeneity issue, we employ an instrumental variable (IV) approach. This method aims to isolate the causal impact of family ownership on CO_2 emissions by using variables that are correlated with family ownership but not with the error term in the main equation. By doing so, we aim to provide a more robust estimation of the causal relationship between family ownership and emissions.

We specify the average tenure of the CEO at the entity level (*CEO Tenure*) as our first instrument for family firms. This choice is motivated by the observation that family firms are often governed by family members or family-related executives, contributing to longer tenures. As such, we expect the length of CEO tenure to be a relevant instrument for identifying family firms. On the other hand, there is no compelling rationale or evidence to suggest that CEO tenure would be *directly* related to variations in CO_2 emissions. This helps satisfy the exclusion restriction, an essential criterion for a valid instrument. This argument for the exclusion restriction is further supported by the absence of a significant effect of *Board Tenure* on emissions, as observed in model 5 of Table 7.

Our second instrument for family firms is derived from the World Value Survey, employing the average response to the question about the number of children in a family at the country level.[14] The survey is conducted on a representative sample of at least 1,000 individuals per country and takes place in waves separated by 5 to 10 years. Respondents report the number of children in their families on a scale from 0 to 7, where 0 indicates no children and 7 indicates

[14] Inglehart, R., C. Haerpfer, A. Moreno, C. Welzel, K. Kizilova, J. Diez-Medrano, M. Lagos, P. Norris, E. Ponarin & B. Puranen et al. (eds.). 2014. World Values Survey: All Rounds - Country-Pooled Datafile Version: https://www.worldvaluessurvey.org/WVSDocumentationWVL.jsp. Madrid: JD Systems Institute.

seven or more children. We compute the average score for each country (*Children*). Countries that value larger families are more likely to have family firms and successful intergenerational transitions, making this a relevant instrument for identifying family ownership. At the same time, the instrument is likely exogenous, as the survey responses are unlikely to be influenced by the specific firms in our sample. The survey respondents are randomly selected from the general population and, therefore, most, if not all, have no direct connection to the firms under study, solidifying the exogeneity of this instrument.[15]

[Table 15]

Panel A of Table 15 presents the first-stage estimation results. In column 1, we utilize CEO tenure as the instrument for family firms, and in column 2, we incorporate the number of children in the family as a second instrumental variable. We include the full array of control variables and cluster standard errors at the firm level. As anticipated, CEOs in family firms have longer tenures than those in non-family firms, and family enterprises are more prevalent in countries that value larger families. Both variables demonstrate statistical significance at the 1% level.

Columns 3 and 4 disclose the second-stage results for Scope 1 emissions (Panel B). When instrumented, firm type corroborates that family firms emit lower levels of CO2 compared to non-family firms.[16] Diagnostic tests presented at the end of the table confirm the robustness of our instruments. The Kleibergen-Paap F-test statistic indicates that the instruments used are strong. Furthermore, the second-stage Hansen's J-tests are not rejected, affirming that the exogeneity assumptions underlying our chosen instruments are valid.

7. Conclusion

Using a large cross-country dataset, we examine the relationship between family firms and CO_2 emissions using different proxies for emission intensity. Our results establish a link between firm type and a firm's CO_2 emissions. Family firms have lower CO_2 emissions - both direct and indirect - than non-family firms. This suggests a higher commitment to environmental protection among family owners. Using the 2015 Paris Agreement as a quasi-exogenous shock,

[15] This dataset was also used in different family firm studies to instrument family control. For example, Bennedsen et al. (2019) instrument the presence of family firms across countries using survey-based questions from the World Value Survey about the strength of family values and trust levels across countries.

[16] The size of the coefficients of the IV regressions are not readily interpretable. First, the number of children in the family is not observable for all countries in our sample; second, the predicted value of Family from the first stage is not a dummy variable.

we find that family firms are more responsive to the agreement and experience a further decline in their emissions.

We explore possible channels that could explain our findings. Looking at the governance characteristics of family firms, we find that the board's ability to adopt a long-term vision plays a significant role. Family values also make a positive contribution. Firms managed directly by family members experience an additional reduction in emissions. Conversely, family firms with externally hired CEOs experience an increase in emissions. Additionally, our results indicate that family firms allocate higher amounts of resources to R&D, suggesting greater investment in innovative technologies, which could lead to reduced CO_2 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 enterprises commit less 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 type influences environmental performance, possibly without the firms themselves being aware of it, as suggested by their lower public engagement and environmental ESG scores. Different governance mechanisms and core values are likely to 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 prioritise actual emissions over corporate pledges and communications, as there may be a significant gap between the two.

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Figure 1 Average CO_2 emissions across regions

The figure below reports the average Scope 1 carbon emission intensities (tonnes of CO_2 by millions of $US Revenue) from the year 2010 to 2019, across three different regions, for family and non-family firms.

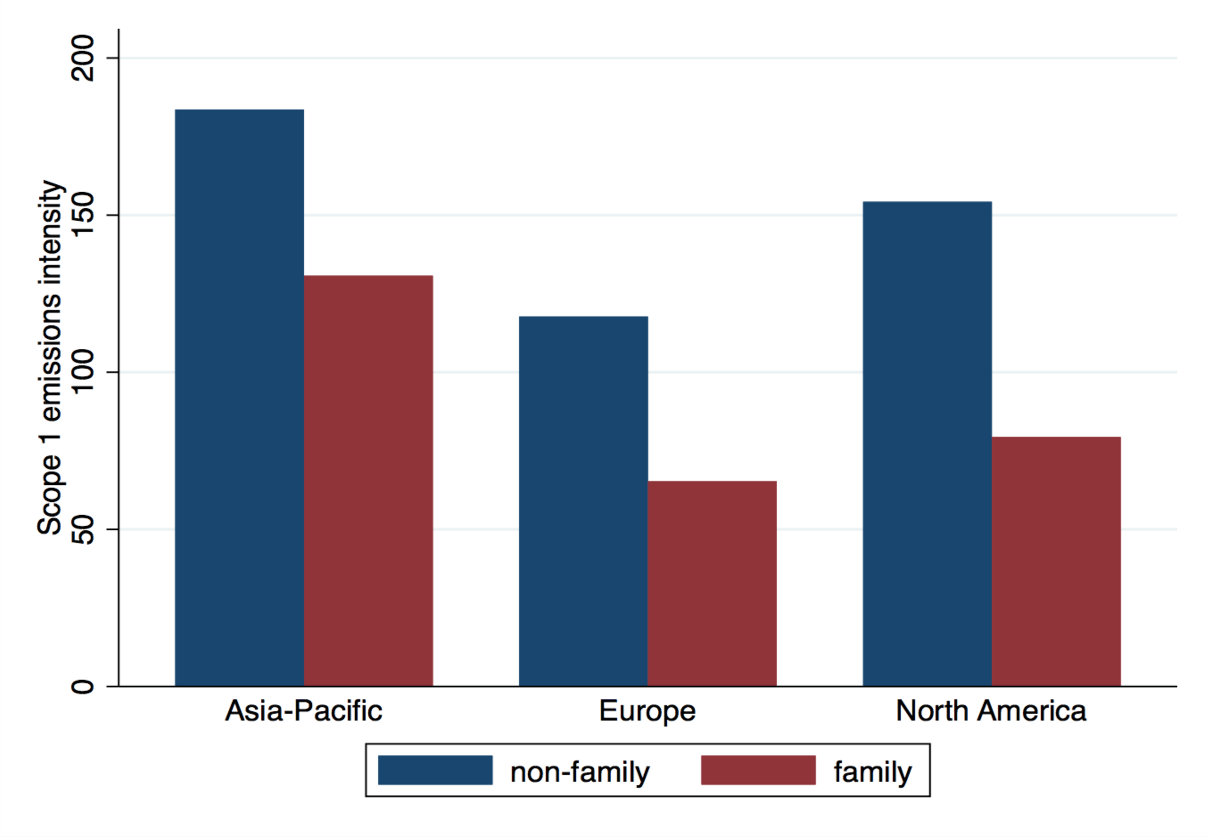

Figure 2 Average CO_2 emissions across sectors

The figure below reports the average Scope 1 carbon emission intensities (tonnes of CO_2 by millions of $US Revenue) from the year 2010 to 2019, across the different industries, for family and non-family firms.

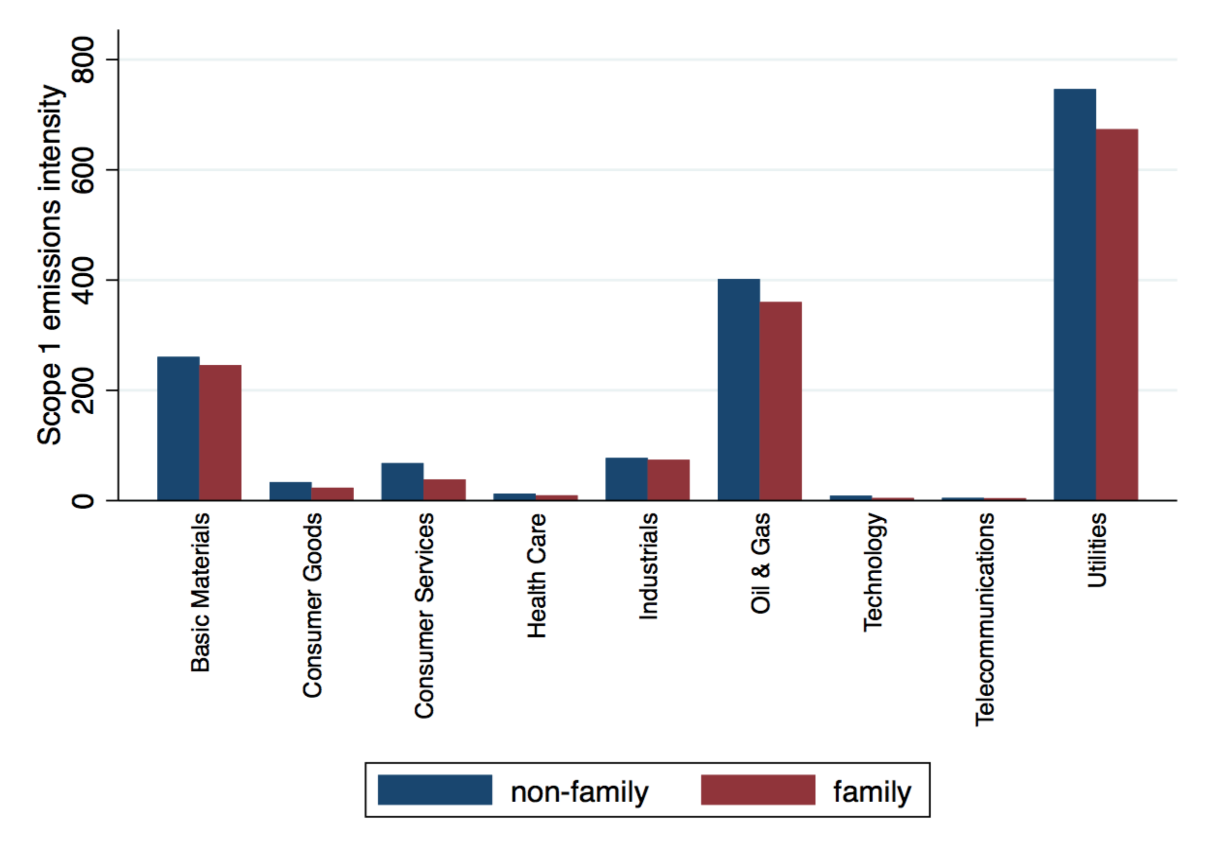

Figure 3 Average CO_2 emissions over time

The figure below reports the evolution of average Scope 1 carbon emission intensities (tonnes of CO_2 by millions of $US Revenue) over time for family and non-family firms.

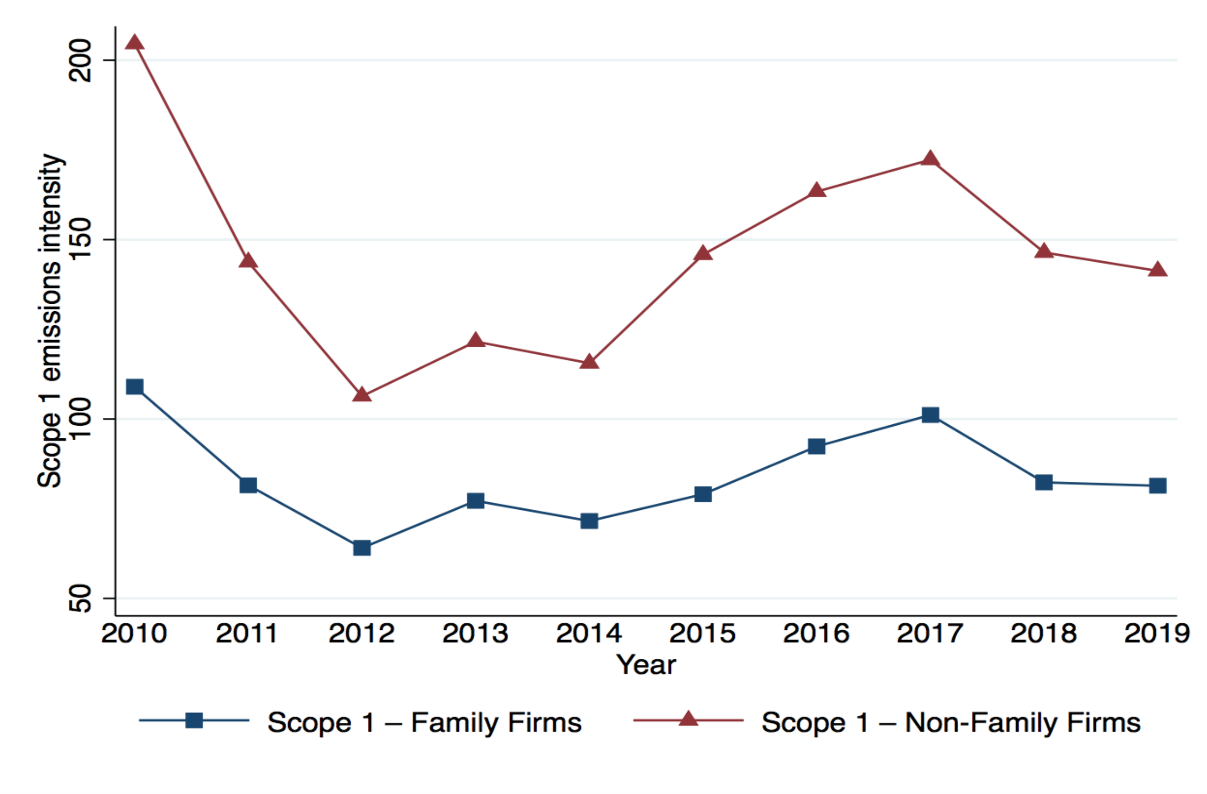

Figure 4 P-scores before and after matching

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

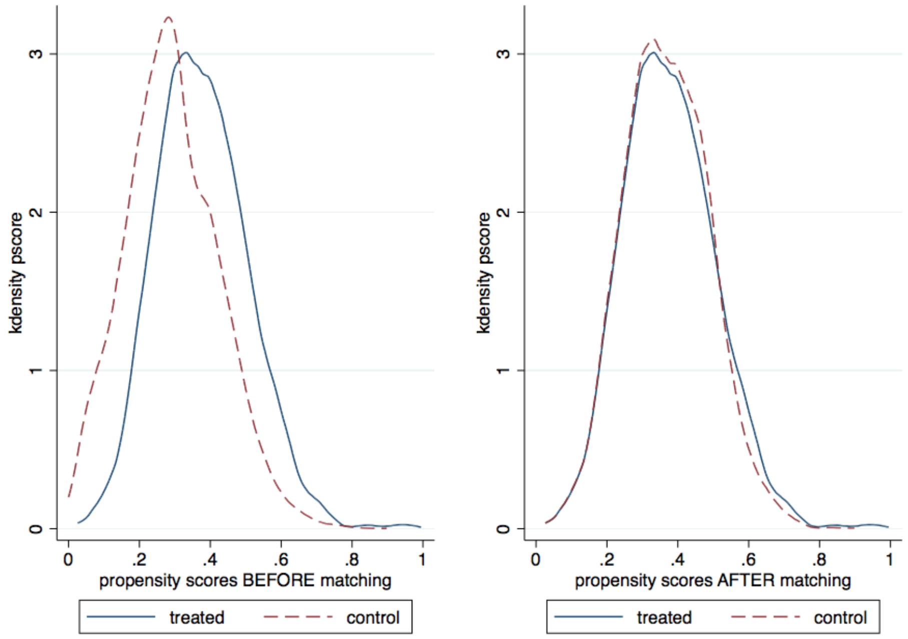

Figure 5 Dynamic treatment effect of the Paris Agreement

The figure displays the dynamic treatment effect of the Paris Agreement on firms' Scope 1 emission intensities (tonnes of CO_2 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*.

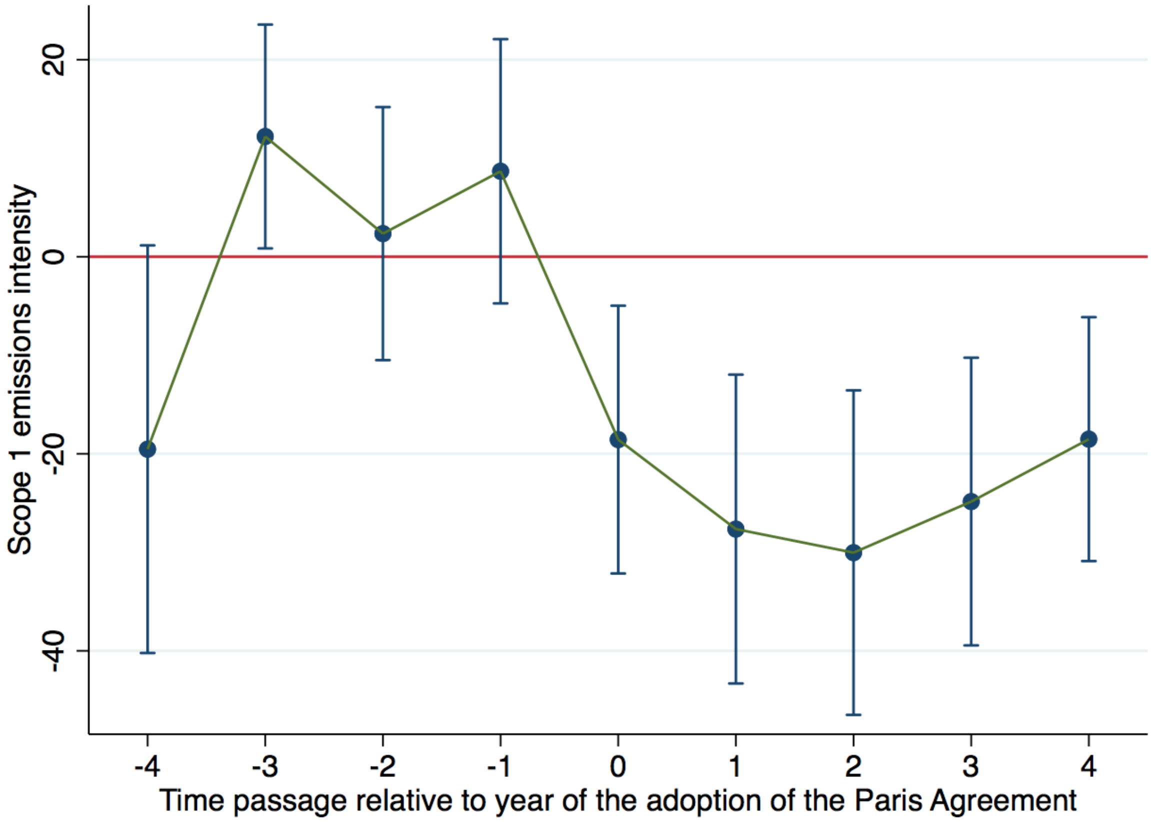

Table 1: Sample distribution

The table reports the number of observations across regions and industries, distinguishing between family and non-family firms in the sample.

	No. of observations			Freq. of Family Firms
	All	Family	Non-family	
Panel A: Region				
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%
Panel B: Industries				
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%
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 38,498 observations for the period 2010–2019. The variables' definition and their sources are presented in Appendix Table A1.

Panel A: Summary statistics

	N	Mean	SD	p25	Median	p75
Family	38,498	0.32	0.47	0.0	0.0	1
iai_1	38,498	124.41	260.55	5.7	11.3	101
iai_1_2	38,498	166.28	293.3	22.3	34.5	164.3
iai 1_2_3	38,498	1,506.36	1,961.88	256.2	673.65	1,837.8
Size	36,977	21.5	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	2.1	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

Panel B: Pairwise correlations

	(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

Panel C: Difference-in-means test

	Family firms		Non-family firms		
	N	Mean	N	Mean	Difference
iai_1	12,469	83.01	26,029	144.24	-61.24***
iai_1_2	12,469	118.85	26,029	189.0	-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	5.4	24,808	5.2	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 firm on firms' emission 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-owned firm 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 reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	iai_1	iai_1_2	iai_1_2_3
	(1)	(2)	(3)
Family	-12.805**	-15.603***	-71.552*
	(5.207)	(5.706)	(37.466)
Size	21.609***	25.373***	146.754***
	(2.116)	(2.377)	(14.060)
MBV	-0.033	-0.032	-0.484*
	(0.022)	(0.025)	(0.250)
PPP	0.857***	1.078***	4.434***
	(0.093)	(0.103)	(0.598)
CAPEX	2.029***	2.378***	16.676***
	(0.579)	(0.628)	(3.939)
ROA	-1.420***	-1.720***	-993***
	(0.166)	(0.183)	(1.352)
Leverage	-0.501***	-0.589***	-3.966***
	(0.136)	(0.153)	(1.024)
Liquidity	-1.773	0.074	15.579
	(1.361)	(1.532)	(10.722)
Age	0.007	0.026	0.922
	(0.109)	(0.125)	(0.785)
Observations	25,596	25,596	25,596
Firms	5,016	5,016	5,016
R^2	0.469	0.476	0.456
Industry FE	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes

Table 4: Family firms and direct emission intensity – industry and geographical heterogeneity

This table reports the OLS regression results of family firm on firms' emissions 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-owned firm and 0 otherwise. All regressions include country-time fixed effects, and a constant term. 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.

	Basic Materials (1)	Cons. Goods (2)	Cons. Services (3)	Health Care (4)	Industrials (5)	Oil & Gas (6)	Technology (7)	Telecommu nications (8)	Utilities (9)
Panel A: Industry heterogeneity									
Family	-8.145	-8.603**	-18.852	-5.578**	-11.732	-36.978*	-2.097	0.505	-77.284
	(21.607)	(4.302)	(14.691)	(2.720)	(10.764)	(19.176)	(1.668)	(1.154)	(63.522)
Observations	2,602	33,55	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	0.039	0.138	0.147	0.164	0.412	0.281	0.042	0.264
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Geographical heterogeneity

	Asia-Pacific (1)	Europe (2)	North America (3)
Family	-24.707	0.242	-13.772**
	(16.141)	(8.303)	(6.037)
Observations	5,132	10,295	10,169
Firms	837	1,849	2,340
R^2	0.411	0.428	0.562
Firm controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes

Table 5: Family firms and emission intensity – DiD Paris Agreement

This table reports the OLS regression results of family firm on firms' emission 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 a family firm 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 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)
Family	-0.663	-2.303	-34.043
	(5.345)	(5.929)	(44.509)
Paris×Family	-23.813***	-26.083***	-73.562*
	(5.263)	(5.795)	(42.220)
Observations	25,596	25,596	25,596
Firms	5,016	5,016	5,016
R^2	0.470	0.476	0.456
Firm controls	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes

Table 6: DiD Paris Agreement – 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 a family firm 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 are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Industry heterogeneity

	Basic Materials (1)	Cons. Goods (2)	Cons. Services (3)	Health Care (4)	Industrials (5)	Oil & Gas (6)	Technology (7)	Telecommunications (8)	Utilities (9)
Family	-24.515	-3.500	-6.707	-4.654*	-12.675	-41.510**	-1.354	1.370	16.478
	(19.671)	(3.991)	(16.715)	(2.721)	(10.463)	(18.028)	(2.185)	(1.250)	(77.451)
Paris×Family	34.100	-9.690**	-23.430**	-1.587	1.852	9.509	-1.434	-1.533	-177.086**
	(27.588)	(3.766)	(11.900)	(3.503)	(9.587)	(23.638)	(1.679)	(1.281)	(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
Country×Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Geographical heterogeneity

	Asia-Pacific (1)	Europe (2)	North America (3)
Family	-1.841	10.976	-3.239
	(15.773)	(8.301)	(6.647)
Paris×Family	-46.580***	-21.339***	-20.053***
	(16.859)	(7.888)	(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

Table 7: Family firms, board characteristics and direct emission intensity

This table reports the OLS regression results of family firm on firms' emission 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 a family firm 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 specific skills. *Board Tenure* is the average board tenure in years. 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. 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	iai_1	iai_1	iai_1	iai_1
	(1)	(2)	(3)	(4)	(5)
Family	-12.337*	-20.952**	-9.611	-12.562	28.305*
	(6.957)	(10.381)	(20.106)	(14.011)	(15.447)
Board Gender	-0.863***	-0.931***			
	(0.261)	(0.307)			
Family×Board Gender		0.358			
		(0.411)			
Board Size	0.051		0.170		
	(1.430)		(1.650)		
Family×Board Size			-0.387		
			(2.268)		
Board Skills	-0.139			-0.110	
	(0.130)			(0.154)	
Family×Board Skills				-0.012	
				(0.225)	
Board Tenure	-1.312				1.238
	(0.880)				(1.228)
Family×Board Tenure					-4.614***
					(1.530)
Observations	17,586	17,798	17,799	17,800	17,597
Firms	3,826	3,863	3,863	3,863	3,828
R^2	0.474	0.474	0.473	0.473	0.474
Firm controls	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes	Yes

Table 8: Family values

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, 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* (FCEO) and *Descendant CEO* (DCEO) are dummy variables equal to 1 if the founder or the descendant is the CEO, respectively, and 0 otherwise. *Founder Dual* (FDual) and *Descendant Dual* (DDual) 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, which are not presented here for brevity. 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)		
FCEO				0.768	
				(7.228)	
Family Share ×FCEO				0.305	
				(0.318)	
DCEO				-37.385***	
				(10.940)	
Family Share ×DCEO				1.283***	
				(0.376)	
FDual					-9.807
					(9.321)
Family Share ×FDual					0.395
					(0.351)
DDual					-32.118**
					(15.391)
Family Share ×DDual					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 9: Family ownership and R&D

This table reports the OLS regression results of family firm 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 a family firm and 0 otherwise. *iai_1* is the scope 1 emission intensity in CO_2 tonnes per USD millions 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. 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	0.427	-0.133	-0.009
	(0.304)	(0.349)	(0.358)	(0.285)
iai_1	-0.000	0.000	-0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.001)
Family×iai_1		-0.001		-0.001
		(0.001)		(0.001)
Paris×Family			0.869**	0.855**
			(0.372)	(0.322)
Paris×iai_1				-0.001
				(0.001)
Paris×Family×iai_1				-0.000
				(0.002)
Size	-0.692***	-0.691***	-0.692***	-0.692***
	(0.107)	(0.107)	(0.107)	(0.121)
MBV	0.002***	0.002***	0.002***	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
PPP	-0.014***	-0.014***	-0.014***	-0.014**
	(0.004)	(0.004)	(0.004)	(0.006)
ROA	-0.202***	-0.202***	-0.201***	-0.201**
	(0.017)	(0.017)	(0.017)	(0.066)
Leverage	-0.008	-0.008	-0.008	-0.008
	(0.010)	(0.010)	(0.010)	(0.016)
Liquidity	0.342***	0.341***	0.342***	0.341**
	(0.079)	(0.079)	(0.079)	(0.115)
Age	0.005	0.005	0.005	0.005*
	(0.004)	(0.004)	(0.004)	(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
Industry FE	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes

Table 10: The impact of Family ownership on ESG rating, commitments and reported emissions

This table reports the OLS regression results of family firm 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), 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 emission reduction target and 0 otherwise. Rai_1 represents Refinitiv reported Scope 1 emission intensity. Family is a dummy variable equal to 1 for a family firm 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 are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	ESG	ESG_E	E_{RE}	E_{EM}	E_{EI}	Commitment	rai_1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Family	-3.881***	-3.812***	-4.342***	-3.066***	-2.370**	-0.546***	-77.505**
	(0.598)	(0.811)	(0.972)	(0.954)	(1.033)	(0.206)	(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 11 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 *Descendent* 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 and their respective lower-order terms, 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)
Panel A: Emission Commitments				
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
Panel B: ESG combined score				
	(1)	(2)	(3)	(4)
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
Panel C: ESG environmental score				
	(1)	(2)	(3)	(4)
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 12: Alternative measurements

This table reports the OLS regression results of family firm on firms' emission using alternative measurements for the dependent variables and family firm. 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 regressions include industry and country-time fixed effects, and a constant term. Table A1 reports variables definition. 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.

Panel A: Absolute Emissions

	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

Panel B: Alternative definitions of Family

	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 13: The impact of Family ownership on emissions intensity: the effect of FE and different ways of clustering

This table reports the OLS regression results of family firm on firms' emission using alternative specifications for the fixed-effects (columns 1-5) and for the level of clustering (columns 6-8). The dependent variables represent Scope 1 emission intensity. *Family* is a dummy variable equal to 1 for a family firm 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" (p.195). A delta superior or equal to one suggests results are robust to an omitted variable bias. The maximum R^2 is computed as $1.3R^2$. 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.

	iai_1 (1)	iai_1 (2)	iai_1 (3)	iai_1 (4)	iai_1 (5)	iai_1 (6)	iai_1 (7)	iai_1 (8)
Family	-61.238***	-36.412***	-6.538	-12.805**	-13.424***	-12.805**	-12.805**	-12.805***
	(6.313)	(6.806)	(5.198)	(5.207)	(5.197)	(4.220)	(5.002)	(2.553)
Observations	38,498	25,618	25,618	25,596	25,028	25,596	25,596	25,596
Firms	6,516	5,016	5,016	5,016	4,955	5,016	5,016	5,016
R^2	0.012	0.141	0.447	0.469	0.513	0.469	0.469	0.469
Cluster	Firm	Firm	Firm	Firm	Firm	Industry	Country# Industry	Country# Industry#Time
Firm controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	Yes	No	No	Yes	Yes	Yes
Country×Time FE	No	No	No	Yes	No	Yes	Yes	Yes
Country×Time× Industry FE	No	No	No	No	Yes	No	No	No
Assumed R^2_{max}		0.183	0.581	0.61	0.667			
Delta		4.96	0.41	0.89	1.25			

Table 14: Propensity score matching analysis

This table reports the OLS regression results of family firm 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 column 4-6 and 8. *Family* is a dummy variable equal to 1 for a family firm 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 are clustered at the firm level and are indicated in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	iai_1	iai_1_2	iai_1_2_3	aai_1	aai_1_2	aai_1_2_3	iai_1	aai_1
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Family	-16.608***	-19.982***	-95.362**	-0.233***	-0.159***	-0.101***	-7.213	-0.172***
	(6.027)	(6.576)	(43.428)	(0.052)	(0.040)	(0.035)	(5.411)	(0.051)
Paris×Family							-21.397***	-0.138***
							(6.107)	(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 15: Instrumental variable approach (2SLS-IV)

This table reports the single-equation instrumental-variables regression results of family firm on firms' emissions using data for 2010–2019. *Panel A* presents the first stage regression results. *Panel B* reports second-stage regression results. The dependent variable in column (1) and (2) is a dummy variable equal to 1 for a family firm and 0 otherwise. The dependent variable in column (3) and (4) is Scope 1 emission intensity. *CEO Tenure* is defined as the average tenure of the CEO at the firm level. *Children* is the mean score response at the country level to the question from the World Value Survey about the number of children in the family. 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. 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.

	Panel A: First stage		*Panel B: Second stage*	
	Family	Family	iai_1	iai_1
	(1)	(2)	(3)	(4)
CEO tenure	0.015***	0.150***		
	(0.001)	(0.001)		
Children		0.048***		
		(0.013)		
Family			-29.388**	-39.199***
			(14.388)	(14.921)
Observations	23,877	17,689	23,877	17,689
Firms	4,878	3,696	4,878	3,696
R^2	0.205	0.183	0.481	0.503
Firm controls	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Country×Time FE	Yes	Yes	Yes	Yes
F-statistics	394	161		
(p-value)	0.000	0.000		
Hansen J-statistics				0.141
(p-value)				0.707

Appendix

Table A1 Variables

Definitions and source of the variables employed in the study.

Variable	Description of variables	Source
	Emission Variables	
iai_1	Intensity Average Inference Scope 1 (tCO_2e/$m Revenue)	Urgentem
iai_1_2	Intensity Average Inference Scope 1 & 2 Total (tCO_2e/$m Revenue)	Urgentem
iai_1_2_3	Intensity Average Inference Scope 1, 2 & 3 Total (tCO_2e/$m Revenue)	Urgentem
aai_1	Log of Absolute Average Inference Scope 1 (tCO_2e)	Urgentem
aai_1_2	Log of Absolute Average Inference Scope 1 & 2 Total (tCO_2e)	Urgentem
aai_1_2_3	Log of Absolute Average Inference Scope 1, 2 & 3 Total (tCO_2e)	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 female on the board	Refinitiv
Board Size	Total number of board members	Refinitiv
Board Skills	Percentage of board members with specific skills	Refinitiv
Board Tenure	Average length of the board tenure in years	Refinitiv
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_2e/$m Revenue)	Refinitiv
	Instrument Variables	
Children	Mean score response at the country level to the question about the number of children in the family.	World Value Survey
CEO Tenure	Average length of CEO tenure in years	NRG

Table A2: Descriptive statistics – additional variables

The table provides summary statistics of the additional variables employed in the study. The descriptive statistics are based on the full sample consisting of 38,498 observations for the period 2010–2019. The variables' definition and their sources are presented in Table A1.

	N	Mean	SD	p25	Median	p75
Board Gender	24,323	17.15	12.81	8.33	16.67	25
Board Size	24,324	9.93	3.26	8	9	12
Board Skills	24,325	52.65	22.29	37.5	53.85	69.23
Board Tenure	24,028	7.6	3.79	4.89	6.95	9.61
Family Share	38,498	6.92	16.55	0	0	1.2
Family Board	33,743	6.28	11.54	0	0	11.11
Family CEO	38,498	0.16	0.37	0	0	0
Family Dual	38,498	0.09	0.28	0	0	0
Founder CEO	38,498	0.1	0.31	0	0	0
Descendant CEO	38,498	0.06	0.23	0	0	0
Founder Dual	38,498	.06	0.24	0	0	0
Descendant Dual	38,498	0.03	0.16	0	0	0
R&D	12,656	6.2	8.95	.91	2.92	7.82
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	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
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	4.155	16.7	160.544
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
CEO Tenure	35,344	9.7	8.64	3	7	13
Children	26,923	0.83	1.75	0.22	1.47	1.65

Table A3: 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 equals to 0.01. *, **, *** indicate statistical significance of 1%, 5% and 10% respectively.

Variables	Treated (1)	Control (2)	t-test (3)
Panel A: Before matching			
Size	21.307	21.83	-17.09***
MBV	71.362	63.327	1.17
PPP	49.304	58.209	-11.65***
CAPEX	6.1331	5.6402	5.05***
ROA	5.6152	4.963	4.01***
Leverage	50.766	55.348	-12.03***
Liquidity	2.1649	1.9213	8.28***
Age	1985.7	1978.7	12.66***
Panel B: After matching			
Size	21.331	21.287	1.27
MBV	64.458	60.69	0.47
PPP	49.826	49.669	0.19
CAPEX	6.0486	5.9685	0.64
ROA	5.5032	5.4186	0.42
Leverage	51.232	51.587	-0.77
Liquidity	2.1377	2.1219	0.43
Age	1985.4	1985.3	0.13