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The Big Three and Corporate Carbon Emissions Around the World

Autores:

José Azar
IESE Business School & C.E.P.R.

Miguel Duro
IESE Business School

Igor Kadach
IESE Business School

Gaizka Ormazabal*
IESE Business School, C.E.P.R. & E.C.G.I

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José Azar
IESE Business School & C.E.P.R.
Miguel Duro
IESE Business School
Igor Kadach
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Gaizka Ormazabal*
IESE Business School, C.E.P.R. & E.C.G.I

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The Big Three and Corporate Carbon Emissions Around the World

ABSTRACT

This paper examines the role of the "Big Three" (i.e., BlackRock, Vanguard, and State Street Global Advisors) on the reduction of corporate carbon emissions around the world. Using novel data on engagements of the Big Three with individual firms we find evidence that the Big Three focus their engagement effort on large firms with high CO2 emissions in which these investors hold a significant stake. Consistent with this engagement influence being effective, we observe a strong and robust negative association between Big Three ownership and subsequent carbon emissions among MSCI index constituents, a pattern that becomes strong in the later years of the sample period. Additional tests exploiting several sources of plausibly exogenous variation in Big Three ownership and in the cost of CO2 emissions suggest that these correlations probably reflect a causal link.

Keywords: Carbon emissions, Big Three, Shareholder Activism, Institutional Ownership.

JEL Classifications: M41

1. INTRODUCTION

This paper studies the role of the "Big Three" (i.e., BlackRock, Vanguard, and State Street Global Advisors) on the reduction of carbon emissions around the world.[1] In recent years, there has been an increasing popular demand that these large investors pressure the companies in their portfolios to curb their greenhouse gas (GHG) emissions, and the leaders of the Big Three have made public statements about their intention to do so.[2] However, whether the effort of the Big Three to reduce corporate carbon emissions is meaningful and/or effective remains an open empirical question.

We study actual CO_2 emissions rather than environmental scores to measure the ultimate objective of environmental efforts more directly. This is important considering current concerns about "greenwashing" (i.e., "window dressing" actions that improve environmental scores but have little real impact on the reduction of actual emissions).[3]

Our analysis focuses on the Big Three to shed light on the recent debate about the role of these investors in the economy (Bebchuk and Hirst 2019b; Coates 2019; Fisch, Hamdani, and Solomon 2019). The current interest in the Big Three responds to the unique combination of characteristics of these investors. The first of these characteristics is their size; they manage an enormous (and growing) amount of investments.

[1] BlackRock, Vanguard, and State Street have important differences in terms of business model and strategy (among other things). However, in economic discussions they are often pooled together based on two important common characteristics: i) BlackRock, Vanguard, and State Street are by far the largest institutional investors in terms of assets under management (AUM), and ii) a large percentage of the investment vehicles sponsored by these asset managers are passively managed funds.

[2] BlackRock's Vice-Chairman Phillip Hildebrand and Global Head of Impact Investing Deborah Winshell stated in a report by the asset manager that "[i]nvestors can no longer ignore climate change. Some may question the science behind it, but all are faced with a swelling tide of climate-related regulations and technological disruption." (BlackRock, 2016). More recently, BlackRock CEO Larry Fink, in his 2020 annual letter, addressed CEOs and their companies stating that "[A]wareness is rapidly changing, and I believe we are on the edge of a fundamental reshaping of finance (…) Indeed, climate change is almost invariably the top issue that clients around the world raise with BlackRock. (…) In the near future – and sooner than most anticipate – there will be a significant reallocation of capital" (https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter).

[3] This concern is illustrated by the following quote by the founder of KLD Research, Lydenberg (2002): "[a]lthough an increasing number of corporations publish environmental and health and safety reports, many are simply token efforts—"greenwashing"—and few address the full range of social issues necessary to assess adequately a corporation's behavior."

While widely diversified, the large monetary value of the pool of assets managed by the Big Three often results in large stakes in their portfolio firms, which makes them likely pivotal voters.[4] This gives the Big Three an influential role and facilitates their engagement with portfolio companies (Fichtner, Heemskerk, and Garcia-Bernardo 2017; Fisch et al. 2019).

The second distinctive characteristic of the Big Three is that a large part of the investment vehicles the Big Three sponsor are passively-managed funds (indexed funds and ETFs). While passive investors have relatively weak incentives to monitor firm-specific issues (e.g., Bebchuk and Hirst 2019a), recent research suggests that passive investors' incentives are stronger when it comes to cross-cutting issues such as sustainability and certain aspects of corporate governance that do not require a significant investment in monitoring (see Online Appendix OA for a detailed discussion).

Beyond possible altruistic reasons, the Big Three could have several economic incentives to engage with firms on environmental issues. One potential motivation is that these large investors believe that reducing CO_2 emissions increases the value of their portfolio. As suggested by survey evidence (Krueger, Sautner, and Starks 2019), a non-trivial number of institutional investors believe that climate risks have financial implications for their portfolio firms and that the risks have already begun to materialize, particularly regulatory risks. The validity of this concern is supported by recent empirical research on the pricing implications of climate risk.[5]

[4] Bebchuk and Hirst (2019b) document that the Big Three have almost quadrupled their collective ownership stake in S&P 500 companies over the past two decades, that they have captured the overwhelming majority of the inflows into the asset management industry over the past decade, that each of them now manages 5% or more of the shares in a vast number of public companies, and that they collectively cast an average of about 25% of the votes at S&P 500 companies.

[5] Recent literature in finance highlights the importance of climate risks for institutional investors. First, some papers provide evidence that environmental policies lower downside risk (Hoepner et al., 2019; Gibson- Brandon and Krueger, 2018). Second, institutional investors can reduce overall portfolio risk by incorporating climate criteria into their investment processes (Jagannathan, Ravikumar, and Sammon, 2018). Modern asset pricing models emphasize climate risks as a long- run risk factor (Bansal, Ochoa, and Kiku, 2017) and the importance of environmental pollution in the cross- section of stock returns (Bolton and Kacperczyk, 2019; Hsu, Li, and Tsou, 2019). Archival literature corroborates these conclusions by showing that extreme weather is reflected in stock and option market prices (Kruttli, Tran, and Watugala 2019). At the firm level, Addoum, Ng, and Ortiz-Bobea (2019) show that extreme temperatures affect firm performance; Chava (2014) and El Ghoul et al. (2018) show that firms can lower their cost of capital and increase value by improving their environmental policies; Ginglinger and Moreau (2019) show that greater climate risk leads to lower firm leverage.

The Big Three could also push firms to reduce CO_2 emissions to attract or retain clients that are sensitive towards environmental concerns. This alternative motivation is supported by prior literature (e.g., Ariely, Bracha, and Meier 2009), which argues that pro-social behavior has several sources: (i) altruism, (ii) direct financial incentives, (iii) building social image (Lacetera and Macis 2010), and (iv) social pressure (DellaVigna, List, and Malmendier 2012). Given the recent proliferation of socially responsible investing, being perceived as environmentally conscious could play an increasingly important role for the Big Three when competing to attract investors' money.

To empirically analyze the effect of the Big Three on corporate carbon emissions around the world, we use two novel datasets. We collect carbon emission data for a wide cross-section of firms between 2005 and 2018. We complement these data with information on Big Three engagements with individual firms, which we hand-collect from recent public disclosures of these fund sponsors. Our data indicates that, on average, these large funds engage annually with a number of firms (for example, from 7/1/2018 to 6/30/2019 BlackRock held personal meetings with directors and executives of 1,458 firms). When we explore the determinants of the probability of observing such engagements, we find corroborating evidence that firms with higher CO_2 emissions are more likely to be the target of Big Three engagements. We also find that the Big Three focus their engagements on large firms (i.e., firms with a potentially larger effect on global carbon emissions) and on firms in which these large investors have a more substantial stake (i.e., firms in which the Big Three are more influential).

Next, we explore whether Big Three engagements are effective in reducing CO_2 emissions. We start by testing whether there is an association between Big Three ownership in a given firm and that firm's CO_2 emissions. We find a negative and significant association. Consistent with an increasing popular demand that these large investors pressure the companies in their portfolios to curb emissions, the pattern is stronger in the later years of the sample.

To sharpen identification, we exploit two sources of exogenous variation in Big Three ownership. First, we exploit the yearly reconstitution of the indexes Russell 1000 and Russell 2000. For companies that are around the 1000/2000 cutoff, the final assignment to the index is relatively random, and the inclusion in the Russell 2000 index likely increases Big Three ownership (a number of funds sponsored by the Big Three track the Russell indexes). We exploit a second source of exogenous variation in Big

Three ownership, namely the global trend in index investing (which we use as instrumental variable following Bartik (1991)'s approach).[6] The results from these two additional tests are consistent with the association between Big Three ownership and carbon emissions, reflecting a causal link.

To further corroborate that our main results are indeed related to the incentives of the Big Three to reduce emissions, we also explore whether the association between Big Three ownership and future emissions is stronger when these emissions are likely to introduce higher costs in the portfolio of index investors. Consistent with our hypothesis, we find that the results are stronger in countries where the population is more sensitive to environmental issues and in periods when the stock market assigns a higher valuation to firms emitting less CO_2.

To reconcile our findings with those of prior work on the role of institutional investors on firms' environmental performance, we analyze whether better environmental scores are associated with lower carbon emissions. Consistent with "greenwashing" concerns, we find that companies with better environmental scores do not exhibit lower carbon emissions. If anything, these scores are positively (rather than negatively) correlated with current and future carbon emissions. This evidence highlights the importance of using actual carbon emissions to assess the effect of shareholder activism on environmental performance.[7]

Our paper contributes to the burgeoning literature on climate risk. One strand of this literature studies the effect of climate risk on firm value. For example, Bansal et al. (2017) study climate risk as a long-run risk factor and Bolton and Kacperczyk (2019) and Hsu et al. (2019) study climate risk in the cross-section of stock returns. In contrast with the view that this environmental concern is too remote and uncertain

6 See Coates (2019) for an analysis of the factors driving the recent rise of index investing in the economy.

7 These results are consistent with recent research by Diebecker, Rose, and Sommer (2019) documenting a weak correlation among sustainability measures developed by different vendors. These measures are also often questioned by commentators and regulators, as illustrated by the SEC Commissioner Hester M. Pierce's recent speech on June 2019: "…There is, for example, a growing group of self-identified ESG experts that produce ESG ratings. …The ambiguity and breadth of ESG allows ESG experts great latitude to impose their own judgments, which may be rooted in nothing at all other than their own preferences... Putting aside the analysis that produces the final score, some ESG scores are grounded in inaccurate information." (http://clsbluesky.law.columbia.edu/2019/06/24/sec-commissioner-peirce-talks-flaws-in-scoring-companies-on-environmental-social-and-governance-factors/).

to have a meaningful economic effect, this literature generally finds substantial price and real effects of climate risk. That said, these papers also find evidence of mispricing and behavioral responses to environmental concerns.

Other recent studies examine whether and how institutions react to climate risk. Some of these papers provide empirical evidence that investors take into account climate risk considerations in their investment portfolio decisions (e.g., Hoepner et al. 2019; Gibson-Brandon and Krueger 2018).[8] However, the evidence on how institutional investors engage with their portfolio companies on climate-risk matters is relatively scant. The available evidence is limited to studies using data from a single fund (Dimson, Karakas, and Li 2015; 2018) and survey data (e.g., McCahery, Sautner, and Starks 2016; Krueger et al. 2019). Similar to our paper, Dyck et al. (2019) use a wide international sample of firms and find a positive association between institutional ownership and corporate environmental scores (measured by ASSET4 E&G scores). Our study differs from this literature in that we analyze the role of the Big Three (rather than that of institutional ownership in general) on CO_2 emissions (rather than on environmental scores).[9] These are important distinctions; the Big Three have unique characteristics and play an important –yet controversial– role in the economy, and environmental scores could reflect "greenwashing" rather than actual environmental improvements.

This paper also adds to the nascent literature on large indexers. The spectacular growth of the volume of assets of these institutions in recent years has spurred a debate on the role of the Big Three in the economy (e.g., Bebchuk and Hirst 2019b; Coates 2019; Fisch et al. 2019). While acknowledging the advantages of index fund investing in terms of diversification and lower management fees, recent academic work has raised some concerns about the Big Three, including anti-competitive effects and

8 Hoepner et al., (2019) and Gibson- Brandon and Krueger (2018) show that better environmental policies are related to lower downside and overall portfolio risk. In a similar spirit, Jagannathan et al. (2018) show that investors can reduce portfolio risk by incorporating climate criteria into their investment processes and Ramelli et al. (2018) provide evidence that investors react to political events related to firms' climate strategies.

9 Two other recent papers empirically analyze the Big Three. Bebchuk and Hirst (2019b) provide descriptive evidence of the growth of these institutions during recent years. Fichtner et al. (2017) analyze proxy vote records and find that the Big Three utilize coordinated voting strategies, and hence follow a centralized corporate governance strategy, but that they generally vote with management.

concerns related to pricing efficiency and trading behavior.[10] More related to our research question, Bebchuk and Hirst (2019a) argue that index funds underinvest in stewardship and defer excessively to the preferences and positions of corporate managers. We add to this important debate by studying a dimension of high social relevance: the reduction of carbon emissions. This dimension of the debate is not without controversy; for example, the fact that the Big Three have provided relatively little voting support to shareholder proposals related to climate issues is sometimes interpreted as evidence that these investors do not contribute to the global effort to reduce corporate carbon emissions (see Online Appendix OB for a detailed discussion).

The evidence in this paper should also be relevant for those who view GHG emissions as a market failure (IPCC 2007).[11] Since a full-scale regulatory solution to the emissions externality problem faces severe coordination frictions across countries, corporate governance is regarded as an alternative, complementary way of addressing climate change.[12] In particular, large diversified institutions are increasingly viewed as catalysts in driving firms to reduce their carbon emissions (Andersson, Bolton, and Samama 2016; OECD 2017).[13]

The remainder of the paper is organized as follows. In section 2, we develop the hypothesis that the Big Three induce firms to reduce carbon emissions. In section 3, we describe the sample construction and measurement choices. In section 4, we analyze engagements of the Big Three with firms. Results on the association between the Big Three and carbon emissions are discussed in section 5. In section 6, we conduct additional tests. Section 7 contains the conclusions of the paper.

[10] For concerns about anticompetitive behavior, see Azar, Kagy, and Schmalz (2016); Azar, Schmalz and Tecu et al. (2018), and Anton et al. (2018), among others. For concerns about pricing and trading see Coates (2019).

[11] For example, Stern (2008) argues that the externalities caused by GHG emissions represent "the biggest market failure the world has ever seen."

[12] The most common type of regulatory solutions is to put a price on carbon, either through Pigouvian taxes or through a cap-and-trade system (Nordhaus, 1977; Stern, 2008). To implement these regulations at the necessary scale, governments would need to overcome significant political obstacles, due to the fact that climate change is a collective action problem that requires global cooperation (Nordhaus, 2010; Stavins, 2011). Global cooperation is challenging because countries would need to appoint an external party that would determine actions, monitor behavior, and impose sanctions (Ostrom, 2010).

[13] In fact, recent research provides evidence consistent with the presence of such coordination in other settings (e.g., Azar et al., 2018; He and Huang, 2017).

2. HYPOTHESES DEVELOPMENT

2.1. Big Three's incentives to reduce carbon emissions

Corporate externalities such as CO_2 emissions are commonly viewed as societal costs that are caused by corporations but not internalized by firms' shareholders and managers. As a result, under this view shareholders (and managers) would have no incentive to reduce corporate externalities.

However, other considerations suggest that it is plausible that large and diversified asset managers internalize at least some of the costs from CO_2 emissions, and therefore would benefit from a reduction in CO_2 emissions across portfolio firms, at least compared to undiversified investors. Theoretically, this idea is supported by early models showing that diversified shareholders could internalize some externalities from their portfolio companies (e.g., Hansen and Lott 1996; Hartford 1997). These externalities potentially include both direct damages to firm assets from climate change, and more indirect costs such as the risk that concerns about emissions may trigger regulation and social stigma. In the case of the effect of CO_2 emissions on the value of indexers' portfolios, this possibility is supported by recent literature showing that climate change can affect firm valuations (Brinkman, Hoffman, and Oppenheim 2008). This type of risk is especially difficult to hedge for indexers, as these investors hold illiquid and permanent ownership positions as a result of index-tracking. Thus, to the extent that large indexers are long-term holders of a large number of corporate securities and that corporate emissions contribute significantly to climate-related systematic risk, reducing carbon emissions can make large indexers better off.

Recent survey evidence on investors' attitude towards climate risk provides support for the idea that reducing carbon emissions can make investors better off. For example, based on a survey of a large number of investment managers, Krueger et al. (2019) conclude that institutional investors believe climate risks have financial implications for their portfolio firms and that the risks have already begun to materialize.

Even if index managers did not believe that climate risk alone has a substantial impact in portfolio value, the Big Three could push for a reduction of CO_2 emissions to attract or retain clients that are sensitive towards environmental concerns. Lack of response to the social demand that the Big Three play a role in the reduction of carbon emissions could result in outflows from the Big Three to asset managers perceived to be more socially and environmentally responsible. Indeed, recent evidence suggests that investors value sustainability beyond pecuniary motives (e.g., Riedl and Smeets 2017; Hartzmark and Sussman 2019), and that mutual funds compete for climate-conscious investment flows (Ceccarelli, Ramelli, and Wagner 2020).

2.2. How can the influence of the Big Three result in lower CO_2 emissions?

Shareholders usually exert power through three mechanisms; selling (or not buying) the stock, exercising voting rights, and engaging with management and voicing their concerns. While firms know that the probability that a passive fund sponsored by the Big Three sells the stock of the company is relatively small as long as the firm is included in the index tracked by the fund, large indexers could be highly influential on corporate decision-making.[14] This is because these large institutions often hold a substantial percent of the shares of a company and thus are increasingly the pivotal votes in control contests, activist campaigns, and mergers (Coates 2019). Moreover, the support of the Big Three could be important in director elections.[15] To the extent that these situations are relatively common, disregarding requests from index sponsors could be costly for firm managers and directors.

But the Big Three could also exert influence over managers without explicit engagements. By making public statements, the Big Three can communicate their preferences to thousands of portfolio companies without having to engage with each company's management individually. For example, these large investors often send letters

[14] The notion that the Big Three rarely react to corporate policies by selling stock is consistent with these investors' public disclosures. Consider, for example, the following excerpt from BlackRock's 3rd Quarter Earnings Release in 2019: "…Of the assets we manage, 50% are equity assets, and of these, 92% are index and 8% active. The index assets closely track market indexes created by others, which means whether we like a company or not –including its management, its strategy, its products – we will still hold it in these portfolios. This is quite different than actively managed portfolios that can express displeasure by 'voting with their feet' and selling the stock. Given this long-term perspective, our investment stewardship activities are focused on maximizing long-term shareholder value." (see https://ir.blackrock.com/files/doc_news/archive/4a1e3da1-e31d-4295-a0e8-96eed78aeef2.pdf)

[15] While directors usually obtain a large majority of votes, losses in voting support are known to have relevant negative implications for directors' professional standing. For example, research shows that losses in voting support at a firm induce directors to take corrective actions (see Cai, Garner, and Walkling 2009, and Fischer et al. 2009). In particular, top managers and directors could lose investors' voting support if they fail to address environmental concerns. For example, in his 2020 recent letter, Larry Fink, CEO of BlackRock states: "[W]e will be increasingly disposed to vote against management and board directors when companies are not making sufficient progress on sustainability-related disclosures and the business practices and plans underlying them."

to each of the most carbon-intensive companies in their portfolios asking them to disclose climate risks (BlackRock 2018). Managers, who need the voting support of these large investors in key issues, have an incentive to take actions to accommodate the preferences of the Big Three even in the absence of direct engagement. For example, according to Condon (2019), at Exxon's 2017 annual meeting the company's largest shareholder, BlackRock, voted against the re-election of two board members in protest of a "non-engagement" policy that precluded directors from talking to shareholders about the company's strategic response to climate change. Following the vote, Exxon reconsidered its opposition to climate risk disclosure and permitted directors to meet with shareholders going forward.

While reducing carbon emissions is usually costly, firms could curb emissions using relatively efficient and non-disruptive product and process improvements. Examples include rebalancing the mix of products sold based on the carbon emissions, substituting inputs with more recycled materials (for example, Starbucks recently introduced a strawless lid for iced tea), improving logistic operations to reduce transportation emissions, switching energy sources (i.e., moving to renewable sources of energy such as natural gas or wind), implementing CO_2 capture and storage mitigation technologies (for example, Chevron uses such technologies for the emissions they flare when converting the natural gas to LNG), and improving end-user energy efficiency (e.g., building weathering, turn down heating, using LED light bulbs, and reducing unneeded trips).

3. SAMPLE AND MEASUREMENT

3.1 Sample construction

Our initial sample includes the universe of public firms covered by Trucost (a commercial provider of corporate carbon emission data) in the period between 2005 and 2018.[16] Trucost is a widely used source of firm carbon emission data for the corporate sector (for example, MSCI and S&P use Trucost data in their indexes) and for international organizations such as UNEP FI (i.e., the United Nations Environment Program Finance Initiative). Trucost covers a wide cross-section of firms around the world (since 2005, this vendor has typically covered an average of 5,046 firms per year, which represent approximately 80% of global market capitalization).[17] Trucost collects carbon emission data from publicly available sources. When a covered firm does not publicly disclose its carbon emissions, Trucost estimates a firm's annual carbon emissions based on an environmental profiling model. Appendix B provides a description of the process followed by Trucost to assess corporate carbon emissions.

Several sample countries have introduced regulations that enhance the reliability of the emissions reported by firms to Trucost, either by mandating strict guidelines and/or by recommending independent verification of the reported emissions.[18] Corroborating the reliability of these data, prior research documents a correlation of 0.99 among the direct CO_2 emissions reported by five providers, namely CDP, Trucost, MSCI, Sustainalytics, and Thomson Reuters (Bolton and Kacperczyk 2019).

We obtain data on institutional ownership from the FactSet/LionShares database. FactSet/LionShares gathers institutional ownership for U.S. equities from mandatory

[16] Carbon emission data are rarely available before 2005. The Carbon Disclosure Project (CDP) launched the first climate change survey in 2006, thus enabling companies to provide standardized disclosure of emission information.

[17] In the data, we observe that in 2016 the coverage increases substantially. To construct a balanced panel and obtain a consistent sample, we exclude these 2016-2017 sample additions from our sample.

[18] For example, the "Grenelle de l'environnement" in France was addressed to all companies with over 500 employees in 2013. The French regulation states that a company's report must be subject to verification by an independent third party (appointed by the executive director or chief executive), which must be accredited by COFRAC (French Committee of accreditation) or by any other accreditation body signatory to the multilateral recognition agreement established by the European coordination of accreditation bodies. In the U.K., the reporting of direct and certain indirect emissions has been mandated from 2013, although verification is not mandatory.

filings with the SEC. For stocks traded outside the U. S., FactSet/LionShares gathers institutional ownership data from national regulatory agencies and stock exchange announcements, as well as direct disclosures of mutual funds, mutual fund industry directories, and company proxies and annual reports. We obtain accounting and market data from Compustat Global and Datastream/WorldScope. These datasets provide stock price, balance sheet, and income statement information for a large number of international firms.

Table 1 outlines the sample selection procedure. As shown in Table 1, we depart from 77,556 firm-year observations in the Trucost dataset. To be included in the sample, we require non-missing institutional ownership and financial data. Our firm-fixed effects specifications also require excluding companies with only one observation over the sample period. The resulting sample consists of 59,265 firm-year observations, 18,832 corresponding to constituents of the MSCI Index and 40,433 corresponding to firms not included in this index.

3.2 Measurement choices and descriptive statistics

To measure a firm's annual carbon emissions, we define *Log*(CO_2) as the logarithm of the firm's annual GHG emission measured in equivalents of metric tons of CO_2. The variable measuring Big Three ownership, *Big3_Hldg,* is defined for each firm-year as the fraction of the firm's equity held by the Big Three in that year. For each firm-year, we compute Big Three ownership at the parent level, that is, we aggregate the holdings of all funds and subsidiaries of BlackRock, Vanguard, and State Street Global Advisors in that firm-year. Most of the Big Three's investments in our sample firms are held in "index" funds (out of the average of 4% of shares owned by the Big Three in the MSCI firms, 3% are owned by index funds managed by the Big Three). The rest of the funds owned by the Big Three are predominantly growth funds.[19] *NonBig3_Hldg* is the fraction of the firm's equity held by institutional investors other than the Big Three.

Our tests include a vector of firm-level control variables, *Controls,* defined as follows. Size is the logarithm of total assets. We include this variable to control for the volume of the firm's business activity as well as for potential public pressure over its environ-

[19] Among the funds managed by the Big Three, 71% are index funds, 22% implement some form of growth strategy (e.g., aggressive growth, growth at accessible price or "GARP"), and only 7% are value funds.

mental impact. *Log(BM)* is the logarithm of the book-to-market ratio (book value of equity divided by market value of equity). We include this variable to control for the firm's growth opportunities. We also include a measure of past performance, *ROA,* defined as net income scaled by total assets. *Leverage* is computed as the sum of the long-term debt and the debt in current liabilities over firm's total assets. *PPE* (asset tangibility) is the ratio of property, plant, and equipment over firm's total assets. We include these two variables to measure credit constraints; more leveraged firms have to cope with regular cash outflows, which may preclude financing of environmentally beneficial investments. Conversely, pledgeable assets support more borrowings, which in turn allow for further investment in pledgeable assets. All continuous control variables are winsorized at the 1 and 99 percentiles to mitigate the effect of outliers. Standard errors are clustered at the firm level (see Appendix OC, section OC.2, for robustness to alternative cluster estimation).

Table 2 presents descriptive statistics for the variables used in our main tests. As shown in Table 2, the average ownership by the Big Three among MSCI firms is 4%, with a standard deviation of 4% and a 75th percentile of 7%. This suggests that the Big Three have substantial voting power in a number of companies around the world (Fichtner et al. 2017). Total institutional ownership (i.e., the sum of *Big3_Hldg* and *NonBig3_Hldg)* is 45% on average, a figure that is in line with prior studies on institutional ownership around the world (Bena et al. 2017). Table 2 also shows that our sample includes a wide variety of firms in terms of size, leverage, and profitability (Panel A), as well as country of origin and industry affiliation (Panels B and C).

4. ENGAGEMENTS OF THE BIG THREE WITH PORTFOLIO FIRMS

In an attempt to provide more direct evidence on how the Big Three induce companies to reduce carbon emissions, we analyze these large investors' engagements with the firms in their portfolio. The Big Three have recently started to publicly disclose detailed data on private engagements with their portfolio firms in investment stewardship reports (ISR). Vanguard and State Street published their engagements data for the first time in 2019. BlackRock started disclosing these data in 2018.[20]

According to the narrative in the ISRs, the engagements go beyond sending a letter to the firm. For example, BlackRock's ISR states that the fund's investment stewardship department had "substantive dialogue with the companies listed as engaged firms." The ISR also states that the fund "engages companies for the following reasons: (1) to ensure that BlackRock can make well-informed voting decisions; (2) to explain its voting and governance guidelines; (3) to convey its thinking on long-term value creation and sound governance practices."

We hand collect engagement information from the most recent ISRs published by the Big Three. The disclosed information excludes engagements by letters and includes only comprehensive engagements via calls and in-person meetings. The length of the period covered by the ISR exhibits some variation across the three investors. BlackRock's 2019 ISR includes engagements from 7/1/2018 to 6/30/2019. Vanguard's 2019 ISR includes engagements from 7/1/2018 to 12/31/2018. State Street's 2019 ISR includes engagements from 1/1/2018 to 12/31/2018. Vanguard and State Street classify engagements into broad categories and report reasons for the engagements. BlackRock simply publishes a list of firms contacted for comprehensive engagement.

We first analyze the descriptive statistics of these data. In absolute terms, we observe that, during the period covered by the ISR reports, the Big Three engage with a relatively large number of firms; BlackRock engaged with 1,458 firms, State Street engaged with 686 firms, and Vanguard engaged with 356 firms. In relative terms, however, the Big Three appear to engage with a relatively small percentage of their

[20] Before 2018, the disclosure of engagement data was scarce. For example, BlackRock limited its disclosure of engagements to summary statistics aggregated by region. In 2015, for instance, BlackRock reported that the fund conducted 90 direct engagements with its portfolio companies on environmental issues, but the identity of the companies engaged was not revealed (see, for example, the 2015 Corporate Governance & Responsible Investment Report https://www.blackrock.com/corporate/literature/whitepaper/blk-cgri-2015-annual-vande-statistics-report.pdf).

portfolio firms: BlackRock, Vanguard, and State Street engage with 9%, 3%, and 5% of their portfolio firms, respectively.

Next, we explore the determinants of the probability that each of the Big Three engages with a firm in its portfolio. We perform the analysis separately for each of the Big Three.

Accordingly, we construct three left-hand-side variables. *Engagement_Blackrock* is an indicator variable that equals one if the firm is included in the list of engagements disclosed in BlackRock's 2019 ISR, and zero otherwise. *Engagement_Vanguard* is an indicator variable that equals one if the firm is included in the list of engagements about "oversight of strategy and risks" in Vanguard's 2019 ISR, and zero otherwise. *Engagement_StateStreet* is an indicator variable that equals one if the firm is included in the list of engagements classified as "Environmental/Social" in State Street's 2019 ISR, and zero otherwise. We construct these variables for the cross-section of our sample firms as of the end of 2017 (i.e., the firms in the Trucost universe that meet the data requirements described in section 3).

The right-hand-side variables are defined as follows. *Log(CO_2)* is the logarithm of CO_2, as previously defined. *BlackRock_Hldg* is the fraction of the firm's shares held by funds managed by BlackRock (i.e., BlackRock's holdings in the firm). Similarly, *Vanguard_Hldg (StateStreet_Hldg)* is the fraction of the firm's equity held by funds managed by Vanguard (State Street). The specification also includes a vector of controls for firm characteristics: *Size, Log(BM), ROA, Leverage,* and *PPE,* all of them as previously defined (additionally, see Appendix A for variable definitions).

Table 3 presents the results of estimating logit and OLS regressions based on the variables described above. The results reveal that the probability of Big Three engagement is higher if the target firm exhibits higher levels of carbon emissions in the previous year (the coefficient on *Log(CO_2)* is consistently positive and statistically significant except for some specifications in Panel B). Table 3 also shows that, in general, the Big Three are more likely to engage with firms in which they hold a larger economic interest (the coefficients on *BlackRock_Hldg, Vanguard_Hldg,* and *State Street_Hldg* are positive and statistically significant). This is consistent with the notion that these large investors believe that carbon emissions could affect the value of their portfolios. The association of the probability of engagement with *Size* is also positive and strong, which suggests that the Big Three focus their engagement efforts on large firms. The focus on large firms is consistent with these firms being more influential and having a potentially stronger effect on climate change.[21] Engagement with these firms could also be more attractive for the Big Three to the extent that these firms are more visible than smaller firms.

[21] Large firms emit the largest portion of corporate emissions. For example, in 2017 the aggregate level of total CO_2 emissions for our sample of U.S. MSCI firms is 3,698 million metric tons of CO_2 equivalent, which is around 70% of the total U.S. CO_2 emissions (https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-fast-facts). The U.S. accounts for approximately 15% of the worldwide emissions.

5. CARBON EMISSIONS AND BIG THREE SHAREHOLDINGS

The previous results indicate that the Big Three selectively engage with a number of firms in their portfolio companies on environmental issues. We next explore whether the influence of these large investors results in lower levels of carbon emissions.

5.1. Association between carbon emissions and Big Three shareholdings

To study the relationship between Big Three ownership and corporate carbon emissions, we estimate the following model:

$$Log(CO_2)it = \alpha + \beta * \mathit{Big3\_Hldg}_{it-1} + \gamma * \mathit{NonBig3\_Hldg}_{it-1} + \phi * \mathit{Controls}_{it-1} + \tau_t + \delta_i + \xi_{it} \quad (1)$$

where *Big3_Hldg*, *NonBig3_Hldg*, and *Controls* are as previously defined (see section 3 and Appendix A for variable definitions). Sub-indexes i and t refer to firm i and year t, respectively. All these independent variables are measured at the end of the prior year to avoid simultaneity bias. τ_t and δ_i denote year and firm-fixed effects, respectively. When estimating this model, we distinguish between constituents of the MSCI World Index and other firms. Our results from tests of the probability of engagement (see Table 3) suggest that the Big Three focus their monitoring efforts on environmental issues in large firms. Thus, we expect that the potential effect of the Big Three on carbon emissions, if any, is concentrated among large firms. Accordingly, we partition the sample based on inclusion in the MSCI World Index (this index aims to cover 85% of total market capitalization in 23 developed countries).

Table 4, Panel A, presents the results of this test. For the subsample of MSCI firms, the coefficient on *Big3_Hldg* is negative and statistically significant, which is consistent with the notion that ownership by the Big Three is associated with a subsequent decrease in CO_2 emissions. The negative association is robust to including year-, industry-, country-, and firm- fixed effects. That is, the association holds both in the cross-section and in the time-series and thus is unlikely to be confounded either by time-invariant country and industry characteristics or by the potential effect of the volume of economic activity on overall levels of CO_2 emissions. In contrast with this result, the coefficient on *NonBig3_Hldg* is not statistically significant, suggesting that institutional ownership is generally not associated with a decrease in carbon emissions.[22] Table 4, Panel A, also shows that there is no significant effect of the Big Three on carbon emissions for smaller, non-MSCI firms.

Figure 1 shows results of estimating equation (1) by year; we plot the coefficient on *Big3_Hldg* estimated in annual cross-sectional regressions and the corresponding confidence intervals. The analysis reveals that the association between Big Three ownership and CO_2 emissions has increased substantially over time. In fact, the effect appears to be significant only in the most recent years. In Online Appendix OC (section OC.1) we corroborate the presence of an evolution in the association between Big Three ownership and carbon emissions by interacting *Big3_Hldg* with a trend variable that increases linearly over the sample period. The result (Table OC.1) confirms that the association is weak at the start of the sample period but becomes strong in later years. This evidence is consistent with an increasing popular demand that these large investors pressure the companies in their portfolios to curb their greenhouse gas emissions, as illustrated by recent public statements by climate activists and top executives of the Big Three.

Figure 2 further delves into the results of Table 4, Panel A. We estimate equation (1) replacing the coefficient on *Big3_Hldg* with separate indicator variables, each marking a 1% interval of *Big3_Hldg* values. That is, the first indicator variable equals one if *Big3_Hldg* ∈ [0%, 1%] and zero otherwise, the second indicator variable equals one if *Big3_Hldg* ∈ (1%, 2%] and zero otherwise, the third indicator variable equals one if *Big3_Hldg* ∈ (2%, 3%] and zero otherwise, and so forth. The last indicator variable equals one if *Big3_Hldg* >10% and zero otherwise. We define the [0%, 1%] interval as baseline, and thus we exclude the indicator variable for *Big3_Hldg* ∈ [0%, 1%]. As shown in Figure 2, the effect of the Big Three becomes significant when the ownership of these investors crosses the 3-4% ownership threshold. This evidence is consistent with our conjecture that firms respond to the Big Three's requests to reduce emissions only when these investors can be pivotal in key corporate elections.

Table 4, Panel B, presents another variant of the analysis in Table 4, Panel A. The alternative specification uses changes of the key variables rather than levels. The dependent variable is Δ_CO_2 (t–s, t), defined as the fractional change of CO_2 emissions

[22] To corroborate this, we reestimate equation (1) replacing *Big3_Hldg* and *NonBig3_Hldg* with *Institutional_Ownership,* namely the fraction of institutional ownership in the firm (Ferreira and Matos, 2008). The coefficient on *Institutional_Ownership* is not distinguishable from zero in this alternative specification.

from year t–s to year t, i.e., (CO_2t–CO2t-s)/CO_2t-s (s=1, …, 12). In parallel to Panel A, the experimental variable is Δ_*Big3_Hldg* (t–s–1, t–1), defined as the change in *Big3_Hldg* from year t–s–1 to year t–1. For consistency with the previous test, we also include Δ_*NonBig3_Hldg* (t–s–1, t–1), defined as the change in *NonBig3_Hldg* from year t–s–1 to year t–1. The results of Table 4, Panel B, are consistent with those in Panel A: changes in Big Three ownership are negatively associated with subsequent changes in carbon emissions. Panel B also highlights that, while part of the effect of the Big Three is already observable in the subsequent year, the influence of these large investors requires several periods to unfold (for example, firms might require more than one year to implement changes or the changes might require some time to become effective).

Gauging whether the potential effect of the Big Three is large enough to meet the worldwide objective of reducing carbon emissions is an extremely ambitious task that exceeds the scope of this paper. With this caveat in mind, we provide some guidance to interpret our results. In Table 4, Panel A, the magnitude of the coefficient on *Big3_Hldg* ranges from –4.66 to –1.25, depending on the specification. A coefficient of 1.25 suggests that a one standard deviation increase in *Big3_Hldg* in a given firm is associated with a reduction of approximately 2% in corporate total CO_2 emissions (the within-firm standard deviation of *Big3_Hldg* is 1.82%). This is a sizable effect when compared to current emission reduction goals proposed by environmental initiatives. For instance, the objective of the Regional Greenhouse Gas Initiative is to reduce emission cap by 2.5% each year from 2015 to 2020 (i.e., 12.5% in five years).[23] While among smaller, non-MSCI firms the effect of the Big Three on corporate CO_2 emissions appears to be insignificant, MSCI firms account for a large portion of the market capitalization and a large part of the corporate CO_2 emissions. In our sample, the 16% of the firms included in the MSCI World Index account for 56% of the total CO_2 emissions (these data correspond to 2018, the most recent year in our sample period).

That being said, some studies on climate change call for higher magnitudes to stop global warming; according to a recent study commissioned by the United Nations, the global volume of GHG emissions needs to drop by 55% by 2030 to limit global warming to 1.5 degrees (i.e., around 5% each year).[24] Moreover, other considerations are important to interpreting the magnitude of our results. First, the magnitude we esti-

[23] The Regional Greenhouse Gas Initiative (RGGI) founded in January 2007 is a state-level emissions capping and trading program carried out by nine northeastern U.S. states (https://www.rggi.org/).
[24] www.fastcompany.com/90272330/global-emissions-must-drop-55-by-2030-to-meet-climate-goals

mate based on our results (i.e., 2%) corresponds to the within-firm standard deviation of *Big3_Hldg*, suggesting that we should not expect a 2% decrease in emissions across the board every year. Second, we do not find a significant effect of the Big Three in the subsample of non-MSCI firms, which includes, among others, all the sample firms incorporated in China, India, and Russia. The emissions from these three countries amount to 39% of the worldwide emissions.

5.2. Sharpening identification

An obvious concern about our previous tests is that firms could reduce carbon emissions for reasons correlated with the ownership of the Big Three in the company. To the extent that our previous results are robust to controlling for time-invariant cross-sectional variation (our models include firm-fixed effects), our inferences cannot be confounded by an omitted variable unless this variable co-varies with our key variables not only in the cross-section, but also in the time-series.

That being said, we further sharpen identification by exploiting two sources of exogenous variation in Big Three ownership: i) the reconstitution of the Russell 1000/2000 Index and ii) global changes in index investing. Both approaches are grounded on prior finance literature.

5.2.1. Russell 1000/2000 reconstitution

Following prior literature (e.g., Appel, Gormley, and Keim 2016), we first exploit the yearly reconstitution of the indexes Russell 1000 and Russell 2000.[25] Every year, these indexes are formed based on end-of-May market capitalizations; the largest 1,000 companies constitute the Russell 1000 (i.e., firms #1–1,000), while the next 2,000 firms in size are included in the Russell 2000 Index (i.e., firms #1,001–3,000). For companies that are around the 1000/2000 cutoff, the final assignation to the index is relatively random in the sense that it can be determined by random variations in market value. Because the firm-specific weight in the index is value-weighted (as a function of float-adjusted market capitalization as of the end of June), the position at

[25] This approach has been widely used in the recent finance literature to assess the effect of passive investors on shareholder activism (Appel, Gormley, and Keim 2019a), firms' corporate governance choices (Appel et al. 2016), payout policy (Crane, Michenaud, and Weston 2016), CEO power and composition of board of directors (Schmidt and Fahlenbrach 2017), firm transparency and information production (Boone and White 2015), etc.

the top of Russell 2000 Index rather than at the bottom of Russell 1000 Index results in a significant increase in the company's weight in the index, which triggers stock purchases by index funds tracking the indexes. Therefore, for each dollar invested in a passive fund using the Russell 1000 as a benchmark, very little of it will be invested in stocks at the bottom of that index; while for each dollar invested in a passive fund using the Russell 2000 as a benchmark, a large proportion of it will be invested in stocks at the top of the index. To the extent that the Big Three invest heavily in funds tracking the Russell indexes, the shift from Russell 1000 to Russell 2000 likely increases Big Three ownership in the firm.[26]

In 2007, to curb the number of stocks changing indexes, Russell adjusted the index switching rules by introducing a banding policy. Under this policy, to switch from Russell 1000 to Russell 2000, a stock has to fall below not only the 1,000-cutoff point, but also the lower threshold of the aforementioned banding range (see Appendix C for more details on Russell's index assignment procedure). As such, we focus our analysis on the stocks around this lower threshold. For robustness, we repeat the analysis using the 1,000-cutoff point (rather than the lower threshold of the banding region), controlling by whether the stock is in the banding region (see Appel et al., 2019). Our inferences are unaffected (see Online Appendix OC).

In the first stage of the 2-step least squares (2SLS) approach, we regress *Big3_Hldg* on $Russell2000_{it}$, the instrumental variable (IV), defined as an indicator equal to one if stock i is assigned to the Russell 2000 Index in year t. Following Appel et al. (2019), we include the following controls. $Mktcap_{it}$ is the CRSP market capitalization of stock i as of the end of May of year *t*. $Float_{it}$ is the float-adjusted market capitalization of stock i as of the end of June of year t used by Russell to determine firm-specific index weights. Finally, the specification also includes firm and year-fixed effects.

Table 5, Panel A, reports results of the first stage estimations. The model is estimated using companies from three bandwidths; we take the 600, 500, and 400 stocks around the lower threshold of the banding range in the period from 2007 to 2018

[26] Appel, Gormley, and Keim (2019) show that ownership by passively managed mutual funds and exchange traded funds (ETFs) is about 40% higher, on average, for stocks at the top of the Russell 2000 Index relative to otherwise similar stocks at the bottom of the Russell 1000 Index. Additionally, they report that, on average, the ownership stakes of Vanguard and State Street are a third higher among firms at the top of the Russell 2000, and each of these three institutions' likelihood of owning more than 5% of a firm's shares increases by two-thirds on average, while their likelihood of being a top five shareholder is higher, on average, by 15%.

(we start in 2007 because in that year Russell adjusted the index switching rules by introducing a banding policy). Following Appel et al. (2019), Glossner (2018), and Wei and Young (2019), we use end-of-May CRSP market capitalization to rank companies. In Columns (1) – (3) we use polynomial controls of the third degree for the firms' market capitalization to account for the possibility that the effect of being included in the index on *Big3_Hldg* is not linear. In line with prior studies, *Russell2000* loads with positive and highly significant coefficients in all three specifications, suggesting that the aggregate ownership by the Big Three is one percentage point higher for firms in the top of Russell 2000 Index than for the other firms around the cutoff.[27]

Table 5, Panel B, reports the results of the second stage estimation. The coefficient on *Big Three* is negative and significant. These results are consistent across all three specifications using different bandwidths, and robust to other common research design variants of this test (see Online Appendix OC, section OC.3). For further robustness, we also repeat our test in Table 5 replacing *Big3_Hldg* with *NonBig3_Hldg*. To the extent that index investing is more prevalent among the Big Three than among other investment companies, this additional analysis is a placebo test. As shown in Online Appendix OC, section OC.4, in this placebo test we do not find significant results in either of the two stages of the estimation. Taken together, this evidence is consistent with the notion that that ownership by the Big Three leads to a significant reduction in corporate carbon emissions.

5.2.2. Global trends in index investing

One limitation of the previous approach is that the exogenous variation is restricted to firms in the margin of inclusion/exclusion in a given index. To address this limitation, we next employ an alternative instrumental variable (IV) approach that builds on previous work by Bartik (1991) and Blanchard and Katz (1992) in labor economics, and has been used recently in a variety of subfields of economics (e.g., Bertrand, Kamenica, Pan 2015; Beaudry, Green, Sand 2018), including finance (e.g., Adelino, Ma, and Robinson 2017).[28] We apply this approach to our setting by exploiting the

[27] The strong association between *Big3_Hldg* and *Russell2000* suggests that the "relevance condition" of the instrumental variable (IV) approach is satisfied. The value of the Kleibergen-Paap F-statistic is greater than 17, which further alleviates the concern that the instrument is "weak" (uncorrelated with the endogenous regressor).

[28] The classic version of the Bartik instrument is constructed by fixing each local labor market's industry composition of employment in a base year (usually the start of the sample period) and

global trend of flows from active towards passive investing. To illustrate, consider a firm that, at the start of the sample period (i.e., 2004), exhibits a high share of Big Three ownership because the firm is included in widely-used stock market indexes. Part of the increase in Big Three ownership the firm will experience over the period 2005-2018 is due to the global-level trend of inflows from active funds into index funds throughout this period (Coates 2019). Therefore, the global trend in flows from active to passive ownership creates plausibly exogenous variation in the change in ownership by the Big Three across companies over the period 2005-2018.

Accordingly, our instrumental variable is defined as the interaction of the global trend in index fund ownership over the sample period with index fund ownership in the firm at the start of the sample period. Intuitively, regressing firm-level Big Three ownership on this instrument captures the variation in Big Three ownership in the firm driven by the global trend in passive ownership. Specifically, *Indexing_Bartik* (i.e., our Bartik-type instrument), is defined as the interaction between *Indexing_Global* (defined as the average institutional ownership by index funds in that year) and *Indexing_Firm* (defined as the fraction of the firm shares owned by index funds in 2004, namely at the start of the sample period). This interaction captures the idea that, depending on firms' preexisting institutional ownership structure, the global trend towards passive investment affects some firms more than others. These preexisting institutional ownership stakes are difficult to adjust in the short run and are assumed to be unrelated to climate change concerns.

Column (1) of Table 6 reports results of the first stage estimations. The coefficient on *Indexing_Bartik* is positive and significant, suggesting that the IV relevance condition is satisfied. In the second stage estimation in Column (2), we continue to find that the association between Big Three ownership and carbon emissions is negative and statistically significant (t-stat –3.43). The effect is economically meaningful; one within-firm standard deviation increase in Big Three ownership leads to a 15% reduction in total carbon emissions. As in the previous approach, the results of this test suggest that the influence of the Big Three induces firms to reduce carbon emissions.

calculating the employment growth that would have occurred in each market had the industry composition not changed but employment in each industry had grown at the national rate. Researchers typically take industry composition from a year that predates measurements of any other variables used for estimation.

5.3. Exploiting variation in the cost of CO_2 emissions for the Big Three

To further corroborate our inferences, we exploit sources of variation in the cost of CO_2 emissions. As previously explained (see section 2), carbon emissions could be costly for index investors because climate risk affects the value of their portfolios. Thus, we test whether our results are stronger when indexers' exposure to climate risk is more intense.

To measure the cost of climate risk for the Big Three, we exploit cross-sectional heterogeneity in sample countries' social norms regarding the environment. Carbon emissions are likely to be more costly in countries with stronger social norms towards the environment. To begin, these countries are more likely to pass regulations to curb emissions. Moreover, consumers in these countries are also more likely to avoid products from firms known as polluters. To exploit such variation in our tests, we follow prior literature (Dyck et al. 2019) and collect country-level data on the Environmental Performance Index (EPI).[29] Based on these data, we define Environmental_Sensitivity as the EPI of the country at the start of the sample period.

Our second measure of the costs of carbon emissions is based on stock prices. The idea is to capture the premium assigned by the market to "clean" firms (i.e., firms that are considered to manage CO_2 emissions efficiently). The premium is computed as the difference between the returns from an index which tracks "clean" firms and a similar index that does not discriminate based on CO_2 emissions (i.e., it also includes less "clean" firms). This measure captures the cost of carbon emissions to the extent that the premium for "clean" firms (i.e., the relative performance of "clean" firms) increases when the cost of being relatively less "clean" increases. This could be the case, for example, if the country passes regulation increasing the cost of carbon emissions, or if there is news about natural disasters attributed to climate change.

[29] The Environmental Performance Index is developed by the Yale Center for Environmental Law (Yale University) and the Center for International Earth Science Information Network (Columbia University). The 2014 Environmental Performance Index (EPI) ranks 178 countries on 20 performance indicators in the following nine policy categories: health impacts, air quality, water and sanitation, water resources, agriculture, forests, fisheries, biodiversity and habitat, and climate and energy. These categories track performance and progress on two broad policy objectives: environmental health and ecosystem vitality. The EPI's proximity-to-target methodology facilitates cross-country comparisons among economic and regional peer groups. The data set includes the 2014 EPI and component scores, backcast EPI scores for 2002-2012. The 2014 EPI was released in Davos, Switzerland at the annual meeting of the World Economic Forum on January 25, 2014.

Accordingly, we define our second measure of *Carbon_Efficiency_Premium* as the difference between the return on the S&P Global CEI (Carbon Efficient Index) and the return on the S&P 1200 Global Index. Table 7 presents the results from modifying equation (1) by including the interaction between Big Three and the aforementioned measures of costs of carbon emissions (*Environmental_Sensitivity* and *Carbon_Efficiency_Premium*). As shown in the table, the coefficients on these interactions are negative and statistically significant (t-stats of –5.59 and –4.00). These results indicate that the negative relationship between *Big Three* ownership and carbon emissions is more pronounced when the costs of these emissions are higher. To refine this measure to the furthest extent possible, in Table OC.5 we replace the S&P Global CEI with the S&P/TSX 60 CEI for Canadian firms and the S&P 500 CEI for U.S. firms.[30] While this alternative measurement causes sample attrition, our inferences are unaffected.[31]

5.4. Decomposing carbon emissions

We further scrutinize the sources of the documented patterns by breaking down the key variables in our analysis. Following the GHG Protocol, Trucost subdivides the total amount of GHG emissions into three "scopes" based on the source of emission. Scope one emissions relate to direct GHG emissions from sources that are owned or controlled by the company, for example from combustion in owned or controlled boilers or furnaces, or from internal combustion engines of a trucking company's truck fleet. Scope two emissions relate to indirect GHG emissions from the consumption of purchased electricity, steam, or other sources of energy generated upstream from a company's direct operations. Scope three emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company, for example employee business travel, outsourced business activities, and other parts of the supply chain (see Appendix D for an example of these three components of corporate carbon emissions).[32]

[30] According to the vendor, the S&P carbon efficient indexes maintain a risk/return profile similar to that of their benchmarks by adjusting constituent weights within each industry group to reduce overall exposure to carbon emissions per unit of revenue. (https://www.spindices.com/topic/carbon-efficient?force_download=true&_ga=2.113549191.1432307098.1581093074-2127852604.1581093074)

[31] While the S&P500 CEI was created before the start of our sample period, the S&P/TSX 60 CEI and the S&P Global CEI were launched in 2009 and 2010, respectively.

32 Scope 3 is based on "upstream", not "downstream" emissions. That is, Scope 3 does not include emissions from the in-use phase of a company's products or services, such as the emissions from the driving of a truck produced by an automobile manufacturer. For more details, see GHG protocol "The

The results in Table 8 reveal that ownership by the Big Three is related to reductions in emissions directly produced by the firm (scope one). In addition, Table 8 shows that ownership by the Big Three is also related to lower emissions from the supply chain (scope three), suggesting that firms internalize part of the pressure to reduce emissions, but also pass on this pressure to suppliers.

5.5. Analysis by country and industry

To explore the generalizability of our results, we repeat our main analysis splitting the sample into the two main economic regions: North America and the rest of the world (ROW). We also test whether the negative association of the Big Three and carbon emissions is present in countries with common law, as well as in countries with civil law.

As shown in Columns (1) – (2) of Table 9, the negative association between Big Three ownership and carbon emissions is not restricted to a single geographical area. Columns (3) – (4) of Table 9 reveal that our inferences hold both for countries with common law and for countries with civil law. Overall, the results in Table 9 suggest that our results reflect a global phenomenon: the Big Three's effect on carbon emissions is present around the world.

We also explore industry variation in the association between Big Three ownership and CO_2 emissions. We start by aggregating the emissions of the sample firms by industry (using the 16-industry classification presented in Panel C of Table 1). Next, we compute the median of these aggregated emissions. Finally, we classify the 16 industries in two groups of eight industries each based on whether industry emissions are above/below the median, and divide our sample of firms based on their affiliation to these two groups. For robustness, we repeat the process with the top four and bottom four industries in terms of emission volume.

Table 9, Panel B, presents the results. As shown in the table, our main result is more pronounced among firms in industries with higher emissions (i.e., "dirtier" industries). This is consistent with the results in Table 3 showing that the Big Three are more likely to engage with higher emitters. In other words, this evidence corroborates that the impact of the Big Three on carbon emissions is more pronounced in cases where environmental issues are more relevant.

gold standard for accounting for greenhouse gas emissions", http://www.wri.org/blog/2011/10/ghg-protocol-gold-standard-accounting-greenhouse-gas-emissions

5.6. Robustness tests to address potential measurement issues

5.6.1. Alternative dependent variable scalars

To check the sensitivity of our results to measurement choices, we reestimate Equation (1) with alternative measures of our dependent variable: *Log(Total CO2/AT), Log(Total* CO_2*/Sales),* and *Log(Total* CO_2*/COGS),* where CO_2*/AT,* CO_2*/Sales* and CO_2*/COGS* are firms' carbon emission per year scaled by total assets (AT), total sales (Sales), and cost of goods sold (COGS), respectively. Deflating CO_2 is an alternative way to control for scale effects (for example, larger companies could have more resources to undertake projects to reduce carbon emissions) and for the potential confounding effect of a decrease in the firm's volume of business. As shown in Table 10, Panel A, our inferences are not affected by these alternative measurement choices.

5.6.2. Reliability of carbon emission estimation

We next explore whether our inferences are confounded by measurement error in the estimation of CO_2 emissions. As explained previously, Trucost collects carbon emission information from corporate disclosures. When this information is not available, Trucost produces its own estimations. To gauge whether our inferences are affected by measurement error in the estimation of CO_2 emissions, we repeat our analysis separately for observations with carbon emissions disclosed by firms and for observations with carbon emissions estimated by Trucost.[33] As shown in Table 10, Panel B, our inferences hold for both groups of observations.

[33] Both Trucost estimates and corporate estimates have potential reliability issues. While Trucost estimates are based on inputs from public information, corporate estimates are based on proprietary (and thus potentially better) information. However, in contrast to Trucost estimates, corporate estimates could be subject to opportunism (even though, as any corporate disclosure, these estimates are subject to regulatory scrutiny and litigation).

6. ENVIRONMENTAL SCORES AND INSTITUTIONAL OWNERSHIP

Prior literature documents an empirical association between environmental scores and institutional ownership (Dyck et al. 2019). In this section, we explore whether our results can be inferred from this prior work. In particular, we address two questions: Are better environmental scores associated with lower carbon emissions? Is the effect of the Big Three on (carbon) emissions different from that of similar institutions?

6.1. Are better environmental scores associated with lower carbon emissions?

Prior literature has analyzed environmental performance using multidimensional scores based on public information about firms' reported actions. Instead, we focus on carbon emissions, as firm's actions purportedly aimed at reducing CO_2 emission could reflect greenwashing rather than a genuine attempt to decrease emissions. Moreover, environmental scores could be subject to measurement error. For instance, Diebecker, Rose, and Sommer (2019) document substantial qualitative differences (i.e., weak correlation) between the two sustainability measures developed by different vendors.[34]

We empirically assess the validity of this concern by testing whether environmental scores are negatively correlated with carbon emissions. Following prior literature (Dyck et al. 2019), we obtain data on firms' environmental performance from the Thomson Reuters ASSET4 ESG database which covers large, publicly traded companies from over 45 countries.[35] ASSET4 ESG evaluates firms' environmental performance in three separate areas: Emission Reduction, Product Innovation, and Resource Reduction. Within each area the environmental score (Environmental_Score) is defined as the (scaled) equally-weighted average of the firms' performance in sev-

[34] There are other complications that potentially affect the correlation between environmental scores and carbon emissions. First, it is possible that some of the corporate actions driving environmental scores are not meant to decrease carbon emissions (for example, corporate actions aimed at reducing water pollution). Second, the effect of the reported actions on carbon emissions could be non-linear (in which case an equally-weighted aggregation of sub-scores would introduce measurement error).

[35] To evaluate firms' annual performance in each line item, ASSET4 ESG acquires data from annual reports, CSR reports, NGOs, and media.

eral qualitative or quantitative line items.[36,37] As shown in Table 11, environmental scores are not negatively related to current and future carbon emissions. If anything, the association is positive (rather than negative).[38] This pattern holds even when we isolate the component of environmental score that focuses on emissions.[39]

6.2. Is the effect of the Big Three on emissions different from that of similar institutions?

We next compare the effect of the Big Three on carbon emissions with that of similar institutions. The purpose of this analysis is to better understand the role of the incentives generated by the indexing strategy and the role of the fund's bargaining power on the observed effect of the Big Three on carbon emissions. First, we compare the Big Three with other large non-index institutions (i.e., with the closest institutions in terms of assets under management (AUM)). These benchmark institutions have similar bargaining power as the Big Three (they hold large stakes and thus are often pivotal in corporate elections), but they could have different monitoring incentives, as they do not follow and index, and thus can adjust their portfolios based on CO_2 emissions (i.e., "vote with their feet").

[36] There are 28 line items in the Emission Reduction area, 25 in the Product Innovation area, and 17 in the Resource Reduction area. Some examples of these items by area are as follows: Emission Reduction – "Does the company show an initiative to reduce, reuse, recycle, substitute, phase out, or compensate CO_2 equivalents in the production process?" (Yes/No); Product Innovation – "Does the company develop products or technologies for use in the clean, renewable energy" (Yes/No); Resource Reduction – "The percentage of recycled materials of the total materials used" (Numeric).

[37] Following Dyck et al. (2019), we turn all line items into indicator variables, so that a "one" corresponds to better environmental performance. For instance, in questions where "Yes" is associated with better environmental performance, we convert the answers for Yes/No questions into 0 (No) and 1 (Yes); for double Yes/No questions we convert the answers into 0 (No, No), 0.5 (Yes, No; or No, Yes), and 1 (Yes, Yes); and for the numeric questions we put 1 (0) for values above (below) the median. We reverse this rule for questions where "No" is associated with better environmental performance.

[38] This result also holds including firm-fixed effects, invalidating the alternative explanation that firms that inherently have higher emissions also have higher environmental scores because they exert more effort to reduce emissions.

[39] To reconcile these findings with those in prior research, we replicate tests in previous literature on the association between *Environmental_Score* and *Institutional_Hldg* (i.e., the fraction of the firm's equity held by institutional investors). In consistency with prior research (Dyck et al. 2019), we find a positive association between the two measures that is robust to the inclusion of control variables, country, industry, and year-fixed effects (see Online Appendix OC, section OC.6).

Second, we compare the Big Three with index funds (i.e., with the closest institutions in terms of monitoring incentives). These benchmark institutions have similar monitoring incentives as the Big Three (they are also passive). However, they have less bargaining power than the Big Three (they have less AUM and thus hold smaller stakes in firms).

To test the effect of institutional investors' size, we split *NonBig3_Hldg* into *NonBig3_Large* and *NonBig3_Small*. *NonBig3_Large* is the fraction of the firm's equity held by the largest 100 institutions other than the Big Three. *NonBig3_Small* is the difference between *NonBig3_Hldg* and *NonBig3_Large*. To test the effect of institutional investors' indexing strategy, we split NonBig3_Hldg variable into *NonBig3_NonIndex* and *NonBig3_Index*. *NonBig3_Index* is the fraction of the firm's equity held by indexers other than the Big Three. *NonBig3_NonIndex* is the difference between *NonBig3_Hldg* and *NonBig3_Index*. Table 12 reports the results. While the coefficient on Big Three remains negative and significant across specifications, the coefficients on *NonBig3_Large* and *NonBig3_Index* are not statistically different from zero. This evidence is consistent with the notion that the effect of the Big Three on carbon emissions is the result of a unique combination of two investor characteristics: i) size and ii) passive investing.

7. CONCLUSION

This paper examines the role of the Big Three (i.e., BlackRock, Vanguard, and State Street Global Advisors) on the reduction of corporate carbon emissions around the world. Using novel data on engagements of the Big Three with individual firms, we find evidence that these engagements are related to CO_2 emissions, and that the Big Three focus their engagement efforts on large firms in which they hold a significant stake.

We also find that higher ownership by the Big Three is followed by lower carbon emissions, especially in later years of the sample period. This pattern also holds using a variety of approaches, exploiting sources of plausibly exogenous variation in Big Three ownership as well as in the cost of CO_2 emissions. Further digging into our results, we find that Big Three ownership is not only negatively associated with direct corporate emissions, but also with emissions from the firms' supply chains. We also document that the negative association is not restricted to a specific economic region or legal system.

Our last set of results highlights the importance of a novel feature of this paper, namely our focus on CO_2 emissions rather than on environmental scores. In particular, we document that widely-used scores based on firms' reported environmental actions are not associated with a reduction in carbon emissions. This result is consistent with current concerns about "greenwashing" (i.e., "window dressing" corporate actions that improve environmental scores but have little real impact on the reduction of actual emissions).

Overall, our evidence suggests that, in the U.S. and beyond, firms under the influence of the Big Three are more likely to reduce corporate carbon emissions. Our evidence is particularly relevant considering that large investment institutions are increasingly viewed as catalysts in driving firms to reduce their carbon emissions (Andersson et al. 2016; OECD 2017).

We conclude with two caveats about the interpretation of our results. First, our results are not sufficient to conclude that the reduction in CO_2 emissions induced by Big Three ownership increases shareholder wealth. Second, our tests do not necessarily imply that the level of monitoring provided by the Big Three is (net) socially optimal. We look forward to future research shedding further light on these important issues.

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APPENDIX A.
VARIABLE DEFINITIONS

Engagement:

Engagement_BlackRock	Dummy variable that equals one if BlackRock engaged with a firm from July 1, 2018 until June 30, 2019.
Engagement_Vanguard	Dummy variable that equals one if BlackRock engaged with a firm from July 1, 2018 until December 31, 2018.
Engagement_StateStreet	Dummy variable that equals one if BlackRock engaged with a firm from January 1, 2018 until December 31, 2018.

Ownership:

BlackRock_Hldg	BlackRock's holding in the firm, namely, the fraction of the firms' equity owned by funds managed by BlackRock.
Vanguard_Hldg	Vanguard's holding in the firm, namely, the fraction of the firms' equity owned by funds managed by Vanguard.
StateStreet_Hldg	Statestreet's holding in the firm, namely, the fraction of the firms' equity owned by funds managed by StateStreet.
Big3_Hldg	Big Three's holding in the firm, namely, the fraction of the firms' equity owned by funds managed by BlackRock, Vanguard, or State Street Global Advisors.
NonBig3_Hldg	Non-Big Three's holding in the firm, namely, the fraction of the firms' equity owned by funds managed by institutions other than BlackRock, Vanguard, and State Street Global Advisors.

Institutional_Hldg	Institutions' holding in the firm, namely, the fraction of the firms' equity owned by institutional investors (i.e., Big3_Hldg+ NonBig3_Hldg).

Carbon emissions:

Log(CO_2)	Logarithm of the total CO_2 emissions of the firm (Scope 1+Scope 2+Scope 3).
CO_2 *directly emitted*	Direct CO_2 emission by the firm (Scope 1).
CO_2 *from purchased electricity*	CO_2 emission associated with production of electricity purchased by the firm (Scope 2).
CO_2 *from supply chain*	CO_2 emission associated with the firm's supply chain except electricity (Scope 3).
CO_2*/Assets Total*	CO_2 emissions of the firm scaled by total assets.
CO_2*/Sales Total*	CO_2 emissions of the firm scaled by sales.
CO_2*/COGS Total*	CO_2 emissions of the firm scaled by cost of goods sold.

Firm-level controls:

Size	Logarithm of the firm's total assets.
ROA	Net income scaled by total assets (in %).
Leverage	Ratio of total debt to total assets. Total debt is the sum of long and short-term debt including all interest bearing and capitalized lease obligations.
Log(BM)	Logarithm of the book value of common equity scaled by the market value of equity.
PPE	Ratio of Property, Plant and Equipment (PPE) to total assets.

Environmental Scores:

Log(Environmental score)	Logarithm of the overall environmental score, which is the average of the three category scores: Emission reduction, Product innovation, and Resource reduction.
Log(Emission reduction)	Logarithm of the sum of all indicator variables in Emission reduction category of ASSET4 database divided by the total number of reported items in Emission reduction category (28) times 100.
Log(Product innovation)	Logarithm of the sum of all indicator variables in Product innovation category of ASSET4 database divided by the total number of reported items in Product innovation category (25) times 100.
Log(Resource reduction)	Logarithm of the sum of all indicator variables in Resource reduction category of ASSET4 database divided by the total number of reported items in Resource reduction category (17) times 100.

APPENDIX B.
PROCESS FOLLOWED BY TRUCOST TO ASSESS CORPORATE CARBON EMISSIONS

Trucost has developed a comprehensive approach to evaluate corporate carbon emissions. This approach employs an environmental profiling model that tracks 464 industries worldwide. In particular, Trucost follows four steps (Ung, Tang, Weimann, and Olufunwa, 2016):

1. **Analysis of company data**: Financial information is assessed to establish the primary business activities of an organization. Revenues to those activities are apportioned accordingly.

2. **Mapping of company data**: Using the information in Step 1, the environmental profiling model calculates an organization's direct and supply chain environmental impacts.

3. **Incorporation of disclosures and public data**: The analysis incorporates reported environmental data obtained from public sources (such as annual reports and websites). Where environmental reporting is not available, Trucost draws on sources of proxy information (namely, fuel use or expenditure data), which can be converted into emissions data. Reported figures are standardized for consistency.

4. **Company verification process**: Each analyzed company is invited to verify or refine the environmental assessment conducted by Trucost.

APPENDIX C.
POST-BANDING RUSSELL INDEX CONSTRUCTION

In 2007, to curb the number of stocks changing indexes, Russell adjusted the index switching rules by introducing a banding policy. The process of construction of the Russell 1000 and Russell 2000 Indexes after the initiation of this banding policy consists of five steps:[40]

1) Russell sorts Russell 3000E Index constituents by their end-of-May market cap in descending order.

2) Russell computes the total end of May market cap of Russell 3000E Index.

3) Russell computes the cumulative market capitalization for every firm in Russell 3000E as a sum of market capitalizations of all stocks ranked above the particular firm.

4) Russell calculates percentiles for the Russell 3000E Index constituents as the ratio of their cumulative market cap to the total market cap of Russell 3000E.

5) Russell calculates the banding range around the 1,000 cutoff point by subtracting (adding) 2.5% from (to) the percentile of the cumulative market cap of the 1,000 cutoff point.

Therefore, after 2006, to switch from Russell 1000 to Russell 2000 a stock has to fall below not only the 1,000 cutoff point, but also the lower threshold of the aforementioned banding range. Due to stock price fluctuations, the banding range is recomputed annually, leading to different ranks of the lower threshold for every year. In the 2007-2015 period, the ranks of the closest stock to the lower threshold of the banding range ranged between 1,180 and 1,243.

[40] See Russell U.S. Equity Indexes Construction and Methodology, v4.0, August 2019. p. 22-23. https://research.ftserussell.com/products/downloads/Russell-US-indexes.pdf

APPENDIX D.
EXAMPLE OF CORPORATE CARBON EMISSIONS

The table below reproduces the GHG emission amounts reported by 3M Co. to the Carbon Disclosure Project (CDP). Amounts are expressed in tons and in CO_2 equivalents to aid comparison.

Emission	Source	Quantity Tonnes	CO_2 Equivalent (CO_2e) Tonnes
Direct CO_2e (Scope 1)			3,288,540
Carbon Dioxide To Air	CDP	3,191,764	3,191,764
HFCs To Air	CDP	14	34,045
Dinitrogen Oxide (Nitrous Oxide) To Air	CDP	108	33,586
PFCs To Air	CDP	2.69	21,094
Methane To Air	CDP	248	5,201
Sulphur Hexafluoride To Air	CDP	0.12	2,849
Other Direct CO_2e			4,892
Other Direct CO_2e	PRE	-	4,892
First Tier Supply Chain CO_2e			3,977,000
Purchased Electricity (Scope 2) CO_2e	CDP	-	1,690,000
Non-Electricity Supply Chain (Scope 3) CO_2e	TC	-	2,287,000
All Other Supply Chain (Scope 3) CO_2e			4,072,000
Sum Of All Other Supply Chain (Scope 3) CO_2e	TC	-	4,072,000
Total			11,342,431

Figure 1. Big Three ownership and carbon emissions by year

We estimate equation (1) year by year and plot the estimated coefficients on *Big3_Hldg* (point estimates) in each year, along with the corresponding 95% confidence intervals. Filled dots (as opposed to empty dots) denote that the coefficient is statistically different from zero at the 10% level (two-tailed).

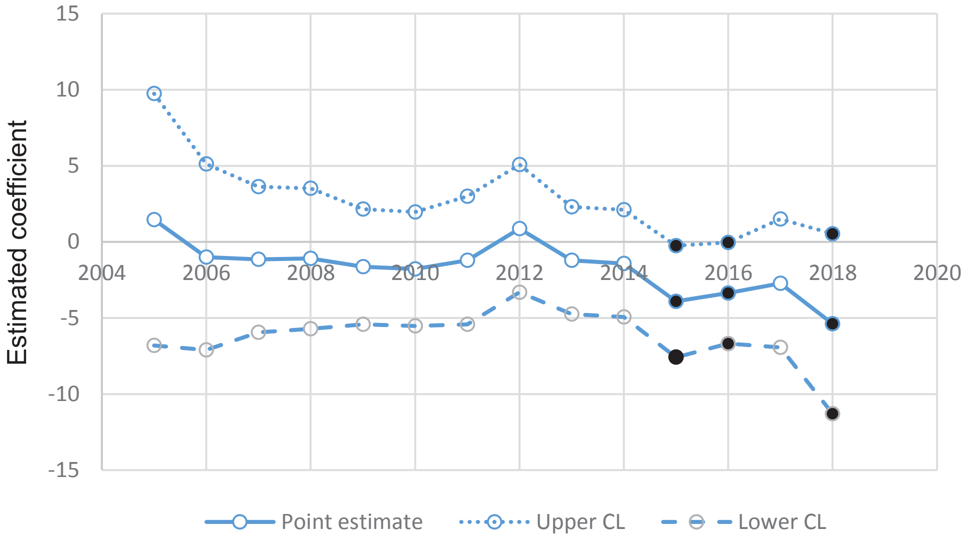

Figure 2. Big Three Ownership thresholds and carbon emissions

We estimate equation (1) but replace the coefficient on *Big3_Hldg* with separate indicator variables, each marking a 1% interval of *Big3_Hldg* values. That is, the first indicator variable equals one if *Big3_Hldg* ∈ [0%, 1%] and zero otherwise, the second indicator variable equals one if *Big3_Hldg* ∈ (1%, 2%] and zero otherwise, the third indicator variable equals one if *Big3_Hldg* ∈ (2%, 3%] and zero otherwise, and so forth. The last indicator variable equals one if *Big3_Hldg* >10% and zero otherwise. We omit the first indicator variable, that is, the indicator variable for *Big3_Hldg* ∈ [0%, 1%]. It therefore serves as benchmark, and has a coefficient value of zero (and no confidence interval). The figure plots the coefficient estimates of the 10 intervals together with their 95% confidence limits. The dependent variable, $Log(CO_2)$, the sample, control variables, and fixed effects are as in Model 3, Table 4, Panel A. Filled dots (as opposed to empty dots) denote that the coefficient is statistically different from the benchmark (i.e., $Big3\_Hldg \in [0\%, 1\%]$) (two-tailed, 10% level).

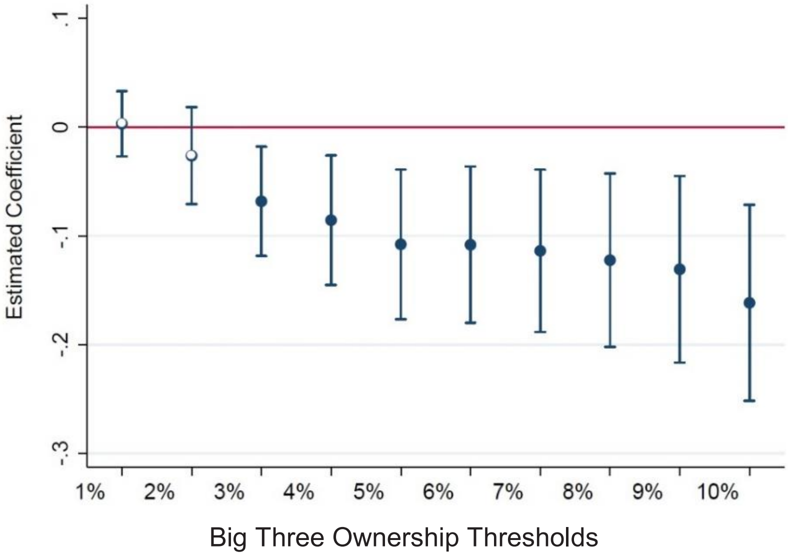

TABLE 1.
SAMPLE CONSTRUCTION

This table describes the procedure to construct our sample.

Steps of the sample selection procedure:	# Firm-Years	# Distinct Firms
Firms covered by Trucost from 2005 to 2018	77,556	11,758
less observations missing institutional ownership information	67,193	10,368
less observations missing accounting and market data	60,296	10,083
less firms with only one observation over sample period	59,265	9,053
Final sample (excluding singletons):		
MSCI constituents	18,832	2,104
Other firms	40,433	6,949

TABLE 2.
DESCRIPTIVE STATISTICS

This table reports descriptive statistics for the variables and observations used in our tests. The sample spans from 2005 to 2018, and includes 18,934 firm-year observations. Panel A presents descriptive statistics for the main variables used in our tests. Panel B presents descriptive statistics by country of incorporation. Other MSCI countries are firms incorporated in tax havens but that fulfill the MSCI requirements and are listed in stock exchanges of the main developed 23 countries. Panel C presents descriptive statistics by industry. Variables are defined in Appendix A. All variables are winsorized at the top and bottom 1%.

Panel A. Descriptive statistics of key variables

	MSCI firms					Non-MSCI firms				
	Std Dev	**P25**	**Median**	**Mean**	**P75**	**Std Dev**	**P25**	**Median**	**Mean**	**P75**
Log(CO_2)	1.85	12.91	14.13	14.18	15.48	2.14	11.08	12.45	12.49	13.84
Big3_Hldg	0.04	0.01	0.03	0.04	0.07	0.03	0.00	0.01	0.02	0.03
NonBig3_Hldg	0.29	0.15	0.31	0.40	0.69	0.24	0.05	0.13	0.23	0.30
Controls:										
Size	2.23	8.67	9.82	10.33	11.77	1.65	6.51	7.54	7.62	8.58
Log(BM)	0.74	–1.25	–0.73	–0.79	–0.26	0.74	–1.15	–0.58	–0.62	–0.06
ROA	6.20	1.57	4.38	5.37	8.16	8.15	1.26	4.10	4.59	8.05
Leverage	0.16	0.11	0.22	0.23	0.34	0.18	0.07	0.21	0.23	0.34
PPE	0.24	0.07	0.21	0.27	0.41	0.24	0.07	0.24	0.29	0.46

Panel B. Sample distribution by country

	MSCI firms					Non-MSCI firms				
	# obs.	% obs.	# firms	Mean CO_2 (millions tons)	Mean Big3_Hldg	# obs.	% obs.	# firms	Mean CO_2 (millions tons)	Mean Big3_Hldg
Austria	106	0.6	15	7.49	0.02	169	0.4	30	0.95	0.01
Australia	824	4.4	97	4.20	0.03	1,806	4.4	351	0.38	0.02
Belgium	144	0.8	18	6.55	0.02	167	0.4	31	1.31	0.02
Canada	1,061	5.6	129	3.97	0.03	742	1.8	186	0.69	0.02
Switzerland	425	2.2	54	8.59	0.03	777	1.9	169	0.69	0.01
Germany	570	3.0	68	17.79	0.03	715	1.7	137	2.76	0.01
Denmark	158	0.8	23	1.46	0.02	175	0.4	31	4.03	0.01
Spain	318	1.7	41	8.85	0.02	280	0.7	47	3.14	0.01
Finland	200	1.1	23	4.61	0.02	190	0.5	32	1.06	0.01
France	818	4.3	82	12.19	0.02	770	1.9	178	1.60	0.01
Great Britain	1,188	6.3	160	5.79	0.03	3,689	8.9	484	0.61	0.02
Hong Kong	309	1.6	31	4.01	0.02	505	1.2	67	7.05	0.02
Ireland	228	1.2	29	4.52	0.06	140	0.3	23	0.99	0.03
Israel	85	0.4	15	2.15	0.02	351	0.8	60	0.74	0.01
Italy	251	1.3	35	18.54	0.02	475	1.1	87	2.79	0.01
Japan	4,297	22.7	440	6.38	0.02	4,238	10.2	1,741	0.94	0.01
Netherlands	288	1.5	37	6.03	0.03	296	0.7	60	1.10	0.02
Norway	114	0.6	17	10.00	0.01	236	0.6	55	1.00	0.01
New Zealand	83	0.4	12	1.13	0.02	105	0.3	31	0.54	0.01
Portugal	85	0.4	11	7.06	0.01	57	0.1	12	2.67	0.01
Sweden	332	1.8	37	2.33	0.02	488	1.2	97	0.89	0.01
Singapore	324	1.7	34	3.69	0.02	194	0.5	40	0.77	0.01
U.S.	6,341	33.5	727	7.79	0.08	5,504	13.3	1,196	1.58	0.08
Other countries	381	2.0	66	6.64	0.02	19,297	46.6	2,737	4.49	0.01

Panel C. Sample distribution by industry

	MSCI firms					Non-MSCI firms				
	#obs.	% obs.	# firms	Mean CO_2 (millions tons)	Mean Big3_Hldg	# obs.	% obs.	# firms	Mean CO_2 (millions tons)	Mean Big3_Hldg
Food	831	4	99	11.52	0.04	2,216	5	418	2.36	0.02
Mining and Minerals	390	2	50	9.84	0.05	1,720	4	267	5.32	0.03
Oil and Petroleum Products	983	5	123	22.53	0.06	1,583	4	259	9.17	0.03
Textiles, Apparel & Footwear	236	1	26	2.61	0.04	615	1	152	0.89	0.02
Consumer Durables	297	2	36	3.72	0.04	773	2	179	1.01	0.02
Chemicals	665	4	70	9.93	0.04	1,406	3	257	3.44	0.02
Drugs, Soap, Perfume, Tobacco	880	5	106	3.29	0.05	1,502	4	289	0.36	0.02
Construction and Constr. Materials	832	4	109	9.71	0.04	3,379	8	665	2.86	0.02
Steel Works Etc.	360	2	44	21.71	0.03	1,292	3	184	12.47	0.02
Fabricated Products	96	1	10	3.80	0.06	367	1	63	0.95	0.03
Machinery and Business Equipment	1,961	10	224	3.14	0.05	4,614	11	861	0.81	0.03
Automobiles	580	3	56	12.17	0.04	1,088	3	192	3.06	0.02
Transportation	1,092	6	125	6.85	0.03	2,281	6	391	2.44	0.02
Utilities	1,069	6	109	33.02	0.05	1,653	4	255	19.72	0.03
Retail Stores	1,134	6	124	3.64	0.04	2,293	6	493	0.57	0.02
Banks, Insurance, and Other Financials	3,337	18	374	0.78	0.04	5,622	14	998	0.42	0.02
Other	4,187	22	516	2.45	0.04	8,962	22	1,959	0.52	0.02

TABLE 3.
BIG THREE ENGAGEMENTS WITH INDIVIDUAL FIRMS

This table presents estimations of the determinants of engagements of the Big Three with individual firms in their portfolios. Panels A, B, and C focus on engagements by BlackRock, Vanguard, and State Street, respectively. The dependent variable in Panel A *(Engagement_Blackrock)* is and indicator variable that equals one if BlackRock engages with the firm, and zero otherwise. The dependent variable in Panel B *(Engagement_Vanguard)* is and indicator variable that equals one if Vanguard engages with the firm about "Oversight of strategy and risk" (which includes environmental issues), and zero otherwise. The dependent variable in Panel C *(Engagement_StateStreet)* is and indicator variable that equals one if State Street engages with the firm about Environmental/Social issues, and zero otherwise. Engagement data is from year 2018 due to limitations in data availability (these data have only been made public recently). The independent variables are measured at the end of the prior year. *Log*(CO_2) is the logarithm of the firm's total carbon emissions. *Blackrock_Hldg (Vanguard_Hldg, StateStreet_Hldg)* is Blackrock's (Vanguard's, State Street's) holding in the firm, namely the fraction of the firm's equity held by BlackRock (Vanguard, State Street). The rest of the variables are defined in Appendix A. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

Panel A. BlackRock

	Dependent Variable: *Engagement_BlackRock*			
	Logit (1)	OLS (2)	OLS (3)	OLS (4)
Log(CO_2)	0.145*** (6.06)	0.018*** (5.56)	0.020*** (3.79)	0.016*** (3.04)
Blackrock_Hldgs	39.190*** (9.48)	6.360*** (10.19)	6.264*** (10.02)	3.109*** (4.78)
Size	0.413*** (13.33)	0.057*** (13.80)	0.063*** (9.99)	0.074*** (11.66)
Log(BM)	0.041*** (7.10)	0.005*** (6.63)	0.004*** (5.24)	–0.002 (–0.53)
ROA	0.018** (2.25)	0.001 (0.70)	0.000 (0.38)	0.002* (1.78)
Leverage	–0.792*** (–2.94)	–0.128*** (–3.57)	–0.138*** (–3.80)	–0.111*** (–3.07)
PPE	–0.163 (–0.86)	–0.025 (–1.04)	0.015 (0.53)	0.008 (0.32)
Industry FE	NO	NO	YES	YES
Country FE	NO	NO	NO	YES
Pseudo R^2 / R^2	0.14	0.13	0.15	0.24
# Obs.	4,234	4,234	4,230	4,224

Panel B. Vanguard

	Dependent Variable: Engagement_Vanguard			
	Logit (1)	OLS (2)	OLS (3)	OLS (4)
Log(CO_2)	0.284*** (5.56)	0.006*** (3.77)	0.002 (0.61)	0.002 (0.86)
Vanguard_Hldg	29.757*** (9.67)	1.528*** (14.34)	1.602*** (13.89)	0.026 (0.13)
Size	0.687*** (10.19)	0.015*** (7.67)	0.025*** (7.66)	0.030*** (8.92)
Log(BM)	0.011 (0.59)	0.000 (0.67)	0.000 (0.16)	–0.002 (–1.08)
ROA	0.077*** (4.66)	0.001* (1.71)	0.001** (2.19)	0.001*** (2.80)
Leverage	0.126 (0.24)	–0.004 (–0.21)	–0.010 (–0.53)	–0.012 (–0.64)
PPE	–0.805** (–2.25)	–0.019 (–1.57)	–0.014 (–0.96)	0.008 (0.54)
Industry FE	NO	NO	YES	YES
Country FE	NO	NO	NO	YES
Pseudo R^2 / R^2	0.33	0.12	0.13	0.16
# Obs.	4,710	4,710	4,419	4,412

Panel C. State Street

	Dependent Variable: *Engagement_StateStreet*			
	Logit (1)	OLS (2)	OLS (3)	OLS (4)
Log(CO_2)	0.210*** (3.13)	0.004*** (3.07)	0.005*** (2.70)	0.005*** (2.64)
StateStreet_Hldg	117.752*** (4.67)	3.606*** (4.74)	3.611*** (4.68)	2.435*** (2.87)
Size	0.408*** (4.71)	0.007*** (4.45)	0.005** (2.19)	0.006** (2.52)
Log(BM)	–0.045** (–2.57)	–0.001*** (–3.36)	–0.001*** (–3.40)	0.000 (0.29)
ROA	0.001 (0.04)	–0.000 (–0.43)	–0.000 (–0.48)	–0.000 (–0.32)
Leverage	–0.015 (–0.02)	–0.004 (–0.32)	–0.005 (–0.37)	–0.003 (–0.23)
PPE	0.345 (0.64)	0.007 (0.79)	–0.001 (–0.08)	0.001 (0.13)
Industry FE	NO	NO	YES	YES
Country FE	NO	NO	NO	YES
Pseudo R^2 / R^2	0.11	0.02	0.03	0.05
# Obs.	4,153	4,153	4,150	4,146

TABLE 4.
BIG THREE OWNERSHIP AND FIRMS' CARBON EMISSIONS

This table presents estimations of the effect of Big Three ownership on total carbon emissions. Panel A presents results of the association between levels of CO_2 emissions and levels of Big Three ownership. The dependent variable is the logarithm of CO_2 (i.e., the firm's total carbon emissions). The experimental variable is the fraction of the firm's equity owned by BlackRock, Vanguard, and State Street. Other variables are defined in Appendix A. Columns (1) – (3) report results of estimations on a subsample of large firms that are members of MSCI World Index (or S&P 500) Index. Columns (4) – (6) report results of estimations on a subsample of smaller firms present in the Trucost database. Both subsamples span the period from 2005 to 2018. Independent variables are measured at the end of the prior year. Panel B presents results for MSCI firms using a specification in changes. Δ_CO_2 (t–s, t) is the fractional change of CO_2 emissions from year t–s to year t, i.e., (CO_2t–CO_2t-s)/CO_2t-s (s=1, …, 12). Δ_*Big3_Hldg* (t–s–1, t–1) is the change in *Big3_Hldg* from year t–s–1 to year t–1. Δ_*NonBig3_Hldg* is the change in *NonBig3_Hldg* from year t–s–1 to year t–1. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

Panel A. Specification in levels

	Dependent Variable: *Log(CO_2)*					
	MSCI firms			Other international firms		
	(1)	(2)	(3)	(4)	(5)	(6)
Big3_Hldg	−2.50*** (−4.43)	−4.66*** (−5.54)	−1.25*** (−3.26)	−0.55 (−1.23)	1.00** (2.03)	0.39 (1.32)
NonBig3_Hldg	0.01 (0.08)	0.11 (0.69)	0.07 (0.71)	0.09 (0.92)	0.04 (0.40)	0.22*** (3.37)
Controls:						
Size	0.47*** (31.31)	0.54*** (39.53)	0.06*** (13.81)	0.97*** (71.13)	0.97*** (69.41)	0.66*** (31.69)
Log(BM)	0.19*** (5.76)	0.19*** (5.70)	0.05*** (3.44)	−0.09*** (−4.46)	−0.07*** (−3.54)	−0.15*** (−11.37)
ROA	0.01** (2.36)	0.01*** (3.87)	0.01*** (3.87)	0.02*** (14.17)	0.02*** (13.29)	0.01*** (6.41)
Leverage	0.62*** (4.00)	0.49*** (3.25)	0.37*** (4.40)	−0.04 (−0.40)	−0.03 (−0.29)	−0.03 (−0.43)
PPE	0.63*** (3.61)	0.63*** (3.72)	0.07 (0.28)	0.84*** (8.78)	0.78*** (8.18)	0.48*** (4.76)
Country FE	YES	YES	NO	YES	YES	NO
Industry FE	YES	YES	NO	YES	YES	NO
Year FE	NO	YES	YES	NO	YES	YES
Firm FE	NO	NO	YES	NO	NO	YES
R^2	0.66	0.69	0.97	0.76	0.76	0.97
# Obs.	18,928	18,928	18,832	41,298	41,298	40,433

Panel B. Specification in changes (MSCI firms)

	Dependent variable: $\triangle\_CO_2$ *(t–s, t)*											
	(1) s=1	**(2) s=2**	**(3) s=3**	**(4) s=4**	**(5) s=5**	**(6) s=6**	**(7) s=7**	**(8) s=8**	**(9) s=9**	**(10) s=10**	**(11) s=11**	**(12) s=12**
△_*Big3_Hldg* (t–s–1, t–1)	–0.91** (–2.24)	–1.98** (–1.97)	–4.05** (–2.52)	–5.09** (–2.43)	–5.94** (–2.24)	–7.64** (–2.56)	–7.15*** (–2.82)	–6.89*** (–3.15)	–5.92*** (–3.05)	–5.52** (–2.54)	–7.50*** (–2.59)	–11.46** (–2.29)
△_***NonBig3_ Hldg*** (t–s–1, t–1)	0.12 (1.49)	0.03 (0.18)	–0.35 (–0.80)	–0.11 (–0.52)	–0.50 (–1.59)	–0.54 (–1.36)	–1.20* (–1.72)	–1.74* (–1.90)	–1.88** (–1.98)	–1.26** (–1.97)	–0.84 (–1.07)	–1.25 (–1.53)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.03
# Obs.	16,674	14,536	12,574	10,871	9,308	7,861	6,526	5,283	4,106	3,003	1,974	1,053

TABLE 5.
EXPLOITING THE RECONSTITUTION OF THE RUSSELL 1000/2000

This table reports estimates from an instrumental variable (IV) 2SLS analysis exploiting the reconstitution of the index Russell 1000/2000. The results correspond to the estimation of the following model:

First stage (Panel A):

$$Big3\_Hldg_{it} = \alpha + \beta * Russell2000_{it} + \Sigma\lambda_n * (\ln(Mktcap_{it}))^n + \nu * \ln(Float_{it}) + \tau_t + \delta_i + \xi_{it} \quad (1)$$

Second stage (Panel B):

$$Log(CO_2)_{it+1} = \alpha + \beta * \widehat{Big3\_Hldg}_{it} + \Sigma\lambda_n * (\ln(Mktcap_{it}))^n + \nu * \ln(Float_{it}) + \tau_t + \delta_i + \xi_{it} \quad (2)$$

$Russell2000_{it}$, the instrument, equals one if stock i is assigned to the Russell 2000 Index in year t, and zero otherwise; $Mktcap_{it}$ is the CRSP market capitalization of stock *i* as of the end of May of year *t;* $Float_{it}$ is the float-adjusted market capitalization of stock *i* as of the end-of-June of year *t* used by Russell to determine firm-specific index weights. $\widehat{Big3\_Hldg}_{it}$ is the fitted value of *Big3_Hldg* from the first stage estimation. The model includes polynomial controls of order N = 3. Results are based on a sample formed by bandwidths of 600, 500, and 400 firms around the Russell1000/2000 cut-off points in the years 2007-2015. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Intercepts are omitted.

Panel A. First stage

	Dep. Var.: *Big3_Hldgt*		
	(1)	(2)	(3)
Russell2000t	0.010*** (4.77)	0.011*** (4.45)	0.011*** (4.12)
Polynomial order, N	3	3	3
Bandwidth	600	500	400
Float control	YES	YES	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
Kleibergen-Paap F-stat.	22.80	19.84	17.02
R^2	0.83	0.82	0.83
# Obs.	2,757	2,083	1,464

Panel B. Second stage

	Dep. Var.: *Log(CO_2)t+1*		
	(1)	(2)	(3)
---3_------	–12.28** (–2.06)	–12.00** (–1.97)	–11.31* (–1.78)
Polynomial order, N	3	3	3
Bandwidth	600	500	400
Float control	YES	YES	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
R^2	0.97	0.97	0.98
# Obs.	4,573	3,573	2,645

TABLE 6.
EXPLOITING GLOBAL TRENDS IN INDEX INVESTING

This table reports results of an instrumental variable (IV) 2SLS analysis of the association between firm carbon emissions and Big Three ownership. The dependent variable is *Log(CO₂)*, where CO_2 is a firm's total carbon emissions per year in tons of CO_2. *Big Three* is the fraction of the firm's equity held by the Big Three (BlackRock, Vanguard, State Street). We instrument for this variable using Bartik (1990)'s approach. In particular, *Indexing_Bartik,* the instrument, is computed as the interaction between *Indexing_Global* (defined as the average institutional ownership by index funds in that year) and *Indexing_Firm* (defined as the fraction of the firm's equity held by the index funds in 2004, namely at the start of the sample period). Column (1) reports results from the first stage estimation. Column (2) reports results from the first stage estimation. $\widehat{Big3\_Hldg}_{it}$ is the fitted value of *Big3_Hldg* from the first stage estimation. The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Intercepts are omitted.

	(1) 1st stage Dep. Var.: Big3_Hldg	(2) 2nd stage Dep. Var.: Log(CO_2)
Indexing_Bartik	0.003*** (11.74)	
$\widehat{Big3\_Hldg}_{it}$		–8.05*** (–3.43)
NonBig3_Hldg		0.08 (0.89)
Controls	YES	YES
Firm FE	YES	YES
Year FE	YES	YES
R^2	0.90	0.97
# Obs.	18,832	18,832

TABLE 7.
EXPLOITING VARIATION IN THE COST OF CO_2 EMISSIONS

This table presents estimations of the sensitivity of the effect of Big Three ownership on total greenhouse gas emissions to social and financial incentives. The dependent variable is the logarithm of the firm's total CO_2 emissions. *Big Three* is the proportion of firm shares owned by BlackRock, Vanguard, and State Street. *Environmental_Sensitivity* as the Environmental Performance Index (EPI) of the country at the start of the sample period. *Carbon_Efficiency_Premium* is the difference between the return on the S&P Global CEI (Carbon Efficient Index) and the return on the S&P 1200 Global Index over that year. The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

	Dependent Variable: *Log(CO_2)*	
	(1)	(2)
Big3_Hldg	−2.05*** (−5.24)	−1.18** (−2.54)
Big3_Hldg*Environmental_Sensitivity	−29.21*** (−5.59)	
Big3_Hldg*Carbon_Efficiency_Premium		−0.19*** (−4.00)
NonBig3_Hldg	0.11 (1.24)	−0.04 (−0.35)
Controls	YES	YES
Year FE	YES	YES
Firm FE	YES	YES
R^2	0.97	0.98
# Obs.	18,189	11,533

TABLE 8.
BREAKING DOWN CO_2 EMISSIONS

This table presents estimations of the effect of *Big Three* ownership on total greenhouse gas emissions and its components. The dependent variables are logarithm of the firm's direct CO_2 emissions, logarithm of the emissions due to purchased electricity, and logarithm of the firm's other supply chain emissions. The test variable is *Big Three*, which is institutional ownership by the largest index investors (BlackRock, Vanguard, State Street). The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

Panel A. Descriptive statistics

	Q25	Mean	Median	Std. Dev	Q75
Directly emitted CO_2	9.98	11.80	11.64	2.67	13.35
Purchased electricity CO_2	10.50	11.69	11.71	1.87	12.96
Supply chain CO_2	12.46	13.63	13.70	1.70	14.84

Panel B. Multivariate analysis

	Log(CO_2 directly emitted)	Log(CO_2 from purchased electricity)	Log(CO_2 from supply chain)
	(1)	(2)	(3)
Big3_Hldg	−1.57** (−2.38)	−0.40 (−0.53)	−1.47*** (−3.65)
NonBig3_Hldg	0.11 (0.75)	0.14 (0.91)	0.09 (1.03)
Controls	YES	YES	YES
Year FE	YES	YES	YES
Firm FE	YES	YES	YES
R^2	0.95	0.89	0.97
# Obs.	18,807	18,802	18,832

TABLE 9.
CROSS-SECTIONAL VARIATION: COUNTRY AND INDUSTRY

This table repeats the analysis in Table 4, Panel A, partitioning the sample based on country and industry affiliation. In columns (1) and (2) of Panel A, countries are classified based on geographic area (North America vs rest of the world or "ROW"). In columns (3) and (4) of Panel A, countries are classified based on their legal origin (common law vs civil law). In Panel B, industries are classified based on the aggregated emissions of each industry (using the 16-industry classification presented in Panel C of Table 1). Columns (1) and (2) of Panel B present results including two groups of eight industries, each based on whether industry emissions are above/below the median (sample of firms are included into either of the two groups based on their affiliation to these two groups). Columns (3) and (4) of Panel B present results including the top four and bottom four industries in terms of emission volume. The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

Panel A. Variation by geographic area and legal origin

	Dependent Variable: Log(CO_2)			
	By Geographic Area		By Legal Origin	
	North America (1)	ROW (2)	Common Law (3)	Civil Law (4)
Big3_Hldg	−1.36*** (−2.89)	−1.52** (−2.08)	−1.45*** (−3.26)	−1.74** (−2.08)
NonBig3_Hldg	0.05 (0.57)	0.16 (1.14)	−0.07 (−0.80)	0.28* (1.82)
Controls	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
R^2	0.98	0.97	0.97	0.98
# Obs.	7,529	11,303	10,298	8,534

Panel B. Variation by industry

	Top 8 vs bottom 8 industries based on emissions		Top 4 vs bottom 4 industries based on emissions	
	"Dirtier" industries (1)	"Cleaner" industries (2)	"Dirtier" industries (3)	"Cleaner" industries (4)
Big3_Hldg	–1.98*** (–2.74)	–0.80* (–1.94)	–2.13** (–2.14)	–1.09** (–2.37)
NonBig3_Hldg	0.04 (0.23)	0.08 (0.74)	0.48** (2.03)	0.00 (0.01)
Controls:	YES	YES	YES	YES
Country FE	NO	NO	NO	NO
Industry FE	NO	NO	NO	NO
Year FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
R^2	5,674	13,125	2,976	9,605
# Obs.	0.95	0.97	0.95	0.97

TABLE 10.
ROBUSTNESS TESTS ADDRESSING POTENTIAL MEASUREMENT ISSUES

This table presents results of robustness tests addressing potential measurement issues. Panel A presents estimations of the effect of *Big Three* ownership on scaled measures of CO_2 emissions. In models (1), (2), and (3) CO_2 emissions are scaled by total assets, sales, and cost of goods sold, respectively. Panel B partitions sample observations based on the source of CO_2 estimates. "Corporate estimates" refers to CO_2 estimates self-reported by the firm. "Trucost estimates" refers to CO_2 emissions estimated by Trucost. The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

Panel A. Alternative dependent variables

	Dependent Variable:		
	Log(CO_2/Assets) (1)	Log(CO_2/Sales) (2)	Log(CO_2/COGS) (3)
Big3_Hldg	–2.04*** (–5.16)	–9.80*** (–15.45)	–8.21*** (–12.87)
NonBig3_Hldg	0.08 (0.87)	0.57*** (4.82)	0.56*** (4.35)
Controls	YES	YES	YES
Year FE	YES	YES	YES
Firm FE	YES	YES	YES
R^2	0.99	0.82	0.79
# Obs.	18,825	18,654	16,060

Panel B. Source of the CO_2 estimates

	Dependent Variable: Log(CO_2)					
	Corporate estimates			Trucost estimates		
	(1)	(2)	(3)	(4)	(5)	(6)
Big3_Hldg	−4.41*** (−6.28)	−6.68*** (−6.31)	−2.17*** (−4.38)	−3.97*** (−5.52)	−1.81* (−1.91)	−1.27** (−2.36)
NonBig3_Hldg	−0.04 (−0.22)	0.07 (0.39)	0.05 (0.43)	0.39** (2.03)	0.25 (1.35)	−0.09 (−0.76)
Controls	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	NO	YES	YES	NO
Industry FE	YES	YES	NO	YES	YES	NO
Year FE	NO	YES	YES	NO	YES	YES
Firm FE	NO	NO	YES	NO	NO	YES
R^2	0.65	0.68	0.98	0.63	0.66	0.97
# Obs.	12,105	12,105	12,002	6,821	6,821	6,589

TABLE 11.
ENVIRONMENTAL SCORES AND CO2 EMISSIONS

This table presents results of the association between corporate carbon emissions and environmental scores from the Thomson Reuters ASSET4 ESG database. *CO_2 (t+s)* refers to CO_2 emissions in year t+s, where t is the current year and s=0, 1. *Environmental_Score* is the average of three sub-scores: *Emission_Reduction, Product_Innovation,* and *Resource_Reduction.* Each sub-score is computed as the scaled sum of a series of indicator variables for certain corporate actions. The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are reported in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

Panel A. Descriptive statistics

	P25	Mean	Median	Std. Dev	P75
Environmental_Score	2.59	3.16	3.36	0.72	3.77
Components of environmental score:					
Emission_Reduction	2.78	3.38	3.52	0.71	3.98
Product_Innovation	2.08	2.79	2.89	0.81	3.47
Resource_Reduction	2.47	3.13	3.38	0.83	3.85

Panel B. Multivariate analysis

	Dependent Variable: Log(CO_2(t+s))							
	s = 0				s = 1			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Environmental score	1.06*** (22.91)		0.20*** (10.03)		1.01*** (21.60)		0.16*** (8.24)	
Emission reduction		1.54*** (20.04)		0.09*** (3.56)		1.51*** (19.20)		0.07*** (2.82)
Product innovation		0.21*** (4.41)		−0.02 (−0.99)		0.22*** (4.50)		−0.00 (−0.01)
Resource reduction		−0.53*** (−9.75)		0.10*** (5.97)		−0.55*** (−9.83)		0.08*** (4.38)
Controls:								
Size	0.30*** (18.98)	0.32*** (21.31)	0.06*** (13.77)	0.06*** (13.66)	0.32*** (18.80)	0.33*** (20.90)	0.06*** (14.55)	0.06*** (14.56)
Log(BM)	0.13*** (3.39)	0.12*** (3.20)	0.06*** (4.01)	0.06*** (4.02)	0.09** (2.27)	0.08** (2.06)	0.00 (0.05)	0.00 (0.08)
ROA	0.01*** (3.94)	0.01*** (3.92)	0.01*** (5.00)	0.01*** (5.03)	0.01*** (3.41)	0.01*** (3.40)	0.01*** (4.51)	0.01*** (4.54)
Leverage	0.32** (1.98)	0.36** (2.36)	0.33*** (4.01)	0.32*** (3.86)	0.32* (1.92)	0.34** (2.19)	0.25*** (3.17)	0.25*** (3.09)
PPE	1.23*** (8.10)	1.07*** (7.75)	0.05 (0.29)	0.05 (0.29)	1.33*** (8.61)	1.17*** (8.36)	0.02 (0.13)	0.02 (0.11)
Country FE	YES	YES	NO	NO	YES	YES	NO	NO
Industry FE	YES	YES	NO	NO	YES	YES	NO	NO
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Firm FE	NO	NO	YES	YES	NO	NO	YES	YES
R^2	0.59	0.62	0.97	0.97	0.59	0.62	0.97	0.97
# Obs.	19,507	19,450	19,712	19,654	17,317	17,314	17,460	17,457

TABLE 12.
COMPARING THE BIG THREE WITH BENCHMARK INSTITUTIONS

This table compares the effect of Big Three ownership on CO_2 emissions with that of benchmark institutions. The dependent variable is the logarithm of CO_2 (i.e., the firm's total CO_2 emissions). *NonBig3_ Large* is the fraction of the firm's equity held by the top 100 institutions other than the Big Three. *NonBig3_Small* is the difference between *NonBig3_Hldg* and *NonBig3_Large*. *NonBig3_Index* is the fraction of the firm's equity held by indexers other than the Big Three. *NonBig3_NonIndex* is the difference between *NonBig3_Hldg* and *NonBig3_Index*. The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

	Dependent Variable: Log(CO_2)	
	(1)	(2)
Big3_Hldg	−1.26*** (−3.29)	−1.31*** (−3.44)
NonBig3_Large	0.13 (1.35)	
NonBig3_Small	0.08 (0.68)	
NonBig3_Index		0.48 (1.60)
NonBig3_NonIndex	0.09	(0.97)
Controls	YES	YES
Year FE	YES	YES
Firm FE	YES	YES
R^2	0.97	0.97
# Obs.	18,665	18,666

The Big Three and Corporate Carbon Emissions Around the World

Online Appendices

José Azar
IESE Business School & C.E.P.R.

Miguel Duro
IESE Business School

Igor Kadach
IESE Business School

Gaizka Ormazabal
IESE Business School, C.E.P.R. & E.C.G.I

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APPENDIX OA.
DISCUSSION ON THE BIG THREE'S INCENTIVES TO ENGAGE WITH PORTFOLIO FIRMS

To the extent that the majority of the funds sponsored by the Big Three are passively managed, the incentives of the Big Three to engage with portfolio firms are called into question by criticisms to passive investors' role on corporate governance. Regarding the benefits from monitoring portfolio firms, these criticisms point out that passive funds are locked into their investments (e.g., they track indexes), which prevents them from exploiting informational advantages through trading, as well as from "voting with their feet" (i.e., exiting from underperforming companies). Regarding the costs of monitoring portfolio firms, critics claim that passive funds compete against other passive funds on cost, and that monitoring would introduce significant research and engagement costs. These commentators conclude that the combination of modest benefits and substantial costs results in weak incentives to research and monitor portfolio companies (e.g., Bebchuk and Hirst 2019).

However, other considerations suggest that the net benefit from monitoring could be greater than suggested by the previous criticisms. As explained by Fisch et al. (2019), considering the incentives of fund sponsors (i.e., the investment management companies that sponsor the fund families) results in new insights on the governance role of the Big Three.

First, the benefits for the Big Three from monitoring portfolio firms can be substantial. The reason is that fund sponsors do not only compete on fees, but also on returns. In particular, index funds do not only compete with funds tracking the same index; they also compete with other passive funds tracking different indexes (currently, there is a proliferation of indexes followed by funds, each yielding a different return). The Big Three also compete with active funds because a number of investors (for example, 401(k) plan participants) can easily shift their assets from one fund to another without paying transaction costs or taxes. As such, monitoring portfolio firms can help large index sponsors to attract and retain investors by boosting the returns of the investment choices offered by the sponsor. The benefits for the Big Three from monitoring portfolio firms are likely to be more pronounced in cross-cutting issues such as corporate governance or sustainability than on firm-specific issues. This is because a passive investor can identify practices that are likely to reduce the risk of underperformance with little firm-specific information, and the investment in identifying an improvement can be deployed across a broad range of portfolio companies.

Prior literature provides evidence consistent with this idea. Appel et al. (2016)'s results suggest that more passive ownership affects corporate governance positively when it comes to *low-cost* governance activities, such as consistently voting according to a predefined program at annual meetings or endorsing removal of poison pills and staggered boards. However, the results in Schmidt and Fahlenbrach (2017) suggest that more passive ownership affects corporate governance negatively and reduces shareholder value when it comes to *high-cost* governance activities, such as the monitoring of mergers and acquisitions, the choice of board members, or the accumulation of titles, which often happen outside of annual general meetings and which require continuous monitoring.

Second, the costs for the Big Three from monitoring portfolio firms can be reduced in several ways. To begin, these large investors can benefit from economies of scale, for example, by setting up a centralized governance or stewardship committee that conducts corporate governance research for all the funds in the family. Moreover, as some of the funds sponsored by the Big Three are actively managed, passive funds could benefit from the firm-specific information generated by active investors in the family of funds. Finally, the large aggregate size of each of the Big Three gives them significant bargaining power in engagements with portfolio firms (they are likely pivotal voters), further reducing monitoring costs.

In support of these arguments, there is mounting anecdotal evidence that the Big Three are taking an active role in the economy. The reported number of engagements of these investors with portfolio firms is substantial and has increased dramatically in recent years.[41] Beyond engagements with individual firms, they are also promoting economy-wide initiatives for board-shareholder engagement, they have been active in the regulatory process (for example, by commenting on and calling for change to the rules adopted by the SEC), and they have engaged with index providers in the composition of the indexes (for example, by requesting the exclusion of firms with practices not favored by the Big Three). In addition, the Big Three actively participate

[41] While public engagements are not very common, private engagements appear to occur relatively often. For example, a recent survey by McCahery et al. (2016) finds that 63% of very large institutional investors have engaged in direct discussions with management over the past five years, and 45% had private discussions with a company's board outside of management's presence. In their Investment Stewardship Annual Report of 2019, BlackRock said that they engaged with 1,458 companies that year. Moreover, with some companies, BlackRock engaged more than once, bringing the total number of engagements to 2,050. Out of these engagements, BlackRock met with 256 companies to discuss climate-related risks (BlackRock 2018).

with various standard-setting organizations, and, in particular, with the SASB (Sustainability Accounting Standards Board).

APPENDIX OB.
DISCUSSION ON BIG THREE VOTING ON SHAREHOLDER PROPOSALS RELATED TO THE ENVIRONMENT

Historically, the Big Three have provided relatively little voting support to shareholder proposals related to climate issues. For example, in 2018, Vanguard voted for climate proposals 12% of the time, and BlackRock 10% of the time. In 2019, BlackRock supported 5 of the 36 climate-related shareholder proposals that came to a vote in the U.S. under Rule 14a-8. This relatively low support is sometimes interpreted as evidence that the Big Three are not active in the global effort to reduce corporate carbon emissions.[42]

Table OB.1 includes disclosures by the Big Three, providing an explanation for their lack of support to some shareholder proposals related to climate issues. The argumentation can be summarized as follows:

i) Shareholder proposals are relatively rare outside the U.S.

ii) Many of the proposals related to climate issues are inappropriate or unnecessary.

iii) The proposals that make sense are adopted in advance by companies. As a consequence, the sensible proposals are often withdrawn and end up not being included on the voting ballot. This is in line with the argument that voting could be a credible threat to discipline companies. A threat does not necessarily need to materialize to be effective (i.e., induce certain behavior).

iv) Actively engaging with companies could be more effective than supporting shareholder proposals.

v) Some of the Big Three have supported climate-related proposals in some well-known cases.[43]

[42] See, for example, https://www.cnbc.com/2019/10/13/blackrock-vanguard-found-religion-on-climate-doubts-are-growing.html, https://www.ft.com/content/8aade207-09bc-41a7-9f0a-24417882f1bc, https://www.bloomberg.com/news/articles/2019-12-13/blackrock-vanguard-face-shareholder-rebuke-over-climate-votes

[43] For example, BlackRock and Vanguard voted in 2017 to require Exxon Mobil to produce a climate change report.

The evidence in the academic literature provides some support for this argumentation. Prior research on shareholder voting raises concerns about the efficacy of this governance mechanism (e.g., Karpoff, Malatesta, and Walkling 1996; Gillan and Starks 2000). In a more recent survey of this literature, Ferri (2012) concludes that the effectiveness of shareholder proposals as a driver of change is unclear, among other things because they are non-binding for the target firm. In particular, Ertimur, Ferri, and Muslu (2011) find almost no support for more proposals to link executive pay to social criteria. Regarding the expected effectiveness of the votes, Ertimur, Ferri, and Stubben (2010) report an implementation rate of 3% for proposals receiving between 30% and 50% of the votes cast, a range that, historically, has been rarely achieved by climate-related proposals. That said, Ferri (2012) observes that the effectiveness of this type of activism has increased over time (although he also points out that whether this has resulted in value creation is still an open question).

Notably, in their study of investor ideology based on voting behavior, Bolton, Li, Ravina, and Rosenthal (2020) classify the Big Three as "center-right", but not as "far right" (these authors include support for environmental proposals among the types of behavior that suggest an ideology towards the "left").

APPENDIX OC.
ADDITIONAL ANALYSES

This appendix contains analyses addressing specific concerns about the inferences of the paper. These analyses are not included in the main body of the paper due to space limitations.

OC.1. Time-trend in the association between Big Three ownership and carbon emissions

We formally estimate the presence of a time-trend in the association between Big Three ownership and greenhouse gas emissions. We do so by reestimating equation (1) interacting *Big3_Hldg* with a variable capturing a time-trend, *Trend,* defined as 1 in 2005, 2 in 2006, 3 in 2007, and so forth. Table OC.1 presents the results of this analysis. The coefficient on the interaction is significantly negative, suggesting that the association between Big Three ownership and greenhouse gas emissions becomes stronger in later years of the sample period.

OC.2. Alternative clustering of standard errors

In our main analyses, we do not cluster standard errors by year because that would result in a small number of clusters (our sample has a relatively short time series), and thus in potential noise in the estimation of standard errors. That said, to corroborate that our inferences do not hinge on any particular way of estimating standard errors, we repeat our tests using different clustering strategies. As shown in Table OC.2, our inferences are unaffected.

OC.3. Exploiting the reconstitution of the Russell 1000/2000. Alternative research design

The identification strategy based on the Russell 1000/2000 has been implemented in several ways in prior papers (see Appel, Gormley, and Keim 2019b). We explore whether our results are sensitive to our implementation of this approach. As it is common in this literature, we focus on whether the stock falls above or below the 1000/2000 cutoff and control for the banding policy and the market capitalization at the end of May and June. In particular, we estimate the following model (Appel et al. 2019a):

First stage (Panel A):

$$Big3\_Hldg_{it} = \alpha + \beta * Russell2000_{it} + \Sigma\lambda_n * (\ln(Mktcap_{it}))^n + \nu * \ln(Float_{it}) + \phi_1 * Band_{it} + \phi_2 * Russell2000_{it-1} + \phi_3 * Band_{it} * Russell2000_{it-1} + \tau_t + \delta_i + \xi_{it} \quad (1)$$

Second stage (Panel B):

$$Log(CO_2)_{it+1} = \alpha + \beta * \widehat{Big3\_Hldg}_{it} + \Sigma\lambda_n * (\ln(Mktcap_{it}))^n + \nu * \ln(Float_{it}) + \phi_1 * Band_{it} + \phi_2 * Russell2000_{it-1} + \phi_3 * Band_{it} * Russell2000_{it-1} + \tau_t + \delta_i + \xi_{it} \quad (2)$$

$Russell2000_{it}$, the instrument, equals one if stock i is assigned to the Russell 2000 Index in year *t,* and zero otherwise; $Mktcap_{it}$ is the CRSP market capitalization of stock *i* as of the end of May of year *t;* $Float_{it}$ is the float-adjusted market capitalization of stock *i* as of the end of June of year t used by Russell to determine firm-specific index weights. $Band_{it}$ equals one if the firm's end of May market capitalization is away from the cutoff by less than 2.5% of Russell3000E cumulative market capitalization, and zero otherwise; $Russell2000_{it-1}$ equals one if the firm is in Russell2000 in the previous year and above the cutoff in the current year, and zero otherwise. $\widehat{Big3\_Hldg}_{it}$ is the fitted value of *Big3_Hldg* from the first stage estimation. The model includes polynomial controls of order N = 1 to 4. Results are based on a sample formed by the top-500 firms of the Russell2000 and the bottom-500 firms of the Russell1000 over the 2007-2015 period. As shown in Table OC.3, our inferences are not sensitive to this common alternative way of implementing the identification strategy based on the Russell 1000/2000.

OC.4. Exploiting the reconstitution of the Russell 1000/2000. Placebo test

We repeat our test in Table 5, replacing *Big3_Hldg* with *NonBig3_Hldg*. To the extent that index investing is more prevalent among the Big Three than among other investment companies, this additional analysis is a placebo test. As shown in Table OC.4, we do not find that *NonBig3_Hldg* is significantly determined by the inclusion in the Russell 1000/2000 indexes. Consistently, in the second stage we do not find any significant association between the fitted value of *NonBig3_Hldg* and carbon emissions. The outcome of this analysis suggests that the inclusion in the Russell 1000/2000 Indexes is not a generic instrument for institutional ownership, but rather an instrument for index investing, and thus –to the extent that most of the Big Three ownership is passive– a valid instrument for Big Three ownership.

OC.5. Alternative measurement of the cost of CO_2 emissions

One limitation of the measure *Carbon_Efficiency_Premium* used in Table 7 is that this measure does not capture cross-sectional variation in the cost of CO_2 emissions. To gauge whether this limitation could affect our inferences, in Table OC.5 we reconstruct this measure by replacing the S&P Global CEI with the S&P/TSX 60 CEI for Canadian firms and the S&P 500 CEI for U.S. firms (similar indexes are not available for other countries). While this alternative measurement causes sample attrition, our inferences are not affected by introducing this cross-sectional variation in *Carbon_Efficiency_Premium* (see Table OC.5).[44]

OC.6. Institutional investors and firms' environmental performance

To reconcile our results with prior research, we replicate tests in previous literature on the association between institutional ownership and environmental scores and total emissions. The dependent variables are Environmental total score and the logarithm of the firm's total CO_2. Institutional_Hldg is computed as institutions' holding in the firm, namely, the fraction of the firms' equity owned by institutional investors (i.e., *Big3_Hldg + NonBig3_Hldg*). Table OC.6 presents the results. In consistency with prior research (Dyck et al. 2019), we find a positive association between the institutional ownership and environmental scores that is robust to the inclusion of control variables, country, industry, and year-fixed effects. However, in contrast with our main results using Big Three ownership, we find that, if anything, the association between institutional ownership and total CO_2 emissions is positive (rather than negative).

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TABLE OB.1.
DISCLOSURES BY THE BIG THREE ABOUT VOTING ON CLIMATE-RELATED SHAREHOLDER PROPOSALS

"…not all markets employ shareholder proposals and not all shareholder proposals are drafted to elicit material, decision-useful information for investors. Specifically, of the 207 companies BlackRock engaged with globally on the topic of climate risk in 2019, only 40 companies globally received shareholder proposals related to climate risk, the majority of which were filed in the U.S. and EMEA, and predominantly targeted by the industrial and energy sectors."

Source: https://www.blackrock.com/corporate/literature/publication/blk-qtrly-commentary-2019-q2-amrs.pdf

"those proposals are often poorly constructed or conflate multiple issues, including ones that a company may not have the ability to act upon, and encourage inconsistent reporting that impedes comparability across different sectors and markets. In our view, given that shareholder proposals represent less than 2% of the ballot items in the U.S., there is disproportionate attention paid to them by commentators, many of whom make a simplistic assessment of an investor's position on the issue raised by the proposal."

Source: https://www.blackrock.com/corporate/literature/publication/blk-qtrly-commentary-2019-q2-amrs.pdf

"BlackRock's approach is to assess the company's current disclosures and management of the issue that the shareholder proposal raises. Particularly in relation to proposals' environmental and social (E&S) issues, we seek to understand how the issue might impact the company's long-term business operations and potential to deliver sustainable financial returns. If we determine that the issue is material and don't have a clear sense that it is being managed appropriately, we will engage the company to discuss its approach to the issue and how the board and management see the situation evolving over time. The importance of engagement is to explain to the company BlackRock's views on the issue and provide feedback on the company's approach from our perspective as a long-term investor on behalf of clients. In the past year, we engaged with over 1,400 individual companies on a wide range of ESG issues. In many cases, we have seen companies improve on 'E' and 'S', as well as 'G' (or governance), issues through engagement(s) over time. In a meaningful number of situations, shareholders who table proposals at companies determine that the company's approach or planned actions are sufficient to address the issue and withdraw the proposal. Similarly, BlackRock may determine that there is no need to support a shareholder proposal that does go to a vote based on our assessment that management's approach broadly addresses the issue."

Source: https://www.blackrock.com/corporate/literature/publication/blk-qtrly-commentary-2019-q2-amrs.pdf

"Blackrock assesses each management and shareholder proposal –through engagement and internal analysis –that comes to a vote. We vote to achieve the outcome that we believe is most aligned with our clients' long-term economic interests. We have been surprised to see some asset managers have a perfect record of voting in favor of shareholder proposals, even when numerous proposals are not advantageous to shareholders or when the company is making demonstrable progress on an issue."

Source: https://www.blackrock.com/corporate/literature/publication/blk-qtrly-commentary-2019-q2-amrs.pdf

TABLE OC.1.
TREND IN THE ASSOCIATION BETWEEN BIG THREE OWNERSHIP AND CO_2 EMISSIONS

This table presents estimations of the time-trend in the association between Big Three ownership and greenhouse gas emissions. The dependent variable is a natural logarithm of the firm's total CO_2 emissions. *Big Three* is the fraction of the firm's equity held by the BlackRock, Vanguard, and State Street. *Trend* is a variable capturing a time-trend, defined as one in 2005, two in 2006, three in 2007, and so forth. The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

	Dependent Variable: *Log(CO_2)*	
	(1)	**(2)**
Big3_Hldg	−4.70*** (−4.26)	2.74 (1.36)
Big3_Hldg*Trend		−0.74*** (−5.50)
NonBig3_Hldg	0.36* (1.88)	0.28 (1.42)
Country FE	YES	YES
Industry FE	YES	YES
Year FE	YES	YES
R^2	0.53	0.53
# Obs.	18,707	18,707

TABLE OC.2.
ALTERNATIVE CLUSTERING OF STANDARD ERRORS

This table presents estimations of the effect of Big Three ownership on total carbon emissions using alternative clustering options. The dependent variable is the logarithm of CO_2 (i.e., the firm's total carbon emissions). The experimental variable is the fraction of the firm's equity owned by BlackRock, Vanguard, and StateStreet. Other variables are defined in Appendix A. Columns (1) – (3) report results of estimations on a subsample of large firms that are members of MSCI World (or S&P 500) Index using different clustering options. Columns (4) – (6) report results of estimations on a subsample of smaller firms present in the Trucost database using different clustering options. Both subsamples span the period from 2005 to 2018. Independent variables are measured at the end of the prior year. Standard errors are double clustered at country and industry levels (columns 1 and 4), triple clustered at country, industry and year levels (columns 2 and 4), and double clustered at firm and year levels (columns 3 and 6). t-statistics are in parentheses. *, ** and *** denote significance at the 10%, 5%, and 1% level (two-tail) respectively. Intercepts are omitted.

	Dependent Variable: *Log(CO_2)*					
	MSCI firms			**Other international firms**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Big3_Hldg	−1.29*** (−2.57)	−1.29*** (−2.57)	−1.25** (−2.54)	0.37 (1.34)	0.37 (1.45)	0.39 (1.29)
NonBig3_Hldg	0.06 (0.45)	0.06 (0.46)	0.07 (0.72)	0.20*** (6.93)	0.20*** (7.48)	0.22*** (3.49)
Controls	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Clustered by	Country and Industry	Country, Industry, and Year	Firm and Year	Country and Industry	Country, Industry, and Year	Firm and Year
R^2	0.97	0.97	0.97	0.97	0.97	0.97
# Obs.	18,608	18,608	18,832	40,373	40,373	40,433

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TABLE OC.3.
EXPLOITING THE RECONSTITUTION OF THE RUSSELL 1000/2000.

Alternative research design

This table reports estimates from an instrumental variable analysis exploiting the reconstitution of the index Russell 1000/2000. The results correspond to the estimation of the following model (Appel et al. 2019a):

First stage (Panel A):

$$Big3\_Hldg_{it} = \alpha + \beta * Russell2000_{it} + \Sigma\lambda_n * (\ln(Mktcap_{it}))^n + \nu * \ln(Float_{it}) + \phi_1 * Band_{it} + \phi_2 * Russell2000_{it-1} + \phi_3 * Band_{it} * Russell2000_{it-1} + \tau_t + \delta_i + \xi_{it} \quad (1)$$

Second stage (Panel B):

$$Log(CO_2)_{it+1} = \alpha + \beta * \widehat{Big3\_Hldg}_{it} + \Sigma\lambda_n * (\ln(Mktcap_{it}))^n + \nu * \ln(Float_{it}) + \phi_1 * Band_{it} + \phi_2 * Russell2000_{it-1} + \phi_3 * Band_{it} * Russell2000_{it-1} + \tau_t + \delta_i + \xi_{it} \quad (2)$$

$Russell2000_{it}$, the instrument, equals one if stock i is assigned to the Russell 2000 Index in year t, and zero otherwise; $Mktcap_{it}$ is the CRSP market capitalization of stock i as of the end of May of year t; $Float_{it}$ is the float-adjusted market capitalization of stock i as of the end of June of year t used by Russell to determine firm-specific index weights. $Band_{it}$ equals one if the firm's end of May market capitalization is away from the cutoff by less than 2.5% of Russell3000E cumulative market capitalization, and zero otherwise; $Russell2000_{it-1}$ equals one if the firm is in Russell2000 in the previous year and above the cutoff in the current year, and zero otherwise. $\widehat{Big3\_Hldg}_{it}$ is the fitted value of *Big3_Hldg* from the first stage estimation. The model includes polynomial controls of order N = 1 to 4. Results are based on a sample formed by the top 500 firms of the Russell2000 and the bottom 500 firms of the Russell1000 over the 2007-2015 period. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Intercepts are omitted.

Panel A. First stage

	Dep. Var.: *$Big3\_Hldg_t$*			
	(1)	(2)	(3)	(4)
$Russell2000_t$	0.009*** (4.43)	0.009*** (4.48)	0.008*** (3.95)	0.008*** (3.92)
Polynomial order, N	1	2	3	4
Banding controls	YES	YES	YES	YES
Float control	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Kleibergen-Paap F-stat.	19.65	20.06	15.64	15.37
R^2	0.82	0.82	0.82	0.83
# Obs.	3,359	3,359	3,359	3,359

Panel B. Second stage

	Dep. Var.: *$Log(CO_2)_{t+1}$*			
	(1)	(2)	(3)	(4)
$\widehat{Big3\_Hldg}_t$	−13.06** (−2.27)	−12.28** (−2.19)	−13.23** (−2.13)	−13.50** (−2.14)
Polynomial order, N	1	2	3	4
Banding controls	YES	YES	YES	YES
Float control	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
R^2	0.97	0.97	0.97	0.97
# Obs.	3,359	3,359	3,359	3,359

TABLE OC.4.
EXPLOITING THE RECONSTITUTION OF THE RUSSELL 1000/2000.
PLACEBO TEST.

This table reports estimates from an instrumental variable analysis exploiting the reconstitution of the index Russell 1000/2000. The results correspond to the estimation of the following model:

First stage (Panel A):

$$Non\_Big3\_Hldg_{it} = \alpha + \beta * Russell2000_{it} + \Sigma\lambda_n * (\ln(Mktcap_{it}))^n + \nu * \ln(Float_{it}) + \tau_t + \delta_i + \xi_{it} \quad (1)$$

Second stage (Panel B):

$$Log(CO_2)_{it+1} = \alpha + \beta * \widehat{Non\_Big3\_Hldg}_{it} + \Sigma\lambda_n * (\ln(Mktcap_{it}))^n + \nu * \ln(Float_{it}) + \tau_t + \delta_i + \xi_{it} \quad (2)$$

$Russell2000_{it}$, the instrument, equals one if stock i is assigned to the Russell 2000 Index in year t, and zero otherwise; $Mktcap_{it}$ is the CRSP market capitalization of stock *i* as of the end of May of year *t*; $Float_{it}$ is the float-adjusted market capitalization of stock *i* as of the end of June of year *t* used by Russell to determine firm-specific index weights. $\widehat{Non\_Big3\_Hldg}_{it}$ is the fitted value of *Non_Big3_Hldg* from the first stage estimation. The model includes polynomial controls of order N = 3. Results are based on a sample formed by bandwidths of 600, 500, and 400 firms around the Russell1000/2000 cut-off points in the years 2007-2015. Standard errors are clustered at the firm level. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. Intercepts are omitted. “FE” stands for “fixed effects”.

Panel A. First stage

	Dep. Var.: *Non_Big3_Hldg*$_t$		
	(1)	(2)	(3)
Russell2000t	−0.008 (−1.02)	−0.013 (−1.63)	−0.008 (−0.94)
Polynomial order, N	3	3	3
Bandwidth	600	500	400
Float control	YES	YES	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
Kleibergen-Paap F-stat.	1.03	2.66	0.88
R^2	0.89	0.89	0.90
# Obs.	2,544	1,946	1,374

Panel B. Second stage

	Dep. Var.: $Log(CO_2)_{t+1}$		
	(1)	(2)	(3)
$\widehat{\text{Non\_Big3\_Hldg}}_t$	10.68 (0.91)	5.90 (1.23)	9.62 (0.85)
Polynomial order, N	3	3	3
Bandwidth	600	500	400
Float control	YES	YES	YES
Firm FE	YES	YES	YES
Year FE	YES	YES	YES
R^2	0.87	0.95	0.90
# Obs.	2,544	1,946	1,374

TABLE OC.5.
ALTERNATIVE MEASUREMENT OF COST OF CO_2 EMISSIONS

This table presents a variant of Table 7. The dependent variable is a natural logarithm of the firm's total CO_2 emissions. *Big Three* is the fraction of the firm's equity held by the BlackRock, Vanguard, and State Street. *Carbon_Efficiency_Premium* is defined using all the available cross-country variation in carbon efficient indexes. For the U.S., this variable is computed as the difference between S&P 500 CEI and the return on the S&P 500. In Canada, we replace the S&P 500 CEI with the S&P/TSX 60 CEI for Canadian firms. In the rest of the sample countries for which there is no specific carbon efficiency index, we replace the S&P 500 CEI with the S&P Global CEI. The rest of the variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

	Dependent Variable: ***Log(CO_2)***
Big3_Hldg	−2.11*** (−5.14)
Carbon_Efficiency_Premium*Big3_Hldg	−0.12*** (−4.96)
Carbon_Efficiency_Premium	−0.00** (−2.54)
NonBig3_Hldg	0.06 (0.56)
Controls	YES
Year FE	YES
Firm FE	YES
R2	0.97
# Obs.	13,990

TABLE OC.6.
INSTITUTIONAL INVESTORS AND FIRMS' ENVIRONMENTAL PERFORMANCE

This table presents estimations of the effect of institutional ownership on environmental scores and total emissions. The dependent variables are *Environmental score* and the logarithm of the firm's total CO_2. Variables are defined in Appendix A. Results are based on the sample firm-year observations corresponding to MSCI firms. Independent variables are measured at the end of the prior year. Standard errors are clustered at the firm level. *t*-statistics are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% levels (two-tail) respectively. Intercepts are omitted.

	Dependent Variable: *Log(Environmental total score)*		Dependent Variable: *Log*(CO_2)	
	(1)	(2)	(3)	(4)
Institutional_Hldg	0.25** (2.35)	0.10 (1.15)	0.46* (1.92)	0.20* (1.67)
Controls:				
Size	0.11*** (18.23)	0.01*** (3.89)	0.36*** (19.12)	0.03*** (7.80)
Log(BM)	0.02 (0.78)	0.00 (0.07)	0.24*** (4.47)	0.05*** (2.73)
ROA	0.00 (0.21)	0.00 (0.40)	0.01 (1.36)	0.01** (2.15)
Leverage	–0.10 (–1.05)	0.05 (0.74)	0.39* (1.69)	0.34*** (2.91)
PPE	0.50*** (7.32)	0.06 (0.80)	2.27*** (10.54)	0.31 (1.09)
Country FE	YES	NO	YES	NO
Industry FE	YES	NO	YES	NO
Year FE	YES	YES	YES	YES
Firm FE	NO	YES	NO	YES
R2	0.43	0.89	0.49	0.97
# Obs.	12,403	12,500	12,592	12,688