CEO Career Horizon and Corporate Environmental Responsibility

ABSTRACT

We investigate the effect of CEO Career Horizon on Corporate Environment Responsibility (CER). CEO Career Horizon reflects the time period that the CEO is expected to stay in office and is an inverse proxy for the short-termism or managerial myopia problem, whereas CER can be defined as the strategies firms apply to deal with environmental risks and opportunities. Though undeniably beneficial for both firms and the planet in the long run, CER initiatives may pose potential short-term costs to CEOs' personal wealth. Using a sample of over 1,000 U.S. firms in the period of 2007-2020, we find consistent evidence that CEO Career Horizon has a positive effect on CER. Our results are robust to concerns of selection bias, omitted variable bias, and reverse causality and remain unchanged after deploying propensity-score matching and entropy balance techniques, an instrumental variables (IV) design, and incorporating a set of multidimensional fixed effects. The results are also robust to alternative proxies of CEO Career Horizon. Overall, our results suggest that CEO with longer career horizon and early tenured are those more likely to invest in CER. We contribute to the ongoing discussion on how companies exhibit diverse responses to risk management, specifically concerning climate change, arising from distinct personal preferences of decision-makers.

Keywords: *CEO Career Horizon; Corporate Environmental Responsibility; Environmental Costs; Economic short-termism; CEO preferences; Climate change.*

1. Introduction

Companies are facing increasing pressure from investors and non-equity stakeholders to prioritize environmentally sustainable practices to minimize the effects of climate change (Clarkson et al. 2015). As Chava (2014) argues, the environmental profile of a company encompasses two different broad areas of action: one that is already regulated by current legislations (e.g., the use of toxic chemicals and the disposal of hazardous materials) and another that is more under discretion of top management (e.g., carbon footprint and the use of alternative sources of energy). Currently, there has been increasing pressure on firms from institutional investors (Azar et al., 2021) via shareholder activism (Flammer et al. 2021), but also from non-equity stakeholders at large (Ramelli et al., 2020) to act in the discretionary aspects of corporate environmental responsibility (CER).

Previous literature argues that the adoption of sustainable practices to mitigate environmental risks is part of a firm's CER (Holtbrügge & Dögl, 2012), which is a subset of a firm's Corporate Social Responsibility (CSR) (Renneboog et al., 2008; Cai et al., 2016; El Ghoul et al., 2018). Empirical investigations on the association between CER and financial performance have been profuse. Garel and Petit-Romec (2023), for example, found that firms with more responsible strategies to environmental issues have experienced better stock returns during Covid-19. Similarly, Cai et al's (2016) findings suggest that CER is inversely related to a firm's stock volatility and stock beta, while El Ghoul et al (2018) suggest a negative relationship between CER and cost of equity capital and Cai and He (2014) show that environmentally responsible firms outperform their counterparts. Previous literature also links CER with negative financial outcomes. Hsu, Li and Tsou (2023), Chava (2014), and Bolton and Kacperczyk (2019) document that investors require extra return from firms with worse environmental performance implying there is a negative correlation between CER and market valuation, while Fernando et al. (2017) has found that increasing CER does not lead to higher market valuation.

While insightful in many respects, these prior studies about the effects of CER on firm's financial outcomes tend to overlook the decision makers' preferences, and the fact that their individual preferences may conflict with firm's equity and non-equity stakeholders. Managerial myopia, for instance, has been recognized as having adverse effects on firms' performance (i.e., Antia et al., 2010), and a managerial behavior that becomes pronounced in companies where CEOs are nearing retirement, a phenomenon often referred to as the "horizon problem" (Dechow & Sloan, 1991). This implies that when deciding about the level of investment on or engagement with sustainable practices, self-interested managers may face a trade-off between individual preferences and firm's long term sustainable performance (i.e., CER). Individual preferences that may be driven by decision-makers personal traits. For example, the studies by Cronqvist and Yu (2017) and Homroy (2023) found an increase in CER when a firm's CEO has a daughter, implying that CEO's family ties matter for decision-making regarding environmental issues. Along the same line, CEO gender (Dyck et al., 2020), CEO educational level (Lewis et al. 2014), and CEO political orientation (Markoczy, Kolev & Qian, 2023) were found to be associated with CER. These studies highlight the relevance of considering CEO's personal traits and preferences on CER, but do not directly address the CEO career horizon problem.

Against this background, we examine whether and how CEO career horizon affects the firm's CER, as reflected in the level of environmental costs a firm generates from its activities. CEO Career horizon can be defined as the remaining period that the CEO is expected to stay in office and is arguably an inverse proxy for what extant literature calls short-termism problem or managerial myopia (Antia et al., 2010; Lee et al, 2018; Matta & Beamish, 2008; Mekhaimer et al 2022). There are three concurrent views that could explain the association between CEO career horizon and CER. The *risk management hypothesis* suggests that longer CEO career horizon will create incentives to decrease firm's environmental impact in order to decrease the risk exposure and potential sanctions against the firm, and ultimately firm's cost of capital. In contrast, the *short-termism hypothesis* suggests that CEOs with longer career horizon are those more likely to be pressured by institutional investors and non-equity stakeholders to create short-term performance even if it compromises long-term performance, implying that they might prefer processes that boost short-term financial performance in detriment of CER. Finally, it also could be the case that CEO career horizon will not affect CER if the firm is already at the optimal point of CER and no alternative options or technology exist. Considering these competing predictions, whether CEO career horizon can explain firm's CER is ultimately an empirical question, which this article aims to answer.

We investigate our research question based on a sample of over 1,000 U.S. listed companies in the period 2007-2020. We collected environmental cost data from S&P Global's *Trucost* to capture firms' CER. *Trucost* assesses the environmental performance of more than 15,000 firms around the world and provides dollar metrics of the impact that each firm has on the environment. We followed previous literature (Antia et al., 2010; Lee et al, 2018; Mekhaimer et al 2022) and measured CEO career horizon as a combination of the CEO's age and tenure. First, there is a clear link between age (tenure) and managerial myopia since, *ceteris paribus*, older (more tenured) CEOs are more likely to be replaced than their younger counterparts. Similarly, older and more tenured CEOs are much closer to retirement than younger and low tenured CEOs, making them more likely to act myopically by focusing only the period before retirement while ignoring what may happen to the firm after the employment time horizon (Antia et al., 2010; Gibbons & Murphy, 1992). As age and tenure increase, retirement is getting closer, and the CEO is increasingly more likely to act sub-optimally within the firm. Additionally, CEOs estimate their remaining time in office by comparing themselves with other CEOs in the same industry, thus we followed Antia et al. (2010) and adjust the measurements of CEO career horizon by the mean value of each firm's industry. Figures 1 and 2 contain, respectively, the distribution of tenure and age. In our sample, the average CEO stays 8.50 years with the same firm and is 57 years old, which is similar to Antia et al. (2010).

Our analysis suggests a robust negative effect of CEO career horizon on direct environmental costs (DEC) but not on total environmental costs (TEC). In other words, and consistent with the horizon problem, our results suggest that CEOs prioritizing short-term gains often sidestep sustainable practices, allocating fewer resources to these initiatives. More precisely, our results suggest that moving CEO career horizon from the 25% to the 75% percentile leads to a decrease in direct environmental costs of over 4% of the firm's total assets—the average firm in our sample has total assets of around 4000 million USD)—implying a significant economic effect. Overall, our results imply that CEO career horizon is an important driver of a firm's CER.

In our main analysis, we include firm and year fixed effects and used lagged control variables to mitigate concerns of simultaneity. However, our results are robust across many different specifications that mitigate concerns of selection bias, omitted variable bias (OVB), and reverse causality as well. First, we show there is significant firm heterogeneity in the level of CEO career horizon and that firms whose CEO has a longer horizon are different than those whose CEO has a shorter horizon. Thus, to mitigate concerns of selection bias we deploy a propensity-scored matched (PSM) and entropy balanced subsamples (Hainmueller, 2012) with no significant changes in our results. Additionally, to alleviate concerns of OVB, we employ 1) a multidimensional fixed effect design including industry-year and executives fixed effects, and 2) an instrumental variables design that uses the Consumer Price Index (CPI) as instrument, following extant literature (Cline and Yore, 2016; Serfling, 2014; Mekhaimer et al 2022). We find no significant changes in the main results. To mitigate concerns of reverse causality, we also estimate the main model excluding the CEOs more likely to present such problem (i.e., those CEOs with tenure lower than 3 years) (Lee et al., 2018) while also estimating a first-difference model. Again, the results are robust and suggest that reverse causality is not driving the main results. Finally, we endeavor in many additional analyses and show that the level of a firm's institutional ownership is not a driver of our results, even when the firm's ownership base contains investors with a long time-horizon, foreign investors from countries with more stringent environmental concerns, or are signatories of the Principles for Responsible Investment (PRI). We also show that recently hired CEOs are those that improve CER. Additionally, we used alternative metrics of CEO horizon with consistent findings. Overall, our results consistently shows that longer CEO career horizon decreases firm's environmental costs, our measure of CER.

Our study contributes to the related literature in several ways. First, we provide new evidence to the CEO time-horizon literature, and the importance to consider CEO personal traits when investigating firm's behavior. Prior studies have shown that CEO time-horizon affects firm's market valuation (Antia et al., 2009), the magnitude of firm's investments in real options (Lee et al., 2018), and the likelihood of international acquisitions (Matta & Beamish, 2008). In this article, we complement this literature by showing the interplay between CEO time-horizon and organizational structure when investigating firm non-financial outcomes, such as CER. In doing so we add to the discussion of firm's heterogenous response to risk management (in our case climate change) arising from decision-makers personal traits.

In addition to providing evidence on the positive effect of CEO career horizon on CER, we provide evidence that CEO career horizon does not affect TEC. Thus, we contribute to the literature analyzing the short- versus long-term effects of firm's CER (Dai et al., 2021), by showing the limitations of CEO career horizon in mitigating indirect, less tangible, and more challenging environmental costs. Reducing indirect environmental costs often requires more extensive changes across the entire value chain, including suppliers and partners, making it a complex and resource-intensive endeavor. Our findings suggests that CEOs still might prioritize reducing direct costs, as they are more controllable and provide quicker returns on investment. Finally, we contribute to existing literature investigating the impact of institutional investors on firms' carbon emissions (Azar et al. 2021; Bolton & Kacperczyk, 2021). Our study reveals that institutional ownership does not significantly influence CER nor the relationship between CEO career horizon and CER, thus providing contrasting evidence in cases where CER encompasses a broader and monetary dimension of environmental costs, instead of volumetric measures of CER such as carbon emissions.

Finally, our article also contributes to the literature on how managerial preferences and managerial compensation shape corporate policies. By showing that CEO career horizon seems to dominate the effect on CER, and that long-term financial incentives play less of a role, we underscore some limitations of compensation structures on shaping CER. Thus, this study may provide to the board of directors an additional dimension to consider when creating the CEOs' incentives packages.

2. Literature review and Hypothesis

Corporate Environmental Responsibility (CER)

While there is an extensive literature on Corporate Social Responsibility (CSR) (Gillan et al., 2021), the literature on CER is more sparce. In fact, previous literature usually argues that CER is a subset of CSR (Cai et al., 2016; El Ghoul et al., 2018). According to Holtbrügge and Dögl (2012), CER refers to how companies deal with environmental risks and opportunities. CER contains many interrelated aspects, such that, to improve CER, firms need to invest not only in the use of clean energy and the reduction of GHG emissions, but also in projects that foster environmental-friendly technology to increase recycling of waste and not pollute water. By focusing on these innovations, companies can not only better manage the risks and long-term performance effects associated with environmental issues, but also create opportunities that arise from such environmental-friendly innovations. According to this view, investments in CER can be referred as a risk management strategy, given that CER may protect firms from climate-related physical and transition risks (Godfrey et al. 2009, McCarthy et al, 2017), which in turn decrease firm's cost of capital (El Ghoul et al., 2018), and stock-price volatility and beta (Cai et al., 2016).

Due to its expected negative association with corporate risk and cost of capital, CER is also expected to increase firm value. This is consistent with Garel and Petit-Romec (2021) who found that firms with more responsible environmental practices show better stock returns during the COVID-19 crisis. Similarly, Fernando et al. (2017) show that institutional investors tend to avoid firms with high exposure to environmental risks, which in turn make firms market value to decrease. Moreover, Chava (2014) shows that firms with more environmental concerns are charged with higher interest rates from debtholders and higher expected returns from shareholders. Along the same line, Matsumura et al. (2014) and Clarkson et al. (2015) also found that firms with larger carbon emission, thus lower CER, have lower market valuation. However, previous literature acknowledges that CER can also decrease firm value if environmental-related investments are negative-NPV projects, especially if firms need to internalize environmental costs to comply with regulations or cannot transfer the costs of environmental-friendly practices to the customers (Matsumura et al., 2014). There have also been arguments that managerial investments in CER might represent a form of insider-initiated philanthropy by which managers sacrifice shareholder’s wealth for the greater good (Bénabou & Tirole, 2010), implying that firm value is not maximized. Consistent with this view, Hsu, Li and Tsou (2023) found that a portfolio combining firms with high toxic emission intensity minus firms with low intensity produces an annual return of over 4%, while Bolton and Kacperczyk (2019) documented that investors earn a premium from investing in firms with high carbon emission levels. Both articles imply a negative association between CER and stock return.

Finally, extant literature also argues that CER influence the reputation of a firm. Gangi et al (2020), for example, show that CER fosters corporate reputation by aligning the environmental-related stakeholders’ expectations with the corporate processes of creating value. They found a positive association between CER and corporate reputation. Similarly, CER is assumed to enhance or stablish strong corporate legitimacy with stakeholders through the transparent disclosure of superior environmental performance (Marquis et al. 2016).

Although the firm valuation benefits of CER discussed above, CER-related capital investments can conflict with CEO risk and return preferences. Previous literature has shown that a misalignment may occur between the preferences of managers and those of the shareholders in many aspects of a firm's daily operations (Jensen & Meckling, 1976; Shleifer & Vishny, 1997). Because managers have incentives to generate and disclose value every quarter, they have incentives to make decisions and favor projects that will deliver short-term performance at the expense of longer-term investment opportunities that otherwise would be more beneficial to the firm (Stein, 1989, 1988; Antia et al., 2010). This managerial short-termism has attracted attention from researchers and practitioners since it is at the core of not only the manager's effectiveness assessment, but also an important determinant of corporate investment policy and value (Aktas et al. 2021). In essence, this literature underscores the tendency of managers to exhibit short-term behavior created by the differences in the intertemporal preferences of managers and shareholders.

One key ingredient of managerial short-termism uncovered by recent literature refers to the CEO career horizon, which can be define as the expected amount of time the CEO has left in the office (Antia et al., 2010; Matta & Beamish, 2008; Lee et al, 2018; Mekhaimer et al, 2022). Because CEOs are more likely to commit to actions that enable them to collect the reward during their tenure, the shorter the CEO career horizon, the more pronounced is the managerial short-termism problem (Lee et al, 2018). In theory, CEOs that are closer to leave the office could even show an extreme version of the risk-taking behavior described in Jensen and Meckling (1976) by investing only in high risky but highly profitable projects, driven by the prospect of securing a higher bonus on their exit, regardless of the long-term consequences for the company. On the other end of the horizon spectrum, CEOs with longer horizons have a higher likelihood of acting with interests aligned to those of the shareholders because they have more time to collect the rewards of their decisions and more time to answer to or repair any misjudged investment decision.

How does CEO carrer horizon affect CER?

To understand the possible effect of CEO horizon on CER, we rely on research drawing arguments from the risk management theory (Godfrey et al. 2009) and the career concern theory (Gibbons & Murphy, 1992), while also embedding concepts from the time-based agency problem between managers and shareholders as described by Flammer and Bansal (2017).

Accordingly, there are many reasons to anticipate that CEOs with longer career horizon will improve CER. First, by improving firm's CER (i.e., decreasing firm's environmental costs), the CEO may reduce the current risk of future regulatory sanctions against the firm (i.e., *risk management hypothesis*). While this reduction in risk is captured by the current stock price, CEOs with longer horizons will benefit the most from such reduction, as long as they stay in the office. Similarly, CEOs with limited career horizon might avoid decisions that could be detrimental to short-term performance evaluation and reputation management (Matta and Beamish, 2008; Flammer & Bansal, 2017) like spending in R&D (Dechow & Sloan, 1991). In extreme cases, CEOs may manage earnings (DeGeorge, Patel & Zeckauser, 1999) or even cut real activities (Roychowdhury, 2006), like CER, just to beat the analysts' earnings forecasts. This is consistent with previous literature showing that older CEOs tend to prefer low-risk corporate policies (Serfling, 2014), while younger CEOs tend to expand the firm and start new lines of business more often (Li et al, 2017). Along the same lines, assuming that CER is a strategy oriented to long-term performance, CEOs with a shorter career horizon are less likely to endeavor in decisions that are beneficial to the firm in the long term but potentially costly to her personal wealth in the short term, such as supporting CER (Fabrizi et al. 2014; Flammer & Bansal, 2017; Oh et al., 2016). Second, embracing CER attracts more institutional investors, potentially leading to a decrease in the cost of capital, as indicated by studies such as Fernando et al. (2017) and Chava (2014). Because CEOs with longer horizon expect to stay longer in the office, they will benefit the most from a decrease in the current cost of capital. Finally, previous literature suggests that younger CEOs are more purpose-driven and tend to respond more strongly to environmental and social movements (Luu & Rubio, 2023), while less tenured CEOs are more likely to disclose environmental risks (Lewis et al, 2013), implying that CEO with longer horizon are more willing to invest in CER initiatives.

Nevertheless, there are many reasons why longer CEO horizon might have an opposite effect that drives lower investments in environmentally responsible practices, thus worsening the firm's CER. Previous literature argues that younger and low-tenured CEOs (e.g., longer CEO horizon) are more concerned and feel more pressured to deliver short-term performance even by making decisions that have negative effects on long-term performance—this is often refereed as the *career concern hypothesis* (Gibbons & Murphy, 1992). Therefore, CEOs with longer expected horizon are those more likely to boost, for instance, factory production and customer services, which might be detrimental to the environmental and increase environmental costs. Second, younger and low-tenured CEOs might receive extra pressure from important institutional shareholders and stakeholders for immediate results pushing them to prioritize cost-cutting measures that may have negative environmental consequences. Third, this short-term focus of young and low-tenured CEOs might make them more likely to, for instance, delay investing in energy-efficient equipment or renewable energy sources, or to cut costs by reducing pollution control measures or using cheaper but more harmful materials. This can lead to increased greenhouse gas emissions, water pollution, and other environmental problems. Ultimately, the *career concern hypothesis* suggests that CEO horizon will negatively affect CER.

Finally, it is also theoretically possible that CEO horizon has no effect on the firm's CER. First, given the recent politicization of ESG issues (Edmans, 2022) and how firms may react to the personal beliefs and values of their managers and investors (Di Giuli & Kostovetsky, 2014; Kim et al., 2020; Starks, 2023), CER may ultimately be driven by non-pecuniary preferences, implying that if the firm's most salient shareholders are not adherent to sustainable investments, then firm's will likely avoid investing in CER. Second, the financial consequences of changing eco-harming to eco-friendly processes and products is unclear, especially if the eco-friendly solutions are more expensive or inexistent. This will make both CEOs with short or long horizon avoid changing the processes of the firm and thus will not impact CER. Third, cleaner technologies might not be available to the firm or maybe the firm is already operating at the optimal CER, thus changes are not realistic or possible. Ultimately, these arguments imply that both CEOs with short or long horizon will not promote significant changes in the firm's CER and thus, no association between CEO horizon and environmental costs will exist.

Considering all these competing perspectives, how does CEO horizon affect CER is ultimately an empirical question, which this article aims to answer. In the next section, we discuss the empirical design used to investigate such question.

3. Empirical Design

3.1 Data

Our sample starts with all firms available at Standard and Poor's (S&P) *ExecuComp*, which covers executive compensation data since 1992 for all S&P 1500 firms, including total compensation, stock options, executives' age, tenure, gender, and ownership. Given our focus on CEO horizon, we required that our sample firms have information of both CEO age and CEO tenure. The CEO of a given firm-year is identified by the variable *PCEO*. To build some of our variables, we also require information on compensation of focal firm's top five executives. We collected environmental cost data from S&P Global's *Trucost* to capture firms' CER. *Trucost* assesses the environmental performance of more than 15,000 firms around the world and provides dollar metrics of the impact that each firm has on the environment. Financial data was collected from *Compustat North America*, while institutional ownership data was collected from *Refinitiv Global Ownership*. Finally, we collected from *Factset* the firms' Sustainable Industry Classification System (SICS), as defined by the Sustainability Accounting Standards Board (SASB)[1].

[1] Unlike other industry classification systems, such as the Standard Industrial Classification (SIC) and the North American Industry Classification System (NAICS), which classify companies based on the source of the revenues, the Sustainable Industry Classification System (SICS) classifies companies based on their sustainability issues and

3.2 Environmental Costs

Following previous literature (Jo et al., 2018), we proxied CER by the estimated value of environmental costs produced by a firm, which we collected from the *Trucost* database. Although CER can incorporate many interconnected corporate actions and strategies, such as carbon compensation and research & development expenses, the sum of the firm's environmental costs is a good measure of the negative impact the firm has on the environment and on the society at large. That is, reductions in firms' environmental costs represents that the firm is reducing its impact on the environment and proxies for the firm's effort to improve the CER. *Trucost* calculates a dollar estimate of the damage in the environment caused by the firm. A firm's total estimated amount of environmental cost is based on six different components and subdivided into the direct and the indirect environmental impact. The direct environmental cost (DEC) is an estimate of the direct impact that the operations of a company have on the environment while the indirect cost is an estimate of a company's impact through its supply chain and customer-base. By summing the direct and indirect costs, *Trucost* also provides an estimate of the total environmental costs (TEC). The six components of direct and indirect environmental costs are: 1) air pollutants, 2) greenhouse gases (GHGs), 3) land and water pollutants, 4) natural resource use, 5) waste, and 6) water.

Consistent with *Trucost* methodology and previous literature (e.g., El Ghoul et al, 2018; Jo et al 2015; Kim et al, 2017), a (negative temporal variation) reduction in these costs indicates that a firm is investing to mitigate its environmental impact, thus reaching greater environmental performance (i.e., CER). Therefore, lower levels of costs indicate the firm has a greater CER. Following the literature, we scale the sum of the six categories of costs by the firm's total assets. Also, because the environmental risks and opportunities are industry specific, we standardized a

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group companies facing similar sustainability risks and opportunities. SICS classifies companies in 77 different industries. For more information, consult <https://sasb.org/find-your-industry/>.

firm's DEC at the SICS-level, by subtracting the industry mean value and scaling by the industry standard-deviation of the environmental costs.[2]

3.3 CEO Horizon

Drawing from previous literature (Antia et al., 2010; Lee et al, 2018; Mekhaimer et al 2022), we calculated CEO horizon by a combination of the CEO's tenure and age. Extant literature assumes that executives estimate their remaining time in office by comparing themselves with other CEOs in the same industry, both in their tenure length and their age. More specifically, previous literature suggests that by comparing their number of years in the office and their age to those of the other CEOs in the same industry, a CEO is able to foresee the remaining number of years they will stay in the office. The industry-adjustment is important to account for the heterogeneity in the expected horizon across industries (Antia et al., 2010). Thus, following this literature, we measure *CEO Horizon* as follows:

$$CEO\ Horizon_{i,t} = (Tenure_{ind,t} - Tenure_{i,t}) + (Age_{ind,t} - Age_{i,t})$$

where $Tenure_{i,t}$ is the number of years since the CEO joined the firm and $Age_{i,t}$ is the age of the CEO who work for firm i in year i. $Tenure_{ind,t}$ and $Age_{ind,t}$ are the industry median of $Tenure_{i,t}$ and $Age_{i,t}$, respectively. Industry is defined based on the SICS classification. A positive (negative) value of $CEO\ Horizon$ indicates that the CEO's expected tenure is longer (shorter) than the other CEOs in the same industry, due to either a younger (older) age or shorter (longer) duration in the office.

For robustness, we also calculated the following two versions of *CEO Horizon*, using only information from either CEO's tenure or CEO's age. [3]

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[2] In untabulated results, we also standardized using the Fama and French's (1996) 30-industries classification and found unchanged results.

[3] In untabulated results, we also calculated *CEO Horizon*, *CEO Horizon (tenure)*, and *CEO Horizon (age)* using the industry average values instead of median values. Using the mean value has the advantage of better accommodating the yearly variation arising from CEO turnover, while the median is less sensitive to yearly variation. However, using mean values are more sensitive to outlier CEOs, i.e., those whose tenure and age are significantly far from the industry mean. The results are untabulated but are similar to those reported using the industry median.

$$CEO\ Horizon\ (tenure)_{i,t} = (Tenure_{ind,t} - Tenure_{i,t})$$

$$CEO\ Horizon\ (Age)_{i,t} = \left(Age_{ind,t} - Age_{i,t}\right)$$

3.4 Control variables

Our set of control variables is designed to control for as many observable individual- and firm-level attributes that can affect CEOs and firm's preferences over CER, respectively.

CEO incentives: As traditional corporate governance literature (Jensen & Meckling, 1976) suggests, one channel by which shareholders can align the interest of managers to theirs is by creating long-term incentives. When a greater portion of CEO's compensation is tied to long-term performance, it is more likely they will pursue projects and make decisions that increase value (Fabrizi et al., 2014; Flammer & Bansal, 2017). Given that CER is becoming increasingly important and determinant to managerial decision-making, we include a proxy for the incentives for long-term performance that CEOs have. Following previous studies (Lee et al. 2018), *CEO long-term incentive* is calculated as the ratio of unexercised options (exercisable + unexercisable) plus restricted stock holdings by total compensation. Similarly, previous literature also suggests that managerial ownership aligns CEOs decisions with firm's stock price performance (Jensen & Meckling, 1976). Therefore, we included *CEO Ownership* as control variable, which is calculated as the percentage of total shares owned by the CEO.

CEO Gender: prior research indicates that women have many different traits than men (Croson & Gneezy, 2009), including higher tendences to be more risk-averse (Faccio et al. 2016) and a positive effect on CSR performance (Borghesi et al., 2014; Cronqvist & Yu, 2017) and CER performance (Dyck et al., 2020). Based on this literature we included a dummy marking whether the CEO is women. We rely on the variable *GENDER* from *ExecuComp*.

CEO Overconfidence: Extant literature suggests that overconfident CEOs affect corporate policies and outcomes in many ways. Hirshleifer et al (2012) suggest that overconfident CEOs lead to greater levels of innovation and higher stock volatility, while Chen et al. (2023) suggest that overconfident CEOs impair workforce safety and increase the rate of injuries in the workplace and Malmendier and Tate (2005) suggest that overconfident CEOs show a greater investment-cash flow sensitivity. Consistent with these studies (Hirshleifer et al., 2012; Malmendier & Tate, 2005; Chen et al., 2023; Banerjee et al., 2018), we calculated the average realizable value per option by dividing the estimated value of in-the-money unexercised exercisable options the CEO has by the number of options held by the CEO. Then, we subtract the average realizable value per option from the fiscal year-end stock price. Consistent with these articles, we then create a dummy marking the first year where the options held by the CEO are at least 67% in-the-money. When this dummy turns into one, it stays one until the last year of our period, consistent with the argument that overconfidence is a persistent trait (Hirshleifer et al., 2012).

CEO Pay slice: Bebchuk et al. (2011) introduced the concept of $CEO\ Pay\ slice$, which represents the fraction of the CEO's total compensation to the total compensation of other executives. This metric reflects the extent to which CEOs can leverage their position to push themselves as the dominant decision-maker in the firm while also increasing their power and influence in all layers of the firm. Following, Jain et al. (2016) and Aktas et al. (2021), $CEO\ Pay\ slice$ is measured as:

$$CEO\ Pay\ slice_{i,t} = \frac{\text{CEO Pay}_{i,t}}{\text{Top 5 total Pay}_{i,t}}$$

where $\text{CEO Pay}_{i,t}$ is the CEO's total compensation (as reported in ExecuComp item *TDC1*) and $\text{Top 5 total Pay}_{i,t}$ is the total compensation of the top five executives including the CEO.

Other Control variables

Using *Refinitiv Global Ownership* database, we calculate firm’s *Institutional Ownership* as the proportion of holdings held by institutional investors, following Azar et al. (2021) who finds that institutional ownership decreases firm’s carbon emission. Furthermore, we collected financial data from Compustat to measure the following variables: *Size* is the natural logarithm of total assets (at), *Capex* is the ratio of capital expenditures (capx) over total assets; *R&D* is the ratio of research and development expenses (xrd) over total assets; *Cash Holdings* is the ratio of cash and equivalents of cash (che) over total assets; *Debt* is the ratio of total debt (dltt + dlc) over total assets; *Sales growth* is the annual change in sales (revt) over lagged total assets; *ROA* is the ratio of net income (ni) over total assets; and *Tangibility* is the ratio of net total property, plant and equipment (ppent) over total assets. All variables are detailed in the Appendix A.

3.5 Empirical model

To study the association between the CEO horizon and DEC, we start by using ordinary least squares (OLS) to estimate the model represented by Equation 1. To mitigate simultaneity concerns, all independent variables are lagged by one year. To control for unobserved effects at the firm-level we included firm fixed effects, while also including year fixed effects. Following standard practice in the literature (Petersen, 2009), standard errors are clustered at the firm level.

$$\begin{aligned} EC_{i,t} = \alpha &+ \beta_1 CEO\ Horizon_{i,t-1} + \beta_2 CEO\ Long\ term\ Incentive_{i,t-1} \\ &+ \beta_3 CEO\ Ownership_{i,t-1} + \beta_4 Female_{i,t-1} + \beta_5 CEO\ Overconfidence_{i,t-1} \\ &+ \beta_6 CEO\ Pay\ Slice_{i,t-1} + \beta_7 Inst.Ownership_{i,t-1} + \beta_8 Size_{i,t-1} \\ &+ \beta_9 Capex_{i,t-1} + \beta_{10} R\&D_{i,t-1} + \beta_{11} Cash\ holdings_{i,t-1} + \beta_{12} Debt_{i,t-1} \\ &+ \beta_{13} Sales\ growth_{i,t-1} + \beta_{14} ROA_{i,t-1} + \beta_{15} Tangibility_{i,t-1} + Firm\ FE \\ &+ Year\ FE + \epsilon_{i,t}\ (\boldsymbol{Equation\ 1}) \end{aligned}$$

Where *EC* is either Direct Environmental Costs over Total Assets (DEC) or Total Environmental Costs over Total Assets (TEC). CEO horizon is either *CEO Horizon*, *CEO Horizon (tenure)*, or *CEO Horizon (age)*. Our sample covers the period from 2007 to 2020 and contains 8,319 firm-year observations. We winsorized all control variables at 1% in both tails.

3.6 Summary statistics

Table 1 contains the summary statistics of all empirical variables, while Appendix A contains the formulas used. The Panel A of Table 1 shows that the means of DEC and the CEO horizon proxies are all near zero but are not equal to zero given that we executed the standardization at the industry level. The variables seem normally distributed, except for DEC, which shows that the 25% percentile is -0.51 while the 75% percentile is 0.22, suggesting a slight skewness distribution. Also, the table shows that 5% of our sample have female CEOs, and the average institutional ownership is around 82%. All remaining variables are comparable to extant literature that combines data from *Compustat* and *ExecuComp*.

The Panel B of Table 1 suggests that CEOs with a longer than average horizon (i.e., *CEO Horizon* >0) manage firms that are different from the firms managed by CEOs with shorter than average horizon (i.e., *CEO Horizon* <=0). Except for the level of *TEC*, *CEO Pay-slice*, *Capex*, *R&D*, and *Tangibility*, all variables show a mean value statistically different between these subgroups of firms. This leads to concerns of sample selection bias, which we will address in the next section.

In Table 2, we present the correlation coefficients between all empirical variables. Table 2 suggests a negative correlation between CEO horizon with *DEC*, but mixed correlations with *TEC*. Finally, we show in Table 3 the mean values of the *DEC* as percentage of total assets and the number of firm-year observations in each SICS. "Coal Operations" is the industry with the higher mean values, where DEC represent over 10% of the firm's total assets, followed by "Iron & Steel Producers" (6.16%) and "Water Utilities & Services" (6.14%). Across all industries, DEC represent slightly less than 1% of total assets.

4 Results

In this section, we present our results about the association between CEO horizon and firm's environmental costs. We also present many robustness tests to mitigate concerns related to selection bias, omitted variable bias (OVB), and reverse causality.

4.1 Main results

Table 4 presents results of estimating Equation 1. Alongside many lagged control variables, we included year fixed effects and firm fixed effects. We also clustered standard errors at the firm-level (Petersen, 2009), as presented at the bottom of Table 4.

Table 4 reports that the three proxies of CEO horizon have a negative association with DEC (t-stats range from -1.99 to -2.54). Based on the coefficients of *CEO Horizon* in the first column (i.e., -0.37), we can infer that moving *CEO Horizon* from the 25% (-0.08) percentile to the 75% percentile (0.05) makes the estimate of the (standardized) DEC of the average firm to move from 0.01 to -0.03, a 0.05 standard deviation decrease. Given that the standard deviation of DEC is 0.86, as shown in Table 1, this suggests a decrease of DEC representing 4.3% of total assets. Taken together, these results underscore the positive impact that CER has on the firm's environmental footprint.

We also include in Table 4 regressions where the dependent variable is the Total Environmental Costs (TEC). This variable is the sum of all direct and indirect environmental costs a firm has. The analysis of Table 4 shows that all the CEO horizon proxies has a negative coefficient but not significant. Therefore, from the last three columns of Table 4, we infer that CEO horizon does not associate with the firm's indirect costs.[4]

Table 4 shows that any of the CEO's characteristics included as control variables (i.e., CEO's Incentives, ownership, gender, overconfidence and pay-slice) have a significant

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[4] Next, we include many additional analyses showing only the results where DEC is the dependent variable. We also estimate the same regressions using TEC as the dependent variable. In all cases, results are mainly insignificant. Thus, we do not report these results.

coefficient. *Institutional Ownership* also shows an insignificant association with DEC. In Table 3, the negative coefficient associated with *Size* implies that the sampled firms benefit from economies of scale in managing environmental costs possible because, as firm size increases, the efficiency of handling environmental costs also increase. Furthermore, while *Capex* is negatively associated with DEC and TEC, *R&D* is positively associated with both DEC and TEC. Finally, we also observe that *Cash holdings* and *Debt* are negatively associated with TEC, while *Sales Growth* and *Tangibility* are positively associated with TEC.

Overall, the results of Table 3 suggest that the expectation of staying longer in the office (i.e., longer CEO horizon) makes CEOs more likely to decrease the environmental costs generated directly by the firm's operations.

4.2 CEO's attributes and CER

Early tenure CEOs

We have shown in the main Analysis a negative association between CEO horizon and DEC. However, the question of whether DEC decreases after the appointment of a new CEO is still open. To further understand the effect of CEO's tenure on DEC, we executed two additional tests. Following Ali and Zhang (2015) and Chen et al (2019), first, we created a binary variable *Early tenure* marking one to the firm-year observations whose CEOs are in the first three years of tenure, and zero otherwise. Second, we created five binary variables marking the CEOs in the first to fifth year of tenure, respectively (*First year tenure* to *Fifth year tenure*). The results are presented in Table 5. We observe a negative coefficient for *Early tenure* and for *First year tenure*, while the remaining of the variables are insignificant. These results are consistent with the arguments that, given that they have more time to benefit from their decisions, early tenured CEOs are willing to make more significant investments in CER in early stages of their career to gain legitimacy in the eyes of shareholders (Fabrizi et al. 2014). These results provide additional nuance about how CEO horizon drives CER.

Never-changing Vs changing CEOs

We complement the previous analysis of Table 5 by exploring whether the negative effect on CEO horizon on DEC is arising mainly from firms that change the CEO or, alternatively, from firms whose CEO are getting older. That is, the proxies of CEO horizon only vary either due to changes in the firm's CEO between a year and the next or due to the firm's CEO aging over time (Lee et al. 2018). Thus, we created a dummy marking 0 to firms that never changed the CEO during our sample period and 1 to firms that changed the CEO at least once during our sample period. Table 6 contains the results using both subsamples and corroborates the results of Table 5. The subsample of firms whose never change CEO shows a nonsignificant effect of CEO horizon on DEC, while the subsample of firms whose CEO changes at least once shows a negative and significant effect.

CER and CEO's long-term incentives

Because incentive mechanisms can alleviate the CEO horizon problem (e.g., Dechow & Sloan, 1991), we explored the potential alignment of CEO interests with those of shareholders through long-term incentives (Fabrizi et al., 2014; Flammer & Bansal, 2017; Lee et al. 2018). Following this literature, we investigated whether the interaction between *CEO Ownership* and *CEO LT incentive* and *CEO Horizon* are associated with DEC. More specifically, we tested if the relationship between *CEO Horizon* and DEC is shaped by the CEO's long-term interests. Building on previous literature, we anticipate a negative coefficient in these interactions, indicating that long-term incentives make CEOs with a longer horizon to reduce more significantly firm's environmental costs. The findings of this test are presented in Table 7. Contrary to our expectations, these interactions do not exhibit statistical significance, suggesting that CEO horizon seems to dominate the CEOs preferences over CER.

4.3 Empirical design remedies

Although we have included firm fixed effects to mitigate concerns of omitted variable bias from unobservable time-invariant factors at the firm-level, and used lagged control variables to mitigate concerns of simultaneity, and alternative proxies for CEO horizon which mitigates concerns of measurement errors in our independent variable of interest, one potential concern with results presented in Table 4 is that we do not control for additional sources of endogeneity, such as selection bias, omitted variable bias, and reverse causality. In this section, we estimate additional models to deal with these concerns.

4.2.1 Selection bias

One potential concern with our analyses of CEO horizon and DEC is that firms whose CEO has a longer horizon (i.e., an expectation of tenure that is longer that other CEOs in the same industry) are different than firms whose CEO has a negative expected horizon (i.e., an expectation of tenure that is shorter that other CEOS in the same industry). This type of situation may happen if some firms (with predetermined characteristics) are more likely to hire CEOs that are younger than the competitors. In fact, Table 2 suggests that this is the case in our sample. Table 2 shows that firms whose CEO has a positive expected horizon present higher level of institutional ownership, are larger, hold less cash, are more indebted, and growth less. The CEOs exhibiting positive horizon also have fewer long-term incentives, lower ownership stakes, a higher representation of women than of men, and are less overconfident. If these differences are the drivers of the level of environmental costs, then the results in Table 4 are biased due to selection bias.

To remedy this concern, we employ both propensity-score matching (PSM) and entropy balancing (Hainmueller, 2012; Hainmueller & Xu, 2013). More specifically, to build a propensity-score matched sample, we start by estimating the propensity that a firm has a CEO with positive horizon (i.e., is part of the treatment group) instead of having a CEO with negative horizon (i.e., is part of the control group) using all control variables as determinants. Next, we match firms from the treatment group with firms from the control group by the estimated propensity-score using the nearest neighbour method, with replacement and without caliper. We match firms in both groups either using the full sample or by year.

The results are presented in Table 8 Panels A and B. The control variables are included but omitted from the table, and we used year fixed effects, firm fixed effects and standard errors clustered at the firm-level. The results of Panel A and B of Table 5 corroborate those in Table 4 and show a negative association between CEO horizon and DEC.

One caveat of PSM is that it matches the propensity-scores between the treatment and control groups using individual observations of firms. As a result, subsamples matched by PSM commonly have less observations than the original sample because not all firm-year observations can be matched. Instead, we can use an entropy balancing technique to balance the moments of the subsamples of firms from the treatment group to the moments of the subsample of firms from the control group. More specifically, entropy balancing alleviates covariate imbalance between subsamples by assigning continuous weights to virtually all observations in the sample, thereby minimizing data discarding (Hainmueller, 2012). Moreover, because entropy balancing uses the known sample distribution moments of the covariates as constraints, the moments of the covariates distributions in the treatment and control groups are nearly identical, which mitigates researcher discretion and avoids potentially harmful decisions, such as visually searching for overlapping propensity-scores, making decisions about replacement criteria, and debating over the number of neighbors used in the matching process (Shipman et al, 2017; King & Nielsen, 2019). Therefore, similar to Chen et al (2023), we balance the first and second moments of the distribution of all covariates of a subsample containing firms having a CEO with positive horizon (i.e., treatment group) with a subsample of firms having a CEO with negative horizon (i.e., control group). As in the PSM analyses, we balance the moments of the subsamples using the full sample or restricting the balancing by year.

Table 8 Panels C and D contain the results after balancing the subsamples. Again, the control variables are included but omitted from the table, and we used year fixed effects, firm fixed effects and standard errors are clustered at the firm-level. The results of Panel C and D also corroborate Table 4 and show a negative association between *CEO Horizon* and DEC. Overall, we interpret the results from Table 4 as unlikely that selection bias is driving our main results.

4.2.2 Omitted variable bias (OVB)

Multidimensional Fixed Effects

Although we included many individual- and firm-level control variables (i.e., observables) alongside year and firm fixed effects, another concern in the results of Table 4 is potential biases coming from omitted variables. To mitigate such concern, we start by employing a multidimensional fixed effects design. More specifically, we included year-industry fixed effects to control for unobserved heterogeneity at the industry-level arising in a given year. This is possible if there are industry-specific waves at different times or if a particular industry receives a shock in the dependent variable (i.e., environmental costs) in a given year (for instance, a new, industry-level environmental regulation is implemented). Additionally, we deploy CEO fixed effects to account for unobserved heterogeneity at the individual-level, which is important to control for persistent unobserved CEO's characteristics that might influence their decision regarding CER. We use the *ExecuComp* variable *EXECID*, which is an individual identification number for any sample CEO. Apart from these year-industry and CEO fixed effects, we keep the year fixed effects and firm fixed effects.

The new results are presented in Table 9, which contains 1,150 firm fixed effects (1,151 firms), 13 year fixed effects (14 years), 848 year-industry fixed effects (849 year-industry interactions), and 1,931 CEO fixed effects (1,932 individual executives). Thus, the estimations in Table 9 contain over 8,300 observations and 3,942 different fixed effects. Table 9 corroborates the main results of Table 4 and suggests a negative association between the three proxies of CEO horizon and DEC.

Instrumental variables design

Our results so far suggest a robust negative association between CEO horizon and DEC. Nevertheless, we still need to address possible biases coming from potential correlations between the CEO horizon measure and unobserved variables that may also influence environmental costs. Hence, OVB can still be driving spurious associations between CEO horizon and DEC.

To address this concern, we use an instrumental variables (IV) design. Identifying an instrumental variable that satisfies both the relevance (i.e., an instrumental variable that is correlated only with CEO horizon) and the exclusion conditions (i.e., an instrumental variable that does not correlate with environmental costs except through its correlation with CEO horizon) is arguably difficult. We follow previous literature (Cline and Yore, 2016; Serfling, 2014; Mekhaimer et al 2022) and use 1) the Consumer Price Index (CPI) at the CEO's birth year, and 2) the CPI at the year of appointment as CEO as instruments. The assumption behind the use of these instruments is that CPI and both CEO's age and tenure are increasing with time, making them highly correlated. As discussed by Mekhaimer et al (2022), the use of CPI as an instrumental variable satisfies the relevance condition because of the negative correlation between CPI at the CEO's birth year and CEO's first year in office, with, respectively, CEO's age and tenure. As a result, these instruments are positively correlated with CEO's horizon[5]. Moreover, due to its nature, it is unlikely that CPI is directly correlated with a firm's environmental costs, which satisfies the exclusion condition.

Table 10 contains the results of the IV estimations. The first stage regression is presented in Panel A and confirms the expected positive association between the instruments and CEO

[5] As pointed by Mekhaimer et al (2022), however, a limitation of this instrument is that the increase in CPI trough time may cause it to be almost a monotonic transformation of years.

horizon. The instruments have the expected positive sign and are significantly different than zero at the 1% level in all regressions. At the bottom of Table 10, following Bertoni et al. (2023), we present the tests of the relevance of the instruments. More specifically, we present the Kleibergen-Paap under-identification test and the Cragg-Donald weak identification test. The Kleibergen-Paap test have a chi-squared distribution and the null hypothesis that the model is underidentified so the instruments are not relevant. The Kleibergen-Paap statistics are all higher than 100 leading to the rejection of the null hypothesis at the 1% level, which suggests that the instruments used are relevant in all models. Additionally, the Cragg-Donald weak identification test verifies whether the instruments are weakly correlated with the endogenous variables (i.e., CEO horizon). The bottom of Table 10 shows statistics of at least 4.000, which are well beyond the critical values of Stock and Yogo (2005). Finally, in the case of *CEO Horizon* where we included both instruments, we are able to test whether the instruments are exogenous using the Hansen-J statistic, which has the null hypothesis that the instruments are uncorrelated with the error term with a chi-squared distribution. The J-statistics all fail to reject the null hypothesis, suggesting that the instruments are valid.

The Panel B of Table 10 contains the second stage regressions. Again, the results support the hypothesis of a negative effect of CEO horizon on DEC. We notice that, in Table 10, only *CEO Horizon* and *CEO Horizon (tenure)* shows significant negative effect and *CEO Horizon (age)* shows a negative but insignificant effect on DEC. Overall, the results of the IV design support our main findings, suggesting that it is unlikely that they are driven by OVB concerns.

4.2.3 Reverse causality problem

After investigating deeper potential concerns arising from selection bias and OVB, our main findings of a negative effect of CEO horizon on CER can still be challenged by potential biases arising from unobserved shifts in the firm's strategies and policies that presumably can decrease environmental costs while also increasing CEO horizon. For example, the turnover of CEO due to the implementation of new board of directors' policies that push for younger executives, with experience with sustainability issues, that are able to increase CER. In such case, the negative correlation between CEO horizon and DEC may be driven by the reverse causality running from the firm's current level of DEC to the appointment of younger CEOs (i.e., with longer horizon).

With this concern in mind, we estimate additional regressions. First, following Lee et al (2018), we run equation 1 excluding the CEOs that are most likely to suffer from the reverse causality issue, i.e., the recently hired CEOs. Thus, if reverse causality is driving our main results, the exclusion of recently hired CEOs should lead to smaller and non-significant coefficients of CEO horizon. We therefore excluded all CEOs whose tenure was smaller than 3 years. These new regressions are presented in Table 11. Again, the findings corroborate our main results and show a negative association between CEO horizon and DEC. The coefficients presented in Table 11 are not different in significance than those in Table 4, but are slightly larger in size.

To further mitigate concerns of reverse causality we estimate a lagged first difference model represented by the following Equation 2. Estimating a lagged first difference model have the main advantages of eliminating any time-invariant unit unobserved effect, like a firm fixed effect model, while also mitigating concerns that the level of past environmental costs is driving the horizon of the CEO in office. Therefore, we estimate Equation 2 differentiating all financial variables while also maintaining the year and firm fixed effects.

$$\begin{aligned}\Delta DEC_{i,t} = \alpha &+ \beta_1 \Delta CEO\ Horizon_{i,t-1} + \beta_2 \Delta\ CEO\ Long\ term\ Incentive_{i,t-1} \\ &+ \beta_3 \Delta CEO\ Ownership_{i,t-1} + \beta_4 \Delta Female_{i,t-1} \\ &+ \beta_5 \Delta CEO\ Overconfidence_{i,t-1} + \beta_6 \Delta CEO\ Pay\ Slice_{i,t-1} \\ &+ \beta_7 \Delta Inst.Ownership_{i,t-1} + \beta_8 \Delta Size_{i,t-1} + \beta_9 \Delta Capex_{i,t-1} + \beta_{10} \Delta R\&D_{i,t-1} \\ &+ \beta_{11} \Delta Cash\ holdings_{i,t-1} + \beta_{12} \Delta Debt_{i,t-1} + \beta_{13} \Delta Sales\ growth_{i,t-1} \\ &+ \beta_{14} \Delta ROA_{i,t-1} + \beta_{15} \Delta Tangibility_{i,t-1} + Firm\ FE + Year\ FE \\ &+ \Delta\epsilon_{i,t}\ (\boldsymbol{Equation\ 2})\end{aligned}$$

Table 12 contains the results of the first difference model. The first difference coefficients mainly corroborate our main results presented in Table 4 and suggests that a positive lagged change in CEO horizon leads to a negative contemporaneous change in DEC.

4.4. Additional Analysis

In this section, we study potential channels by which CEO horizon drives DEC and endeavor in some investigations about the outcomes when CEOs increase CER.

Industries with Low vs. High financial materiality factors

Recent articles have emphasized the importance of financial materiality of Environmental, Social, and Governance (ESG) issues (Khan et al. 2016; Consolandi et al. 2020; Schiehll & Kolahgar, 2021; Martins, 2023) as crucial factors that might impair future firm value. More specifically, financial materiality refers to industry-specific sustainability information that is relevant to the creation of a firm's long-term value, such that their omission or misstatement can significantly influence market valuation (Khan et al., 2016). We use the SICS classification created by SASB to count the number of issues that are material to each industry in the environment dimension.[6] We then separate the industries with high materiality (i.e., two or more material issues) from those with low materiality (i.e., those with zero or one material issue). The results are presented in Table 13. While the coefficients are all negative, they are significant only in the subsample of industries with high materiality.

Institutional ownership

Recent studies have shown that institutional investors care about corporate carbon emissions and shape the firm's CER (Azar et al. 2021; Bolton & Kacperczyk, 2021; Dyck et al. 2019). Thus, in

[6] In total, the Environment dimension contains six different issues: GHG Emissions, Air Quality, Energy Management, Water & Wastewater Management, Waste & Hazardous Materials Management, and Ecological Impacts. Thus, for any given industry, the minimum number of material issues is zero, while the maximum is six.

this section, we investigate whether our main results are driven by the level of institutional shareholdings in the firm's investor base. More specifically, we add to our main empirical specification, the interaction term of *CEO Horizon* with *Institutional Ownership* to test whether the negative association between CEO horizon and environmental costs is different due to the levels of institutional shareholdings. The first column of Table 14 contains the new results. The coefficient of the interaction is insignificant.

We also explore in Table 14 some investors attributes that are related to their probability of affecting a firm's CER. First, previous literature argues that the investor time-horizon is an essential determinant of how investors weight portfolio firms' environmental performance into their decisions (Neubaum & Zahra, 2006; Walls et al. 2012; Krueger et al 2020). Following this literature, we calculate the ownership of the investors classified as Passive by Refinitiv. Second, similar to Dyck et al. (2019), we use the *Environmental Performance Index* (EPI)[7] as a proxy for the importance of environmental policies and how close the countries are to establishing targets for environmental policies to calculate the total ownership of owners based on countries with High EPI. Finally, to proxy for investors' orientation, we calculate the ownership of only the investors that are PRI signatories[8], as they are more likely to embed environmental issues into their screening, investment analysis, and activism strategies and, therefore, allocate greater importance to firms' environmental performance.

The results of this investigation are presented in the second to fourth columns of Table 14. Contrary to the expectations, none of the interactions show a significant coefficient. Therefore, the combined evidence presented in Table 14 suggests that institutional owners' ownership attributes are not the main driver of our results.

[7] https://epi.yale.edu/
[8] https://www.unpri.org/signatories

Outcomes of CER: market valuation, and financial performance

Antia et al (2010) showed a positive effect of CEO horizon on market valuation. However, the question about what is the combined effect that CEO horizon and DEC have on market valuation is still unanswered. Therefore, to answer this question we investigated what is the effect that such an interaction of variables has on industry-adjusted *Tobin's Q* and *ROA*. Table 15 contains the results of this model. Consistent with Antia et al (2010), CEO horizon is positively associated with industry-adjusted *Tobin's Q*. However, CEO horizon does not relate to industry-adjusted *ROA*. We also observe that DEC is positively related to Tobin's Q but not with ROA. Finally, the interaction terms do not significantly relate to both *Tobin's Q* and *ROA*, suggesting that the combined effect of CEO Horizon and CER on market valuation is not distinguishable from zero.

5. Conclusions

The increasing concerns about firms' environmental impact have created a wave of societal pressure, shareholder activism, and regulations trying to influence companies to increase their corporate environmental responsibility (CER). CEOs are also receiving pressure to act in the name of stakeholders to improve a firm's CER and decrease the environmental externalities of their firms. While firm-level incentives and monitoring mechanisms can provide frameworks to improve CER, a CEO's personal traits and time horizon ultimately shape the decision-making process. In this study, therefore, we investigate whether and how CEO horizon affects CER by looking at the level of direct and total environmental costs of over 1,000 U.S. listed companies in the period 2007-2020.

Our results suggest a consistent negative association between of CEO horizon and direct environmental costs (DEC), implying that longer CEO horizon is associated with improved CER. We explore many remedies to concerns of endogeneity with unchanged conclusions. We also explored many alternative CEO characteristics—including CEO gender, incentives, overconfidence, and pay-slice—and found consistent results that CEO horizon seems to dominate as the factor influencing corporate environmental costs. Finally, we investigate the effect of institutional ownership on DEC and find that institutional ownership does not significantly influence DEC nor the relationship between CEO horizon and DEC, which indicates possible limitations of institutional owners when CER encompasses more nuanced aspect of CER, such as DEC. Overall, our study contributes to the discussion on how companies exhibit diverse responses to risk management, specifically concerning climate change, based on the individual characteristics and preferences of decision-makers.

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Figure 1 – Histogram of final sample's CEO's Tenure

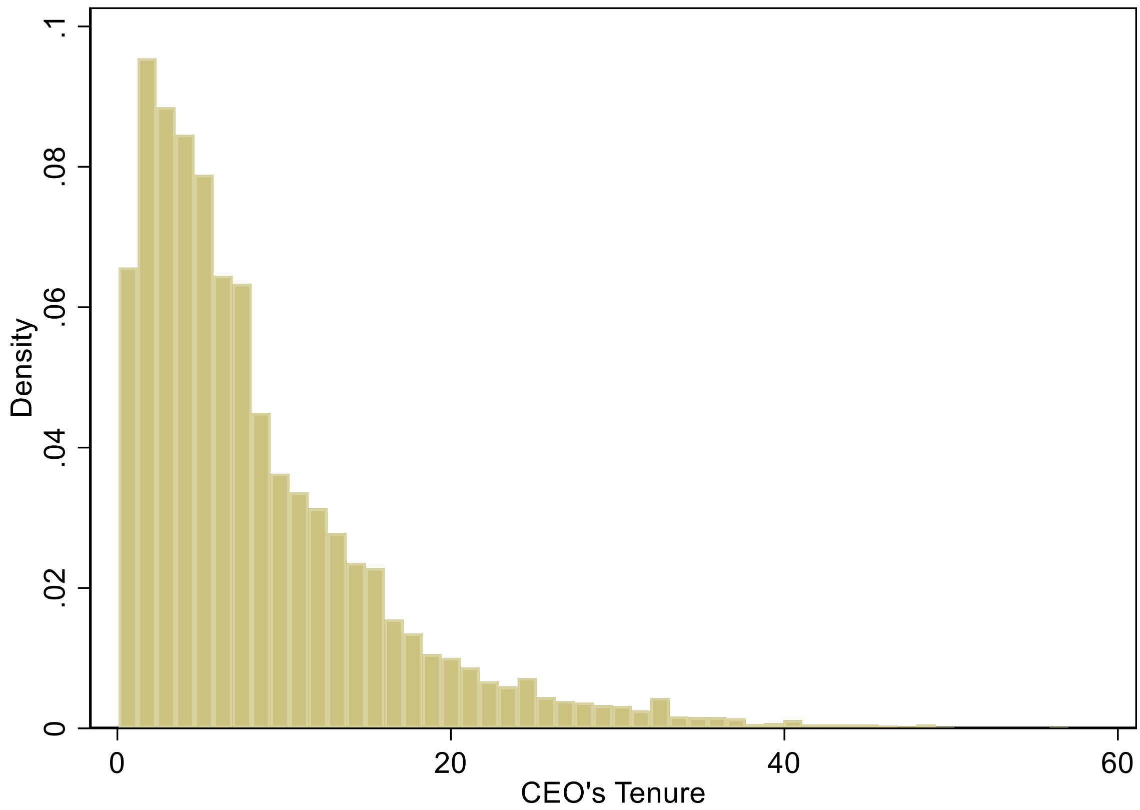

Figure 2 – Histogram of final sample's CEO's Age

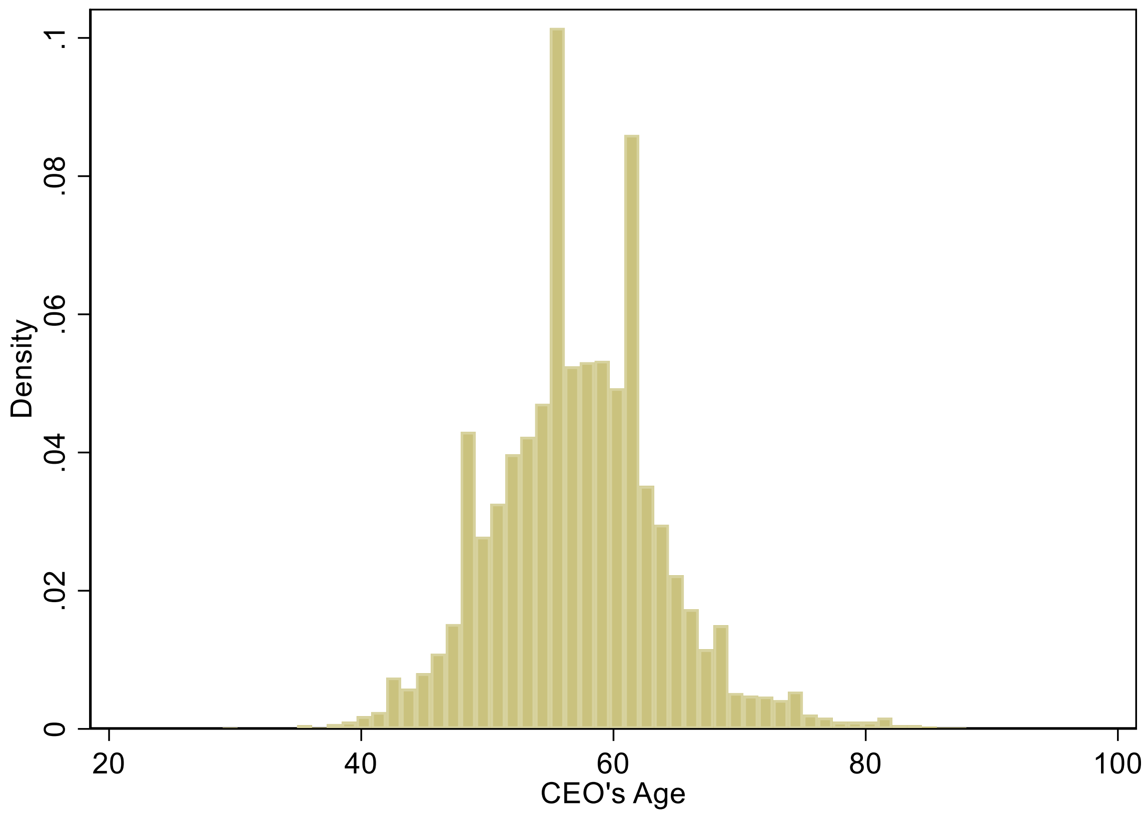

Table 1 - Summary statistics - Full sample

Panel A – Summary statistics

Variable	P25	Mean	P50	P75	S.d	Obs.
Direct Env. Cost (DEC)	-0.51	-0.00	-0.23	0.22	0.86	8319
Total Env. Cost (TEC)	-0.57	0.03	-0.18	0.41	0.90	8319
CEO Horizon	-0.08	-0.02	-0.01	0.05	0.12	8319
CEO Horizon (Tenure)	-0.05	-0.02	0.00	0.03	0.07	8319
CEO Horizon (Age)	-0.04	-0.00	0.00	0.04	0.06	8319
CEO LT incentive	0.03	0.18	0.08	0.19	0.35	8319
CEO Ownership	0.00	0.02	0.00	0.01	0.05	8319
Female	0.00	0.05	0.00	0.00	0.22	8319
CEO Overconfidence	0.00	0.54	1.00	1.00	0.50	8319
CEO Pay-Slice	0.35	0.41	0.42	0.48	0.11	8319
Inst. Ownership	0.73	0.82	0.86	0.95	0.17	8319
Size	7.24	8.28	8.23	9.30	1.57	8319
Capex	0.02	0.05	0.03	0.06	0.05	8319
R&D	0.00	0.03	0.00	0.03	0.06	8319
Cash holdings	0.03	0.14	0.09	0.20	0.15	8319
Debt	0.13	0.28	0.26	0.39	0.22	8319
Sales Growth	-0.01	0.07	0.04	0.12	0.19	8319
ROA	0.02	0.05	0.05	0.09	0.10	8319
Tangibility	0.09	0.28	0.20	0.41	0.24	8319

Panel B – Mean difference test

Variable	Mean if CEO horizon <=0 (n: 4,392)	Mean if CEO horizon >0 (n: 3,949)	Diff.	t-stat
Direct Env. Cost (DEC)	0.02	-0.03	0.05	2.52
Total Env. Cost (TEC)	0.03	0.03	-0.01	-0.26
CEO Horizon	-0.10	0.07	-0.17	-91.88
CEO Horizon (Tenure)	-0.06	0.02	-0.08	-62.91
CEO Horizon (Age)	-0.04	0.04	-0.08	-78.14
CEO LT incentive	0.20	0.16	0.04	5.25
CEO Ownership	0.03	0.01	0.02	22.63
Female	0.04	0.06	-0.02	-5.08
CEO Overconfidence	0.66	0.41	0.24	23.07
CEO Pay-Slice (top5)	0.41	0.41	0.00	0.48
Inst. Ownership	0.82	0.83	-0.01	-3.35
Size	8.22	8.36	-0.14	-3.94
Capex	0.05	0.05	0.00	1.79
R&D	0.03	0.03	0.00	0.95
Cash holdings	0.15	0.13	0.01	4.40
Debt	0.26	0.30	-0.04	-7.61
Sales Growth	0.07	0.06	0.01	2.47
ROA	0.05	0.05	0.01	2.53
Tangibility	0.28	0.28	0.00	0.12

Table 2 - Correlation

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Direct Env. Cost (DEC)	1.00																		
Total Env. Cost (TEC)	0.71	1.00																	
CEO Horizon	-0.03	-0.00	1.00																
CEO Horizon (Tenure)	-0.03	0.01	0.87	1.00															
CEO Horizon (Age)	-0.03	-0.01	0.83	0.46	1.00														
CEO LT incentive	-0.00	-0.01	-0.06	-0.09	-0.01	1.00													
CEO Ownership	0.07	0.04	-0.39	-0.43	-0.22	0.16	1.00												
Female	-0.03	0.01	0.07	0.08	0.05	-0.01	-0.03	1.00											
CEO Overconfidence	-0.03	-0.04	-0.24	-0.28	-0.12	0.10	0.08	-0.04	1.00										
CEO Pay-Slice	-0.01	0.01	0.02	0.02	0.01	-0.19	-0.16	0.01	0.09	1.00									
Inst. Ownership	-0.03	-0.07	0.07	0.06	0.06	-0.19	-0.27	-0.02	0.07	0.11	1.00								
Size	-0.15	-0.12	0.08	0.15	-0.02	-0.13	-0.20	0.03	-0.06	-0.03	-0.06	1.00							
Capex	0.04	0.04	-0.02	-0.01	-0.02	-0.01	0.04	0.01	-0.01	-0.07	-0.04	0.05	1.00						
R&D	0.01	0.01	-0.01	-0.04	0.02	0.19	0.04	0.00	0.05	-0.06	-0.03	-0.24	-0.13	1.00					
Cash holdings	0.01	-0.01	-0.07	-0.08	-0.04	0.17	0.13	-0.01	0.06	-0.11	-0.02	-0.33	-0.19	0.54	1.00				
Debt	-0.02	-0.01	0.09	0.09	0.07	-0.01	-0.09	-0.01	-0.02	0.08	-0.00	0.21	0.01	-0.12	-0.29	1.00			
Sales Growth	0.04	0.05	-0.01	-0.04	0.03	0.04	0.07	-0.02	0.10	-0.02	-0.01	-0.12	0.01	0.07	0.08	-0.07	1.00		
ROA	0.01	0.04	-0.04	-0.05	-0.02	-0.15	0.01	-0.00	0.10	0.03	0.05	0.09	0.01	-0.29	-0.02	-0.10	0.17	1.00	
Tangibility	0.11	0.10	0.01	0.03	-0.03	-0.08	-0.04	0.03	-0.09	-0.03	-0.09	0.21	0.69	-0.28	-0.37	0.13	-0.12	-0.06	1.00

Table 3 – Average Environmental Direct Costs over Total Assets (in %) by SICS

SICS	Mean	Obs.	SICS	Mean	Obs.
Advertising & Marketing	0.04	38	Hotels & Lodging	0.15	58
Aerospace & Defense	0.12	152	Household & Personal Products	0.39	103
Agricultural Products	2.58	41	Industrial Machinery & Goods	0.37	517
Air Freight & Logistics	0.85	76	Internet Media & Services	0.02	87
Airlines	3.07	68	Iron & Steel Producers	6.16	123
Alcoholic Beverages	0.22	40	Leisure Facilities	0.06	30
Apparel, Accessories & Footwear	0.25	284	Managed Care	0.01	1
Appliance Manufacturing	2.88	24	Marine Transportation	4.94	26
Auto Parts	0.19	122	Meat, Poultry & Dairy	2.70	29
Automobiles	0.19	66	Media & Entertainment	0.02	105
Biofuels	3.24	10	Medical Equipment & Supplies	0.12	432
Biotechnology & Pharmaceuticals	0.21	335	Metals & Mining	3.61	89
Building Products & Furnishings	0.80	144	Multiline and Specialty Ret.& Dist.	0.18	520
Car Rental & Leasing	0.50	11	Non-Alcoholic Beverages	0.28	45
Casinos & Gaming	0.07	87	Oil & Gas - Exploration & Production	1.33	235
Chemicals	2.35	312	Oil & Gas - Midstream	0.78	43
Coal Operations	10.27	17	Oil & Gas - Refining & Marketing	2.05	49
Construction Materials	3.72	88	Oil & Gas - Services	0.40	131
Containers & Packaging	2.08	141	Processed Foods	0.35	159
Drug Retailers	0.13	40	Professional & Commercial Services	0.07	286
E-Commerce	0.07	34	Pulp & Paper Products	5.16	23
Education	0.17	56	Rail Transportation	1.23	31
Electric Utilities & Power Generators	5.85	337	Real Estate	0.02	107
Electrical & Electronic Equipment	0.15	263	Real Estate Services	0.06	39
Electronic Manufacturing Services & Original Design Manufacturing	0.15	22	Restaurants	0.29	163
Engineering & Construction Services	0.43	97	Road Transportation	1.42	66
Food Retailers & Distributors	0.41	65	Semiconductors	0.15	328
Forestry Management	1.52	5	Software & IT Services	0.03	516
Fuel Cells & Industrial Batteries	0.18	4	Solar Technology & Project Developers	0.10	26
Gas Utilities & Distributors	0.87	87	Telecommunication Services	0.02	130
Hardware	0.15	223	Tobacco	0.08	26
Health Care Delivery	0.12	148	Toys & Sporting Goods	0.15	44
Health Care Distributors	0.26	65	Waste Management	2.74	59
Home Builders	0.23	141	Water Utilities & Services	6.14	50
Full Sample Mean	**0.93**				
Full sample Obs.	**8,319**				

Table 4 – Main Results

	Direct Env. Cost (DEC)			Total Env. Cost (TEC)		
CEO Horizon	-0.37**			-0.13		
	[-2.54]			[-0.99]		
CEO Horizon (Tenure)		-0.63**			-0.19	
		[-2.52]			[-0.89]	
CEO Horizon (Age)			-0.53**			-0.23
			[-1.99]			[-0.87]
CEO LT incentive	-0.01	-0.01	-0.01	0.01	0.01	0.01
	[-0.46]	[-0.50]	[-0.35]	[0.22]	[0.22]	[0.25]
CEO Ownership	0.16	0.16	0.32	0.39	0.41	0.43
	[0.47]	[0.49]	[0.90]	[0.89]	[0.96]	[1.01]
Female	-0.02	-0.03	-0.02	-0.04	-0.04	-0.04
	[-0.29]	[-0.40]	[-0.31]	[-0.57]	[-0.62]	[-0.55]
CEO Overconfidence	-0.02	-0.02	-0.01	-0.02	-0.02	-0.01
	[-0.70]	[-0.68]	[-0.30]	[-0.75]	[-0.67]	[-0.65]
CEO Pay-Slice	0.03	0.02	0.04	0.07	0.07	0.07
	[0.32]	[0.27]	[0.41]	[0.87]	[0.86]	[0.91]
Inst. Ownership	0.01	0.01	0.02	-0.17	-0.17	-0.17
	[0.11]	[0.08]	[0.13]	[-1.55]	[-1.57]	[-1.54]
Size	-0.13***	-0.13***	-0.13***	-0.18***	-0.18***	-0.18***
	[-3.54]	[-3.46]	[-3.53]	[-4.97]	[-4.92]	[-4.98]
Capex	-0.99**	-1.01**	-1.00**	-0.76*	-0.77*	-0.76*
	[-2.41]	[-2.43]	[-2.42]	[-1.94]	[-1.95]	[-1.93]
R&D	0.67*	0.66*	0.68*	0.79***	0.79***	0.80***
	[1.81]	[1.76]	[1.88]	[2.90]	[2.88]	[2.93]
Cash holdings	-0.05	-0.05	-0.05	-0.27**	-0.27**	-0.27**
	[-0.35]	[-0.34]	[-0.37]	[-2.34]	[-2.33]	[-2.35]
Debt	-0.00	-0.00	-0.00	-0.17**	-0.17**	-0.17**
	[-0.03]	[-0.04]	[-0.04]	[-2.07]	[-2.08]	[-2.07]
Sales Growth	0.06	0.06	0.06	0.11***	0.11***	0.11***
	[1.55]	[1.56]	[1.51]	[3.57]	[3.56]	[3.56]
ROA	0.14	0.14	0.14	0.07	0.07	0.07
	[0.96]	[0.95]	[0.96]	[0.62]	[0.61]	[0.61]
Tangibility	0.45*	0.46*	0.46*	0.45**	0.45**	0.45**
	[1.84]	[1.86]	[1.87]	[2.04]	[2.06]	[2.04]
Constant	0.95***	0.94***	0.94***	1.47***	1.46***	1.47***
	[3.02]	[2.95]	[2.99]	[4.81]	[4.77]	[4.82]
R-squared	0.038	0.038	0.037	0.037	0.037	0.037
R-squared Adjusted	0.035	0.034	0.034	0.034	0.033	0.034
Observations	8319	8319	8319	8319	8319	8319
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes	Yes	Yes	Yes

Table 5 – Additional Analysis: Low-tenured CEOs

	Direct Env. Cost (DEC)	
Early tenure	-0.03*	
	[-1.89]	
First year tenure		-0.05*
		[-1.80]
Second year tenure		-0.03
		[-1.13]
Third year tenure		-0.03
		[-1.05]
Fourth year tenure		0.01
		[0.38]
Fifth year tenure		-0.01
		[-0.47]
CEO LT incentive	-0.01	-0.01
	[-0.48]	[-0.45]
CEO Ownership	0.49	0.51
	[1.46]	[1.49]
Female	-0.04	-0.04
	[-0.56]	[-0.57]
CEO Overconfidence	0.00	0.00
	[0.05]	[0.17]
CEO Pay-Slice	0.00	0.01
	[0.04]	[0.09]
Inst. Ownership	0.00	0.00
	[0.03]	[0.04]
Size	-0.12***	-0.12***
	[-3.37]	[-3.37]
Capex	-1.02**	-1.01**
	[-2.42]	[-2.42]
R&D	0.68*	0.68*
	[1.86]	[1.86]
Cash holdings	-0.05	-0.05
	[-0.36]	[-0.36]
Debt	-0.01	-0.01
	[-0.09]	[-0.09]
Sales Growth	0.05	0.05
	[1.37]	[1.37]
ROA	0.13	0.12
	[0.86]	[0.85]
Tangibility	0.49*	0.49**
	[1.96]	[1.97]
Constant	0.90***	0.90***
	[2.89]	[2.88]
R-squared	0.036	0.036
R-squared Adjusted	0.033	0.032
Observations	8319	8319
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
S.E. clustered at firm-level	Yes	Yes

Table 6 – Additional Analysis: Firms never-changing vs changing CEOs.

	Direct Env. Cost (DEC)					
	Panel A: CEO never-changing firms			*Panel B: CEO changing firms*		
CEO Horizon	-0.43			-0.36**		
	[-0.59]			[-2.46]		
CEO Horizon (Tenure)		-1.00			-0.56**	
		[-0.74]			[-2.14]	
CEO Horizon (Age)			-0.48			-0.53**
			[-0.40]			[-2.02]
CEO LT incentive	-0.03	-0.03	-0.03	0.00	0.00	0.01
	[-0.62]	[-0.60]	[-0.66]	[0.09]	[0.07]	[0.25]
CEO Ownership	0.03	0.03	0.10	0.21	0.23	0.41
	[0.05]	[0.06]	[0.17]	[0.47]	[0.56]	[0.91]
Female	-2.64***	-2.57***	-2.68***	0.00	-0.01	0.00
	[-23.93]	[-16.43]	[-19.59]	[0.02]	[-0.10]	[0.04]
CEO Overconfidence	-0.11	-0.11	-0.10	-0.02	-0.02	-0.01
	[-1.53]	[-1.59]	[-1.45]	[-0.74]	[-0.63]	[-0.43]
CEO Pay-Slice	-0.07	-0.05	-0.07	0.08	0.08	0.09
	[-0.36]	[-0.31]	[-0.39]	[0.84]	[0.77]	[0.96]
Inst. Ownership	0.41*	0.41*	0.41*	-0.19	-0.20	-0.19
	[1.85]	[1.88]	[1.84]	[-1.22]	[-1.26]	[-1.19]
Size	-0.22***	-0.21***	-0.22***	-0.11**	-0.10**	-0.11**
	[-3.53]	[-3.52]	[-3.53]	[-2.31]	[-2.25]	[-2.32]
Capex	-1.59***	-1.59***	-1.60***	-0.80	-0.81	-0.81
	[-3.05]	[-3.02]	[-3.08]	[-1.47]	[-1.48]	[-1.48]
R&D	0.53	0.53	0.54	0.71	0.70	0.73
	[0.85]	[0.84]	[0.85]	[1.44]	[1.39]	[1.49]
Cash holdings	-0.02	-0.02	-0.02	-0.13	-0.13	-0.13
Debt	-0.05	-0.06	-0.05	0.03	0.03	0.03
	[-0.34]	[-0.38]	[-0.34]	[0.21]	[0.21]	[0.21]
Sales Growth	0.05	0.05	0.04	0.06	0.06	0.06
	[0.70]	[0.72]	[0.68]	[1.29]	[1.29]	[1.27]
ROA	0.18	0.18	0.18	0.14	0.14	0.14
	[0.83]	[0.82]	[0.83]	[0.71]	[0.70]	[0.70]
Tangibility	0.31	0.31	0.33	0.50	0.51	0.50
	[0.87]	[0.86]	[0.90]	[1.57]	[1.59]	[1.58]
Constant	1.62***	1.58***	1.61***	0.89**	0.87**	0.87**
	[3.06]	[3.04]	[3.04]	[2.20]	[2.15]	[2.16]
R-squared	0.073	0.073	0.072	0.039	0.038	0.038
R-squared Adjusted	0.062	0.063	0.061	0.034	0.034	0.034
Observations	2352	2352	2352	5967	5967	5967
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Table 7 – Additional Analysis: CEO incentives

	Direct Env. Cost (DEC)					
CEO LT incentive	-0.01	-0.01	0.00	-0.01	-0.01	-0.01
	[-0.38]	[-0.42]	[0.06]	[-0.51]	[-0.38]	[-0.27]
CEO Ownership	0.17	0.02	0.20	0.17	0.31	0.13
	[0.49]	[0.04]	[0.59]	[0.38]	[0.87]	[0.26]
CEO Horizon	-0.38**	-0.35**				
	[-2.51]	[-2.35]				
CEO Horizon # CEO LT incentive	0.05					
	[0.35]					
CEO Horizon # CEO Ownership		-0.93				
		[-0.35]				
CEO Horizon (Tenure)			-0.70***	-0.64**		
			[-2.69]	[-2.44]		
CEO Horizon (Tenure) # CEO LT incentive			0.36			
			[1.57]			
CEO Horizon (Tenure) # CEO Ownership				0.16		
				[0.04]		
CEO Horizon (Age)					-0.48*	-0.46*
					[-1.75]	[-1.72]
CEO Horizon (Age) # CEO LT incentive					-0.28	
					[-1.15]	
CEO Horizon (Age) # CEO Ownership						-3.52
						[-0.72]
R-squared	0.038	0.038	0.038	0.038	0.037	0.037
R-squared Adjusted	0.035	0.035	0.035	0.034	0.034	0.034
Observations	8319	8319	8319	8319	8319	8319
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Table 8 –Propensity-Score Matched- samples & Entropy Balanced-samples

	Direct Env. Cost (DEC)					
	Panel A *After PSM full sample*			*Panel B* *After PSM by year*		
CEO Horizon	-0.30** [-2.27]			-0.26** [-2.06]		
CEO Horizon (Tenure)		-0.69*** [-2.60]			-0.51** [-2.26]	
CEO Horizon (Age)			-0.41** [-2.04]			-0.30 [-1.56]
R-squared	0.777	0.783	0.783	0.794	0.797	0.791
R-squared Adjusted	0.724	0.734	0.737	0.745	0.751	0.746
Observations	5857	6145	6614	5821	6104	6568
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust S.E	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
	Panel C *After entropy balancing full sample*			*Panel D* *After entropy balancing by year*		
CEO Horizon	-0.24** [-2.25]			-0.28*** [-2.70]		
CEO Horizon (Tenure)		-0.48** [-2.28]			-0.64*** [-3.22]	
CEO Horizon (Age)			-0.36** [-2.05]			-0.32* [-1.84]
R-squared	0.769	0.776	0.763	0.771	0.778	0.773
R-squared Adjusted	0.731	0.740	0.724	0.734	0.741	0.735
Observations	8319	8319	8319	8319	8319	8319
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Robust S.E	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Table 9 – Multidimensional Fixed Effects (Year-industry & CEO fixed effects)

	Direct Env. Cost (DEC)		
CEO Horizon	-0.34***		
	[-2.65]		
CEO Horizon (Tenure)		-0.62***	
		[-2.73]	
CEO Horizon (Age)			-0.52**
			[-2.28]
CEO LT incentive	0.01	0.00	0.01
	[0.19]	[0.15]	[0.25]
CEO Ownership	0.29	0.25	0.41
	[0.79]	[0.69]	[1.10]
Female	-0.03	-0.04	-0.02
	[-0.40]	[-0.57]	[-0.37]
CEO Overconfidence	-0.03	-0.04	-0.03
	[-1.24]	[-1.24]	[-0.97]
CEO Pay-Slice (top5)	0.01	0.00	0.01
	[0.07]	[0.03]	[0.08]
Inst. Ownership	0.17	0.17	0.17
	[1.51]	[1.50]	[1.50]
Size	-0.13***	-0.13***	-0.13***
	[-2.90]	[-2.88]	[-2.89]
Capex	-1.07**	-1.08**	-1.07**
	[-2.52]	[-2.53]	[-2.51]
R&D	0.42	0.42	0.43
	[1.09]	[1.07]	[1.13]
Cash holdings	-0.10	-0.09	-0.10
	[-0.70]	[-0.69]	[-0.72]
Debt	0.08	0.08	0.08
	[0.58]	[0.57]	[0.57]
Sales Growth	0.08*	0.08*	0.08*
	[1.87]	[1.86]	[1.84]
ROA	0.03	0.03	0.03
	[0.23]	[0.25]	[0.21]
Tangibility	0.41	0.41	0.41
	[1.59]	[1.58]	[1.60]
Constant	0.94	0.89	0.96
	[1.39]	[1.32]	[1.42]
R-squared	0.444	0.444	0.444
R-squared Adjusted	0.313	0.313	0.313
Observations	8319	8319	8319
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Year-industry Fixed Effects	Yes	Yes	Yes
CEO Fixed effects	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes

Table 10 – Instrumental Variables design

First Stage

	CEO Horizon	**CEO Horizon (Tenure)**	**CEO Horizon (Age)**
CPI (Tenure)	0.00***	0.00***	
	13.96	34.02	
CPI (age)	0.01***		0.01***
	7.40		10.09
Controls	Yes	Yes	Yes

Second Stage

	Direct Env. Cost (DEC)		
CEO Horizon	-0.52**		
	[-2.31]		
CEO Horizon (Tenure)		-1.04***	
		[-2.64]	
CEO Horizon (Age)			-0.54
			[-1.39]
R-squared	0.027	0.026	0.027
R-squared Adjusted	-0.127	-0.128	-0.127
Observations	8285	8285	8285
Firm Fixed Effects	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Kleibergen-Paap Underid. test – chi2-stat.	160.02	129.01	113.88
Kleibergen-Paap Underid. test – chi2-stat. (p-value)	0.00	0.00	0.00
Cragg-Donald Weak Identification F-stat.	4731.21	9127.78	9182.06
Hansen J Overid. test stat.	1.784		
Hansen J Overid. test stat. (p-value)	0.182		

Table 11 – CEO Tenure larger than 3 years

	Direct Env. Cost (DEC)		
CEO Horizon	-0.48**		
	[-2.16]		
CEO Horizon (Tenure)		-0.63*	
		[-1.73]	
CEO Horizon (Age)			-0.92**
			[-2.20]
CEO LT incentive	-0.04	-0.04	-0.04
	[-1.32]	[-1.31]	[-1.26]
CEO Ownership	-0.12	-0.05	-0.04
	[-0.31]	[-0.15]	[-0.10]
Female	-0.02	-0.03	-0.02
	[-0.19]	[-0.27]	[-0.18]
CEO Overconfidence	-0.01	0.00	-0.00
	[-0.16]	[0.02]	[-0.02]
CEO Pay-Slice	-0.12	-0.12	-0.11
	[-1.02]	[-1.00]	[-0.98]
Inst. Ownership	0.09	0.08	0.09
	[0.59]	[0.55]	[0.60]
Size	-0.15***	-0.14***	-0.15***
	[-3.51]	[-3.41]	[-3.54]
Capex	-0.81*	-0.82*	-0.80*
	[-1.73]	[-1.75]	[-1.71]
R&D	1.00**	1.01**	1.00**
	[2.08]	[2.09]	[2.13]
Cash holdings	-0.04	-0.04	-0.04
	[-0.28]	[-0.27]	[-0.29]
Debt	0.08	0.08	0.08
	[0.64]	[0.61]	[0.64]
Sales Growth	0.06	0.06	0.06
	[1.53]	[1.50]	[1.52]
ROA	0.35**	0.35**	0.35**
	[2.08]	[2.06]	[2.10]
Tangibility	0.38	0.40	0.38
	[1.56]	[1.62]	[1.55]
Constant	1.06***	1.02***	1.06***
	[2.96]	[2.84]	[2.99]
R-squared	0.038	0.037	0.039
R-squared Adjusted	0.034	0.032	0.035
Observations	6298	6298	6298
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes

Table 12 – First difference model

	Direct Env. Cost (DEC)		
D.CEO Horizon	-0.25***		
	[-2.72]		
D.CEO Horizon (Tenure)		-0.48***	
		[-3.10]	
D.CEO Horizon (Age)			-0.30*
			[-1.80]
D.CEO LT incentive	0.03	0.03	0.04*
	[1.44]	[1.38]	[1.70]
D.CEO Ownership	-0.29	-0.35	-0.14
	[-0.99]	[-1.26]	[-0.47]
D.Female	0.00	-0.00	0.00
	[0.08]	[-0.12]	[0.04]
D.CEO Overconfidence	-0.06***	-0.06***	-0.06***
	[-3.22]	[-3.34]	[-2.96]
D.CEO Pay-Slice	0.01	0.01	0.02
	[0.27]	[0.25]	[0.41]
D.Inst. Ownership	-0.12	-0.12	-0.08
	[-1.49]	[-1.48]	[-0.98]
D.Size	0.11***	0.11***	0.13***
	[2.80]	[2.80]	[2.91]
D.Capex	-0.38	-0.39	-0.46
	[-1.29]	[-1.29]	[-1.45]
D.R&D	0.06	0.05	0.13
	[0.23]	[0.19]	[0.45]
D.Cash holdings	-0.03	-0.03	-0.04
	[-0.30]	[-0.31]	[-0.40]
D.Debt	0.15*	0.14*	0.15*
	[1.67]	[1.66]	[1.66]
D.Sales Growth	0.00	0.00	-0.00
	[0.06]	[0.07]	[-0.02]
D.ROA	-0.12	-0.12	-0.11
	[-1.54]	[-1.55]	[-1.37]
D.Tangibility	0.09	0.10	0.10
	[0.43]	[0.44]	[0.47]
Constant	0.05	0.05	0.04
	[1.24]	[1.27]	[0.94]
R-squared	0.015	0.015	0.016
R-squared Adjusted	0.011	0.012	0.012
Observations	6953	6953	6978
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes

Table 13 – Additional Analysis: splitting by the level of environmental materiality

	Direct Env. Cost (DEC)					
	Low Mat.	**High Mat.**	**Low Mat.**	**High Mat.**	**Low Mat.**	**High Mat.**
CEO Horizon	-0.28	-0.53**				
	[-1.45]	[-2.42]				
CEO Horizon (Tenure)			-0.52	-0.84**		
			[-1.51]	[-2.36]		
CEO Horizon (Age)					-0.35	-0.87**
					[-1.04]	[-2.05]
CEO LT incentive	-0.02	-0.01	-0.02	-0.01	-0.02	0.00
	[-0.57]	[-0.10]	[-0.61]	[-0.11]	[-0.52]	[0.01]
CEO Ownership	0.09	0.21	0.07	0.21	0.25	0.37
	[0.21]	[0.41]	[0.18]	[0.42]	[0.53]	[0.75]
Female	-0.14	0.18**	-0.15*	0.17**	-0.15	0.19**
	[-1.60]	[2.21]	[-1.67]	[2.08]	[-1.64]	[2.25]
CEO Overconfidence	0.01	-0.08*	0.01	-0.07	0.02	-0.07
	[0.38]	[-1.73]	[0.28]	[-1.62]	[0.75]	[-1.52]
CEO Pay-Slice	-0.00	0.09	-0.00	0.08	0.00	0.11
	[-0.00]	[0.68]	[-0.03]	[0.63]	[0.02]	[0.84]
Inst. Ownership	-0.02	0.09	-0.03	0.08	-0.02	0.09
	[-0.16]	[0.50]	[-0.18]	[0.46]	[-0.13]	[0.50]
Size	-0.13***	-0.10	-0.13***	-0.09	-0.13***	-0.10
	[-2.86]	[-1.55]	[-2.81]	[-1.51]	[-2.83]	[-1.56]
Capex	-0.78	-1.09**	-0.79	-1.11***	-0.79	-1.09**
	[-0.93]	[-2.56]	[-0.94]	[-2.59]	[-0.95]	[-2.54]
R&D	0.69*	1.60	0.68*	1.67	0.71*	1.52
	[1.80]	[1.51]	[1.74]	[1.57]	[1.87]	[1.43]
Cash holdings	-0.07	-0.07	-0.07	-0.06	-0.07	-0.07
	[-0.41]	[-0.32]	[-0.40]	[-0.29]	[-0.43]	[-0.33]
Debt	-0.23*	0.33*	-0.23*	0.33*	-0.23*	0.33*
	[-1.89]	[1.86]	[-1.89]	[1.81]	[-1.91]	[1.90]
Sales Growth	0.03	0.10*	0.03	0.10*	0.03	0.10*
	[0.51]	[1.76]	[0.53]	[1.77]	[0.48]	[1.74]
ROA	0.21	0.00	0.21	0.01	0.22	-0.01
	[1.11]	[0.01]	[1.08]	[0.03]	[1.11]	[-0.04]
Tangibility	0.77**	0.18	0.78**	0.18	0.78**	0.19
	[1.98]	[0.63]	[2.00]	[0.63]	[2.00]	[0.67]
Constant	0.94**	0.71	0.92**	0.69	0.91**	0.69
	[2.47]	[1.32]	[2.41]	[1.28]	[2.43]	[1.29]
R-squared	0.065	0.035	0.065	0.034	0.064	0.034
R-squared Adjusted	0.059	0.027	0.059	0.026	0.058	0.026
Observations	4645	3674	4645	3674	4645	3674
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes	Yes	Yes	Yes

Table 14 – Additional Analysis: Institutional ownership

	Direct Env. Cost (DEC)			
Ownership proxy =	*Inst. Ownership*	*LT Horizon Ownership*	*High EPI Countries Ownership*	*PRI Signatories Ownership*
CEO Horizon	-1.19**	-0.74**	-1.17**	-0.31*
	[-2.19]	[-2.39]	[-2.15]	[-1.65]
Ownership	0.01	0.14	0.00	-0.09
	[0.09]	[0.81]	[0.03]	[-0.37]
CEO Horizon # Ownership	0.99	1.21	0.98	-0.69
	[1.59]	[1.44]	[1.55]	[-0.59]
CEO LT incentive	-0.01	-0.01	-0.01	-0.01
	[-0.50]	[-0.43]	[-0.50]	[-0.47]
CEO Ownership	0.02	0.08	0.02	0.19
	[0.06]	[0.23]	[0.07]	[0.56]
Female	-0.03	-0.02	-0.03	-0.02
	[-0.38]	[-0.36]	[-0.38]	[-0.28]
CEO Overconfidence	-0.02	-0.02	-0.02	-0.02
	[-0.61]	[-0.64]	[-0.61]	[-0.71]
CEO Pay-Slice	0.02	0.02	0.02	0.03
	[0.29]	[0.28]	[0.28]	[0.35]
Size	-0.13***	-0.13***	-0.13***	-0.13***
	[-3.55]	[-3.56]	[-3.55]	[-3.54]
Capex	-0.98**	-0.98**	-0.98**	-0.99**
	[-2.41]	[-2.37]	[-2.41]	[-2.39]
R&D	0.66*	0.66*	0.66*	0.67*
	[1.80]	[1.78]	[1.80]	[1.80]
Cash holdings	-0.05	-0.06	-0.05	-0.05
	[-0.36]	[-0.43]	[-0.36]	[-0.33]
Debt	-0.00	0.00	-0.00	-0.00
	[-0.01]	[0.02]	[-0.01]	[-0.04]
Sales Growth	0.06	0.06	0.06	0.06
	[1.51]	[1.60]	[1.51]	[1.54]
ROA	0.14	0.13	0.14	0.14
	[0.94]	[0.92]	[0.94]	[0.97]
Tangibility	0.45*	0.45*	0.45*	0.45*
	[1.83]	[1.82]	[1.82]	[1.83]
Constant	0.96***	0.94***	0.97***	0.97***
	[3.06]	[2.98]	[3.07]	[3.08]
R-squared	0.039	0.039	0.039	0.038
R-squared Adjusted	0.035	0.035	0.035	0.035
Observations	8319	8319	8319	8319
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes	Yes

Table 15 – Additional Analysis: Outcomes of CER

	Tobin's Q	Tobin's Q	ROA	ROA
CEO Horizon	0.19**	0.19**	0.04	0.04
	[2.14]	[2.08]	[0.77]	[0.70]
Direct Env. Cost (DEC)	0.04**	0.04**		
	[2.28]	[2.25]		
CEO Horizon # Direct Env. Cost (DEC)		0.02		
		[0.30]		
Direct Env. Cost (DEC)			0.01	0.01
			[0.77]	[0.81]
CEO Horizon # Direct Env. Cost (DEC)				0.02
				[0.43]
CEO LT incentive	-0.03	-0.03	0.01	0.01
	[-1.05]	[-1.05]	[0.32]	[0.31]
CEO Ownership	0.68*	0.69*	0.19	0.20
	[1.81]	[1.83]	[0.93]	[0.95]
Female	0.07	0.07	0.00	0.00
	[1.27]	[1.29]	[0.01]	[0.03]
CEO Overconfidence	0.05**	0.05**	0.03**	0.03**
	[2.39]	[2.38]	[2.31]	[2.30]
CEO Pay-Slice	0.05	0.05	0.04	0.04
	[0.81]	[0.79]	[1.01]	[0.99]
Inst. Ownership	-0.01	-0.01	-0.18***	-0.18***
	[-0.11]	[-0.11]	[-3.00]	[-2.99]
Size	-0.09***	-0.09***	-0.10***	-0.10***
	[-3.47]	[-3.48]	[-4.78]	[-4.78]
Capex	-0.26	-0.26	0.16	0.16
	[-0.87]	[-0.86]	[0.93]	[0.93]
R&D	0.02	0.02	0.01	0.02
	[0.08]	[0.10]	[0.08]	[0.10]
Cash holdings	0.30***	0.30***	0.07	0.07
	[2.72]	[2.72]	[1.31]	[1.31]
Debt	-0.01	-0.01	0.02	0.02
	[-0.18]	[-0.18]	[0.27]	[0.27]
Sales Growth	0.05	0.05	0.02	0.01
	[1.54]	[1.54]	[0.81]	[0.79]
ROA	0.22*	0.22**	0.23***	0.23***
	[1.96]	[2.01]	[3.13]	[3.16]
Tangibility	0.11	0.11	-0.21	-0.21
	[0.50]	[0.50]	[-1.48]	[-1.48]
Constant	0.49*	0.49*	1.08***	1.08***
	[1.91]	[1.92]	[5.59]	[5.59]
R-squared	0.028	0.028	0.031	0.032
R-squared Adjusted	0.024	0.024	0.028	0.028
Observations	7234	7234	7688	7688
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
S.E. clustered at firm-level	Yes	Yes	Yes	Yes

APPENDIX

Variable	Description	Source
Independent variables		
CEO Horizon	CEO Horizon is defined as: = $(Tenure_{ind,t} - Tenure_{i,t}) + (Age_{ind,t} - Age_{i,t})$	ExecuComp
CEO Horizon (Tenure)	CEO Horizon (tenure) is defined as: $(Tenure_{ind,t} - Tenure_{i,t})$	ExecuComp
CEO Horizon (Age)	CEO horizon (age) is defined as: $(Age_{ind,t} - Age_{i,t})$	ExecuComp
Dependent Variable		
Environmental Costs	There are six different areas of costs: 1) air pollutants, 2) greenhouse gases (GHGs), 3) land and water pollutants, 4) natural resource use, 5) waste, and 6) water. The *Direct Costs* (DEC) are an estimate of the direct impact that the operations of a company have on the environment. The *Indirect Costs* are an estimate of a company's impact on the environment through its supply chain and customer-base. The *Total Costs* (TEC) are the sum of the *Direct Costs* and *Indirect Costs*.	Trucost
Control variables		
CEO Characteristics		
CEO Long-term Incentive	The sum of unexercised exercisable (opt_unex_exer_num), unexercised unexercisable options (opt_unex_unexer_num), and restricted stock holdings (stock_unvest_num) over total compensation (tdc1)	ExecuComp
CEO Ownership	The percentage of total shares owned by the CEO (shrown_tot_pct)	ExecuComp
Female	Dummy marking 1 for female CEOs, and 0 for male CEOs.	ExecuComp
CEO Overconfidence	First, we calculated the average realizable value per option by dividing the estimated value of in-the-money unexercised exercisable options the CEO has (opt_unex_exer_est_val) by the number of options held by the CEO (opt_unex_exer_num). Then, we subtract the average realizable value per option from the fiscal year-end stock price (prcc_f). Finally, we created a dummy marking the first year where the options held by the CEO are at least 67% in-the-money.	ExecuComp
CEO Pay-Slice	The fraction of the CEO total compensation (tdc1) to the top 5 executives' total compensation $(\frac{\text{CEO Pay}}{\text{Top 5 total Pay}})$	ExecuComp

Financials		
Institutional Ownership	The proportion of holdings held by institutional investors.	Thomson-Reuters
Size	The natural logarithm of firm's total assets (at)	Compustat
Capex	The ratio of capital expenditures (capx) over total assets (at).	Compustat
R&D	The ratio of Research & Development expenses (rdx) over total assets (at).	Compustat
Cash holdings	The ratio of cash and equivalents of cash (che) over total assets (at).	Compustat
Debt	The ratio of total debt (dltt + dlc) over total assets (at).	Compustat
Sales growth	The annual change in sales (revt) over lagged total assets (at).	Compustat
ROA	The ratio of net income (ni) over total assets (at).	Compustat
Tangibility	The ratio of net total property, plant and equipment (ppent) over total assets (at)	Compustat