Controlled Firms, Preferences, and Environmental Sustainability

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Abstract

Controlled firms constitute a significant percentage of the world's publicly traded firms, are insulated from outside investors' pressure, and can choose to be *cleaner* than widely held firms if they wish. We test whether control is related to carbon emissions in a sample of 3,769 firms from 35 countries. We use large language models with retrieval-augmented generation to construct a novel measure of owners' environmental preferences for family-controlled firms, the most frequent type of controlled firm globally. We find that preferences for *clean* matter, but not always in ways that one might expect. Families with *clean* preferences perform no better than widely held firms while those without emit about 20% more carbon than widely held firms. Thus, non-pecuniary preferences for *clean* apparently do not overcome the pecuniary private benefit drift towards *dirty* that affects all controlled firms.

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I. Introduction

Hart and Zingales (2017) ask whether a firm that changed its focus from financial value maximization to shareholder welfare maximization would in fact be more *clean*. For the widely held firm, their answer is no. Even though many investors in such a firm may have non-pecuniary preferences for *clean*, "the market for corporate control will push a board who wants to choose *clean* into a choice of *dirty*: we call this an *amoral drift.*" However, for the closely controlled firm that is insulated from takeover pressure, the situation is different. If its owner has non-pecuniary preferences for *clean*, its owner can choose *clean.* As Hart and Zingales (2017) state, if a closely controlled company "has a single shareholder, nobody would suggest that this single shareholder cannot instruct directors to maximize her utility, rather than her financial return." (p. 263). Thus, to better understand whether non-pecuniary *clean* preferences are truly capable of moving the needle towards *clean*, it is important to investigate what closely controlled firms actually do in terms of environmental performance. This is the research question we address in this paper.

In our analysis, we consider several important factors. Two are somewhat obvious: the strength of a controlling shareholder's environmental preferences for *clean* and the expected marginal financial cost of becoming more *clean.* It is also important to consider that control has the potential to negatively impact the choice to be *clean.* With entrenched control, a large literature has shown that controlling owners will consume pecuniary private benefits of control by diverting current cash flows to themselves. This reduces cash available for environmental investments, creating a 'pecuniary private benefit drift' towards *dirty* which may in aggregate cancel out owners' preferences for *clean.*

To conduct tests of whether a closely controlled firm—that is free to pursue shareholder welfare maximization—actually chooses *clean*, we use a non-U.S. sample. Outside of the U.S., closely controlled firms are generally the most common type of firm ownership structure (La Porta, Lopez-De-Silanes, and Shleifer, 1999; Aminadav and Papaioannou, 2020). This large frequency of controlled firms provides power for empirical tests that aim to identify the impact of ownership structures on environmental performance. Being so prevalent, controlled firms are also interesting to study in their own right. They contribute significantly to climate change and their influence is likely to increase as global emissions growth now comes from developing countries (Copeland, Shapiro, and Taylor, 2021) where closely controlled firms are the most common (Lins, 2003).

We identify three categories of closely controlled firms: family-controlled, government-controlled, and other-controlled firms. Other-controlled firms are not widely held and are neither controlled by a family nor controlled by a government-affiliated entity. These firms either have multiple controlling owners with no obvious leading owner, are controlled by financial owners (hedge funds, private equity, and others), or their ultimate controlling owner(s) is impossible to identify.

Our sample consists of 3,769 firms from 35 countries. In this sample, 55% of firms are closely controlled and 45% are widely held. Family control accounts for 42% of all sample firms, government control accounts for 7% of firms, and 6% of firms are other-controlled.

Our research question requires the identification of the environmental preferences of the controlling shareholder. No database currently exists to measure such preferences. We therefore exploit recent advances in generative AI and use two state-of-the-art large language models (LLMs)—GPT and Perplexity—to construct a novel measure of a controlling shareholder's environmental preferences, at scale. For these tests, we restrict our attention to family-controlled firms, as they are the largest category of controlled firms and they are expected to have significant heterogeneity in their environmental preferences (as will be discussed in the next section). We prompt the LLM to use public information and quantify indicators from five different types of activities: 1) the family's personal philanthropy towards environmental causes; 2) the family's public advocacy for environmental issues; 3) the family's participation in environmental NGOs; 4) 'green' investments in the family's personal portfolio outside the firm; and 5) the family's support and contributions for environmental policies. Importantly, the LLM ignores the controlled firm's own environmental performance in its assessment.

Our research question also requires us to identify the expected marginal cost of pursuing *clean*. When the marginal costs of improving environmental performance are high, spending money to be even cleaner will require very strong environmental preferences, but the reverse is also true. Controlling shareholders' preferences should therefore matter most when the marginal costs of pursuing *clean* are relatively low. We use a country level indicator, the Climate Change Performance Index (CCPI), to proxy for the expected marginal costs firms face to improve their carbon emissions. The CCPI index, created by Germanwatch and used in prior work by Bolton and Kacperczyk (2023), measures the climate mitigation performance of countries and is constructed from country-level regulations, commitments, and actual carbon performance. It is useful for our tests because in high CCPI countries, the government has forced firms to internalize more of their carbon externalities and firms have therefore likely already exhausted low-cost options to improve their carbon performance. In low CCPI countries, low-cost options to improve carbon emissions performance likely still exist.

We use a firm's actual reported carbon emissions as our measure of *clean*. These are CO2 equivalent emissions and convert methane and other non-CO2 emissions into CO2 equivalents following the Greenhouse Gas Protocol. In June of 2023, the International Sustainability Standards

Board (ISSB) issued its first sustainability standards, mandating reporting of carbon emissions starting in 2024.[1]

Our tests use year-end 2023 data, as by that point the vast majority of firms report their Scope 1 and Scope 2 carbon emissions. We do not use panel data primarily because actual reported carbon emissions from years well before 2023 would have a self-selection bias as only the better firms would voluntarily disclose their emissions. Additionally, if one tried to impute emissions, the firm characteristics used in imputation—such as industry, firm size, and revenue—are likely correlated with ownership type, which severely limits the inferences that can be drawn from any tests.

In our tests, we regress carbon intensity (emissions scaled by revenue) and absolute carbon emissions on our three controlling-owner categories (with widely held firms as the omitted category) and controls for industry, country, and firm characteristics. Our key tests subdivide the family category by the strength of environmental preferences using our AI-based measure. In further tests, we split the sample at the country level based on whether a country's CCPI score is above or below the median score of the full sample to capture differences in the expected marginal costs of being *clean*.

Our baseline tests show that no category of controlled firm delivers lower carbon emissions than the widely held firm. The results range from no difference for the government-controlled firm, to marginally and substantially worse environmental performance for family-controlled and other-controlled firms.

[1] The ISSB is an independent standard-setting body within the International Financial Reporting Standards (IFRS) foundation that issues sustainability standards and metrics. U.S. firms are not subject to IFRS, which is another reason we exclude them from our sample.

Our key finding is that the environmental preferences of controlling shareholders matter, but not always in ways that one might expect. Families with high environmental preferences perform no better on carbon emissions than widely held firms. This result suggests that strong environmental preferences do not overcome the pecuniary private benefit drift towards *dirty* that affects all controlled firms. Further, we find that families with low environmental preferences emit about 20% more carbon than widely held firms, all else equal. One broad (and perhaps surprising) takeaway is that allowing preferences to dictate environmental outcomes can lead to worse rather than better environmental performance.

Our second key finding is that the expected marginal cost of improving environmental performance plays an important role in a controlled firm's choice to be *clean* or *dirty*. In high CCPI countries that already demand carbon efficiency, family-controlled firms are much worse in terms of their carbon performance no matter their environmental preferences. This is consistent with the pecuniary private benefit drift towards *dirty* dominating non-pecuniary preferences for *clean* when the cost to improve carbon emissions is relatively high. Only when there are both low expected marginal costs for increasing carbon efficiency (low CCPI countries) and a high family preference for *clean*, we find a 20% reduction in emissions relative to widely held firms. In all other settings, controlled firms are not better than widely held firms and are often worse. Thus, the pecuniary private benefit drift towards *dirty* can indeed be overcome, but this is the exception rather than a general outcome.

Taken together, our results appear to throw cold water on the hypothesis that moving from financial value maximization to shareholder welfare maximization will meaningfully increase the likelihood that a firm chooses to be *clean*. If controlled firms, that can choose to be cleaner if they wish, are in almost all settings not actually cleaner, then this strongly suggests limits to what can be expected absent regulations that force all firms to be clean.

We make four contributions. First, we provide new evidence on the way in which environmental preferences of controlling owners influence corporate sustainability. This extends prior evidence that investors' preferences and social values shape sustainability outcomes (e.g., Hong and Kacperczyk, 2009; Hart and Zingales, 2017; Dyck, Lins, Roth, and Wagner, 2019; Pastor, Stambaugh, and Taylor, 2021; Pastor, Stambaugh, and Taylor, 2022; Pedersen, Fitzgibbons, and Pomorski, 2021; Lins, Roth, Servaes, and Tamayo, 2024). We find that family owners with pro-environmental preferences do not lower firms' carbon emissions on average, but do so only when expected abatement costs are low. Importantly, when family owners lack pro-environmental preferences, their firms produce substantially higher carbon emissions.

Second, we contribute to the literature on the broader governance and institutional factors that influence firms' environmental performance. Prior work shows the positive impact of institutional ownership (Dyck et al., 2019; Krueger, Sautner, and Starks, 2020), shareholder engagement (Dimson, Karakaş, and Li, 2015), internal governance and board expertise (Dyck, Lins, Roth, Towner, and Wagner, 2023; Iliev and Roth, 2023), leadership characteristics (Cronqvist and Yu, 2017), and regulatory and supply-chain forces (Ioannou and Serafeim, 2012; Liang and Renneboog, 2017; Schiller, 2018; Dai, Liang, and Ng, 2021; Freund, Nguyen, and Pham, 2023) on sustainability outcomes. We add ownership structure to this list, finding that it is a determinant of carbon performance, but that it has both negative and positive impacts. Using the most up-to-date emissions data, we show that, in most cases, controlled firms perform worse on emissions compared to widely held firms. Our findings for the family-controlled firm contradict conclusions from Borsuk, Eugster, Klein, and Kowaleski (2024) that family firms have lower emissions. Their research relies on an unbalanced panel design for the years 2010 to 2019, when carbon reporting was far less frequent than it is today.

Third, we contribute to the family-ownership literature. A long line of research in finance explores how family control affects firm value, governance, and strategy (Anderson and Reeb, 2003; Villalonga and Amit, 2006; Masulis, Pham, and Zein, 2011; Lins, Volpin, and Wagner, 2013; Bennedsen and Fan, 2014). We show that the impact of family ownership on carbon emissions is significantly influenced both by the strength of the controlling families' non-financial preferences and the expected cost of satisfying those preferences. We find that family control has pro-environmental impacts only when families both have observable preferences for *clean* and their expected costs of further carbon abatement are low.

Fourth, we introduce a methodological innovation by developing a retrieval-augmented generation (RAG) LLM-based measure of shareholders' environmental preferences. Exploiting recent advances in generative AI, we construct an index of a controlling family's preference for *clean* using public information on multiple indicators of their preferences. Prior work has used AI to extract sentiment from specific data inputs such as public-firm disclosures (Hassan, Hollander, van Lent, and Tahoun, 2019) or conference calls (Jha, Qian, Weber, and Yang, 2024). Our study broadens the input scope to quantify an otherwise private shareholder attribute. By demonstrating that such a RAG-derived measure can explain differences in corporate outcomes, our paper shows that otherwise unobservable owner values can be quantified *at scale* in finance research.

II Theoretical Considerations

We begin our analysis by postulating that a controlled firm can behave in the way that Hart and Zingales (2017) suggest, acting as if there is only a single shareholder, and directing the firm to pursue the controller's utility maximization irrespective of what other investors may prefer if they had a voice. We make this assumption because a closely-controlled firm is protected from takeover and activist pressures and its board is effectively entrenched.

Directing the firm to improve the controlling shareholder's utility creates private benefits for that shareholder that may affect other shareholders. The rivalrous nature of private benefits is clear with pecuniary private benefits, as cash diverted to the controlling shareholder is not available to be distributed to other investors. Non-pecuniary private benefits, such as the good feeling a controlling shareholder receives who has high environmental preferences and directs her firm to be clean, are also potentially rivalrous. Some of the other investors may not derive any utility from these preferences for *clean*, and it may harm their utility if directing the firm to be *clean* reduces financial returns from their investment.

We first consider the impact of pecuniary private benefits on a firm's likelihood to pursue *clean*. There is a significant body of literature that focuses on how the control of voting power in firms gives controlling shareholders the potential to reward themselves at the expense of all other investors in the firm (e.g., Shleifer and Vishny, 1997). A large literature shows these control rights create financial benefits for controlling shareholders and are significant around the world (e.g. LaPorta et. al., 1999; Lins, 2003; Dyck and Zingales, 2004). If the closely-controlled firm's owner uses their control rights for pecuniary private benefits, this shifts a firm towards being *dirty*—what we call a 'pecuniary private benefit drift.' This is because consuming a firm's current cash flows leaves less available for environmental investments.

Next, we consider the relative strength of *clean* preferences of the three categories of controlled owners. First, for other-controlled firms, the pecuniary private-benefit drift towards *dirty* is unlikely to be offset by preferences for *clean*. Consider each of the types of firms in the other-controlled category. Hart and Zingales (2017) suggest that an owner cares about a clean or dirty outcome only "if he feels responsible for the action in question (p. 250)." This may be true if there is a single owner but it is much less likely the case with multiple owners where no one owner is dominant. For the opaque-controlled firm in which there is a controlling shareholder, but neither us nor AI can identify the ultimate controlling shareholder, there is clearly a problem with transparency. Such owners can avoid social sanctions associated with choosing to be *dirty,* and they also cannot derive a reputational benefit from being seen to be *clean*. Finally, financial-controlled firms focus on financial value maximization and they have relatively short time horizons, making them less likely to invest today to reduce carbon emissions for long term payoffs.

Family-controlled firms can plausibly have strong *clean* preferences and are more likely to act upon them than other types of controlled firms. Family-controlled firms have what are called 'family assets', identified in the literature (e.g., Andersen and Reeb, 2003; Bennedsen and Fan, 2014) to include beliefs, values, norms, and relationships that enhance the reputation of the family. These firms are frequently passed on from generation to generation and can generate high and consistent levels of trust that should improve the contracting environment.[2] These long-term assets can be impaired if a family-controlled firm is not perceived to be *clean* enough. Family firms are also generally less diversified, with much of their wealth concentrated in their own firms, making them more sensitive to long-term firm-specific risks such as a sudden clampdown on carbon emissions, giving them a further incentive to choose *clean*. As will be described in the next section, we use LLMs to characterize the strength of *clean* family preferences.

Finally, we discuss government-controlled firms. We do not expect government owners to have stronger preferences for *clean* compared to owners of a widely held firm. From an environmental standpoint, if a government believes that *clean* is important, it can enact regulations

[2] For example, a family firm with such trust is better positioned to make implicit contracts with employees and contractors to reward them for making firm-specific investment decisions, thus generating value.

and force all firms to meet that higher standard of *clean*—as such, there is no reason for a government to invest even further in *clean* via the firms it controls.

III. Sample and Summary Statistics

Our starting point is the universe of non-financial publicly traded firms with ESG data coverage in Refinitiv as of year-end 2023. Refinitiv, previously ASSET4 and recently renamed as LSEG, is a key ESG rating provider used by both practitioners and academia. We gather financial metrics for these firms from Worldscope. We require firms to have non-missing assets and a minimum market capitalization of $100 million. We exclude firms incorporated in the U.S., Russia, and China, and firms from countries where we have less than ten observations.[3] The final sample comprises 3,769 firms from 35 countries.

A. Environmental Performance Metrics

We focus on carbon emissions as our environmental performance metric. The centrality of emissions for environmental performance is evident in the actions taken by the ISSB in June of 2023 to highlight climate risk and its measurement as the first international sustainability standard, mandating reporting of carbon emissions starting in 2024 for all firms subject to IFRS accounting standards. Several recent finance papers also focus on carbon emissions as their key outcome variable (e.g., Shive and Forster, 2020; Bolton and Kacperczyk, 2023).

Our primary emissions metric is actual reported total CO2 equivalent emissions (from Refinitiv).[4] This metric includes all GHG emissions and converts methane and other non-CO2

[3] We exclude the U.S. because the vast majority of firms do not have a controlling shareholder. We exclude Russia and China, given the difficulty for families to establish effective control rights in these settings.
[4] Using Refinitiv rather than a different data provider for reported carbon emissions does not impact inferences from our tests. We compare reported carbon emissions values across multiple data providers and find virtually identical values, consistent with Busch, Johnson, Pioch, and Kopp (2018) who find correlations of ~0.99 across five data providers for this metric.

emissions into carbon equivalent emissions following the Greenhouse Gas Protocol. These carbon emissions are the sum of Scope 1 emissions (direct emissions from firm-owned or controlled sources) and Scope 2 emissions (indirect emissions from the generation of purchased energy).[5] In our analysis, we focus on the year 2023, the most recent year for which emissions data are available and because at this point, the vast majority of firms report carbon emissions.

We do not use panel data for several reasons. First, reported emissions data from years well before 2023 would have a self-selection bias as only the better firms would voluntarily disclose their carbon emissions. Second, using imputed or estimated emissions is problematic for several reasons.[6] Empirical results that rely on estimates could simply be an artifact of the estimation procedure rather than reflecting actual emissions. The firm characteristics used in imputation would almost certainly be correlated with ownership types. Further, estimated emissions are noisy, as alternative providers of estimates produce significantly different estimates with no clarity at this point as to the most appropriate method. Busch et al. (2018) report correlations across emissions of three data providers that use estimates of just 0.79 for Scope 1 and 0.63 for Scope 2 emissions. With such noisy estimates, it is unlikely they will be weighted heavily in assessments by owners, stakeholders, and regulators. Finally, a firm's control structure is sticky which gives false power to a panel structure without firm fixed effects and if one were to include firm fixed effects, then the results would be driven by only a handful of firms that change their ownership in the sample period.

[5] We note that as of 2023 there are few firms that report Scope 3 emissions, and we do not include Scope 3 emissions in our analysis. This point is also addressed in Aswani, Raghunandan, and Rajgopal (2024).

[6] Aswani, Raghunandan, and Rajgopal (2024) discuss the many papers that have use imputed emissions to maintain sample sizes, and report that 'estimated emissions seem to be a nearly deterministic function of size, sales growth, industry, and time.' This could be highly problematic for the tests we conduct as such characteristics are likely to be correlated with ownership structures (e.g., closely-controlled firms are on average smaller than widely held firms). This does not imply that estimates are not useful in other studies, such as of stock returns, where financial actors could very well be using such estimates as part of their analyses.

Table 1, Panel A reports key emission metrics used in our tests. Among our sample firms, 88% report CO2 emissions in 2023. The median firm in our sample emits the equivalent of 83,562 tons of CO2 per year. Median Scope 1 emissions are roughly 28,000 tons, while Scope 2 emissions are roughly 31,000 tons. The large standard deviation in emissions suggests the need to control for the intensity of activity used to generate these emissions, and to control for industry differences—we do both in our tests.

Controlling shareholders with strong E preferences might also want to be seen to be seen by outsiders as *clean*, as this would burnish their environmental credentials. Outsiders consider a variety of metrics to inform their opinions, including softer measures such as targets and policies, and comprehensive metrics that combine qualitative environmental data items and quantitative measures of environmental performance including emissions. In robustness tests, we therefore also examine the impact of ownership on these environmental metrics. We first use commercial environmental scores (E scores) that are comprehensive and are compiled by Refinitiv. We also construct our own score that tries to isolate less material E metrics, building on the Bolton and Kacperzyk (2023) approach, where they identify binary variables that are potentially 'mostly empty promises.'[7] Of all the 269 Refinitiv data items for environmental performance, we identify 73 binary variables that predominantly indicate disclosure of qualitative environmental policies and targets and use these to construct an equally-weighted less-material environmental score.[8] In

[7] The metrics they use are whether a firm has made a commitment to join the Science Based Targets initiative (SBTi), whether a firm has committed to a target that can be validated by the initiative, and by whether a firm reports emission targets to the Carbon Disclosure Project.

[8] We cannot measure disclosure and performance separately because, at least since an update to Refinitiv's methodology in 2020, Refinitiv assigns a score of one if a firm has a certain environmental policy or target and a score of zero if a firm does not have such a policy or target or does not report at all (Berg, Fabisik, and Sautner, 2021). We use Refinitiv's polarity categorization where we convert all variables into positive environmental policies (e.g., whether the firm has a Policy for Water Efficiency). We add up all 73 binary metrics to create an overall qualitative environmental score. We repeat this procedure for Refinitiv's subcategories and calculate qualitative scores for the subcategories resource use, emissions, and environmental innovation. Refinitiv has no missing values for 66 of the 73 data items. Refinitiv has missing values for 7 items and we assign a value of zero if they are not populated. Our results

Table 1, we report that the median firm in our sample has an E score of 52 out of 100 and a less material environmental score of 23 out of 73.

B. Establishing Controlling Owners

We focus on firms' ownership structures as of the year 2022, thus identifying ownership at the end of the year prior to the year we use to measure carbon emission performance.[9] We take great efforts to identify firms that are closely-controlled. We start with commercially available data sources such as Bureau van Dijk's (BvD) Orbis, Refinitiv, Datastream, and Worldscope, all of which provide data to trace the ownership of firms. We then manually research, categorize, and verify each firm's ultimate ownership with data from a variety of additional sources, including annual reports, internet searches, and country guides. Attempting to categorize ultimate ownership in any other way is insufficient, given the reported findings in Aminadav and Papaioannou (2020) that sources such as BvD have large numbers of misclassifications once a manual check is done.

We construct four categories of ownership: family-controlled, government-controlled, other-controlled, and widely held. We classify a firm as family-controlled if i) the sum of the shares owned by the family members exceeds those of any other shareholder and is greater than 20%, ii) the sum of family stakes exceeds those of any other shareholder, is greater than 10%, and family members hold the CEO or chair position, or iii) the sum of family stakes exceeds those of any other shareholder, is greater than 10%, and the firm has multiple voting class shares. Government-controlled firms are firms where the largest shareholder is the government and they own at least

are the same if we restrict attention to the 66 fully-populated qualitative data items. The full list of data items is available in Table A2 in the Appendix.

[9] Prior papers have assembled information on ownership, but even the more recent ones do not provide hand-collected cross-sections for 2022; for example, family ownership around the world is measured for the year 2002 by Masulis, Pham, and Zein (2011), and up to the year 2012 by Aminadav and Papaioannou (2020).

20% of the shares.[10] Other-controlled includes firms controlled by financial owners (private equity, hedge funds, venture capitalists), multiple owners where no one owner is dominant, and multi-owners (with no clear controlling owner), and opaque-controlled firm in which there is a controlling shareholder, but neither us nor AI can identify the ultimate controlling shareholder. Widely held firms are all remaining firms that are not controlled.

In identifying controlling shareholders, our searches often involve consideration of multiple entities and voting stakes. To illustrate, consider two examples. The first is *Pfeiffer Vacuum Technology AG*, a small-cap German company specializing in vacuum technology. As of December 2022, it has a single class of common equity, with its largest shareholder, *Pangea GmbH*, holding a controlling 63% stake. *Pangea* is an investment vehicle owned by *Busch SE*, which is wholly owned by *Busch GBR*, which in turn is entirely owned by members of the Busch family. Through this layered structure, the Busch family exercises indirect control over *Pfeiffer Vacuum Technology AG*, despite the presence of seemingly separate corporate entities. Another example is *Canadian Utilities Limited*, a large Canadian electric utility, where we identify *Sentgraf Enterprises* to be the controlling shareholder based on its voting power (97.3%) rather than its economic stakes (2.5%) We identify the ultimate owner of *Sentgraf* to be the Southern Family, led by CEO Nancy Southern, who is the daughter of the company's founder, Ron Southern.

Panel A of Table 1 shows summary statistics for the ownership types in our sample. We find that 45% of firms are widely held, 42% are family-controlled, 7% are government-controlled, and 6% are other-controlled. Other-controlled firms include 3% that are controlled by financial owners, 2% that have unidentified controlling owner(s), and 1% that have multiple large owners.

[10] Note, we use voting stakes where available, and economic stakes when not. Further, in identifying the largest shareholder we exclude from our consideration those owners that are widely diversified asset managers (e.g. Vanguard) as they are largely passive and unlikely to contest control.

Our empirical tests do not analyze the sub-categories of other-controlled firms, given the small number of such firms in each sub-category.

In Panel B of Table 1, we report, by country, the incidence of the ownership types. There is substantial variation in how common controlled firms are around the world. For example, family ownership is highest in the Philippines and South Korea, where 84% and 83% of firms are family-controlled, respectively, and lowest in Australia, Ireland, Japan, Taiwan, and the U.K., where family firms represent less than 20%. Figure 1 provides a country map of the incidence of family control around the world.

C. Measuring Environmental Preferences of Controlling Families

Next, we seek to measure the strength of *clean* preferences of family owners. This is a private characteristic for which no database exists. Since we cannot elicit those preferences directly from families via a survey or similar mechanism, we rely on the publicly observable data footprint that families leave across various languages in the public domain.

To that end, we proxy for a family's *clean* preferences using indicators from five different types of activities: 1) the family's personal philanthropy towards environmental causes; 2) the family's public advocacy for environmental issues; 3) the family's participation in environmental NGOs; 4) 'green' investments in the family's personal portfolio outside the firm; and 5) the family's support and contributions for environmental policies.

Prior research supports the use of indicators of such types of activities. For example, field experiments track donations and show that individuals' donations to environmental causes reflect intrinsic motivations (Alpízar et al., 2008), and in the corporate finance literature researchers measure directors' affiliations with nonprofit organizations and interpret these as signals of prosocial preferences (Masulis and Reza, 2015; Cai, Xu, and Yang, 2021; Kim, Minton, and

Williamson, 2025). Other work shows that public advocacy for environmental issues emerges in response to weak regulation and reflects strong environmental preferences among citizens (Daubanes and Rochet, 2019). As a further example, voluntary participation is systematically related to pro-environment attitudes and values (Lowry, 1998), making NGO involvement a credible, observable indicator of underlying environmental commitment.

Tracking multiple components of preferences allows us to more accurately measure revealed *clean* preferences than focusing on a single measure. For example, a family that cared deeply about environmental outcomes might well signal that by doing all of the following: making donations to environmental causes that are reported in the news, by being vocal in advocating personally for pro environmental outcomes that generate coverage, by participating in organizations devoted to environmental improvement that are visible, by making visible investments in green firms, and by political contributions that support pro environmentally policies. Other families may prefer to speak only with money and avoid public engagement, or alternatively only with public engagement and not money.

Manually searching for these preferences measures across 35 countries and across languages is infeasible. An LLM can at low cost consider a wide range of sources in various languages, which is helpful as no single source tracks all five measures across countries.

To assess a family owner's environmental preferences, we identify the family name of the controlling owner using manual searches. To confirm our manual classification and to assess environmental preferences of the family, we then take advantage of the capabilities of two benchmark-setting LLMs. In what follows, we describe our approach in detail and provide additional information about the 'prompts' we use in Appendix B.

Our use of LLMs to score family's environmental preferences proceeds in two sequential stages, executed at temperature 0.2 through the vendors' REST APIs. First, OpenAI's GPT-4o (knowledge cut-off October 2023) receives a structured context block that includes the firm's name, country, and our assessment of family control, and returns the dominant family surname plus up to five family directors. Second, the family identifiers are fed into Perplexity's Sonar-pro, a search-augmented multilingual LLM that retrieves real-time web content and assigns a score of 0 to 10 on each of the five dimensions above and an equally weighted sum, with a maximum of 50. The prompt expressly instructs Sonar-pro to ignore the environmental performance of the target firm to avoid tautological inference, and the model records its own confidence level and provides citation-linked sources (capped at 10 sources).

Although this architecture offers broad coverage with fast processing times, it raises potential concerns that we acknowledge and mitigate where possible. First, the open-web RAG approach complicates replicability as the LLM is not restricted to any static dataset. We mitigate this by publishing, in the Internet Appendix, the exact prompts and a Python notebook that reproduces API calls and post-processing steps. Second, LLMs can hallucinate. By separating family identification (GPT-4o) from preference scoring (Sonar-pro) we reduce correlated hallucination risk, while Sonar-pro's citation-linked output enables ex-post manual verification; indeed, for a random sample of 20 families we read every cited document and found no spurious sources. Appendix Table A6 provides four work-through examples of families with high environmental preferences from Brazil, Malaysia, the Philippines, and Turkey, to illustrate how the scores are compiled.

Third, because we give Sonar-pro unrestricted web access, it could in principle incorporate information dated after our period of interest and introduce look-ahead bias. We therefore delimit the search to items timestamped on or before December 31, 2022—any residual leakage is unlikely to be material, as family preferences are likely to be persistent over time. Fourth, the LLM could base its analysis primarily on the environmental choices of the firm we are analyzing. To mitigate this concern, we explicitly direct the LLM to ignore the target firm in producing its evaluation. Fifth, a generative model can always return an answer even when the underlying evidence is thin. We therefore discard observations in which the model's self-reported confidence falls below 0.8.

Together, these design choices deliver an environmental preference assessment that is transparent, replicable, and—subject to the safeguards described—robust to the customary concerns about hallucination, look-ahead bias, and low-information noise. At the same time, we exploit the breadth, multilingual reach, and real-time search capability of modern LLMs to measure a latent family characteristic at scale that is otherwise unobservable.

Table 1, Panel A shows the average family's environmental preferences is 17 out of a maximum of 50, the median is 12. The lowest score we obtain is 1 for several families—the Bangs (Korea), the Marans, Sankeshwars, and Suryavishinis (India), the Freres (Switzerland), the Coutiers and Falcs (France), and the Bijlevads (Thailand), and the maximum is 44 for the Herlins (Finland). We use these scores to construct low and high preference indicators to make sure inferences are based on large differences in preferences, to give weight to all five dimensions of family preferences, and for better distributional properties. We classify families with scores ≥ 20 as High E Family, and those with scores < 20 as Low E Family. The LLM pipeline is unable to come up with a score for some families (or has low confidence that it has established the preferences of the family with precision)—we label them as Inconclusive E Family.

As a share of the full sample, 20% of firms are classified as Low E Family, 11% are High E Family, and 11% are Inconclusive E Family. Since 42% of all firms are family-controlled, these figures imply that within the universe of family firms, almost half exhibit low owner-level environmental preferences. The even split between the high and inconclusive groups underscores a key advantage of our LLM approach—we can flag families for which the public record is too sparse to support a reliable score rather than forcing an arbitrary assignment.

To illustrate Sonar-pro's assessment of families, consider two family firms in our sample. The firm classified as Low E Family is Korea Zinc Inc, a Korean metals smelter. Its controlling owners are the Chang and Choi families. The environmental preferences of these two families are assessed by Sonar-pro as 7 out of 50, placing them in the third lowest decile among all sample families. Importantly, the LLM explicitly ignores the corporate environmental activities of Korea Zinc in its assessment.

The LLM's reasoning for its assessment is that "the Chang and Choi families, controlling shareholders of Korea Zinc Inc., show limited personal environmental preferences based on available information. There is little evidence of their personal philanthropy, public advocacy, or participation in environmental NGOs. Their focus appears to be primarily on business interests rather than environmental causes. The recent conflicts within the company suggest differing views on green investments and sustainability initiatives, with the Choi faction pushing for more green materials investments while the Chang faction prefers maintaining traditional business models and strong dividends. This indicates some, albeit limited, interest in green investments. Overall, their environmental preferences appear relatively low based on publicly available information."

The firm classified as High E Family is Telefonaktiebolaget LM Ericsson, a Swedish network firm. It is controlled by the Wallenberg family. Perplexity assesses the Wallenberg family's environmental preferences at 41 out of 50, placing the family in the third highest decile among all sample firms. The LLM's reasoning is that "the Wallenberg family demonstrates strong environmental preferences across multiple dimensions. They have a long-standing commitment to supporting research and innovation, including significant investments in environmental and climate-related projects through their foundation. The family actively promotes sustainability […]. Their investment arm, FAM, focuses on innovative and sustainable companies. While direct participation in environmental is less evident, the family's overall approach to long-term, responsible ownership and their emphasis on sustainability in business and research funding indicate a high level of environmental concern.” We provide additional examples of families and the open-web RAG that the LLM uses to improve its assessment in Table A6 in the Appendix.

D. Measuring Expected Marginal Costs of Improving Carbon Emissions

In our analysis we exploit variation in expected marginal costs of improving environmental performance across countries. To measure a country’s expected marginal cost of improving carbon emission performance, we use the Climate Change Performance Index (CCPI) that is focused on creating transparency in country efforts to mitigate climate performance, facilitating comparisons of climate protection efforts relative to international standards. This index is created by Germanwatch and used in Bolton and Kacperczyk (2023).

The summary CCPI score is based on four categories measured at the country level: GHG emissions, renewable energy, energy use, and climate policy. The index has a possible range from zero (worst) to 100 (best). We group firms in subsamples based on the sample median score of 60, with all countries below this score identified as low CCPI countries.[11] CCPI scores are highest in the Nordic countries, India, and the Philippines, and lowest in South Korea, Canada, Taiwan, and Malaysia. An attractive feature of the CCPI metrics is their low correlation with GDP per capita.

[11] CCPI scores are not available for Israel, Peru, and Singapore.

For example, Australia, Canada, and Austria are low CCPI countries that have relatively high levels of GDP per capita.

To assess the robustness of our results to CCPI splits based on medians, we also split countries based on terciles of their CCPI scores. Further, we also report results when we use CCPI's GHG emissions category scores rather than the overall CCPI score. The GHG emissions category score has a 40% weight in the overall CCPI score and is based on assessments of countries' GHG emissions per capita, trends in emissions, and current emissions and reduction targets compared to a well-below -2°C compatible pathway.

IV. Results

A. Carbon Emissions Disclosure

We use carbon emissions data from 2023 because by this point in time almost all firms have begun reporting their carbon emissions, given growing pressures to report, including a year-2024 requirement from IFRS. Prior research may have been plagued by significant selective disclosure bias—with only firms having relatively good carbon emissions performance disclosing their data. But that is substantially less of a concern in 2023. Table 1 reports that 88% of our sample firms disclose their carbon emissions.[12]

If selective disclosure bias exists, and is related to ownership type, this could make it difficult to draw strong conclusions from our main regressions that assess whether ownership type drives carbon emissions. In Table 2, we test whether the disclosure of carbon emissions is linked to ownership type. In these tests as well as for the other tests that follow in this section, we include a variety of control variables. For firm controls, we use firm size (log of assets), cash, asset

[12] As a point of reference, for a sample comparable to ours a decade earlier, only 57% of firms reported carbon emissions.

tangibility, leverage, and profitability. We include firm size as prior literature has shown it to be related to ownership structures, and larger firms may be subject to more external pressures. We control for financial slack as Hong, Kubik, and Scheinkman (2012) suggest that this helps explain the adoption of sustainability-oriented policies. To that end, we include cash, asset tangibility, and leverage to capture credit constraints and profitability to capture the impact of performance. Given the substantial variation across countries and industries, we include country and industry (72 SASB industry codes) fixed effects. We cluster standard errors by country.

In column 1 of Table 2, we find a negative and significant coefficient on family control and on government control. This indicates that the frequency of disclosure of carbon emissions is lower for such controlled firms relative to widely held firms (the omitted mutually exclusive ownership category). This result supports our research design that focuses only on the most recent year with carbon emissions data, as it shows that even with almost all firms voluntarily disclosing carbon emissions, selective disclosure bias remains and is related to ownership type. It is likely that selective disclosure bias would have been a more serious problem if we had chosen an unbalanced panel design and incorporated years quite distant from this current point in time.

In column 2, we only include firms from countries without mandated carbon disclosure legislation. We find similar coefficients on the controlled firm categories, but the family control coefficient loses statistical significance. This finding for family-controlled firms, in a setting where they have freedom of choice regarding disclosure, suggests that the emission tests may not be meaningfully driven by a self-selection bias for family control. The negative and significant coefficient for government firms leaves the concern that their emissions performance in subsequent tests could be optimistically biased.

B. Carbon Emissions Performance

We provide our baseline results in Table 3, where we test for the impact of ownership type on carbon emissions and limit the sample to firms that discloses emissions. The existing literature has no consensus as to how to appropriately measure emissions, with papers using emissions intensity (scaled emissions) or raw emissions.[13] Aswani et al. (2024) argue in favor of emissions intensity as the appropriate metric,[14] and further suggest that revenue-scaled carbon emissions is preferred to asset-scaled emissions given the stronger correlation between emissions and revenue.[15] To facilitate comparisons with the literature we report results using both emission intensity and raw emissions but focus our discussion on revenue-scaled emissions results. In regressions with unscaled emissions as the dependent variable, we also control for firms' revenue accounting that emissions depend heavily on sales.

To test for the impact of ownership on carbon emissions, we estimate models using the following baseline specification:

$$Log(Emissions_i) = \alpha + \beta' X_i + \gamma' Y_i + \Lambda + \varepsilon_i , \tag{1}$$

where the dependent variable is the log of total CO2 equivalent emissions of firm i, scaled by revenue or unscaled, X_i are ownership structure indicator variables for ownership by family, government, and other opaque, omitting widely held firms as the baseline category, Y_i are a set of

[13] See, for example, Shive and Forster (2020) and Bolton and Kacperczyk (2022).

[14] They note that using unscaled emissions 'is analogous to using net income rather than ratios such as return on assets (ROAs) to measure financial performance,' that 'the ratio of emissions to net sales the most commonly used metric in practice', and that it 'better captures a firm's emissions performance by avoiding mechanical correlations with firm size.'

[15] Aswani et al. (2024), using a sample of U.S. firms, report a correlation of log Scope 1 emissions and log sales of 0.70 (compared to 0.46 for log assets). Focusing on Scope 2 emissions the correlations are 0.847 for log sales and 0.548 for log assets.

firm-level controls, and Λ are individual country and industry fixed effects. We use logs for our dependent variables to obtain better distributional properties and to reduce the impact of outliers.

In columns 1 and 2 we consider all family-owned firms in aggregate. We find that no category of controlled firm delivers statistically significant lower carbon emissions than the widely held firm. For family-controlled firms, we find a positive coefficient suggesting family-controlled firms emit 13% more carbon than widely held firms. This result is only marginally significant and does not consider the strength of the *clean* preferences of family owners. For other-controlled firms, we find a negative and significant coefficient at the 10% level, consistent with our priors that these firms lack *clean* preferences, implying 26-29% greater carbon emissions than the widely held firm. We find no significant relationship between government control and carbon emissions. We conclude that government-controlled firms thus do not choose lower emissions than the widely held firm, given their self-selection bias to be *cleaner* as discussed in Table 2.

Columns 3 and 4 provide our first tests of whether the environmental preferences of controlling shareholders matter, a key component of our analysis. Using the LLM-identified environmental preferences of controlling families, we split family firms into the previously described three groups, firms controlled by families with low environmental preferences (Low E Family), firms controlled by families with high environmental preferences (High E Family), and firms controlled by families with unknown environmental preferences (Inconclusive E Family). Results for other-controlled firms and government-controlled firms are the same as in the first two columns.

We find that the environmental preferences of controlling shareholders matter, but not always in ways that one might expect. The statistically insignificant coefficient on High E Family indicates that families with high environmental preferences perform no better on carbon emissions than widely held firms. This result is important, as it indicates that strong family preferences for environmental performance apparently do not overcome the pecuniary private benefit drift towards dirty that affects all controlled firms. Further, we find a statistically significant and positive coefficient on Low E Family, indicating that such families emit about 20% more carbon than widely held firms, all else equal. We also note that families with inconclusive environmental preferences similarly perform no better on carbon emissions than the widely held firm.

One broad takeaway from Table 3 is that the Hart and Zingales (2017) hypothesis that carbon outcomes can be different if we allow for shareholder utility maximization is true. Controlled firms deliver worse carbon performance than the widely held firm. Preferences influence environmental outcomes, but the aggregate result appears to be worse rather than better in terms of achieving *clean*. There simply aren't enough families with strong preferences and/or the strength of their preferences aren't high enough to overcome the pecuniary private benefit drift that affects controlled firms.

C. Accounting for the Expected Marginal Costs to Reduce Carbon Emissions

We next exploit variation in the expected marginal costs firms are likely to face when they seek to improve their environmental performance. In Table 4, we group firms into two subsamples based on their countries' CCPI scores. We are specifically interested in whether family-controlled firms perform differently on carbon emissions in low CCPI countries where the expected marginal costs to improve are smaller. Columns 1 through 4 focus on family firms in aggregate. Columns 5 through 8 allow us to examine whether families' environmental preferences matter.

We first discuss the findings in high CCPI countries that have already taken substantial steps to address concerns about climate performance and already demand carbon efficiency. These results are found in columns 3, 4, 7, and 8. In these high CCPI countries, we find a positive and significant coefficient on family-controlled firms showing that family-controlled firms have approximately 20% higher carbon emissions than widely held firms. Further, the positive and significant relationship between family control and carbon emissions obtains regardless of the strength of a family's environmental preferences. Low E families have 22 to 25 percent higher carbon emissions, while High E Families have 17 percent higher emissions. We find an even stronger positive and significant coefficient for other-controlled firms. These findings are consistent with the pecuniary private benefit drift towards *dirty* dominating any preference effects when the cost to improve carbon emissions is relatively high. The one setting where we find the strength of environmental preferences reducing carbon emissions is in low CCPI countries. Focusing on columns 5 and 6, we find an economically meaningful negative and significant coefficient on family-controlled firms for High E Family and for Inconclusive E Family. In low CCPI countries, Low E Family has emissions that are no different than that of widely held firms, and the same is true for other-controlled firms.

V. Robustness

In this section we consider the robustness of our principal findings. First, we assess biases or other limitations in our LLM-based family-preference metric. Second, we assess potential limitations of our country-based estimates of the expected marginal costs of reducing carbon emissions. Third, we consider whether results are robust when we allow for variation across firms in their level of expected private benefits.

A potential concern with using LLM-based family-preference metrics is that the LLM is a 'Blackbox' and could be influenced by potential biases in how the LLM accesses information. For example, it is possible that the LLM may exhibit language-based biases if it were primarily trained on English-language content or if its web retrieval capabilities were restricted to English sources, potentially compromising the quality of assessments for families operating in non-English contexts. It is also possible the LLM could disproportionately focus on wealthier countries that have more media coverage. It is also possible that the score the LLM produces could be based on characteristics unrelated to family environmental preferences. For example, wealthier families, or families affiliated with larger firms, could attract more media attention, including positive evaluations, and the LLM would give such families a higher score really because they are wealthier or bigger rather than having strong environmental preferences.

Some of these concerns seem to have limited validity based on the description of the LLM provided by the data provider (e.g., according to the LLM provider, it does not focus exclusively on English-language content, and it states its web retrieval capabilities are not restricted to English sources). Nevertheless, we test for patterns in the environmental performance scores related to language and other characteristics and construct an alternative score that is orthogonalized to these influences and examine whether our results in Tables 3 and 4 persist.

Table 5, Panel A tests whether our LLM-based family-preference metric is mechanically driven by observable country, family, or firm attributes that could bias the scores. In column 1, we consider: 1) whether English is the native language of the country (English Narrow), 2) the country's income level (log GDP per capita), 3) the family's wealth status (Forbes-listed billionaires), and 4) the scale and industry of the controlled firm (log assets and SASB industry fixed effects). For wealth status, we use the 2022 list of billionaires collected by Forbes and use a 1/0 dummy to indicate those families that are billionaires. Column 2 uses the same covariates but includes another dummy to capture firms from countries where there is widespread English use, but English is not the native language (such countries are called English Extensive).

The results show that these factors explain a modest share of the variation in family environmental preferences, with R^2 around 0.09. Two variables stand out: billionaire families exhibit, on average, a 2.4 point higher environmental-preference score, and each log-unit increase in firm assets is associated with roughly a 1.6 point increase in the score—both significant at the 1% level. By contrast, neither measure of English-language prevalence is significant, while wealthier countries are, if anything, associated with lower scores. These patterns are reassuring that the LLM is not simply rewarding Anglophone media visibility or country affluence, yet it does capture meaningful heterogeneity linked to family wealth and firm size.

Panel B tests whether environmental preferences within family firms—both the raw score and its (orthogonalized) residuals from columns 1 and 2 of Panel A—are associated with carbon emissions. In columns 1 and 2 we establish a baseline by using the raw scores, including all controls as in Tables 3 and 4. Not surprisingly, this test shows that families that have higher environmental preferences are associated with lower carbon emissions. In terms of magnitude, a one-point increase in the raw score is associated with roughly 0.9% lower carbon emission intensity (column 1) and 0.8 % lower unscaled emissions (column 2).

In columns 3-6, we repeat these tests but use the orthogonalized environmental preference scores based on column 1 of Panel A (columns 3-4) and column 2 of Panel A (columns 5-6). We find that the coefficients on the residual measures, $\varepsilon_{Family\ (1)}$ and $\varepsilon_{Family\ (2)}$ are close in magnitude and significance to the results using the raw environmental preference scores, indicating that the negative relationship persists even after stripping out the modest cross-sectional effects of English language, country income, billionaire status, firm size, and industry. These results confirm that within the universe of family-controlled firms, stronger owner-level environmental preferences are associated with measurably lower carbon emissions.

In Panel C, to verify the stability of our findings, we repeat our specifications from Table 4 using the orthogonalized environmental preference scores from column 2 of Table 5, Panel A to create Low E Family and High E Family preferences. As Panel C shows, our results remain robust and qualitatively unchanged—in high CCPI countries, where expected marginal costs of improving carbon emissions are high, family firms emit 20% or more carbon, regardless of their environmental preferences. As before, family-controlled firms emit significantly less carbon only in those countries where the expected marginal costs of reducing emissions are low (low CCPI countries) and environmental preferences are high.

Next, we assess potential limitations of CCPI aggregate scores and the choice to split countries based on the median country score in our sample. CCPI aggregate scores are based on four separate categories (emissions, renewable energy, energy use, and climate policy) and some of these may not clearly translate into higher expected marginal costs for firms to improve their carbon performance. As such, in Table A3, we replace for each country the overall CCPI score with the CCPI emissions score, which is the category that most directly speaks to carbon emissions. Results using this split are substantially similar. Again, family firms have greater emissions in high CCPI emissions countries regardless of the environmental preferences of the family owner. A second potential concern is the choice to split the countries using the median country score in the sample. In Table A4, we alternatively split the sample into CCPI terciles and perform the same tests. The inferences are similar, and there is a monotonic increase in the coefficient on family firms as we move from the lowest to the highest CCPI tercile. As before, the negative impact of family firms on carbon emissions is strongest in the highest CCPI countries.

Finally, we consider whether our results are robust when we allow for variation across firms in their expected level of private benefits. One variable that arguably captures variation across firms in their private benefits and that is used extensively in the corporate governance literature, is whether a firm has issued dual class shares that create a wedge between control rights and cash flow rights. In companies that choose to use such share structures, private benefit extraction is more likely. We identify all firms in our sample with dual class shares, and in Table A5 we rerun our regressions from Tables 3 and 4, but now include a dual class share dummy as an additional control. All previously reported results are robust to the inclusion of this variable.

VI. Extension: Aggregate Environmental Scores

Controlling shareholders with strong *clean* preferences might also want to be seen by outsiders as *clean*, as this would burnish their environmental credentials. One way to signal an owner has clean preferences is for their firm to be rated highly by commercial environmental data providers. These providers consider a variety of metrics to inform their ratings, including softer measures such as targets and policies, and produce comprehensive metrics that combine qualitative environmental data items and quantitative measures of environmental performance including emissions. In the tests in this section, we examine the impact of ownership on these environmental metrics. Such tests aid in reconciling our results with the prior literature that used these metrics, and extends that literature by exploring whether environmental preferences (based on our LLM algorithm) matter for these metrics.[16]

In Table 6 we analyze how controlled firm ownership affects the environmental pillar score from Refinitiv (column 1) and our less material environmental score (column 2). In these tests, we use a different set of industry fixed effects. Berg, Koelbel, and Rigobon (2022) note that in 2020

[16] For example, a body of research (see, e.g., El Ghoul, Guedhami, Wang, and Kwok, 2016; Dyck et al., 2023; Tufano, Villalonga, and Wang, 2025) concludes that family control is bad for environmental sustainability based on findings of a strong negative relationship between family control and commercially provided ESG scores (rather than carbon emissions as the sustainability metric). Others have explored the relationship between ESG scores and other types of controlled firms such as government-controlled firms (e.g. Hsu, Liang, and Matos, 2023)

Refinitiv introduced a new proprietary model whereby they assigned industry-specific weights to particular data items. Since this weighting is done at the industry level, it is important that we use the same industry classifications as Refinitiv. To that end, we include industry fixed effects based on Refinitiv's 57 industry groupings. As in our previous tests, we also employ country fixed effects and firm controls.

In Panel A, column 1 we consider family-controlled firms in aggregate. We find that in 2023, consistent with prior research, there remains a negative and highly significant coefficient on the family-controlled dummy (note that in these tests a higher score indicates better environmental performance). In column 2, we provide new results on whether the strength of *clean* preferences influences environmental scores. We find a very strong effect. Low E Family has significantly lower environmental scores, while High E Family has environmental scores that are not different than widely held firms. This is consistent with High E Family being interested in preserving their 'family assets' by signaling that they care both about hard measures of environmental performance (the emissions results from Table 3), and softer measures of policies and targets that dominate the construction of the environmental scores provided by commercial rating firms.

In Panel B, we split countries based on the expected marginal costs of becoming more *clean*. These results differ from our findings on carbon emissions. With carbon emissions as the metric, the impact of family ownership on performance depended in a significant way on the expected marginal cost of improving emissions performance. With commercial environmental scores as the performance metric, there is no such variation. In columns 1 and 3, we find negative and significant coefficients showing that family control is associated with worse environmental performance across all countries. Turning to High vs. Low E Family in columns 5 and 7, we again find an insignificant coefficient on High E Family, suggesting their performance is indistinguishable from that of widely held firm in both high and low CCPI countries. This again is consistent with their concern for 'family assets' offsetting any pecuniary private benefit drift. Low E families have significantly worse scores across all countries.

In Panel A and B, we also repeat these tests using our less material environmental score as the dependent variable. An advantage of using this variable is that it is not based on carbon emissions at all but rather on the 73 line items that we deem to be less material, as they relate only to policies and targets. Improvements in these less material scores are unlikely to be as expensive as improvements in reducing carbon emissions. Results are similar.

VII. Conclusion

One broad takeaway is that the Hart and Zingales (2017) hypothesis that carbon outcomes will be different if we allow for shareholder utility maximization is true. When owners have the freedom to direct firms to satisfy their non-pecuniary preferences, this does influence environmental outcomes. Families having strong preferences for *clean* only translates into meaningful improvements in carbon emissions if the expected marginal cost of reducing emissions is relatively low. But, the aggregate effect of control appears to be worse rather than better in terms of achieving *clean* because in all other scenarios, controlled firms' environmental performance is no better—and often worse—than that of widely held firms. Regarding the often-negative impact of family control on carbon emissions, there simply aren't enough families with strong preferences and/or the strength of their preferences aren't high enough to overcome the pecuniary private benefit drift that affects controlled firms.

We interpret these results as evidence that shifting from strict financial value maximization to broader shareholder welfare maximization is unlikely to deliver significant environmental gains without stronger regulatory support. The few exceptions we observe—where family-controlled firms perform better in low-cost contexts—underscore that voluntary improvements tend to arise only under narrow conditions. Taken together, these insights caution against relying solely on controlling shareholders to address negative environmental externalities and highlight the need for robust policies and institutions to encourage cleaner corporate behavior.

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Figure 1
Family Control Around the World

This figure reports the incidence of family control for the 35 countries in our sample. Family control is manually verified for each firm and defined as follows: we classify a firm as family-controlled if the sum of the shares owned by family members is greater than 20%, family members own at least 10% of the shares and have a position of CEO/Chair, or family members own at least 10% of the shares and the company has multiple voting share classes. We also require that family members own more shares than any other shareholder.

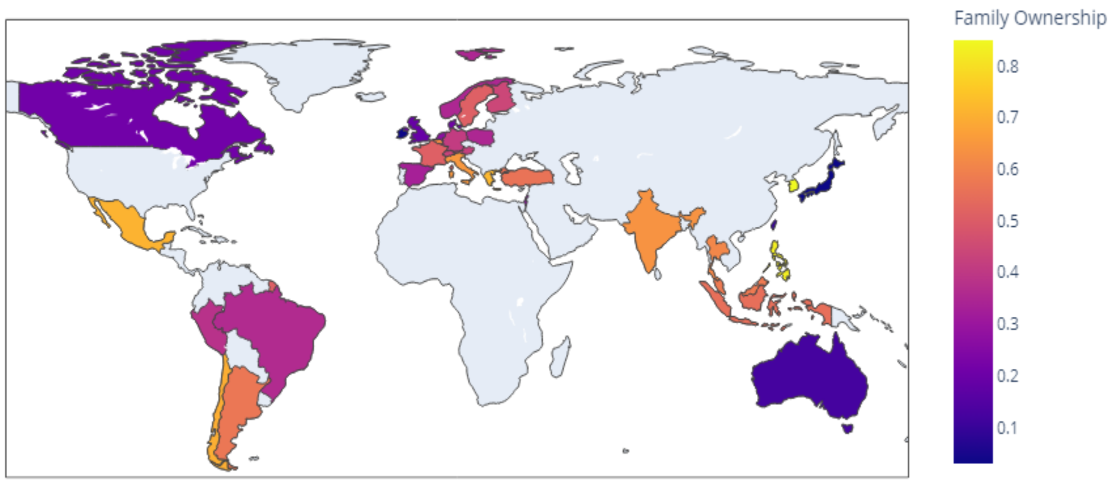

Table 1
Summary Statistics

This table shows summary statistics for our sample. All variables and industry classifications are described in Table A1 in the Appendix.

Panel A: Full Sample

	Mean	Median	SD	N
A. Environmental Performance				
Reports CO2e	0.88	1.00	0.32	3,769
CO2e	1,732,000	83,562	7,477,000	3,325
Log (CO2e)	11.28	11.34	2.814	3,320
Log (CO2e, Scope 1)	10.21	10.23	3.32	3,205
Log (CO2e, Scope 2)	10.14	10.33	2.58	3,231
Log (CO2e / Revenue)	3.714	3.593	2.159	3,320
Log (CO2e Scope 1/ Revenue)	2.61	2.35	2.70	3,205
Log (CO2e Scope 2/ Revenue)	2.56	2.67	2.03	3,231
Commercial Environmental Score	52.33	53.65	23.13	3,698
Less Material Environmental Score	23.36	24.00	8.90	3,769
B. Ownership				
Family-controlled	0.42	0.00	0.49	3,769
Government-controlled	0.07	0.00	0.26	3,769
Other-controlled	0.06	0.00	0.25	3,769
Widely Held	0.45	0.00	0.50	3,769
C. Family Owners' Environmental Preferences				
Family E Preference	16.71	12.00	11.80	1,159
Low E Family	0.20	0.00	0.40	3,769
High E Family	0.11	0.00	0.32	3,769
Inconclusive E Family	0.11	0.00	0.31	3,769
D. Other Firm Characteristics				
Total Assets (in $ million)	9,551	2,331	26,393	3,769
Log (Total Assets)	21.62	21.57	1.64	3,769
Log (Revenue)	7.36	7.35	1.79	3,769
Cash	0.15	0.11	0.14	3,769
Tangibility	0.31	0.27	0.22	3,769
Leverage	0.26	0.24	0.39	3,769
Profitability	0.04	0.04	0.18	3,769

Panel B: Summary Statistics by Country for the Full Sample

Country	Ownership				Family Owners' Environmental Preferences			CCPI	Average Total Assets (in $ million)	N
	Family	Gov't	Other Ctrl	Widely Held	Low	High	Unkn			
Argentina	0.67	0.07	0.07	0.20	0.60	0.07	0.00	45.4	4,109	15
Australia	0.18	0.00	0.04	0.78	0.05	0.02	0.11	45.7	4,244	223
Austria	0.42	0.26	0.11	0.21	0.26	0.16	0.00	58.2	7,936	19
Belgium	0.64	0.06	0.08	0.22	0.08	0.03	0.53	55.0	10,840	36
Brazil	0.42	0.07	0.15	0.37	0.11	0.06	0.25	61.7	10,847	101
Canada	0.27	0.02	0.10	0.62	0.16	0.10	0.01	31.6	7,546	252
Chile	0.71	0.14	0.00	0.14	0.07	0.04	0.61	68.7	8,882	28
Denmark	0.21	0.06	0.26	0.47	0.11	0.09	0.02	75.6	6,669	47
Finland	0.39	0.11	0.11	0.39	0.20	0.15	0.04	61.1	4,104	54
France	0.55	0.08	0.07	0.29	0.39	0.14	0.03	57.1	26,083	137
Germany	0.48	0.07	0.09	0.36	0.06	0.04	0.38	65.8	17,134	174
Greece	0.68	0.26	0.00	0.05	0.11	0.53	0.05	60.3	4,917	19
India	0.66	0.12	0.02	0.20	0.32	0.29	0.05	70.3	3,375	459
Indonesia	0.59	0.18	0.08	0.16	0.45	0.06	0.08	57.2	4,603	51
Ireland	0.14	0.00	0.00	0.86	0.12	0.02	0.00	51.4	13,962	42
Israel	0.45	0.06	0.10	0.39	0.03	0.03	0.39	n/a	4,264	31
Italy	0.69	0.21	0.03	0.07	0.11	0.09	0.48	50.6	9,735	87
Japan	0.09	0.01	0.03	0.86	0.07	0.01	0.01	42.1	17,675	413
Luxembourg	0.50	0.00	0.08	0.42	0.04	0.13	0.33	65.1	9,033	24
Malaysia	0.65	0.17	0.06	0.13	0.46	0.17	0.03	38.6	3,117	120
Mexico	0.68	0.00	0.00	0.32	0.07	0.05	0.56	55.8	7,431	57
Netherlands	0.25	0.00	0.17	0.58	0.13	0.08	0.04	70.0	17,412	53
Norway	0.38	0.09	0.13	0.40	0.16	0.15	0.07	67.5	6,603	55
Peru	0.33	0.22	0.00	0.44	0.33	0.00	0.00	n/a	2,747	18
Philippines	0.89	0.04	0.00	0.07	0.30	0.59	0.00	70.7	10,001	27
Poland	0.39	0.39	0.09	0.13	0.26	0.13	0.00	44.4	8,327	23
Singapore	0.50	0.28	0.00	0.22	0.33	0.15	0.02	n/a	8,352	54
South Korea	0.83	0.06	0.01	0.09	0.54	0.24	0.05	30.0	17,826	140
Spain	0.43	0.09	0.13	0.35	0.13	0.07	0.22	63.4	16,053	54
Sweden	0.48	0.02	0.07	0.44	0.29	0.10	0.08	69.4	3,488	181
Switzerland	0.47	0.06	0.07	0.40	0.29	0.13	0.06	61.9	9,275	119
Taiwan	0.16	0.05	0.04	0.76	0.10	0.02	0.03	36.9	7,775	148
Thailand	0.64	0.17	0.02	0.17	0.40	0.20	0.05	61.4	4,872	111
Turkey	0.66	0.20	0.09	0.05	0.21	0.38	0.07	43.8	7,076	56
U.K.	0.19	0.00	0.10	0.71	0.01	0.01	0.17	62.4	8,574	341

Table 2
Family-Controlled Firms and GHG Emissions Disclosure

This table shows regression estimates of measures of firms' GHG reporting on ownership variables, control variables, and country and industry fixed effects. The dependent variables are whether the firm reports CO2 equivalent emissions and the log of total CO2 equivalent emissions (scaled by revenue and raw emissions). Industry fixed effects are based on SASB Industry Classifications. Ownership data is from 2022, all other variables from 2023. All other variables are described in Tables A1 in the Appendix. Standard errors are clustered at the country level and *t*-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	Reports CO2e	
	Full Sample	Countries Without Mandated Carbon Disclosure Legislation
	(1)	(2)
Family-controlled	-0.038*	-0.036
	(-1.72)	(-1.32)
Government-controlled	-0.052*	-0.073**
	(-1.80)	(-2.11)
Other-controlled	0.018	0.048
	(0.84)	(1.56)
Log (Total Assets)	0.002	0.007
	(0.21)	(0.55)
Log (Revenue)	0.054***	0.059***
	(6.51)	(6.35)
Cash	-0.105**	-0.020
	(-2.11)	(-0.32)
Tangibility	0.104**	0.122**
	(2.18)	(2.12)
Leverage	0.005	0.006
	(0.57)	(0.79)
Profitability	0.096***	0.092**
	(3.14)	(2.65)
Country FE	Yes	Yes
SASB Industry FE	Yes	Yes
N	3,769	2,600
Adjusted R^2	0.182	0.183

Table 3
Family-Controlled Firms and GHG Emissions

This table shows regression estimates of measures of firms' GHG emissions on ownership variables (columns 1 and 2) and family owners' environmental preferences (in columns 3 and 4), control variables, and country and industry fixed effects. The dependent variables are log of total CO2 equivalent emissions (scaled by revenue and raw emissions). Industry fixed effects are based on SASB Industry Classifications. The sample year is 2022. All other variables are described in Tables A1 in the Appendix. Standard errors are clustered at the country level and *t*-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)
	(1)	(2)	(3)	(4)
Family-controlled	0.130	0.129*		
	(1.67)	(1.71)		
Low E Family			0.225**	0.214**
			(2.56)	(2.49)
High E Family			0.045	0.048
			(0.46)	(0.51)
Inconclusive E Family			0.063	0.074
			(0.64)	(0.76)
Government-controlled	-0.039	-0.045	-0.039	-0.046
	(-0.31)	(-0.36)	(-0.31)	(-0.37)
Other-controlled	0.288*	0.264*	0.289*	0.265*
	(2.00)	(1.88)	(2.00)	(1.88)
Log (Total Assets)	0.144***	0.386***	0.147***	0.386***
	(7.17)	(5.25)	(7.11)	(5.18)
Log (Revenue)		0.736***		0.738***
		(9.40)		(9.38)
Cash	-0.210	-0.356	-0.193	-0.339
	(-0.79)	(-1.39)	(-0.72)	(-1.30)
Tangibility	2.871***	2.780***	2.873***	2.783***
	(7.75)	(7.64)	(7.77)	(7.67)
Leverage	-0.027	-0.015	-0.022	-0.011
	(-0.61)	(-0.35)	(-0.52)	(-0.26)
Profitability	-1.188***	-0.772**	-1.205***	-0.791**
	(-3.15)	(-2.14)	(-3.22)	(-2.19)
Country FE	Yes	Yes	Yes	Yes
SASB Industry FE	Yes	Yes	Yes	Yes
N	3,319	3,319	3,319	3,319
Adjusted R^2	0.593	0.763	0.594	0.763

Table 4
Family-Controlled Firms and GHG Emissions: Splits by the Climate Change Performance Index

This table provides subsample analysis of regression estimates of measures of firms' GHG emissions on ownership variables (columns 1-4) and family owners' environmental preferences (columns 5-8), control variables, and country and industry fixed effects. The subsamples are based on a country's score on the Climate Change Performance Index (CCPI), a standardized framework used to compare the climate performance of 63 countries and the EU. We construct subsamples using the overall CCPI score which is based on four categories: GHG Emissions, Renewable Energy, Energy Use and Climate Policy. The dependent variables are total CO2 equivalent emissions (scaled by revenue and raw emissions). Industry fixed effects are based on SASB Industry Classifications. The sample year is 2022. All variables are described in Table A1 in the Appendix. Standard errors are clustered at the country level and *t*-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	CCPI							
	Low CCPI		High CCPI		Low CCPI		High CCPI	
	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Family-controlled	-0.114	-0.112*	0.205**	0.197**				
	(-1.73)	(-1.76)	(2.23)	(2.28)				
Low E Family					0.013	0.011	0.247**	0.223**
					(0.13)	(0.12)	(2.37)	(2.18)
High E Family					-0.233*	-0.218*	0.175*	0.171*
					(-2.07)	(-1.93)	(1.75)	(1.84)
Inconclusive E Family					-0.301*	-0.305*	0.183	0.191
					(-1.77)	(-1.90)	(1.59)	(1.68)
Government-controlled	-0.197	-0.214	0.121	0.114	-0.197	-0.214	0.120	0.112
	(-1.14)	(-1.27)	(0.86)	(0.76)	(-1.18)	(-1.32)	(0.86)	(0.75)
Other-controlled	-0.050	-0.061	0.516***	0.481***	-0.050	-0.061	0.516***	0.481***
	(-0.33)	(-0.42)	(3.99)	(3.92)	(-0.33)	(-0.42)	(4.00)	(3.94)
Log (Total Assets)	0.093***	0.383***	0.180***	0.421***	0.092**	0.380***	0.182***	0.421***
	(3.03)	(3.06)	(9.67)	(5.14)	(2.93)	(3.04)	(9.38)	(5.08)
Log (Revenue)		0.688***		0.733***		0.689***		0.734***
		(5.93)		(7.45)		(5.96)		(7.45)
Cash	0.281	0.004	-0.681**	-0.754***	0.299	0.022	-0.669**	-0.747***
	(0.73)	(0.01)	(-2.86)	(-3.34)	(0.78)	(0.06)	(-2.74)	(-3.19)
Tangibility	2.740***	2.689***	3.266***	3.154***	2.731***	2.681***	3.268***	3.156***
	(5.69)	(5.50)	(6.25)	(6.18)	(5.71)	(5.53)	(6.25)	(6.18)
Leverage	-0.308	-0.369	0.023	0.037	-0.305	-0.366	0.025	0.039
	(-1.05)	(-1.25)	(0.65)	(1.17)	(-1.03)	(-1.22)	(0.71)	(1.23)
Profitability	-1.910***	-1.379***	-0.592*	-0.233	-1.917***	-1.387***	-0.602*	-0.239
	(-4.19)	(-3.37)	(-1.87)	(-0.64)	(-4.21)	(-3.36)	(-1.90)	(-0.65)
SASB Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,576	1,576	1,654	1,654	1,576	1,576	1,654	1,654
Adjusted R^2	0.578	0.742	0.624	0.782	0.579	0.743	0.624	0.782

Table 5
Orthogonalized Family Owners' Environmental Preferences and GHG Emissions

This table shows regression estimates of family owner's environmental preferences on country, family and firm characteristics in Panel A, and regression estimates of the residuals from Panel A on measures of GHG emissions in Panel B. In Panel A, the dependent variable is the family owners' environmental preferences. In Panels B and C, the dependent variables are log of total CO2 equivalent emissions (scaled by revenue and raw emissions); all control variables are as in Table 2. In Panel B, $\varepsilon_{Family\ (1)}$ and $\varepsilon_{Family\ (2)}$ indicate the residuals from columns (1) and (2) of Panel A, respectively. In Panel C, Low (High) E Family, $\varepsilon_{Family\ (2)}$ indicate families with low (high) environmental preferences based on $\varepsilon_{Family\ (2)}$. All other variables are described in Table A1 in the Appendix. The sample year is 2022. Standard errors are clustered at the country level and t-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Explaining Family Owners' Environmental Preferences

	Family Owner's Environmental Preferences (y_{Family})	
	(1)	(2)
English Narrow	0.888	0.888
	(1.09)	(1.11)
English Extensive		1.341
		(0.93)
Log(GDP/Capita)	-1.638***	-1.296***
	(-5.53)	(-3.07)
Forbes List	2.470*	2.423*
	(1.83)	(1.81)
Log(Total Assets)	1.600***	1.643***
	(5.78)	(5.85)
Country FE	No	No
SASB Industry FE	Yes	Yes
Observations	1,161	1,161
Adj. R-squared	0.085	0.0851

Panel B: Within-Family Environmental Preferences and GHG Emissions

	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)
	(1)	(2)	(3)	(4)	(5)	(6)
y_{Family}	-0.009***	-0.008***				
	(-3.14)	(-2.93)				
$\varepsilon_{Family\ (1)}$			-0.009***	-0.008***		
			(-3.03)	(-2.85)		
$\varepsilon_{Family\ (2)}$					-0.009***	-0.008***
					(-3.04)	(-2.86)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
SASB Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	995	995	992	992	992	992
Adj. R-squared	0.616	0.743	0.616	0.743	0.616	0.743

Panel C: Family Owners' Environmental Preferences and GHG Emissions: Splits by the Climate Change Performance Index

	CCPI			
	Low CCPI		High CCPI	
	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)
	(1)	(2)	(3)	(4)
Low E Family, $\varepsilon_{Family\ (2)}$	0.038	0.032	0.238**	0.211*
	(0.39)	(0.35)	(2.26)	(2.07)
High E Family, $\varepsilon_{Family\ (2)}$	-0.224**	-0.206**	0.209**	0.209**
	(-2.34)	(-2.20)	(2.41)	(2.58)
Inconclusive E Family	-0.299*	-0.303*	0.184	0.192
	(-1.77)	(-1.90)	(1.62)	(1.71)
Government-controlled	-0.196	-0.212	0.126	0.118
	(-1.17)	(-1.29)	(0.91)	(0.80)
Other-controlled	-0.047	-0.058	0.517***	0.482***
	(-0.31)	(-0.40)	(4.05)	(3.99)
Controls	Yes	Yes	Yes	Yes
SASB Industry FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
N	1,576	1,576	1,654	1,654
Adjusted R^2	0.579	0.743	0.624	0.782

Table 6
Family-Controlled Firms and Firms' Environmental Scores

This table replicates the regressions of Tables 3 and 4 using as dependent variables firm's commercial environmental scores from LSEG and firms' less material environmental scores. Table A2 lists the data items used to construct the less material environmental scores. The main independent variables are family control and family owner's environmental preferences. Industry fixed effects are based on Refinitiv Industry Classifications. All other variables are described in Table A1 in the Appendix. The sample year is 2022. Standard errors are clustered at the country level and *t*-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Family Control and Family Owners' Environmental Preferences

	Commercial Environmental Score		Less Material Environmental Score	
	(1)	(2)	(3)	(4)
Family-controlled	-3.768***		-1.330***	
	(-4.24)		(-4.61)	
Low E Family		-5.526***		-1.626***
		(-4.69)		(-3.34)
High E Family		-0.079		-0.120
		(-0.08)		(-0.29)
Inconclusive E Family		-4.090***		-1.817***
		(-3.14)		(-5.86)
Government-controlled	-2.355	-1.998	-1.079	-0.926
	(-0.97)	(-0.86)	(-1.27)	(-1.14)
Other-controlled	-3.066	-3.080	-1.081**	-1.085**
	(-1.64)	(-1.66)	(-2.62)	(-2.68)
Log (Total Assets)	4.844***	4.696***	2.067***	2.012***
	(9.59)	(9.96)	(9.85)	(9.74)
Log (Revenue)	3.394***	3.404***	1.134***	1.141***
	(6.88)	(6.92)	(5.36)	(5.37)
Cash	3.000	2.534	0.199	0.088
	(0.71)	(0.60)	(0.14)	(0.06)
Tangibility	-0.582	-0.663	2.254**	2.251**
	(-0.33)	(-0.39)	(2.65)	(2.65)
Leverage	0.760	0.583	0.235*	0.183
	(1.52)	(1.14)	(1.89)	(1.45)
Profitability	1.181	1.246	0.136	0.141
	(0.60)	(0.63)	(0.25)	(0.26)
Country FE	Yes	Yes	Yes	Yes
Refinitiv Industry FE	Yes	Yes	Yes	Yes
N	3,695	3,695	3,766	3,766
Adjusted R^2	0.417	0.421	0.526	0.528

Panel B: CCPI Splits

	CCPI							
	Low CCPI		High CCPI		Low CCPI		High CCPI	
	Commercial Environmental Score	Less Material Environmental Score	Commercial Environmental Score	Less Material Environmental Score	Commercial Environmental Score	Less Material Environmental Score	Commercial Environmental Score	Less Material Environmental Score
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Family-controlled	-5.374***	-1.437**	-2.023**	-1.003***				
	(-3.49)	(-2.91)	(-2.57)	(-3.02)				
Low E Family					-6.912***	-1.608**	-3.774**	-1.584**
					(-4.49)	(-2.56)	(-2.60)	(-2.55)
High E Family					0.335	0.236	-0.379	-0.214
					(0.17)	(0.33)	(-0.28)	(-0.41)
Inconclusive E Family					-6.837**	-2.499***	-1.413	-0.960***
					(-2.73)	(-3.27)	(-1.27)	(-3.90)
Government-controlled	0.034	-0.626	-4.007	-1.395	0.365	-0.508	-3.906	-1.312
	(0.01)	(-0.77)	(-1.34)	(-1.07)	(0.14)	(-0.67)	(-1.37)	(-1.06)
Other-controlled	-3.687	-1.095*	-1.284	-0.449	-3.519	-1.031	-1.311	-0.465
	(-1.25)	(-1.80)	(-0.47)	(-0.82)	(-1.21)	(-1.75)	(-0.48)	(-0.86)
Log (Total Assets)	4.466***	1.935***	4.418***	1.550***	4.362***	1.889***	4.376***	1.522***
	(5.29)	(5.42)	(6.05)	(6.08)	(5.36)	(5.31)	(6.22)	(6.46)
Log (Revenue)	3.496***	1.480***	3.769***	1.625***	3.452***	1.472***	3.721***	1.612***
	(4.09)	(3.63)	(5.91)	(7.14)	(4.06)	(3.60)	(5.64)	(7.21)
Cash	-5.322	-2.013	10.238**	0.265	-5.589	-2.046	9.580**	0.035
	(-0.63)	(-0.65)	(2.41)	(0.18)	(-0.66)	(-0.66)	(2.33)	(0.03)
Tangibility	-4.828**	0.410	2.802	3.218***	-4.593*	0.489	2.658	3.154***
	(-2.14)	(0.26)	(1.54)	(3.35)	(-2.08)	(0.31)	(1.47)	(3.40)
Leverage	-2.356	-1.240	1.304**	0.437***	-2.524	-1.270	1.205**	0.392**
	(-0.69)	(-1.26)	(2.50)	(3.42)	(-0.72)	(-1.29)	(2.20)	(2.86)
Profitability	-1.184	-0.826***	6.309	2.264	-1.152	-0.808**	6.647	2.347
	(-0.88)	(-2.98)	(1.45)	(1.75)	(-0.88)	(-2.92)	(1.44)	(1.70)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SASB Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,773	1,817	1,816	1,841	1,773	1,817	1,816	1,841
Adjusted R^2	0.458	0.573	0.400	0.503	0.463	0.576	0.402	0.505

Appendix A

Table A1
Variable Descriptions and Data Sources

This table reports variable definitions and data sources. Unless otherwise stated, all data are as of fiscal year end 2023

Variable	Description	Source
A. Environmental Performance		
Reports CO2e	A dummy variable equal to one if a firm reports CO2 equivalent emissions.	LSEG[17]
Log (CO2e)	Log of total CO2 equivalent emissions in tonnes; includes Scope 1 and Scope 2 emissions; includes CO2 and CO2 equivalent (CH4, N2O, HFCS, PFCS, SF6, NF3). Calculate following the Greenhouse Gas Protocol.	LSEG
Log (CO2e, Scope 1)	Log of total Scope 1 CO2 equivalent emissions in tonnes.	LSEG
Log (CO2e, Scope 2)	Log of total Scope 2 CO2 equivalent emissions in tonnes.	LSEG
Log (CO2e / Revenue)	Log of total CO2 equivalent emissions in tonnes scaled by revenue in millions of US$.	LSEG, Worldscope
Log (CO2e Scope 1/ Revenue)	Log of total Scope 1 CO2 equivalent emissions in tonnes scaled by revenue in millions of US$.	LSEG, Worldscope
Log (CO2e Scope 2/ Revenue)	Log of (Scope 2 CO2 equivalent emissions in tonnes over net total revenue in millions of US$).	LSEG, Worldscope
Commercial Environmental Score	The LSEG ESG overall environmental score based on sub-scores from the Resource Use, Emissions, and Environmental Innovation categories.	LSEG
Less Material Environmental Score	The sum of all 73 binary environmental data items reported as "Yes" by a firm for the Resource Use, Emissions, and Environmental Innovation categories. "Yes" indicates the better direction of environmental performance for all data items.	LSEG
B. Ownership		
Family-controlled	A dummy variable equal to one if a firm is classified as controlled by a family (as of December 2022). Control requires that the sum of the shares owned by family members is greater than 20% or that family members own at least 10% of the shares and the company has multiple voting class shares, and the sum is greater than any other shareholder.	Manual classification
Government-controlled	A dummy variable equal to one if the largest shareholder of the firm owns at least 20% of the firm and is the government or a sovereign wealth fund (as of December 2022).	Manual classification
Other-controlled	A dummy variable equal to one if the largest shareholder owns at least 20% of the firm and is a private equity fund, hedge fund, venture capital fund, other type of blockholder, or if ownership cannot be established (as of December 2022).	Manual classification
Widely Held	A dummy variable equal to one if a firm is not classified as Family, Government, or Other Opaque (as of December 2022).	Manual classification
C. Family Owners' Characteristics		
Family Owner's Environmental Preferences	The sum of five LLM generated measures ranking from zero to 50 (each component has a range of 0 to 10). Larger numbers are associated with greater environmental preferences. The five measures are: 1) personal philanthropy and charitable giving towards environmental causes; 2) public statements and advocacy for environmental issues; 3) participation in environmental NGOs; 4) green investments in the family's personal	GPT, Perplexity

[17] Formerly Refinitiv.

	portfolio outside the firm; 5) policy support and political contributions for environmental policies.	
Low E Family	A dummy variable equal to one if the sum of the LLM generated family owner's ownership preferences is less than 20, and zero otherwise.	GPT, Perplexity
High E Family	A dummy variable equal to one if the sum of the LLM generated family owner's ownership preferences is equal or greater than 20, and zero otherwise.	GPT, Perplexity
Inconclusive E Family	A dummy variable equal to one if the sum of the LLM generated family owner's ownership preferences is unknown, and zero otherwise.	GPT, Perplexity
Forbes List	Indicates whether the controlling family appears in Forbes' the World's Billionaires 2022.	Forbes
D. Other Firm Characteristics		
Total Assets	Total assets in $ million.	Worldscope
Revenue	Revenue in $ million.	Worldscope
Cash	Cash over total assets.	Worldscope
Tangibility	PP&E over total assets.	Worldscope
Leverage	Long-term debt over total assets.	Worldscope
Profitability	Net income over total assets.	Worldscope
E. Country Characteristics		
CCPI	The Climate Change Performance Index (CCPI) is a standardized framework used to compare the climate performance of 63 countries and the EU. The overall CCPI score is based on four categories: GHG Emissions, Renewable Energy, Energy Use and Climate Policy.	Germanwatch
English Narrow	English Narrow indicates native English-speaking countries (Australia, Canada, Ireland, UK).	Wikipedia
English Extensive	English Extensive indicates countries with widespread English use (India, Malaysia, the Philippines, Singapore).	Wikipedia
Log(GDP/Capita)	Log of GDP per capita in US$.	World Bank

Table A2
Less Material Sustainability Metrics: Binary Environmental Variables from Refinitiv

This table reports the list of all Refinitiv binary variables and whether they are fully populated.

	Data Item	Fully Populated
A. Resource Use Category		
1	Climate Related Risks Assessment Process	No
2	Transition Plan Financial Planning	Yes
3	Transition Plan Scope 3 Emissions	Yes
4	Transition Plan Time Horizon Coverage	Yes
5	Transition Plan Offsets	Yes
6	Financial Exposure to Transition Risk	Yes
7	Financial Exposure to Physical Risk	Yes
8	Scope 1 and 2 Paris Agreement Aligned	No
9	Scope 1, 2, and 3 Paris Agreement Aligned	No
10	Intensity Scope 1 and 2 Paris Agreement Aligned	No
11	Intensity Scope 1, 2, and 3 Paris Agreement Aligned	No
12	Portfolio Alignment	Yes
13	Environment Management Team	Yes
14	Environment Management Training	Yes
15	Policy Water Efficiency	Yes
16	Policy Energy Efficiency	Yes
17	Policy Sustainable Packaging	Yes
18	Policy Environmental Supply Chain	Yes
19	Targets Water Efficiency	Yes
20	Targets Energy Efficiency	Yes
21	Environmental Materials Sourcing	Yes
22	Toxic Chemicals Reduction	Yes
23	Renewable Energy Use	Yes
24	Green Buildings	Yes
25	Environmental Supply Chain Management	Yes
26	Env Supply Chain Partnership Termination	Yes
27	Land Environmental Impact Reduction	Yes
28	Environmental Supply Chain Monitoring	Yes
29	Resource Reduction Policy	Yes
30	Resource Reduction Targets	Yes
31	No Environmental Controversies	Yes
B. Emissions Category		
32	Policy Emissions	Yes
33	Targets Emissions	Yes
34	Biodiversity Impact Reduction	Yes
35	NOx and SOx Emissions Reduction	Yes
36	VOC Emissions Reduction	Yes
37	Particulate Matter Emissions Reduction	Yes
38	Waste Reduction Initiatives	Yes
39	e-Waste Reduction	Yes
40	Emissions Trading	Yes
41	Environmental Partnerships	Yes
42	Environmental Restoration Initiatives	Yes
43	Staff Transportation Impact Reduction	Yes
44	Climate Change Commercial Risks Opportunities	Yes
45	Environmental Investments Initiatives	Yes
46	Internal Carbon Pricing	Yes
47	Policy Nuclear Safety	Yes

C. Environmental Innovation Category

48	Eco-Design Products	Yes
49	Environmental Products	Yes
50	Noise Reduction	Yes
51	Hybrid Vehicles	Yes
52	Environmental Assets Under Mgt	Yes
53	Equator Principles	Yes
54	Environmental Project Financing	Yes
55	Labeled Wood	Yes
56	Organic Products Initiatives	Yes
57	Take-back and Recycling Initiatives	Yes
58	Product Environmental Responsible Use	Yes
59	No GMO Products	Yes
60	Agrochemical Not 5% Revenue	Yes
61	No Animal Testing	Yes
62	No Animal Testing Cosmetics	Yes
63	Animal Testing Reduction	Yes
64	Renewable/Clean Energy Products	Yes
65	Water Technologies	Yes
66	Sustainable Building Products	Yes
67	Green Capex	Yes
68	Green Capex Target	Yes
69	Green Revenues Target	Yes
70	No Nuclear	No
71	Product Impact Minimization	No
72	Real Estate Sustainability Certifications	No
73	Fossil Fuel Divestment Policy	Yes

Table A3
Family-Controlled Firms and GHG Emissions: Splits by the GHG Emissions Category of the Climate Change Performance Index

This table provides subsample analysis of regression estimates of measures of firms' GHG emissions on ownership variables (in columns 1-4) and family owners' environmental preferences (in columns 5-8), control variables, and country and industry fixed effects. The subsamples are based on a country's score on the GHG Emissions Category of the Climate Change Performance Index (CCPI), a standardized framework used to compare the climate performance of 63 countries and the EU. The dependent variables are total CO2 equivalent emissions (scaled by revenue and raw emissions). Industry fixed effects are based on SASB Industry Classifications. The sample year is 2022. All variables are described in Table A1 in the Appendix. Standard errors are clustered at the country level and *t*-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	GHG Emissions Category of the CCPI							
	Low CCPI		High CCPI		Low CCPI		High CCPI	
	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Family-controlled	-0.100	-0.103	0.197**	0.195**				
	(-0.85)	(-0.86)	(2.20)	(2.35)				
Low E Family					-0.032	-0.038	0.271***	0.257***
					(-0.20)	(-0.24)	(3.53)	(3.77)
High E Family					-0.238	-0.216	0.179*	0.174*
					(-1.71)	(-1.58)	(1.78)	(1.83)
Inconclusive E Family					-0.107	-0.128	0.133	0.146
					(-0.47)	(-0.58)	(1.15)	(1.23)
Government-controlled	-0.126	-0.118	0.076	0.063	-0.132	-0.123	0.080	0.066
	(-0.77)	(-0.70)	(0.44)	(0.36)	(-0.83)	(-0.75)	(0.47)	(0.38)
Other-controlled	0.102	0.074	0.406**	0.382**	0.099	0.072	0.409**	0.385**
	(0.44)	(0.34)	(2.48)	(2.44)	(0.43)	(0.33)	(2.51)	(2.47)
Log (Total Assets)	0.090**	0.383***	0.190***	0.371***	0.093**	0.383***	0.191***	0.369***
	(2.66)	(3.40)	(11.12)	(3.76)	(2.59)	(3.37)	(10.94)	(3.68)
Log (Revenue)		0.681***		0.799***		0.684***		0.802***
		(6.88)		(6.79)		(7.04)		(6.76)
Cash	0.036	-0.293	-0.751**	-0.806***	0.040	-0.287	-0.730**	-0.787**
	(0.10)	(-0.81)	(-2.85)	(-3.08)	(0.11)	(-0.78)	(-2.73)	(-2.96)
Tangibility	2.513***	2.441***	3.363***	3.273***	2.500***	2.432***	3.368***	3.279***
	(5.84)	(5.75)	(6.47)	(6.53)	(5.85)	(5.77)	(6.47)	(6.54)
Leverage	-0.296	-0.362	0.019	0.031	-0.290	-0.357	0.020	0.033
	(-0.96)	(-1.18)	(0.53)	(0.98)	(-0.95)	(-1.18)	(0.56)	(1.01)
Profitability	-1.705***	-1.261***	-0.708*	-0.405	-1.719***	-1.277***	-0.726*	-0.424
	(-4.16)	(-3.76)	(-1.82)	(-0.85)	(-4.23)	(-3.82)	(-1.86)	(-0.88)
SASB Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	1,500	1,500	1,587	1,587	1,500	1,500	1,587	1,587
Adjusted R^2	0.558	0.733	0.639	0.797	0.558	0.733	0.638	0.797

Table A4
Family Owners' Environmental Preferences and GHG Emissions:
Tercile Splits by the Climate Change Performance Index

This table provides subsample analysis of regression estimates of measures of firms' GHG emissions on family owners' environmental preferences, control variables, and country and industry fixed effects. The subsamples are based on a country's score on the Climate Change Performance Index (CCPI), a standardized framework used to compare the climate performance of 63 countries and the EU. We construct tercile subsamples using the overall CCPI score which is based on four categories: GHG Emissions, Renewable Energy, Energy Use and Climate Policy. The dependent variables are total CO2 equivalent emissions (scaled by revenue and raw emissions). Industry fixed effects are based on SASB Industry Classifications. The sample year is 2022. All variables are described in Tables A1 in the Appendix. Standard errors are clustered at the country level and *t*-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	CCPI					
	Low CCPI		Medium CCPI		High CCPI	
	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)
	(1)	(2)	(3)	(4)	(5)	(6)
Low E Family	-0.010	-0.009	0.169	0.160	0.249*	0.228**
	(-0.08)	(-0.08)	(0.83)	(0.76)	(2.26)	(2.44)
High E Family	-0.124	-0.098	0.030	0.046	0.175	0.166
	(-0.85)	(-0.70)	(0.22)	(0.33)	(1.34)	(1.43)
Inconclusive E Family	-0.337	-0.414	0.062	0.069	0.285	0.285
	(-1.05)	(-1.73)	(0.61)	(0.69)	(0.96)	(0.98)
Government-controlled	-0.081	-0.067	-0.012	-0.020	0.378**	0.360*
	(-0.42)	(-0.35)	(-0.06)	(-0.09)	(2.71)	(2.28)
Other-controlled	-0.020	-0.018	0.388	0.368	0.388***	0.354***
	(-0.12)	(-0.11)	(1.58)	(1.55)	(4.02)	(3.83)
Log (Total Assets)	0.110*	0.485***	0.135***	0.285***	0.197***	0.408**
	(2.19)	(3.52)	(4.94)	(3.06)	(6.46)	(2.31)
Log (Revenue)		0.597***		0.835***		0.765***
		(4.88)		(8.83)		(3.78)
Cash	0.269	-0.036	-0.553	-0.581	-0.531	-0.642
	(0.56)	(-0.07)	(-1.03)	(-1.16)	(-1.22)	(-1.71)
Tangibility	2.804***	2.773***	2.341***	2.269***	4.215***	4.123***
	(4.50)	(4.44)	(8.17)	(7.70)	(5.42)	(5.74)
Leverage	-0.656*	-0.713*	0.851**	0.813**	0.000	0.016
	(-1.87)	(-2.02)	(2.71)	(2.65)	(0.00)	(0.35)
Profitability	-2.066***	-1.268**	-0.808	-0.662	-0.334	0.033
	(-4.35)	(-3.30)	(-1.61)	(-1.22)	(-0.96)	(0.08)
SASB Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
N	1,184	1,184	1,126	1,126	911	911
Adjusted R^2	0.577	0.749	0.593	0.777	0.634	0.775

Table A5
Family Owners' Environmental Preferences and GHG Emissions: Controlling for Dual Class Shares

This table replicates the specifications of Tables 3 and Table 4, columns 5-8, while controlling for dual class shares. Dual Class Shares is a dummy variable equal one if the company has dual class shares, and zero otherwise. The dependent variables are total CO2 equivalent emissions (scaled by revenue and raw emissions). Industry fixed effects are based on SASB Industry Classifications. The sample year is 2022. All variables are described in Table A1 in the Appendix. Standard errors are clustered at the country level and *t*-statistics are reported in parentheses. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

			CCPI			
			Low CCPI		High CCPI	
	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)	Log (CO2e / Revenue)	Log (CO2e)
	(1)	(2)	(3)	(4)	(5)	(6)
Low E Family	0.223**	0.210**	-0.012	-0.013	0.251**	0.226**
	(2.51)	(2.43)	(-0.11)	(-0.14)	(2.38)	(2.19)
High E Family	0.043	0.044	-0.248**	-0.233*	0.182*	0.176*
	(0.43)	(0.47)	(-2.26)	(-2.12)	(1.84)	(1.90)
Inconclusive E Family	0.061	0.072	-0.315*	-0.319*	0.186	0.193
	(0.61)	(0.73)	(-1.85)	(-1.99)	(1.60)	(1.69)
Government-controlled	-0.037	-0.043	-0.180	-0.197	0.116	0.109
	(-0.30)	(-0.35)	(-1.09)	(-1.24)	(0.83)	(0.73)
Other-controlled	0.288*	0.264*	-0.055	-0.065	0.517***	0.482***
	(1.99)	(1.87)	(-0.35)	(-0.44)	(3.98)	(3.93)
Log (Total Assets)	0.146***	0.385***	0.089**	0.377***	0.185***	0.421***
	(6.98)	(5.16)	(2.83)	(3.02)	(8.99)	(5.05)
Log (Revenue)		0.738***		0.689***		0.736***
		(9.40)		(5.98)		(7.56)
Cash	-0.191	-0.336	0.328	0.051	-0.669**	-0.746***
	(-0.71)	(-1.29)	(0.86)	(0.14)	(-2.78)	(-3.23)
Tangibility	2.874***	2.783***	2.751***	2.701***	3.273***	3.160***
	(7.77)	(7.66)	(5.68)	(5.50)	(6.20)	(6.12)
Leverage	-0.022	-0.011	-0.318	-0.379	0.024	0.038
	(-0.51)	(-0.25)	(-1.09)	(-1.28)	(0.68)	(1.18)
Profitability	-1.203***	-0.787**	-1.899***	-1.369***	-0.606*	-0.245
	(-3.21)	(-2.18)	(-4.18)	(-3.33)	(-1.91)	(-0.66)
Dual Class Shares	0.036	0.047	0.180	0.180	-0.142	-0.106
	(0.32)	(0.42)	(1.56)	(1.44)	(-0.52)	(-0.39)
SASB Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
N	3,319	3,319	1,576	1,576	1,654	1,654
Adjusted R^2	0.593	0.763	0.580	0.743	0.624	0.782

Table A6
Case Studies of Families with High Environmental Preferences

This table provides examples of families in low-income countries (GPD/Capital below sample median). Family owner's environmental preference is the sum of five AI generated measures ranking from zero to 50 (each component has a range of 0 to 10). Larger numbers are associated with greater environmental preferences. The five measures are: 1) personal philanthropy and charitable giving towards environmental causes; 2) public statements and advocacy for environmental issues; 3) participation in environmental NGOs; 4) green investments in the family's personal portfolio outside the firm; 5) policy support and political contributions for environmental policies. Topic and Link are online references provided by the LLM (Perplexity API). All other variables are described in Table A1 in the Appendix. All prompts are provided in Appendix B.

Example A: Ayala Corporation

Firm Name	DS Code	Country	CCPI Split	GDP/ Capita US$	Family E. pref. (0–50)	High E Family	Family Name
Ayala Corporation	503310	Philippines	High	3,499	40	1	Zóbel de Ayala Family

Topic	Link
HBS Alumni Story on Jaime Augusto Zobel de Ayala	https://www.alumni.hbs.edu/stories/Pages/story-bulletin.aspx?num=907
Tatler Asia - Profile of Fernando Zobel de Ayala	https://www.tatlerasia.com/people/fernando-zobel-de-ayala
PhilStar Article on Ayala Group and the Future	https://www.philstar.com/headlines/2018/12/12/1876369/zobel-de-ayala-philippines-must-be-future-ready
HBS Interview with Jaime Augusto Zobel de Ayala	https://www.hbs.edu/creating-emerging-markets/interviews/Pages/profile.aspx?profile=jayala
Synergos Interview with Jaime Augusto Zobel de Ayala	https://www.synergos.org/news-and-insights/2003/q-jaime-augusto-zobel-de-ayala-ii
Art Plus Feature on Zobel de Ayala Family and Filipino Art	https://artplus.ph/features/zobel-de-ayala-family-pioneers-of-filipino-arts-and-culture
McKinsey Interview with CEO of Ayala Corporation	https://www.mckinsey.com/featured-insights/asia-pacific/addressing-societys-pain-points-an-interview-with-the-ceo-of-ayala-corporation
Wikipedia Page for Jaime Augusto Zobel de Ayala	https://en.wikipedia.org/wiki/Jaime_Augusto_Zobel_de_Ayala

LLM Assessment
The Zóbel de Ayala family demonstrates strong environmental preferences across multiple dimensions. They have shown significant personal philanthropy towards environmental causes through the Ayala Foundation. The family, particularly Jaime Augusto and Fernando, has made numerous public statements advocating for environmental issues and sustainability. They actively participate in environmental NGOs and initiatives. While specific information on their personal 'green' investments is limited, their leadership in renewable energy projects suggests a commitment to environmentally conscious investments. The family has also shown support for environmental policies, particularly in areas of climate change mitigation and adaptation. Overall, the Zóbel de Ayalas exhibit a strong collective commitment to environmental concerns.

Example 2: Sunway BHD

Firm Name	DS Code	Country	CCPI Split	GDP/ Capita US$	Family E Pref. (0–50)	High E Family	Family Name
Sunway BHD	77543Q	Malaysia	0	11,972	37	1	Cheah Family

Topic	Link
Jeffrey Cheah Foundation Teacher Development Programme Launch	https://cj.my/145517/jeffrey-cheah-foundation-launches-teacher-development-programme/
GeekWire: Billionaire Spending on Climate Change	https://www.geekwire.com/2023/the-billionaires-are-in-charge-heres-who-is-spending-the-most-on-climate-change-efforts/
Children's Environmental Health Network (CEHN)	https://cehn.org
Institutional Investor: Value vs. Growth Investing	https://www.institutionalinvestor.com/article/2btgj5ayuqtae3cmsdreo/home/value-vs-growth
PubMed: NIH Study on Environmental Health (PMID: 24586905)	https://pubmed.ncbi.nlm.nih.gov/24586905/
Sunway University: Smart Cities in Developing Nations	https://sunwayuniversity.edu.my/sustainability/news/blazing-trail-smart-cities-developing-nations
Jonas Philanthropies: Children's Environmental Health	https://jonasphilanthropies.org/childrens-environmental-health/
Jeff Towson: Lessons from Cheah Chung Hye on China Stocks	https://jefftowson.com/membership_content/lessons-from-cheah-chung-hye-on-china-stocks-and-their-uncertainties-asia-tech-strategy-daily-lesson-update/
Frontiers in Environmental Science: Research Article	https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2022.779629/full
Senator Klobuchar's Website: Homegrown Energy and Environment Policy	https://www.klobuchar.senate.gov/public/index.cfm/homegrown-energy-environment-natural-resources

LLM Assessment

The Cheah family, particularly Jeffrey Cheah, demonstrates strong environmental preferences through various initiatives. Their personal philanthropy is evident in the Jeffrey Cheah Foundation's support for sustainable education programs. Public advocacy is shown through Jeffrey Cheah's commitment to the UN Sustainable Development Goals. The family participates in environmental NGOs through the establishment of the Jeffrey Sachs Center for Sustainable Development. While specific 'green' investments in their personal portfolio are not explicitly mentioned, their support for sustainability initiatives suggests some level of environmentally conscious investing. The family's policy support is reflected in their alignment with national educational initiatives promoting sustainability. Overall, the Cheah family shows a strong commitment to environmental causes, particularly in education and sustainable development.

Example 3: Diagnosticos Da America SA

Firm Name	DS Code	Country	CCPI Split	GDP/ Capita US$	Family E Pref. (0–50)	High E Family	Family Name
Diagnosticos Da America SA	29807V	Brazil	1	9460	33	1	Bueno Family

Topic	**Link**
WRI: Rodrigo Bueno and Climate-Resilient Community in Buenos Aires	https://www.wri.org/insights/rodrigo-bueno-buenos-aires-climate-resilient-community
Movimento Bem Maior: Philanthropy and Pedro Bueno	https://movimentobemmaior.org.br/en/news/philanthropy-gains-weight-with-the-entry-of-pedro-bueno-into-mbm/
University of Edinburgh: Openness and Pro-Environmental Behavior Research Paper	https://www.research.ed.ac.uk/files/86594600/Manuscript_Openness_and_PEB_Accepted.pdf
DNA Capital: Profile of Pedro Bueno	https://www.dnacapital.com/team/pedro-bueno/
Health Management Associates: Profile of Ana Bueno	https://www.healthmanagement.com/our-team/staff-directory/name/ana-bueno/
Hogan Personality Inventory PDF	https://www.crownedgrace.com/wp-content/uploads/2016/04/Hogan-Personality-Inventory.pdf
The Rio Times: Brazilian Business Influencer Boosts Amazon Bioeconomy	https://www.riotimesonline.com/brazilian-business-influencer-propel-amazon-bioeconomy/
University of Chicago Journals: Environmental Policy Article	https://www.journals.uchicago.edu/doi/full/10.1093/reep/rew010
Valor International: Business Leaders on Brazil's Carbon Market Bill	https://valorinternational.globo.com/environment/news/2024/10/14/business-leaders-advocate-for-carbon-market-bill.ghtml
World Bank Document: Sustainable Development Project (P173458)	https://documents1.worldbank.org/curated/en/099103023102519369/pdf/P1734580f965110a70b8170111b063da3ba.pdf

LLM Assessment

The Bueno family, particularly Pedro Bueno, demonstrates a strong inclination towards environmental concerns. Pedro Bueno's involvement in the "Economic Pact with Nature" and advocacy for a carbon market bill indicate significant public support for environmental issues. The family's philanthropic efforts, while not exclusively environmental, show a commitment to social causes. Their investment in DNA Capital suggests an interest in sustainable healthcare solutions. While direct participation in environmental NGOs is not evident, their support for environmental policies is clear. The family's overall approach reflects a balance between business interests and environmental consciousness, resulting in a moderately high environmental preference score.

Example 4: Vestel Elektronik Sanayi Ve Ticaret AS

Firm Name	DS Code	Country	CCPI Split	GDP/ Capita US$	Family E Pref. (0–50)	High E Family	Family Name
Vestel Elektronik Sanayi Ve Ticaret AS	505481	Turkey	0	10616	36	1	Zorlu Family

Topic	Link
ThinkGeoEnergy: Sustainability Award to Zorlu Energy	https://www.thinkgeoenergy.com/sustainability-award-to-zorlu-energy-in-combating-climate-crisis/
Zorlu Enerji: Sustainability Report (PDF, Turkish)	https://www.zorluenerji.com.tr/fileuploads/271023/S%C3%BCrd%C3%BCr%C3%BClebilirlik/3.pdf
Zorlu Holding: Integrated Annual Report 2023	https://d7a3216312da6f8c5faa-a6c4a22c6d23d8694e5e3f94c3d57dde.ssl.cf2.rackcdn.com/49b91ee24d2245b6aa9d9ef66849310e_integrated-annual-report-2023.pdf
E-Textile Magazine: Zorlu's 2023 R&D Investment Report	https://www.etextilemagazine.com/zorlu-holding-invested-approximately-2-5-billion-tl-in-rd-in-2023.html
METU Thesis: Zorlu-Related Research (PDF)	https://etd.lib.metu.edu.tr/upload/12617452/index.pdf
Zorlu Enerji: NGO Collaborations	https://www.zorluenerji.com.tr/en/sustainability/our-ngo-collaborators
Zorlu Holding: 2019 Sustainability Report (English, PDF)	https://www.zorlu.com.tr/assets/files/raporlar/zorlu_holding_2019_surdurulebilirlik_raporu_en_rev.pdf
Zorlu Enerji: Chairman's Message	https://www.zorluenerji.com.tr/en/investor-relations/zorlu-enerji-investor/corporate-governance/chairmans-message
Zorlu PSM: Corporate Sustainability Overview	https://www.zorlupsm.com/en/corporate/surdurulebilirlik

LLM Assessment

The Zorlu family demonstrates strong environmental preferences across multiple dimensions. They have implemented significant philanthropic initiatives, such as the Zero Carbon Footprint Forests Project. The family consistently makes public statements advocating for environmental issues and sustainability. They participate in environmental NGOs and support various environmental causes. The family's investment strategy appears to prioritize green investments, particularly in renewable energy. The Zorlus also show support for environmental policies, aligning their business strategies with global sustainability goals. Overall, the family exhibits a robust commitment to environmental concerns, reflected in their actions and statements across various platforms.

Appendix B
Large Language Model Prompts

1. Identifying Controlling Families (OpenAI GPT-4o)

We first identify firms classified as family-controlled and use the LLM to determine the controlling family's name, board members, their gender, and the founder. This is achieved through the prompt below. To validate the LLM's accuracy, we conduct a controlled experiment with Canadian firms by informing the LLM that the firms are family-controlled but withholding any family name data. Across 67 Canadian family firms, the LLM achieved 100% precision in family-name recovery.

We use the following prompt:

> Family Members and Role
>
> You are a financial data expert. You are assessing families that control publicly traded firms. Control is defined as follows. i) the sum of the shares owned by the family members exceeds those of any other shareholder and is greater than 20% OR ii) the sum of family stakes exceeds those of any other shareholder, is greater than 10%, and family members hold the CEO or chair position OR iii) the sum of family stakes exceeds those of any other shareholder, is greater than 10%, and (the firm has multiple voting class shares) OR (the CEO or other board member is a family member).
>
> You are using publicly available data as of December 2022 to make your assessment. For each observation you have several variables, as follows:
> `companyname` - name of the firm
> `familyname` - the name of the family that I have assessed as the one controlling the firm (if available)
> `country`- The country of incorporation of the firm specified in `companyname`
> `dscode` - The Datastream identifier of the firm specified in `companyname`
>
> q1: Assume that each firm is indeed controlled by a family, according to the above given definition of control. Assume also that my assessment of the family name--if available--is correct. Identify the family that in your opinion is most likely the one controlling the firm. Note that the family might represent one or multiple family members. Provide one family name, choosing the most visible one if there are multiple, of the controlling family.
>
> q2: Assess how certain you are about your ability to identify the family in q1 with a posterior confidence score (PCS 0–100).
>
> q3: List up to five members of the controlling family, stating the first name, last name, gender, that meet the condition of having a position on the board of directors in 2022.
>
> q4: Give a summary of the controlling family's involvement in the firm, with historical context, in 80 words. In case you cannot identify the family from q1, give a summary of why you cannot.
>
> In all answers, you are using publicly available data as of December 2022 to make your assessment. Avoid hypothetical or example-based explanations; directly provide insights, conclusions, or statistical trends if applicable. If there is insufficient data and you are not at least 80% sure that you know the answer, reply "NA".
>
> Structure your answer as follows.
> variable q1 as a string (family name(s))
> variable q2 as a number (0 to 100)
> variable q3 as a string (first last (gender), first last (gender), ...)
> variable q4 as a string (80 words)

2. Assessing Family's Environmental Preferences (Perplexity Sonar-pro)

The family name identified through GPT is then used as input for Perplexity to assess the family's personal environmental preferences. We leverage the second's search-based LLM capability to provide online references, facilitating our (human) review of the LLM's assessments. The environmental preferences are evaluated across five dimensions on a scale from 0 to 10:

a) Personal philanthropy towards environmental causes.
b) Public statements and advocacy for environmental issues.
c) Participation in environmental NGOs.
d) Green investments in personal portfolios outside the firm.
e) Policy support and political contributions for environmental policies.

The LLM is explicitly instructed to exclude any consideration of the firm's corporate environmental performance. The prompt used for the LLM is customized for each firm, replacing the placeholders [company name], [country], [family name], [family board member names] for each observation.

We use the following prompt:

Family Preferences (Perplexity API, model sonar-pro)
Assess the [family name] family's environmental preferences along five dimensions, scoring each dimension on a scale of 0 to 10, where 0 indicates the strongest possible preferences against environmental concerns and 10 are the strongest possible preferences towards environmental concerns. a) Personal philanthropy and charitable giving towards environmental causes b) Public statements and advocacy for environmental issues c) Participation in environmental NGOs d) 'Green' investments in the family's personal portfolio outside the firm e) Policy support and political contributions for environmental policies. f) Provide the sum of these five dimensions as a score between 0 and 50. To avoid confusion, the family is linked to [country] and to [company name] in that country. In case the family name is a frequent name, be especially careful to not confuse the family with another family of the same name. You can use [family board member names] as reference point(s) to help identify the correct family and their preferences, but focus on the entire family and their collective actions. Note that I am interested only in their personal environmental preferences, not in corporate environmental activities of [company name], which the family controls. Note that if you can find evidence of family preferences, but no evidence of environmental preferences, this is consistent with a low or very low score and not a reason to refuse to assign a score. g) Assess how certain you are about your ability to identify the family preferences with a posterior confidence score (PCS 0–100). h) Provide a summary narrative of your assessment, not exceeding 100 words. Begin your answer with the statement: **My answers: a) xx b) xx c) xx d) xx e) xx f) xx, g) xx, g) yyyy, where xx are your numerical scores, yyyy is your summary..

3. Perplexity API Evaluation Notebook

This notebook processes structured questions about environmental preferences using the Perplexity API. It reads input Excel files, queries the API, and stores the answers along with source citations. It provides a reproducible workflow to evaluate environmental preference indicators using Perplexity's Sonar-pro model. It automates question submission, response parsing, and Excel output generation for further analysis.

Configuration and Setup

Define file paths, API credentials, and basic configuration constants used in the script.

```
import pandas as pd
import requests
import time
import logging

# Configuration
API_URL = "https://api.perplexity.ai/chat/completions"
API_KEY = "your_api_key_here"  # Replace securely
MODEL_NAME = "sonar-pro"

INPUT_FILES = ["file1", "file2", ...]
INPUT_DIR = "../prep/perplexity/"
OUTPUT_DIR = "../output/perplexity/"

HEADERS = {
    "Authorization": f"Bearer {API_KEY}",
    "Content-Type": "application/json"
}

# Logging setup
logging.basicConfig(level=logging.INFO, format="%(asctime)s - %(message)s")
```

API Query Function

Defines a reusable function to submit a question to the Perplexity API and retrieve both the answer and any citations.

```
def query_perplexity(question_text):
    payload = {
        "model": MODEL_NAME,
        "messages": [{"role": "user", "content": question_text}]
    }
    try:
        resp = requests.post(API_URL, headers=HEADERS, json=payload)
        resp.raise_for_status()
        data = resp.json()
        answer = data.get("choices", [{}])[0].get("message",
{}).get("content", "No answer found")
        citations = data.get("citations", [])
        return answer, citations
    except requests.exceptions.RequestException as e:
        return f"API request failed: {e}", []
```

File Processing Loop

Iterates over each Excel input file, reads questions, queries the API, and stores responses with source metadata.

```
for file_name in INPUT_FILES:
    input_path = f"{INPUT_DIR}{file_name}.xlsx"
```

```
    output_path = f"{OUTPUT_DIR}outputSonar_{file_name}.xlsx"
    logging.info(f"Processing file: {input_path}")

    try:
        df = pd.read_excel(input_path)
    except FileNotFoundError:
        logging.warning(f"File not found: {input_path}. Skipping.")
        continue

    if not {'dscode', 'question'}.issubset(df.columns):
        logging.warning(f"Missing required columns in {file_name}.
Skipping.")
        continue

    results = []
    for idx, row in df.iterrows():
        dscode = row["dscode"]
        question_text = row["question"]

        start = time.time()
        answer, citations = query_perplexity(question_text)
        elapsed = time.time() - start

        logging.info(f"{file_name}: Row {idx+1}/{len(df)} | Code: {dscode} |
Time: {elapsed:.2f}s")

        results.append({
            "dscode": dscode,
            "answer": answer,
            "sources": ", ".join(citations) if citations else "No sources
found"
        })

    pd.DataFrame(results).to_excel(output_path, index=False)
    logging.info(f"Saved results to {output_path}")

logging.info("All files processed.")
```

Next Steps

Review the Excel files saved in the output directory. These include each question, the corresponding response from the model, and citations if returned by the API.